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# Beach Morphological Characteristics and Coastal Processes Along Dakshina Kannada Coast, West Coast of India

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# BEACH MORPHOLOGICAL CHARACTERISTICS AND COASTAL PROCESSES ALONG DA SHINA ANNADA COAST, WEST COAST OF INDIA

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***Abstract:*** *Coast is the dynamic junction of water, atmosphere and land, which undergoes continuous geo-morphologic changes in response to natural forces and human activities. The monitoring of the coast mainly the shoreline changes, beach erosion/accretion, are very important for the proper management of the coastal zone. In order to monitor the beach morphology a study on Sasihitulu beach of Dakshina Kannada coast, West coast of India has been carried out. Weekly beach profiles, dry beach width and sediment samples were collected from the field and analyzed. The results of the study were encouraging and reveals that the erosion/accretion trend in the study area is cyclic in nature and repeats every year, estuarine beaches suffer severe erosion due to the migration of river mouths. Estimates of sediment budget and beach profile configurations reveal that the beaches in the study area are fairly stable except at the vicinity of the river mouth.*

***Keywords:*** *beach morphology; erosion; accretion; sediment; shoreline configuration.*

## INTRODUCTION

India has a vast coastline of 6000 kms along the mainland in addition to the Andaman and Nicobar Islands in Bay of Bengal and Lakshadweep Islands in the Arabian Sea. The vast coastal zone has been playing major role in the economic development of the country since ancient times by its contribution to sea trade, fishing, ocean industry and human settlement. Scientific assessment of the coastal protection is the prerequisite in projects like ports and harbours, fisheries, coastal protection, marine recreation, pollution control and land reclamation. Coastal erosion is a natural process that accounts for the movement of beach materials. Atmosphere and ocean weather, such as El Nino, storms, winds, tides, currents, waves and storm surges are major factors in coastal erosion .Erosion and siltation problems are frequently observed near harbours and close to existing coastal structures. The important factors governing the beach erosion is the coastal processes which are controlled mainly by the wave characteristics and near shore sediment transport

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(Sanil kumar et.al. 2000). Information on long shore sediment transport is essential for studies pertaining to shoreline erosion, harbour development, sedimentation dredging, tidal inlets, design of coastal structures, development of marinas and tourist resorts (Chandrasekhar, 1996).

Coastal Geomorphologic features of the East and West coast of India are complex long sandy beaches with dunes along the almost straight and low-lying East coast and the pocket beaches between the headlands and promontories along the highly indented West coast are the main features (Chandramohan, 1994). The East coast experiences two stormy conditions (Chavadi, 1995) whereas West coast of India experiences a major erosion phase during the southwest monsoon season (June-Sept), a secondary but minor phase during north east monsoon (Dec-Jan) and accretion during the other months (Chavadi and Hegde, 2003, Chandramohan et.al. 1994). The morphological changes of the beaches in the vicinity of river mouth are much more complex owing to the site specific control of wind and wave processes (Jackson and Northron, 1992). The variation in sediment influx into the beach environment results in a complex adjustment of sediments between the sea and the foreshore 9n the vicinity of the estuary (Hegde et.al. 2009). Waves are the dominant forces in foreshore morphological changes (Davis and Hayes, 1984). In addition to waves, local and regional wind phenomena also influence the geomorphic processes in tropical coasts. The studies on morphological changes in the vicinity of estuary beaches are rare especially in central west coast of India where silting and erosion problems are common. The present study was carried out with a view to understand the shoreline configuration through seasonal foreshore profile variation, sediment characteristics and in-situ wave measurements.

