

Shoreline changes of Kerala coast using IRS data and aerial photographs

S P Sreekala, M Baba & M Muralikrishna

Centre for Earth Science Studies, Trivandrum 695 031, India

Received 26 May 1997, revised 17 December 1997

Long-term erosional/accretional trend along Kerala coast is studied using satellite imageries and aerial photographs for the year 1990 and the survey of India topographic maps of 1967. Based on this study the sectors undergoing erosion/accretion are identified. It is found that 148 km of the Kerala coast (including some areas protected by sea walls) is eroding and 304 km coast is accreting. Thirty kilometer of the coast comes under high erosion category. Twenty one kilometer of coast recorded high rate of accretion.

Long-term variations of beach processes are to be studied to identify locations which require permanent protection and management interventions. The remote sensing techniques are extensively used for studying coastal dynamics. The long-term trend of shoreline changes can be studied within a short period of time using remote sensing data. In this study visual interpretation of the long-term trend of erosion or accretion of beaches of Kerala are analysed using the IRS-1A geo-coded imageries of 1990, aerial photographs of 1989-91 and the Survey of India topographic maps of 1967.

Materials and Methods

The topographic map and the imagery used are in 1:50,000 scale. The land-water boundary of the imagery and the LWL of the topographic maps are compared to study the long-term trend of beaches. The vegetation line of the imagery and the high water line in toposheets are also compared. In the case of imagery, the FCC available [IRS-1A, 1990] are used for demarcating the land-water boundary (LWL) and the vegetation line (HWL). The measurement of HWL and LWL from control points are taken into an accuracy of 12.5 m in the field. These distances are measured at approximately half a kilometer interval along the entire Kerala coast. It is found that there is a scale distortion in the IRS imagery when compared with the topographic maps. Corrections are applied in this case to the imagery data considering topographic sheet as the base map. The change in

LWL and HWL are found for a period of 23 years (1967-1990). These values are plotted in Fig.1 with respect to stretches of beaches from south to north. The accretion/erosion values are graded into high, moderate and low. The shoreline sectors with up to 100 m change are taken as 'low' between 100 m and 200 m are considered as 'moderate' and above 200 m as 'high' erosion/accretion zones.

Selected areas are checked with the aerial photographs of 1989-91. Shoreline, which forms a transition between land and sea provides a complex system of brightness variation. High brightness values are registered for dry sands, medium for wet sand and low for water and vegetation. This helps in demarcating the dynamic features to a great amount of accuracy. While using aerial photographs, the scale correction, however, is found to be a difficult procedure. In the present study the actual scale of aerial photograph is measured by using its central portion to avoid peripheral distortion and the average of different values are calculated to find the correct scale. It is then reduced to the scale of the base map for the comparison. For confirmation of the results obtained, they are compared with field studies reported previously.

Results and Discussion

The classification of the coastal sectors as low, moderate and high erosion/accretion areas and their alongshore distances are depicted in Fig.2. Stable beaches are represented by a line. The stability is often found to be due to the construction of shore

