

## Studies on sediment transport along Kerala coast, south west coast of India

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Longshore sediment transport characteristics of the Kerala coast have been examined to delineate various physical processes affecting the different coastal environments. Monthly averages of the daily LEO (Littoral Environmental Observation) data for one year made at each station have been used for this study. Monthly longshore sediment transport rates showed high variability in the sediment transport mechanism.

Studies on sediment transport and accumulation are of vital importance to projects involving the water to land interface. A number of studies have been conducted along the west coast on different aspects of sediment movement and coastal processes phenomenon<sup>1-4</sup>, but quantitative determination of littoral flows along the west coast of India have been made only at few localities. Present study consist of the problems of beach erosion, sand transport and the rate of sand movement along the Kerala coast.

### Materials and Methods

In the present study, daily observations were carried out for a period of one year ( March 1990 - February 1991) at 8 selected stations (Fig.1) which comes under different morphological settings. Significant wave height was estimated by visual observation and wave period by using a stop watch. The breaking wave angle with respect to the coastline was measured using a surveyor's magnetic compass. Longshore current velocity and direction were measured by releasing neutrally buoyant floats in the surf zone. The approximate width of the surf zone was visually estimated.

Walton<sup>5</sup> technique has been used for the estimation of annual longshore sediment transport rate.

$$Q = \frac{K\rho gH_b WVC_f}{0.78 (5\pi / 2) (V / V_o)} \quad \dots(1)$$

where Q is the annual longshore sediment transport rate in m<sup>3</sup> yr<sup>-1</sup> and the value K = 1288 is a dimensional constant,  $\rho = 1025 \text{ kg m}^{-3}$ ,  $g = 9.81 \text{ ms}^{-2}$ ,  $C_f = 0.01 =$  frictional coefficient dependent on

bottom excursion and bottom roughness,  $H_b =$  breaking wave height in m,  $W =$  surfzone width in m,  $V =$  longshore current velocity and  $V/V_o =$  theoretical dimensionless longshore current velocity, assumed mixing parameter  $p = 0.4$  and is dependent on the parameter  $X/W^6$ . The daily LEO data for one year made at each station have been used in eq. (1). Monthly net transport has been calculated for all the stations. Premonsoon (January-April), monsoon (May-September) and post-monsoon (October-December) are the three seasons discussed in this study.

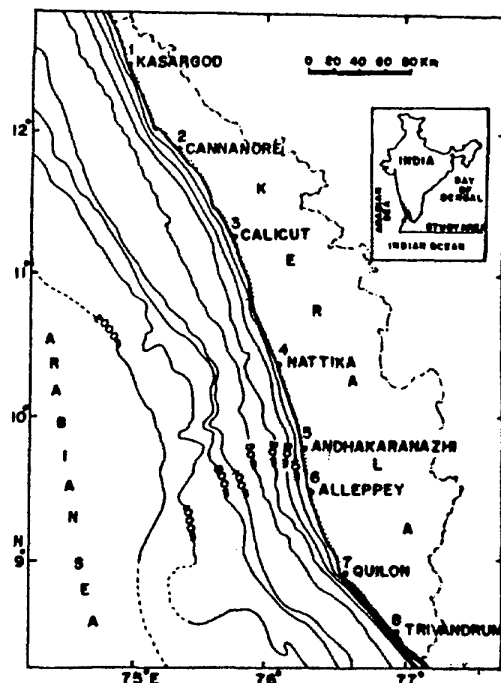


Fig. 1—Location of stations and bathymetry of the nearshore regions

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## Results and Discussion

### *Littoral environmental characteristics*

Monthly average variations of surfzone width, breaking wave height, breaking period, breaking angle and longshore current velocity and direction at stations 1 to 8 are presented in Figs. 2 and 3. The surfzone seems to be wider during the monsoon and postmonsoon seasons and shows a seasonal tendency in most of the study locations except at station 4 (Nattika) and at station 8 (Trivandrum). At Nattika, the surfzone width is >10m during most of the time irrespective of season due to gently sloping

foreshore of this beach.