## STUD AREA

Sasihithilu coastline of length 7km extending from NITK beach to Mulky- Pavanje river mouth along Dakshina Kannada coast, West coast of India and covered between 13 00'48.40 N 74 47'16.45 E to13 4'36 N 74 48'32.40 E. The study area is oriented along NNW-SSE and characterized by long narrow and straight open sandy beaches and estuaries. The average wave height observed during southwest monsoon is 6m; Tides are semidiurnal in nature, with mean tidal range of 0.6m.The annual rainfall is 3954mm, of which 87% is during southwest monsoon itself. Climate is tropical with high humidity and maximum temperature recorded so far is $36^0$C. (Murthy et.al, 1988)

## DATA PRODUCTS

The present study carried using both conventional data and field data are given in Table.1

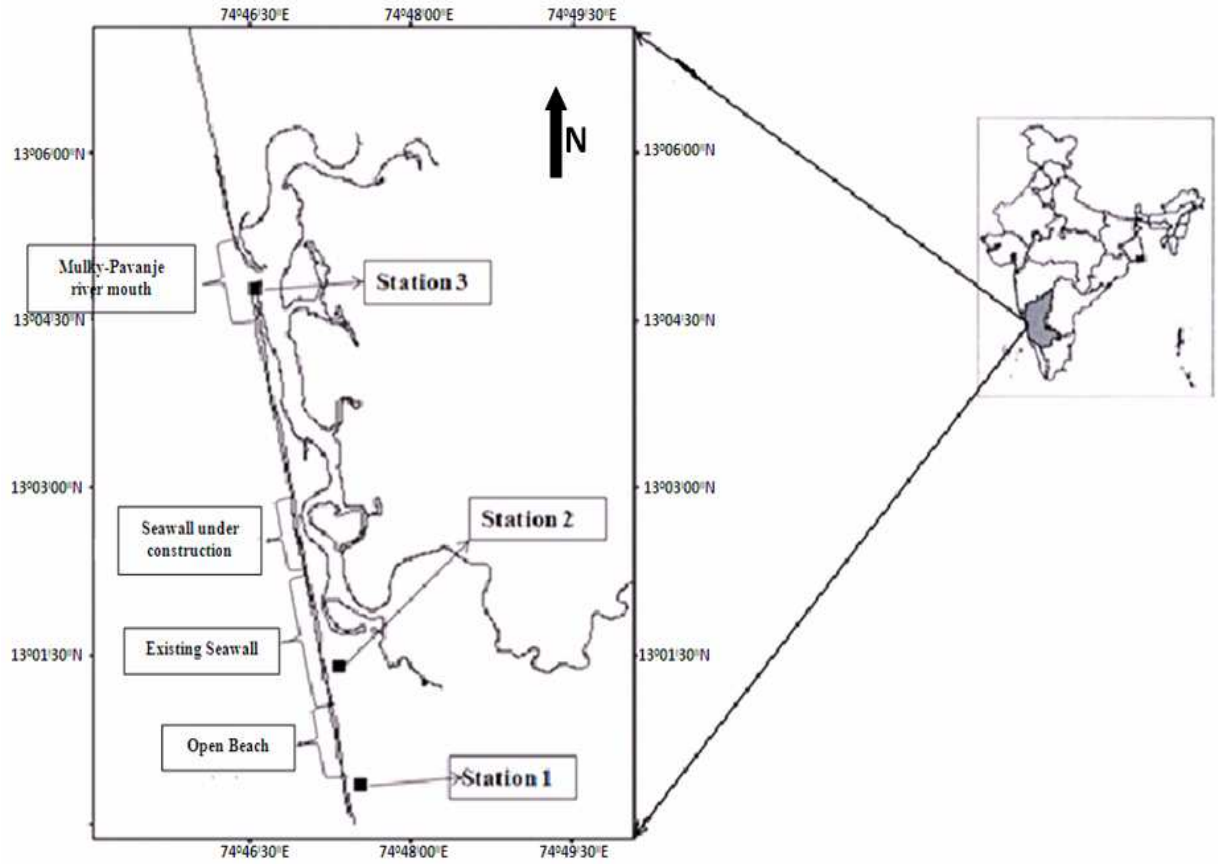



Fig 1. Location map of study area

Table 1: Database of the present study

| Sl. No | Type of Data | Source | ear | Purpose |
|---|---|---|---|---|
| 1 | Beach Profile | Beach profile survey | 2009-2010 | To study the Erosion and deposition patterns. |
| 2 | Dry Beach Width | Beach profile survey | 2007-2010 | To monitor the variation in beach width due to direct wave action. |
| 3 | Sediment Data | Foreshore beach samples collected at stations 1, 2 and 3 | 2007-2010 | To find the type and source of sediment deposited. |
| 4 | Rainfall Data | IMD Sub-station, NITK-Surathkal. | 2006-2010 | Additional data |