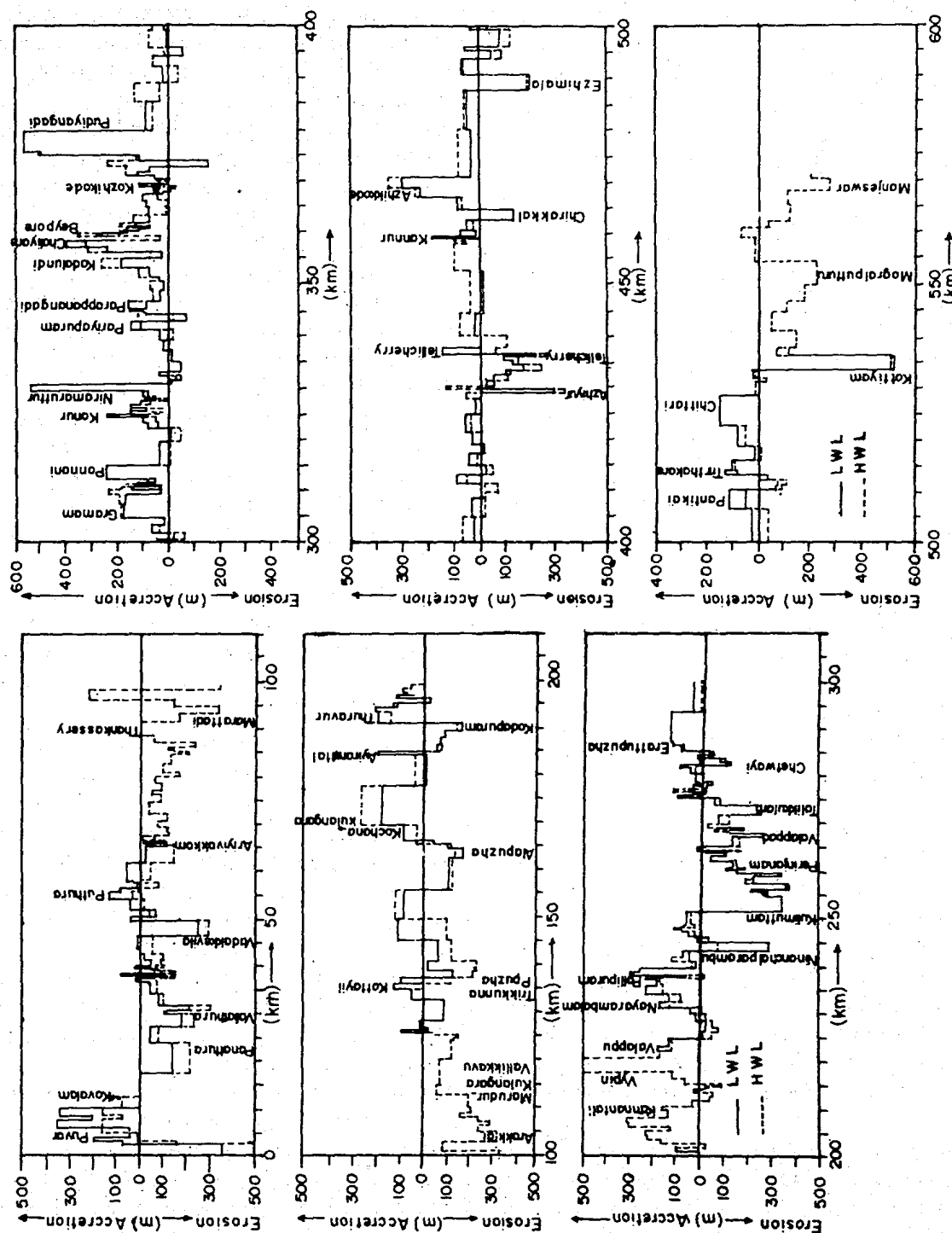


Fig. 1—Erosional/accretional trends of Kerala coast

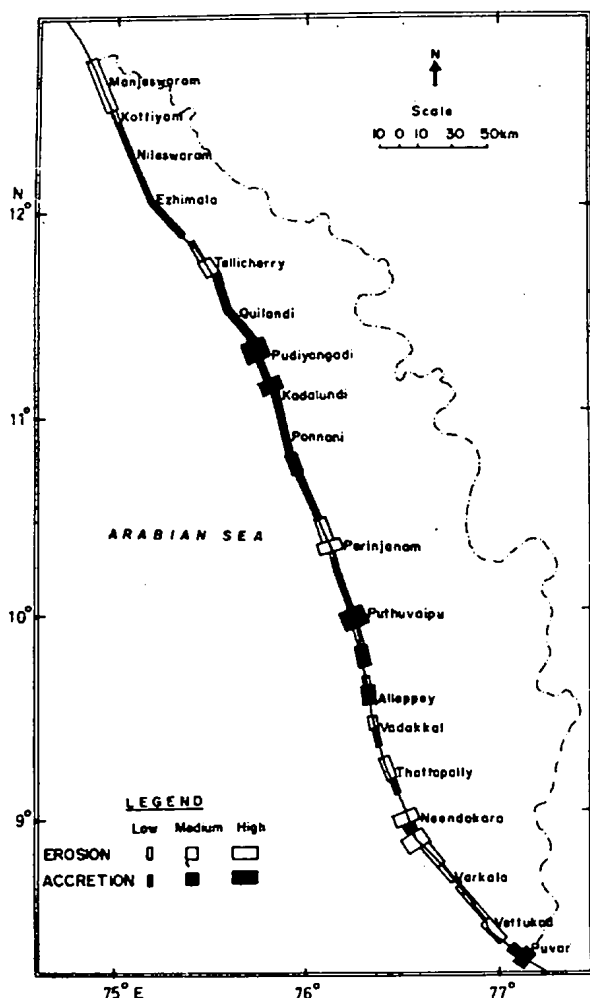


Fig. 2—Categorisation of erosion/accretion along Kerala coast

protection structures or due to the presence of rocky shores. As a whole 148 km of the coast is eroding and 304 km is accreting. In both the categories there are seawall areas, which have a total of 347 km.

