

Topographic Changes of the Beach at Valiathura, Kerala

C S MURTY & V V R VARADACHARI

National Institute of Oceanography, Dona Paula, Goa 403 004

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Studies on the topography of the beach and the inshore reaches at Valiathura, near Trivandrum reveal that the beach is in a stable equilibrium and presents well defined cyclicity in accretion and erosion every year. During 1 year, the beach experiences a phase of major erosion closely associated with the monsoonal wind and wave climates and a secondary phase of minor erosion under the impact of northeast monsoon. The sediments eroded during the period of primary erosion move considerably offshore resulting in shallowing up of the inshore reaches while they are subjected to alongshore flows during the period of minor erosion. The nature of the prevailing environmental factors and the physical processes that lead to these topographic changes have been discussed.

Along the west coast of India, beaches of different types exist. The composition of the beach materials varies significantly from region to region and also with time. Over most of the west coast region, the rainfall during the southwest monsoon averages to about 300 cm. The existing river systems when flooded transport the detritus from the coastal low lands and supply it to the nearshore regions. These discharges take place along the coast of Kerala through the lagoon systems which behave like filters to the sediments that are otherwise available directly to the nearshore regions. However, on the extreme southern reaches off Kerala, no outfalls exist except for minor discharges through creeks. The bay-side beaches on the northern coast are relatively stable while the barrier beaches of Kerala are migratory in nature and are known to experience erosion during some years¹. Studies on the variations in the topography of the beach and the inshore regions at a location on the southernmost part of the Kerala coast are presented here.

Description of study area—The study area, a straight beach comprising sandy sediments in medium size class, is about 6 km north of Kovalam Pt. (Fig. 1). The beach has a backshore width of nearly 25 m with moderately sloping offshore bathymetry. The nearshore bathymetry shows even topographic features. In the nearshore regions, the sediments are mostly sands and extend over the shelf. In the vicinity, a small stream joins the sea and to some extent supplies sediments to the adjoining beach zone.

This region experiences tides in the micro-tidal range (< 1 m). Winds at this location during the southwest monsoon season have northerly components. The local air circulation comprising the land and sea breeze system is fairly well developed with wind

speeds of 6 to 8 m/sec during the noon hours. Swell waves approach the shore between 158 and 330°N.

In general, by about March/April, the beach presents fully developed status indicating maximum sediment storage. Under the influence of monsoonal wave climate it experiences erosion resulting in a transient recession of the shoreline (30 to 35 m). As the beach experiences erosion, the foreshore attains gentle slopes and the sediment storage capacity becomes minimum.

Methods

The beach and the immediate inshore regions at Valiathura were surveyed at monthly intervals from a 230 m long pier. The data collected using a lead line

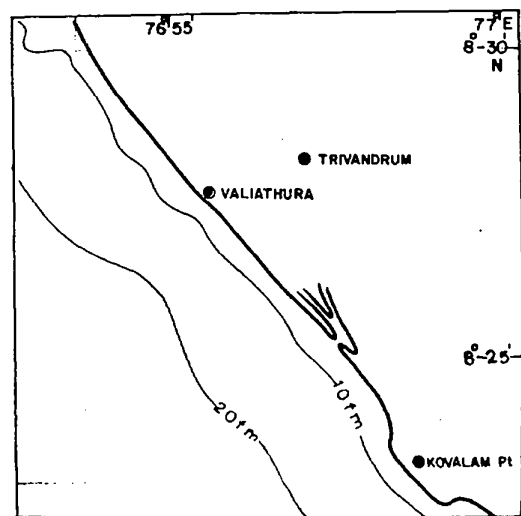


Fig. 1—Location map

were reduced to mean low water level. The accretion and erosion as noticed from the observed elevations above and below the mean low water are presented in Fig. 2.

Results

Profile measurements were started when the beach was fully grown (profile of June 1967, Fig. 2) as seen from the well developed berm crest situated around 70 m from the reference point. The foreshore was relatively steep while the inshore reaches, up to 30 m from the mean low water mark, had gentle slopes. From 130 to 190 m, the sea bottom showed an increase in slope beyond which the gradient reversed. Within a month of the commencement of these surveys, the berm crest was totally eroded and the beach face presented moderate slopes. In the inshore regions, ridge and

runnel patterns were clearly noticeable. The sediment deposit beyond 150 m contributed to shallowing up of the nearshore zone by as much as 2.5 m. By September, the beach was found to experience accretion. This material deposit gradually migrated from inshore regions to lower foreshore and further up the beach-face. The berm crest development by November and its subsequent erosion to a minor degree was compensated by the relatively lower rates of deposition which continued up to April. The erosion on the beach face during November and December coincided with the northeast monsoon.