## METHODOLOG

A field data collection program includes beach profile surveys, dry beach width measurements, collection of sediments from the foreshore zone of a beach, tracking of high tide line along the coastline of the study area was conducted since 2007. This paper focuses on the beach morphology due to coastal landforms. Annual and seasonal profiles were compared to obtain corresponding morphological changes. Beach width was measured from a fixed point in the backshore to the outer limit of the foreshore. Foreshore is the part of a beach lying between the crest of the seaward berms and low tide mark. Backshore is a zone lying between the foreshore and the limit up to which waves act during severe storms. Wave breaker directions were measured using a magnetic compass. Also the High Tide Line (HTL) was marked using Global Positioning System (GPS) to know the places of erosion and deposition.

### Beach profile

Profiles taken perpendicular to the shoreline have characteristic features that reflect the action of littoral process (SPM, vol 1, 1973).Weekly beach profile measurements at stations 1, 2 and 3 were recorded from a permanent landmark to a point seaward up to a few meters beyond the low water line using auto level, levelling staff and a tape. Vertical changes were measured at every 2m and additional readings were recorded at all significant points where there is a change in slope (Mallik et.al. 2002).

### Beach width

Daily beach width data was collected at two stations 1 and 2 from August 2007 to January 2010. Dry beach width was measured during the low tides using a standard tape then weekly, monthly and seasonal changes of dry beach width due to direct wave action were calculated.

### Sediment Data

Weekly sediment samples were collected from the foreshore of the beach during the low tide from August 2007 to January 2010 by hand grab method. The sediment samples were prepared for sieve analysis following IS 2720 code on a Ro-Top sieve shaker and textural parameters were derived from the sieved fractions by plotting log-probability graphs.

### Rainfall Data

Rainfall data of the study area was collected from August 2007 to January 2010 and used as additional data while calculating the beach width.

## RESULTS AND DISCUSSION

The results of various data analysis are discussed in detail in the following sections.

**Beach Profile**

The changes obtained from the first and the last set of monthly profiles reveal that for a period of 5-6 months the beach is attaining its original width and slope (Fig 3.).