Out of the eroding areas only 30 km come under severe erosion category and 68 km are under moderate erosion. Only these areas may require structural protection. The low erosion stretch of 50 km may require only soft protection, except in places where important installation/property is involved.

Among the accretion sites 21.3 km record high rates. The 238.9 km length identified as low accretion include those areas, which undergo seasonal erosion. These areas may also sometimes record net low erosion in an yearly cycle as evident from the analysis provided below. These areas require only sound management strategies so as to

avoid negative anthropogenic influences on the sediment budget.

In Puvar area, low accretion along a stretch of 4.9 km is observed and a high accretion stretch of 3.3 km is found in the Karumkulam-Pulinkudi sector. The Kovalam, Vizhinjam and Mulloor-Pulinkudi promontories protect this section from the monsoonal waves and the littoral drift causes accretion particularly in the southern sector. Because of the presence of headland, Kovalam beach is found to be in an equilibrium state.

A stretch between Panathura and Sankumukham (8.3 km) is found to be under moderate erosion. In spite of the presence of two backwater systems in this stretch, the erosion is moderate probably due to the wider beaches (hence, large sediment buffer) and low backshore relief.

The sector Sankumukham to Puthantura (13.1 km) recorded low erosion. A 5.1 km stretch high erosion from Puthantura to Vadakkevela and 11.9 km stretch of low erosion from Ariyivakkom to Pozhikkara sector are noticed. Between the above stretches a 4.9 km low accretion sector in the Vatathuruthu-Anjengo is also found in this study. Previous study¹ indicated a uniform erosion north of Trivandrum coast between Kollam and Trivandrum.

In Kollam district it is found that 7.2 km stretch from Thanni to Pallithottam is under moderate erosion, 2.8 km from Pallithottam to Jonakapuram under low erosion and a 3.2 km sector from Thirumullavaram to Marattadi is under high erosion. Sakthikulangara to Azhikkal is a high accretion area along a stretch of 1.6 km under the influence of Neendakara breakwater and Puttanthura-Kallumudu, where the placer mining area of Chavara-Alappad is situated, is found to be a high erosion sector along 10.9 km. Also it is found that Kallumudu-Vallikkavu, a 6.1 km is under low erosion and from Vallikkavu to Perumpallitura is under moderate erosion.

In Alleppey district the sector from Ramancheritira to Kottayil of length 10.4 km is found to be under low accretion. This study indicates that towards south of Purakkad from Thrikkunnappuzha to Thottappally, a zone of 4.3 km is under moderate erosion. Murthy & Veerayya² observed a prograding beach at Nirkunnam, a place located midway between Purakkad and Punnappra, whereas the beaches at Purakkad and Punnappra

undergo erosion³. A stretch of 12.3 km from Purakkad to Vadakkal (north of Punnapra) undergoes low accretion. Murty *et al.*⁴ show that this accretion in Punnapra is the result of mudbank formation. From Vadakkal to Thumboli, there is a moderate erosion sector along a stretch of 5 km. Also it is found that the sectors Kochanakulangara to Ayiramthal (12.8 km) and Thuravur to Manasseri (17.8 km) are under moderate accretion.

The southern side of Cochin gut (Mundamveli to Mattancheri) shows low erosion in the long-term trend. This area is protected by seawall almost throughout. A stretch of 1.9 km low accretion trend is noticed along Mattancheri to Fort Kochi and a very high accretion is observed within a zone of 1.5 km in the Puthuvaipu. From Puthuvaipu to Elankunnapuzha 1.9 km is found to be under moderate accretion. At Puthuvaipu located between Elankunnapuzha and Saudi the converging flows result in an accumulation of material^{3,4}. Here the accretion is, in fact, very high with the shoreline advancing to more than 1 km to the sea. The very high accretion in the Puthuvaipu area could be attributed to the onshore transport of dredge spoil dumped in the offshore by Cochin port⁵. Continuous erosion at Elankunnapuzha north of this site during 1965, necessitated the construction of sea wall⁶. Thereafter the beach profiles indicated initial progradation of the beach and later cyclic variations with minor losses or gains. Nayarambalam and Munambam beaches shows accretionary trend by the long-term data with an 8.8 km stretch of high accretion in the Nayarambalam-Pallipuram stretch. From Pallipuram to Munambam, 2.6 km is found to be under low accretion. High erosion along a stretch of 2.3 km is also noticed in the Munambam - Ninanchal Parambu sector.