Breaker height is maximum in the monsoon months and gradually decreases towards the other seasons with a secondary peak of comparatively lesser magnitude during the postmonsoon season. Average breaker height shows a progressive increase from premonsoon season to monsoon season. Maximum breaker height was observed during July at stations 1,2,3 and 6 and during June at the other stations (4,5,7 and 8). Kasargod and Trivandrum showed higher breaker heights throughout the year. The breaker period varies

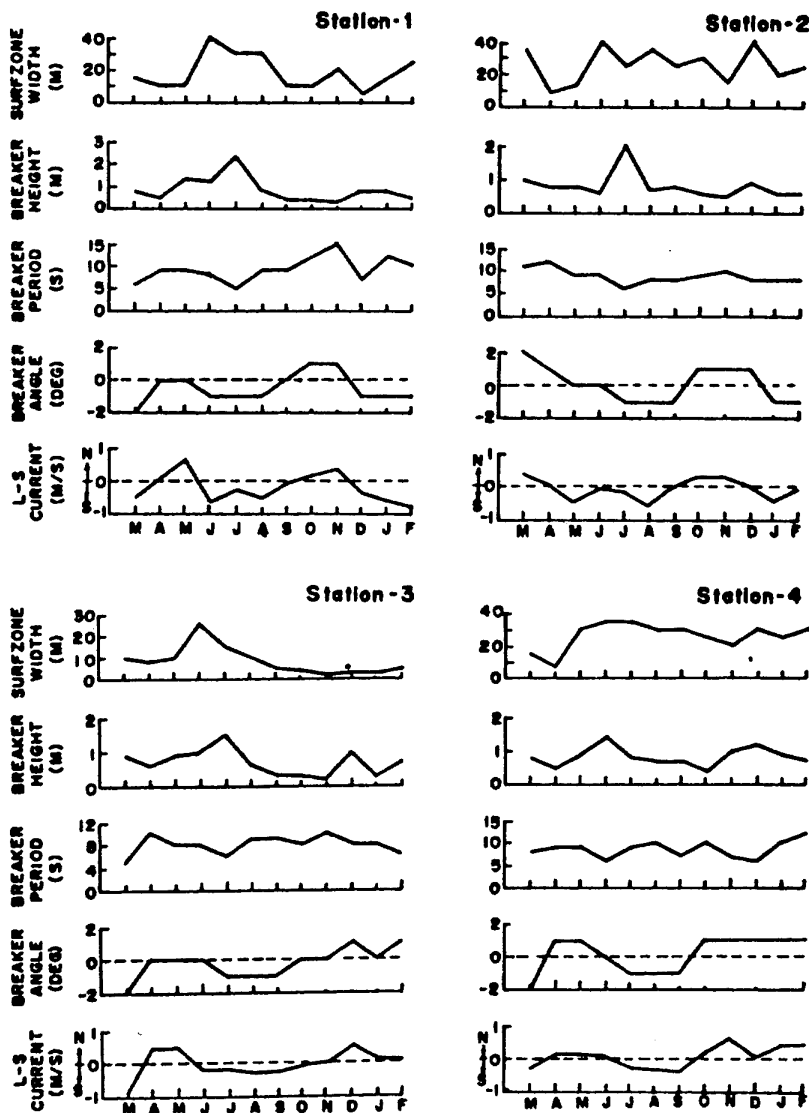


Fig. 2—Monthly littoral environmental parameters at stations 1-4

between 5 sec. to 15 sec. during an year at all stations. Frequency of breakers is more during the monsoon and post monsoons. Breakers are mostly plunging or surging type. Breakerangle also showed a seasonal change in the direction of approach. At stations 2,4,5,6 and 8 breaker direction is from north-northwest to westerly during the premonsoon period and during monsoon season it was in the south-southwest direction.