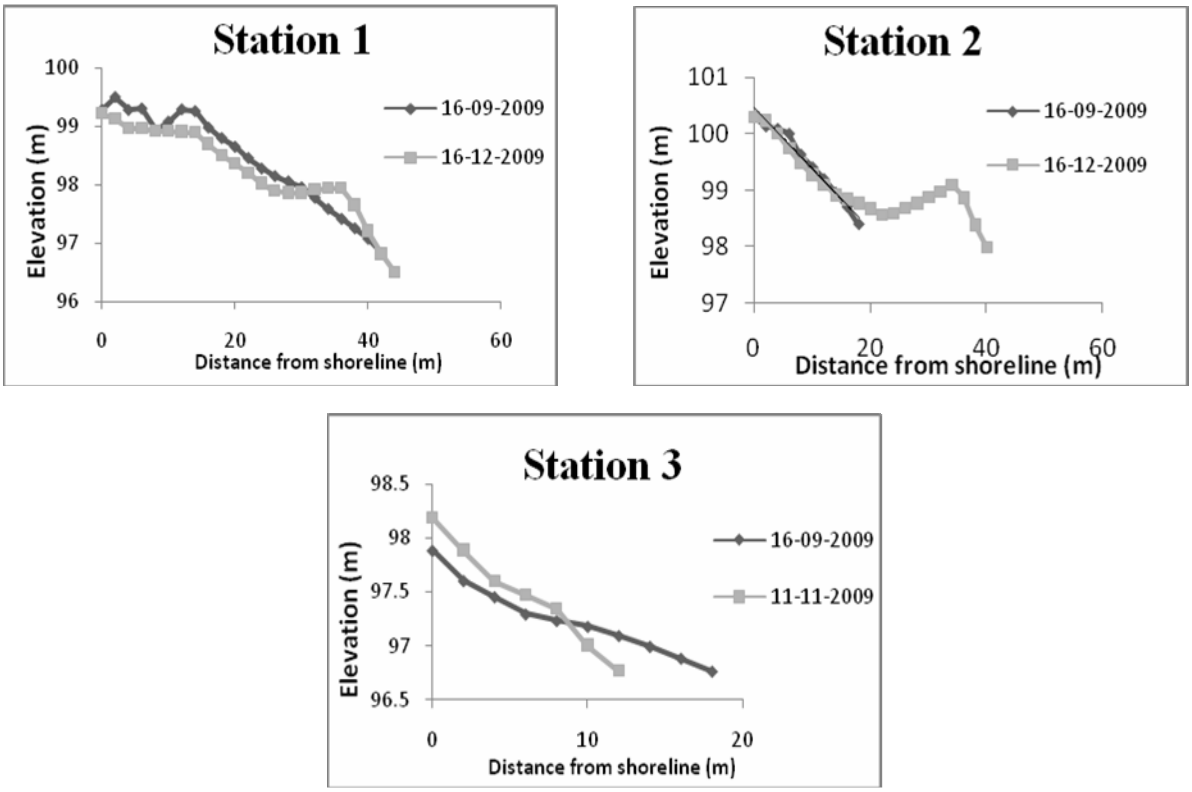
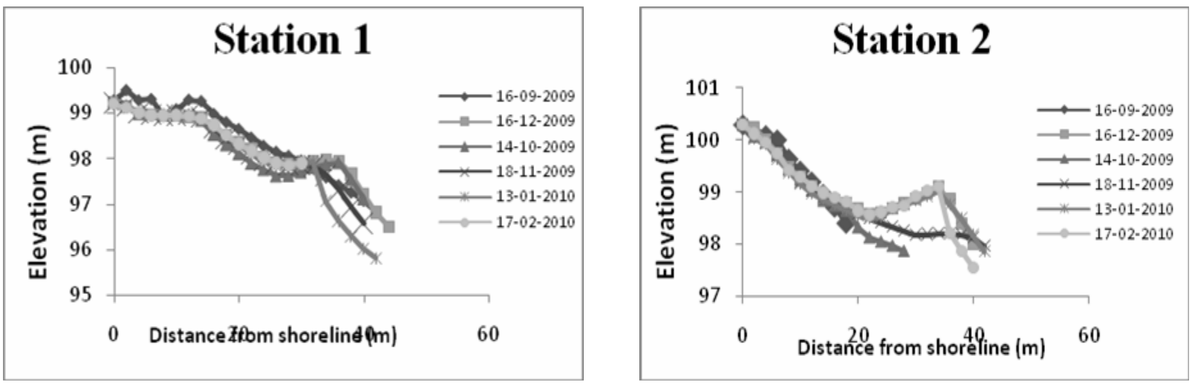



Fig 3: Beach profile variations of monsoon and post monsoon period.

It can be observed from south west monsoon profiles of September that beaches become narrower and steeper at stations 1 and 2 compared to January profiles. Beaches get accreted from mid of November to February over the eroded surfaces. Hence the changes in the beach morphology are more prominent in post monsoon and south west monsoon seasons of the same year (Fig 4.).



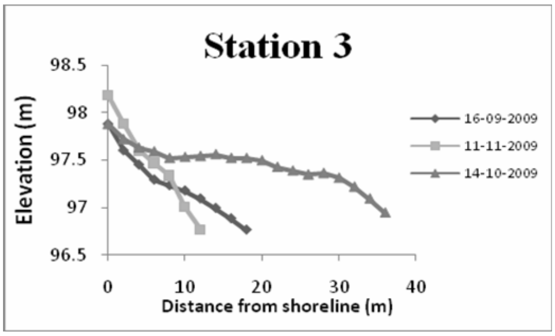



Fig 4: Beach profile variations between monsoon and post monsoon periods

The occurrence of cyclone in the month of November 2009 resulted in the severe beach erosion at station 3 and the movement of sediments resulted in the formation of Barrier Island in the offshore region, and hence no profiles and beach width were collected after this period.

