Comparative evaluation of erosion accretion criteria for a tropical beach

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Beach processes along the Neendakara-Kayamkulam sector on the coast of Kerala related to the offshore waves and local wind conditions are investigated. This study is based on the field observations made during March 2012 to March 2013, which indicates that a major portion of the beach is dynamically stable except for a few hot spot locations, wherein, the natural balance or equilibrium has been disturbed due to excessive mining or introduction of hard structures as a part of harbour development activities or shore protection measures. It is also observed that the condition of some of the areas which were under heavy erosion during the last decade has improved considerably or remained more or less stable in recent past probably due to the protection measures adopted.

[Keywords: Accretion, Erosion, Littoral, Waves]

Introduction

The Neendakara-Kayamkulam coastal stretch (Fig. 1) is part of an open coast barrier beach sandwiched between the Arabian Sea on the west, the Travancore-Shoranur (T.S.) canal on the east and the Neendakara and Kayamkulam inlets on the southern and northern boundaries respectively. During the period 1968-1989 and 1989-2006 this was an eroding coast. It was also during this period that two long breakwaters were constructed at the Neendakara and Kayamkulam inlets in connection with the development of fishing harbours. However, during the period 2006-2010, the situation gradually improved but the hot spot locations such as the mining sites continued to be the worst affected areas with higher rates of erosion.

The present study is an attempt to study the stability of the beach along the Neendakara-Kayamkulam coastal stretch in the present condition with reference to the coastal wind, offshore waves and beach processes at work in this region. The study is based on the field data collected for a period of one year from March 2012 –March 2013. The study area is a 22 km long coastal stretch extending between the Kayamkulam inlet in the north and Neendakara inlet in the south.

Data Collection

The field data includes offshore wave data, coastal wind data, and the shoreline and beach profile data collected at regular intervals. The offshore wave data is from a Wave Rider Buoy that was deployed in 22 m water depth at a distance of 9 km off the Ponmana coast located in the central region of the study area.

For the present study, the data collected for a period of 4 months from May 2012-Sept 2012 have been used. The wind data for the period is the data collected using an Automatic Weather Station installed close to the beach at the same location.
(Ponmana). Shoreline survey and beach profiling at pre-defined locations along the beach were conducted at regular intervals. The locations were judiciously selected in such a way that the entire study area, which is composed of natural beaches, beaches under the influence of anthropogenic activities such as mining, construction of hard structures etc. were represented well.

**Waves**

The mean values of the offshore wave parameters during the period May-September 2012 are presented in Table 1. The maximum Hs value around 2 m is during the months of June and July. The wave direction is predominantly in the SSW direction during the pre-monsoon month of May and is dominated by the presence of long period swell waves. However, during the peak monsoon months of June and July, the waves are predominantly from the WSW direction and the wave heights are maximum, with the significant wave height, Hs about 2 m. Maximum wave steepness is also witnessed during this period. The wave heights are comparatively less during the monsoon months of August and September. During this period an increase in peak wave period is also observed thereby indicating the dominance of swell waves.

**Wind**

During the months of May and June the coastal winds (Fig. 2) are predominantly in the WSW direction, whereas, it is mostly in the SSW direction during June-July. It is also observed that the wind speed is relatively high during June-Sept with the maximum values being recorded in July and September. A maximum value of 11.6 m/s has been recorded. A diurnal variation in wind speed and direction is also noticed. This data will be useful in understanding the sediment transport in the surf zone region.

**Beach profiling and shoreline survey**

Shoreline variations along the coast were studied by closely monitoring the beach for a period of one year (March 2012-March 2013). Beach profiling was carried out at 4 pre-defined locations (BP-11-14) as indicated in Fig. 3 during the months of March, July, October, November, December, January and March. It was observed that at almost all the locations except the mining sites, the beach started building up by October and regained its original width by December - January. The beach profile variations at the monitoring locations for a period of one year are presented in Figs.4-7. The station immediately to the south of the Kayamkulam inlet showed a drastic increase in beach width of nearly 150 m (Figs. 4 and 8). This is evident due to the presence of a long breakwater arm trapping the northerly littoral transport that dominates during the post-monsoon season.

![Fig. 2—Plot of offshore wave and coastal wind data during May-September 2012](image-url)
Further south a few kilometres away from the breakwater as can be seen in Figs. 5 and 9, increase in the beach width during the fair season is only 15-20 m which is typical of an open beach. The profile stations in the central part of the study area are located very close to the mining areas and its impact is clearly visible in the beach profile and shoreline surveys from Figs 6-9. There is hardly any beach during the monsoon season, June-Sept. From October onwards, the beach building process commences but is not able to sustain for long, probably, because of the high mining rates soon after the monsoon period. The beach profile variation for the location near the Vellanathuruthu mining site which shows considerable oscillations even during the fair season can be related to the mining activity that is at its peak during the fair season. Hence the profile variation cannot be considered as an equilibrium profile.

Apart from this, the seasonal shoreline variation along a stretch of the study area protected by short groins was also studied.
Fig. 6—Beach profiles taken near to Vellanathuruthu mining site (BP-12)

Fig. 7—Beach profiles taken to the south of Kovilthottam mining site (BP-11)

Fig. 8—Shoreline variation for a 1km stretch to the south of Kayamkulam inlet

Fig. 9—Shoreline variation for the 2-3 km stretch south of Kayamkulam inlet
The one year shoreline variation in the presence of shore connected structures like combination of groin field (consisting of 4 groins each of 40 m length) and seawall is presented in Fig. 10. A beach built up of the order of 25-40 m is observed between the groins during the fair season of October-March. However, a closer examination of the shoreline variations for one year period indicates that the structures were not able to retain the beach during the monsoon season. This probably could be the high rate of offshore transport which dominates during the monsoon.

The shoreline change and beach profile data recorded at the observation stations were further analysed to find a relation between the offshore wave data and cross-shore volume change during different seasons. A detailed analysis of the data showed that the field observations were in tune with the predictive criteria for erosion/accretion.

Conclusions

From the study, it can be inferred that the general condition of the coastal stretch from Neendakara to Kayamkulam has improved compared to that in the previous decades. But there are certain erosion hot spots which are badly affected and this can be directly linked to anthropogenic activities in which excessive mining plays the lead role. The impact due to construction of breakwaters has significantly reduced over the years probably due to a readjustment of the shoreline in order to attain a new stable equilibrium configuration. A relationship between offshore waves, coastal wind and beach processes could be established. The field observations were in tune with the predictive criteria for erosion/accretion.

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