The field observations on longshore current at selected locations along Kerala coast spanning over a period of one year revealed high variability in their

direction and speed. Longshore current values show significant temporal and spatial variations along the beaches under study. During the onset of monsoon, reversal of longshore current direction towards south is noted in most of the stations. Changes in wind direction during the onset of monsoon cause the change in wave direction which results in the reversal of longshore current direction. Reversal in longshore current direction (towards north) with high magnitude is observed during post monsoon season. Longshore current direction is seen to be transitional and inconsistent during March,

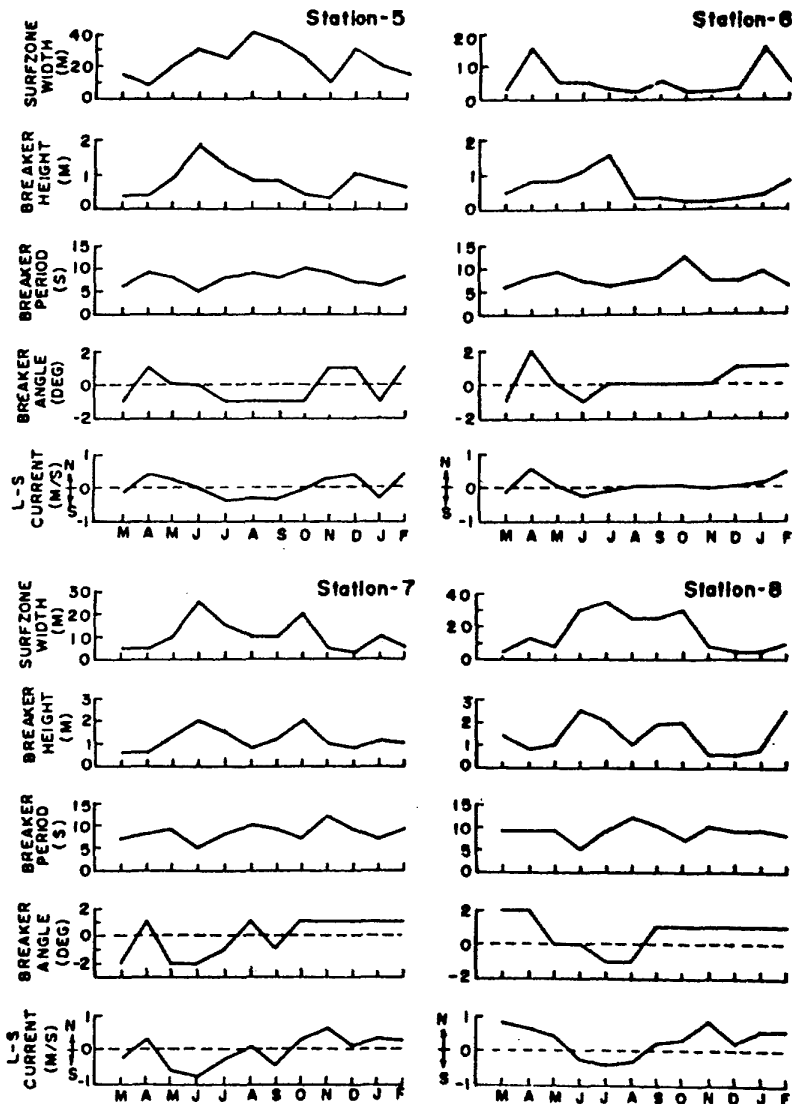


Fig. 3—Monthly littoral environmental parameters at stations 5-8

December and January. A progressive increase in current velocity occurs from November through January and February along the studied locations. Current speed is highest ( $0.88\text{m sec}^{-1}$ ) in Trivandrum beach during November. Current speeds of  $0.2 - 0.6\text{ m sec}^{-1}$  were frequently recorded at many locations. Current velocity was low ( $0.02$  to  $0.05\text{ m sec}^{-1}$ ) at Calicut and Alleppey regions.