**Dry Beach Width**

The analysis of the weekly dry beach width in a period of two years reveals that the station 1 and 2 shows a cyclic behaviour, If the station 1 gets accreted in a particular week erosion was observed at the station 2 and vice versa. This was in conjunction with the monthly and annual beach width (Fig 5, 6, 7). The multiple berms were formed at stations 1 and 2 during fair weather period while single or no berms were found during the monsoon season.

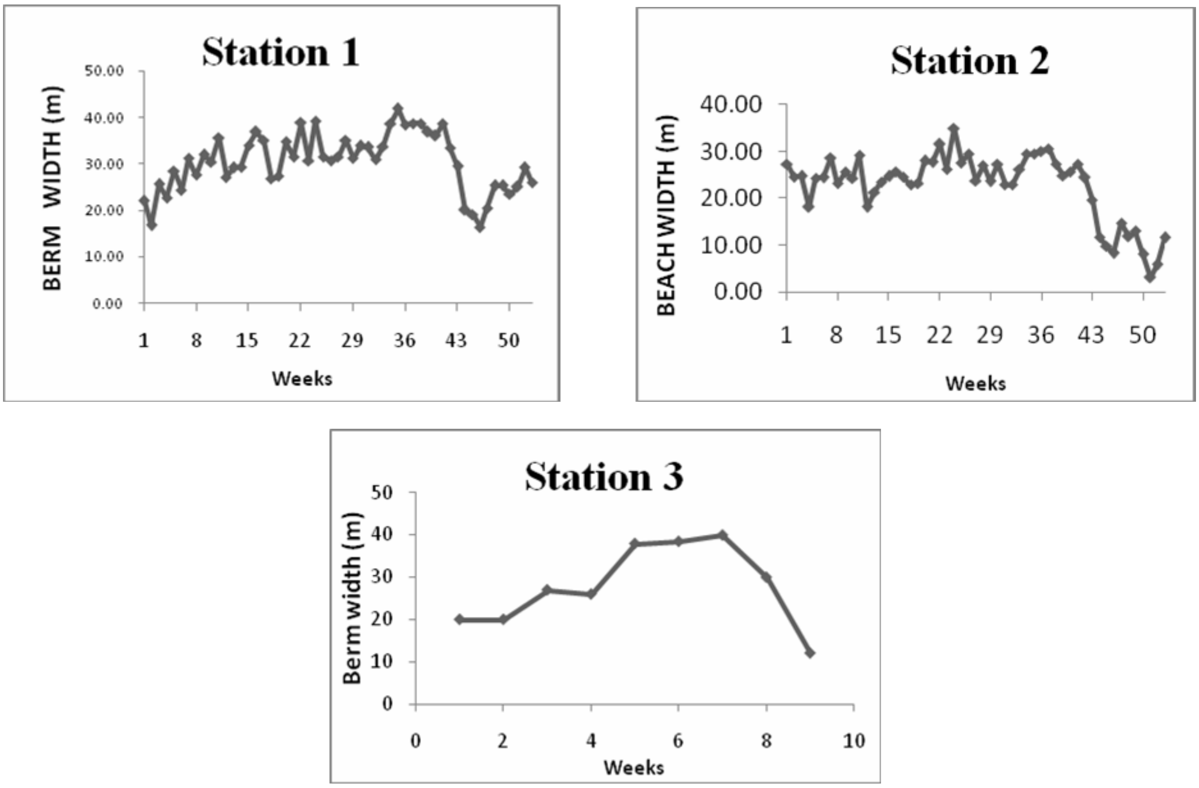



Fig 5: Average weekly dry beach width variations from 2007 to 2009

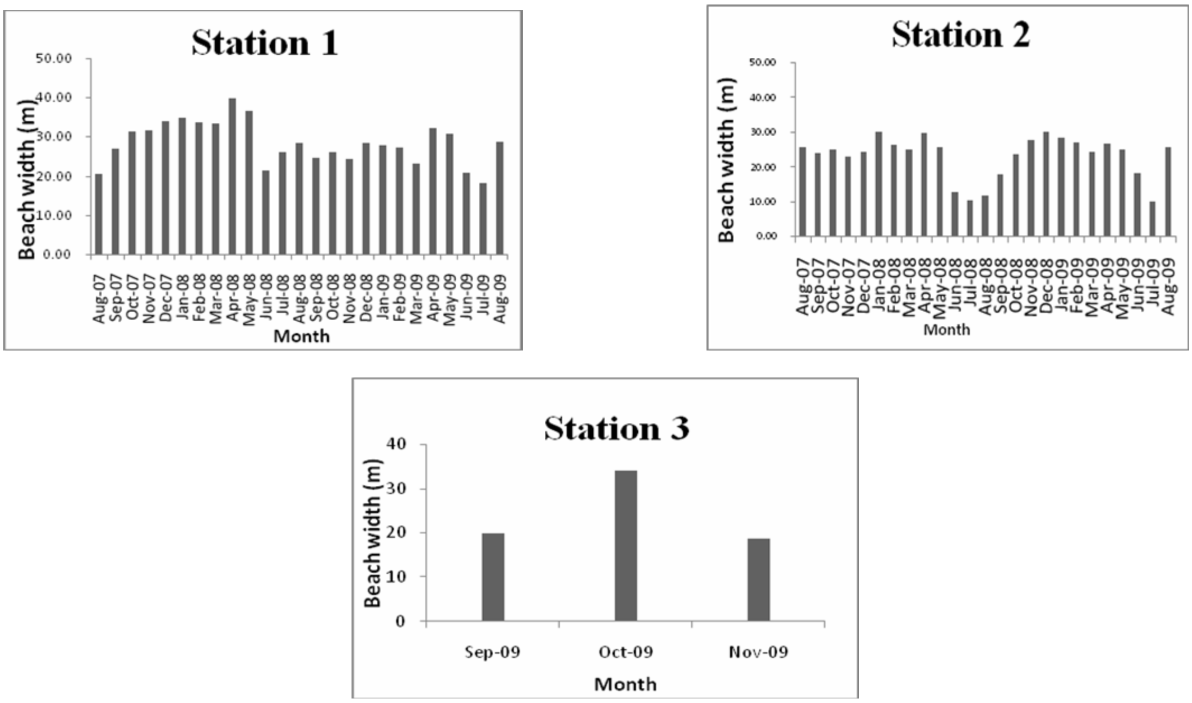