Discussion

The morphological changes of the beach at Valiathura are mainly due to changes in turbulent diffusion, advection, etc. related to the prevailing wave climate.

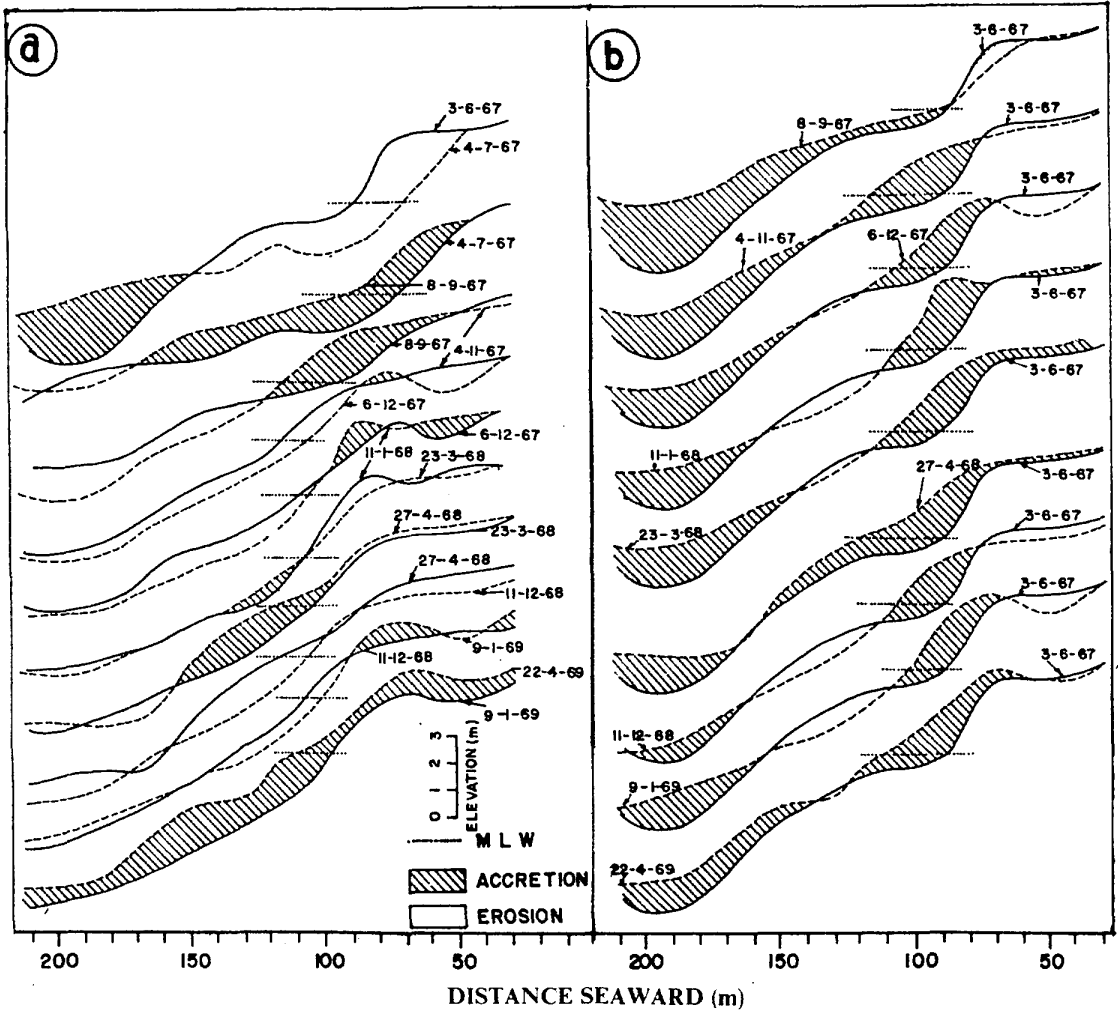


Fig. 2—Typical beach profiles at Valiathura showing (a) erosion and accretion during the interval between 2 consecutive observations; and (b) nature of cyclic changes with reference to June 1967 profile