*Longshore sediment transport*

The estimated monthly longshore sediment transport rates at all the stations are presented in Table 1. The negative sign in Table 1 is used for southerly drift, whereas the positive for northerly drift. Annual net transport in each location is presented in Fig. 4. Kasargod beach (station 1), which is an open coast high energy beach, showed higher values of littoral drift compared to the other stations. The LEO also showed the presence of high waves during all the time. In the premonsoon season southerly drift is noted during March while northerly drift during April-May. During May, the drift magnitude amounts to  $0.8 \times 10^5\text{ m}^3$ . With the onset of monsoon, a southerly shift was observed in June and continued in the same direction till the end of the season. The drift maxima of  $2.95 \times 10^5\text{ m}^3$  was observed in the month of June. The maximum drift was brought in by the prevailing high wave energy at this location. During postmonsoon season, the drift is comparatively low and inconsistent in direction. Annual net transport computed for this station shows a southerly drift of  $0.73 \times 10^6\text{ m}^3$  which is the highest compared to the other stations (Fig. 4). This higher drift magnitude along the Kasargod beach is related to the high energy condition which

prevails the area most part of the year.

At Cannanore beach (station 2), in the vicinity of Ezhimala promontory, it is seen that during premonsoon period the drift is northerly with a maximum value of  $1.26 \times 10^5\text{ m}^3$  in March. The beach shows southerly littoral drift during May - September and it is northerly during the other months. A decrease in magnitude is observed during June ( $0.19 \times 10^5\text{ m}^3$ ) followed by an increase towards August ( $1.38 \times 10^5\text{ m}^3$ ). From September onwards the drift is consistently directed towards north. Annual net drift was southerly with a magnitude of  $0.019 \times 10^6\text{ m}^3$ .

The Calicut beach (station 3), is an open coast beach with low energy and reported occurrence of mud bank. Littoral drift values showed lesser magnitude compared to the locations on the north. Monthly drift was southerly during March with the highest value of  $0.76 \times 10^5\text{ m}^3$ . The drift was northerly during April-May. During the monsoon season the drift was southerly. Littoral drift was

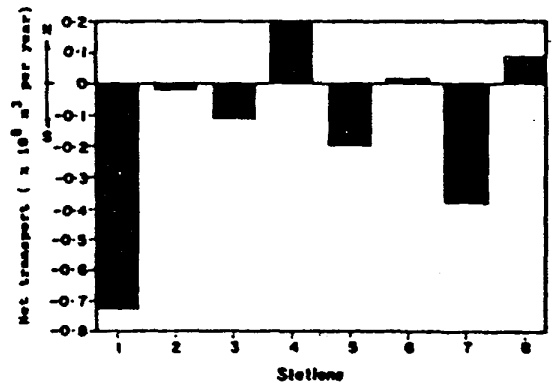


Fig. 4—Annual net transport for different locations

Table 1—Monthly drift values at different stations

| Months     | Stations |          |          |          |          |          |          |          |
|------------|----------|----------|----------|----------|----------|----------|----------|----------|
|            | 1        | 2        | 3        | 4        | 5        | 6        | 7        | 8        |
| March'90   | -0.60998 | +1.26592 | -0.76541 | +0.32845 | -0.07624 | -0.01906 | -0.07918 | +0.56795 |
| April      | +0.03421 | +0.03128 | +0.19238 | +0.05132 | +0.11887 | +0.12903 | +0.08211 | +0.68115 |
| May        | +0.80061 | -0.47782 | +0.35191 | +0.34311 | +0.35191 | +0.01173 | -0.80060 | +0.32845 |
| June       | -2.95609 | -0.18768 | -0.48877 | +0.38319 | -0.26393 | -0.15054 | -3.91017 | -1.97952 |
| July       | -1.88861 | -0.83091 | -0.39590 | -0.68428 | -1.11440 | -0.05718 | -0.61585 | -2.87398 |
| August     | -1.21997 | -1.38909 | -0.16422 | -0.67743 | -1.00100 | +0.00117 | +0.05474 | -0.80647 |
| September  | -0.03128 | -0.01955 | -0.03665 | -0.78008 | -0.95799 | +0.00439 | +0.53960 | +1.02153 |
| October    | +0.06256 | +0.52787 | -0.00586 | -0.19550 | -0.07820 | +0.00195 | +1.17305 | +1.93553 |
| November   | +0.21115 | +0.21994 | +0.00117 | +1.21215 | +0.07624 | -0.00117 | +0.30792 | +0.40822 |
| December   | -0.13685 | +0.07038 | +0.15249 | +0.24634 | +1.11440 | +0.00264 | +0.02346 | +0.06451 |
| January'91 | -0.68037 | +0.49268 | +0.00879 | +0.87978 | -0.51614 | +0.07038 | +0.34409 | +0.22679 |
| February   | -0.95310 | +0.10264 | +0.00342 | +0.82113 | +0.32552 | +0.17595 | +0.12219 | +1.41743 |