Fig 6. Average monthly dry beach width variations from 2007 to 2009

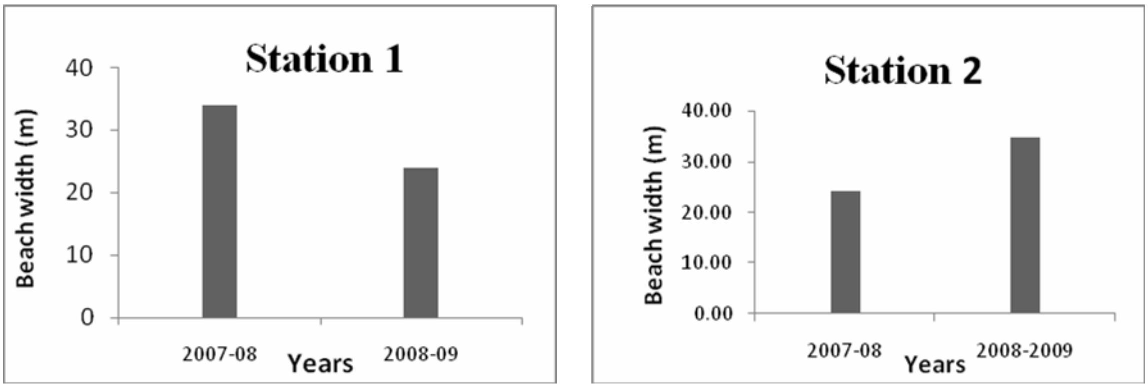



Fig 7: Average Annual dry beach width variations from 2007 to 2009

**Sediment Data**

Monthly and seasonal changes in sediment volume indicate erosion during the storms and accretion during the fair weather period. As the spacing between the adjacent locations is about 1000 m, the net sediment volume change in $Mm^3$ for 1000m length of the beach has been determined. This estimation reveals that approximately 0.25 $Mm^3$ of sediment has accumulated between location 1 and location 2.