The winds over the Arabian Sea undergo seasonal changes. Associated with these, the wave field also changes. Prior to the commencement of the monsoonal rains, the wind field shows an increase in constancy of direction and magnitude. The winds blow along the coast from directions varying between NW and W. These winds generate waves which propagate shoreward. In addition swell waves from directions ranging from WSW and SW due to storm winds in the western part of the Arabian Sea also approach the shore. Occasionally swell waves, with periods of the order of 20 sec from the south Indian Ocean also approach these shores, associated with the weather disturbances. Under the influence of the strong and steady winds, around May/June the heights of the waves approaching the shoreline are increased. Consequently, the steepness of the incoming waves increases and it contributes to an increase in wave set up in the beach zone. By this time, the beach is in a fully developed state with a well grown berm crest (June profile, Fig. 2). As the monsoon progresses, local seas are generated, under the influence of the steady and strong onshore winds. These locally generated sea waves interact with the swell waves coming from long distances in the Indian Ocean, resulting in short crested wave activity. Due to the increased wave set up on the beach face, the run up on the beach face increases. The waves break as plunging breakers. The asymmetric nature of the short crested waves increases the backwash over the steep foreshore. As a result the sediments from the saturated beach zone are carried by the backwash leading to erosion. Due to the near normal direction of the approach of these waves during this monsoon period, the littoral currents generated in the surf zone present weak alongshore components. The sediments removed from the beach would get transported by the relatively strong offshore flows. These offshore moving sediments are likely to get deposited in the inshore regions, as they encounter the incoming waves leading to a shallowing up of the surf zone. In the present study, the shallowing up feature is about 2.5 m. Similar features are reported along the Scripps Pier, USA². The littoral currents associated with wave refraction³ have weak alongshore components when the direction of approach of the deep water waves is from WSW and SW. As a result of the beach erosion the beach face becomes flat and the width of the surf zone increases. The increased width of the surf zone alters the type of wave breaking from plunging to spilling. This helps in the distribution of incoming wave energy over a wider surf zone in contrast with the restricted zone of wave energy dissipation owing to the plunging type of breaking occurring prior to and during the initial stages of beach erosion. In July, the wave heights in this area exceed 3m

and these waves would break at depths of about 4 m. Landward of this, multiple breaking occurring in 5 to 6 rows, helps in the dissipation of wave energy over 150m wide surf zone. In the inshore reaches, the multiple breaking contributes to developments of ridge and runnel bottom topography. These physical processes give rise to changes in the sedimentary deposits on the beach and the resistance of the beach zone increases by about July/August. This increase in beach resistance and decrease in wave energy at the shoreward reach brings about considerable reduction in changes in the beach topography, although the beach passes through a state of erosion. Thus the monsoonal wave climate gives rise to erosion of the beach initially at a rapid rate which is reduced later.

By about September, the beach presents accretionary conditions under the influence of low and long period swell waves. This tendency continues till November. During November and December the northeast monsoon winds generate waves moving offshore. The interaction of these offshore moving waves with the incoming swell waves contributes to short crested waves, which move shoreward and undergo refraction. This results in an increase in the heights of waves and consequently their steepness. Under the influence of this wave activity, the beach experiences erosion. The relatively lower magnitude of the incident wave energy compared to that during the southwest monsoon and the alongshore flows due to the breaking of the waves at an angle to the shoreline lead to erosion of a lower magnitude and extent on the beachface. Vertical cut on the beachface prevails all along the coast during this period. The sediments eroded get transported alongshore though some material deposits can be seen in the inshore reaches. From January/February, the low and long period swell waves are free from offshore moving local seas and the resulting interactions and thus they contribute to deposition of sediments on the beachface. During this period, the beach material moves from the lower reaches to the upper reaches. The berm crest develops followed by steep foreshore. This accretion continues at a slow rate till the southwest monsoonal wave climate gives rise to changes in the processes of sedimentation.

Thus, the studies reveal a well-defined cyclicality in accretion and erosion on the beach closely associated with the seasonal changes in the meteorological and oceanographic conditions of the area.

The long pier at Valiathura has enabled a detailed study and documentation of the fact that the sediments eroded from the beachface during the monsoon months would get transported to the adjoining inshore zone by the predominant offshore flows. The development of these offshore flows is mainly due to

the approach of the waves nearly normal to the shoreline during May to August. The normal approach of waves gives rise to several closed circulation cells in the surf zone and the eroded sediments from the beach get caught in the cells and get transported offshore. Similar features have been reported also along the coast of Louisiana⁴.

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References

- 1 Murty C S, *Studies on the physical aspects of shoreline dynamics at some selected places along the west coast of India*, Ph D Thesis submitted to the University of Kerala, 1977.
- 2 Shepard F P & LaFond E C, *Am J Sci*, **238** (1940) 277.
- 3 Reddy M P M & Varadachari V V R, *J Indian Geophys Un.* **10** (1972) 169.
- 4 Sonu C J, *J Geol*, **81** (1973) 42.