+ Northerly; - Southerly

minimum ( $0.001 \times 10^5 \text{ m}^3$ ) in November. Annual net drift was southerly with very small magnitude ( $0.11 \times 10^6 \text{ m}^3$ ). Along Nattika beach (station 3), which is an open coast beach with the occurrence of the extension of Vypin mud bank, littoral drift show slightly larger values compared to Calicut beach. Drift direction shows a typical monsoonal trend, i.e. southerly during monsoon and northerly during the other seasons. Maximum southerly drift was in September with a magnitude of  $0.78 \times 10^5 \text{ m}^3$  and maximum northerly drift  $1.21 \times 10^5$  in November. Annual net transport along the beach was towards north with a magnitude  $0.19 \times 10^6 \text{ m}^3$ .

At station 5 (Andhakaranazhi beach), a barrier type beach, the monthly transport showed southerly drift during monsoon months with a maximum of  $1.11 \times 10^5 \text{ m}^3$  in July. Subsequently the magnitude decreases towards October. During all the months, except March and January the drift is towards north. Results of the earlier investigations showed similar features in this region. Annual net drift along this stretch of the beach was southerly with magnitude of  $0.2 \times 10^6 \text{ m}^3$ .

Monthly drift values estimated for the Alleppey beach (station 6) which is an open beach with occurrence of seasonal mud bank, showed southerly drift with low magnitudes during monsoon season. In all the months except March, the drift was northerly. Maximum northerly drift was ( $0.13 \times 10^5 \text{ m}^3$ ) in April. Annual net drift value shows a northerly drift ( $0.016 \times 10^6 \text{ m}^3$ ) and is least compared to the other beaches examined.

An open beach at Quilon (station 7), the estimated monthly drift values are more in magnitude. During pre and postmonsoon months, the monthly drift shows northerly trend, while during monsoon it is southerly. A maximum value of sediment drift ( $3.91 \times 10^5 \text{ m}^3$ ) was in June.

Magnitude of drift values shows a decreasing trend towards September followed by a shift in direction. Lowest northerly drift value of  $0.023 \times 10^5 \text{ m}^3$  was in December. Annual net transport ( $0.38 \times 10^6 \text{ m}^3$ ) was towards south. The estimated value of the monthly drift for station 8 (Trivandrum beach), which is an open coast exposed to high wave energy environment prevailing over the period, showed higher magnitude than at Quilon beach. Drift was southerly during the monsoon period and northerly in other months. Higher magnitude of the drift values along this beach was due to the high energy conditions prevailing along this beach. From the monthly and daily wave breaker height analyses (Fig. 3), it is evident that this beach has all the typical characteristics of a high energy beach. With the onset of monsoon, an increase in southerly drift value was observed and shows a maximum value in July ( $2.87 \times 10^5 \text{ m}^3$ ). During postmonsoon months an increase in drift value was observed with a maximum of  $1.93 \times 10^5 \text{ m}^3$  in October and is northerly. Annual net drift along this beach was towards north with a low value of  $0.05 \times 10^6 \text{ m}^3$ .

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