Although large-scale erosion took place during southwest monsoon at location 1 and location 2 they regain their original profile in the post monsoon period of November/December and January. The visual observations made in front of man-made structures near location 2 and location 3, sediment balance was not found associated with beach topographical changes, mean-grain size and beach sediment also shows slight changes with relatively coarser material during erosive periods and finer material during accretive periods.

The analysis of average monthly D50 value reveals that finer fragments of sediments are observed in the month of April and May where as coarser fragments of sediments are observed in the month of August and September (fig 8) which results in shaping of the beach profile .

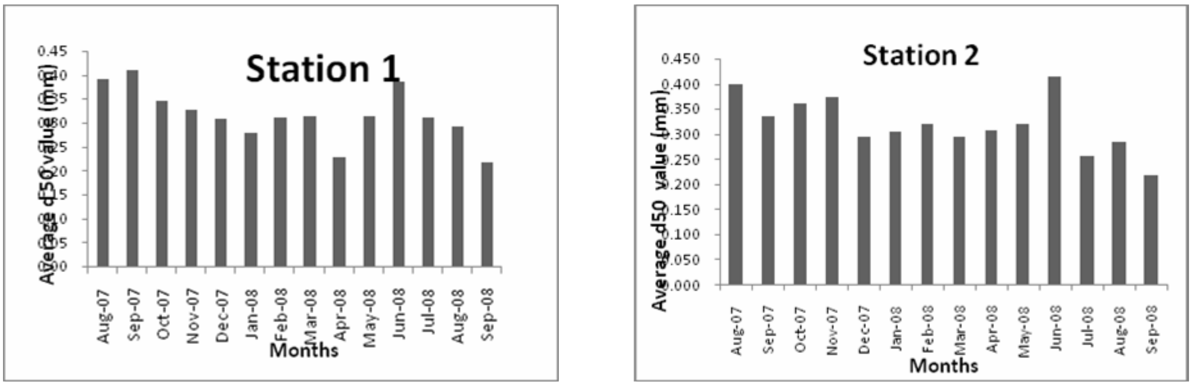



Fig 8: Average monthly D50 value variations from 2007 to 2008.

All the rivers in the study area originate in the Western Ghats, flow westward and take a $90^0$ bend near the shore and run parallel to the shore, either towards North or South, before joining the Arabian Sea [KREC Study team, 1994, Jayappa, 2003]. The sediment balance is not found at places of rocky outcrops or river mouth which interrupts shoreline. Estuarine beaches suffer erosion due to migration of river mouths. Estimates of sediment budget and beach profile configurations reveal that beaches in the study area are fairly stable except in the vicinity of river mouth. Human interference includes mainly construction of breakwaters and seawalls. Seawalls are the predominant coastal structures in the study area. A number of sea walls covering a distance of 3km length of coastline have been constructed. Apart from this another 0.7 km long sea wall construction is in progress. From the field survey at station 2 it is found that a stretch of sea wall was destroyed by huge waves.

## CONCLUSION

The Sasihithilu coastline exhibits wide variations in near-shore sediment transport pattern resulting in complex shoreline oscillations. The presence of seawalls and river mouth in the region also significantly influence the littoral sediment transport and alters the natural equilibrium of the beach.

From the present studies it is observed that on-shore sediment transport during non-monsoon periods and offshore sediment transport during monsoon period. The measured beach profile and beach width data reveals that the erosion/accretion patterns in the study area are cyclic in nature. The beaches are almost stable throughout the study area except at the Mulky - Pavanje river mouth which has experienced severe erosion during the North-East monsoon period. The estuarine mouth was migrating towards North during pre monsoon period. But during the monsoon period it has migrated towards South which may be due to the variations in the discharge of sediments by the river on the beaches.

Comprehensive studies are needed to evaluate longshore and onshore-offshore sediment transport, onshore-offshore sediment transport is initiated by the high and short period waves resulting from the storm removing the sand from the beach and transporting it into the sea to form offshore sand bars. During the ensuing fair weather period, the sediments formed as offshore bar tend migrate onshore and build up the beach. This cycle may be is linked to the climatic season in which offshore transport dominates during the monsoon season while onshore transport dominates during the fair weather season. Longshore sediment transport seems to be more dominant than onshore-offshore transport and of great significance to the coastal engineers.