In Thrissur District, from Arattuvazhi to Thattankadavu, 3.7 km is found to be under low accretion and from south Kulimattom to Perinjanam high erosion is observed along a stretch of 5 km. Perinjanam - Talikkulam sector (14.3 km) is found to be under moderate erosion. Also it is noticed that Vadanapalli - Putiyiruthi (28.3 km) and Ponnani-Vallikunnu (38.9 km) sectors are under low accretion. Moderate accretionary tendency observed in the Gramam-Ponnani (7.4 km) and Vallikkunnu - Kadalundi (2.2 km) sectors. Kadalundi to Beypore, a stretch of 5 km is found to be under high accretion

which confirms the previous observations¹. The sector from Beypore to Puthiyangadi of length 13.2 km is found to be under low accretion. Previous study along 1 km stretch of beach along the Kozhikode pier⁷ found it to be stable. A short stretch of length 1.1 km between Puthiyangadi and Puthur is found to have high accretion. This may be due to the influence of the breakwater. The sector from Vengalam to Azhiyur of length 43.5 km is of low accretion.

Mahe to Thalassery, a stretch of 6.5 km is under moderate erosion. The beach development along the Thalassery beach is controlled by an offshore stack and the tombolo behind it⁸. The study showed an erosional trend at this stretch.

In this study 67.2 km of beach from Kannur to Chittari is found to be under low accretion and a stretch of 3.5 km from Agasarahola to Kottiyam is under high erosion. Based on a field study of annual cycle⁹ also found these beaches to be of accretionary character.

Kottiyam to Kasargod of length 9.2 km is under low erosion. Kasargod to Mogral shows moderate erosion tendency for a coastal length of 6.6 km. Moderate erosion is observed along the 7.8 km stretch from Uppala to Manjeshwaram. The long-term trend based on the present study indicates medium erosion in the Kasargod-Manjeshwaram sector.

The long-term trend analysis based on the remote sensing data and aerial photographs seems to be in consonance with the observations made in the field by different workers. Though the short-term findings vary in some locations the above data can be reliably used with the necessary precautions to predict the long-term changes in the erosional/accretionary scenario of the beaches. This becomes handy when planners/engineers are constrained to use fragmented beach erosion/accretion data, owing to the logistical problems associated with the field studies.

Acknowledgement

Authors are grateful to Director, Centre for Earth Science Studies for facilities and to Dr. N P Kurian, Marine Sciences Division for useful discussions.

References

- 1 Mallik T K, Samsuddin M, Prakash T N, Vasudevan V & Machado T, *Environ Geol Water Sci*, 10 (1987) 105.

- 2 Murthy C S & Veerayya M, *Mahasagar-Bull Natn Inst Oceanogr.* 18, (1985) 163.
- 3 Murty C S, *Studies on the physical aspects of shoreline dynamics at some selected places along the west coast of India*, Ph D thesis, University of Kerala, India, 1977.
- 4 Murty C S & Varadachari V V R, *Indian J Mar Sci*, 9 (1980) 31.
- 5 Kurian N P, *Remote sensing application for estimation of suspended sediment concentration in coastal waters of Cochin, Kerala*, Project report to IIRS (CESS, Trivandrum) (1987).
- 6 Murty C S, Sasthry J & Varadachari V V R, *Indian J Mar Sci*, 9 (1980) 77.
- 7 Prasanna Kumar M, Kurian N P & Baba M, *A study of nearshore processes and beach profiles at Calicut*, CESS Tech Report, 40 (CESS, Trivandrum) 1981, pp 12.
- 8 Baba M, Kurian N P, Thomas K V, Kumar M P, Hameed T S S & Harish C M, *Studies on waves and their refraction in relation to beach erosion along the Kerala coast*, CESS Tech. report 29 (CESS, Trivandrum), 1983, pp 28.
- 9 Samsuddin M, Ramachandran K K & Suchindan G K, *J Geol Soc India*, 38 (1991) 82.