## REFERENCES

Chandramohan P, Sanil Kumar V, Nayak.B.U and Raju N.S.N, 1994, Surf zone dynamics along the coast between Bhatkal and Ullal, West coast of India ,*Indian Journal of Marine Sciences*, 23, 189-194.

Chandrasekar.N, Sudheer A.S, Victor Rajamanickam.G and Loveson V.J, 1996, studies on littoral sediment transport along the southern coast of Tamil nadu, *Geological congress*, 60-63.

Chauhan O.S, 1995, Monsoon induced temporal changes in beach geo-morphology and associated sediment dynamics, Central east coast of India, *Journal of Coastal Research*, 1(13),776-787.

Chavadi V.C, Bannur C.R, Hamangond P.T, and Korkoppa M.M, 1999, Morphology and sediment characteristics of Uttara Kannada beach, West coast of India, *Indian Journal of Geo-Morphology*, 4(1 2),19-34.

Davis. R.A and Hayens .M.O, 1984, what is Wave Dominated Coast *Marine Geology*, 60, 313-329.

Hegde V.S, Kanchanagouri.D, Gadavi.X , Hamangond P.T, Huchannavar G.K, Shaini.G And Bhat M.S,2004, depositional environment and silting in the Shavarathi estuary, central west coast of India, *Indian Journal of Marine Sciences*,33(3), 296,302.

Hedge V.S, G.Shalini, S.R Nayak, A.S.Rajawat, A,Surynarayana, S.Jayakumar, B.K.KOti and G.K.Girish,2009, Low-Scale Foreshore Morphdynamic Processes In The Vicinity Of A Tropical Estuary At Honnavar, Central West Coast Of India, *Journal of Coastal Research*, 25(2),305-314.

Jackson N.I And Nordtorn K.F, 1992, Site Specific Control On Wind And Wave Processes And Beach Stability On Estuarine Beaches, *Journal Of Coastal Research*, 8, 88-96.

Jayappa K.S, G.T Vijaya Kumar and R. Subrahmanya, 2003, Beach Morphology of Southern Karnataka, *Journal of Coastal Research*, 19 (2), 389-408.

KREC Study Team, (1994), Study on coastal erosion (Dakshina Kannada district),input to environment master plan study, *Danida-DEE-Mangalore*, KREC, Surathkal, pp.113-189.

Mallik T.K, Samsuddin.M, Prakash T.N, Vasudevan.V And Terry Machado,2002, Beach Erosion And Accretion-An Example From Lerala,Southwest Coast Of India,*Environmental,Geological Water Science* vol 10(2),105-110.

Murthy T.R.S., M. N. Madhyastha, I. J. Rao, and K. N. Chandrashekharappa (1988), Study of physical determinants of natural environments and their impact on land use in Netravati and

Gurpur river basins of western ghat region, Karnataka: *Project report*, Department of environment and Forests, Government of India, New Delhi , pp.60.

V.Sanilkumar, P.Chandramohan, K.Ashok Kumar, R.Gowthanam, and P.Pednekar, Longshore Current And Sediment Transport Along Kannirajapuram Coast, Tamilnadu, India, 2000, *Journal of Coastal Research*, 16(2),247-254.

## BIBLIOGRAPH

Dattatri.J. J, N.B.S.Rao, Subba Rao, Dwarakish.G.S and Nagendra Kumar.B, 1997, Beach profile studies along Dakshina Kannada Coast of Karnataka State , second *Indian National Conference on Harbor and Ocean Engineering (INCHOE-97)*, Thiruvananthapuram, December 7-10, 1997, 1135-1143.

Chandramohan P, 1994 Shoreline Dynamics of the Indian Coast pg no 112-113, *online publication*.

Sanil Kumar, Pathak. K.C, Pednekar, N.S.Raju and Gouthaman, R 2006.Coastal processes along the Indian Coastline. *Research Communications*, 91 (4), 25-32.

Shore Protection Manual, 1973, vol 1, pg no sec 4 pg 1-154.