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Proceedings of ninth International Conference on Hydro-Science and Engineering (ICHE 2010), IIT Madras, Chennai, India.
2 - 5 August 2010

COASTAL SEDIMENT D NAMICS AROUND NETRAVATI GURPUR RIVER MOUTH THROUGH INTEGRATED APPROACH

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Abstract: *Coastal Zone is the triple interface of land, ocean and atmosphere and it is defined as the region from the 200m bathymetric contour at sea to the 200m elevation contour on the land. To design coastal structures properly, an estimate of the annual amount of sand supplied to or lost from the coast is necessary. The most probable sources of beach materials are streams and gullies, cliff erosion and onshore movement of sand by wave action, wind action and coral reefs. The Netravati-Gurpur river mouth at Mangalore, along Karnataka Coast, West Coast of India, is undergoing seasonal changes, and causing lot of problems in the form of erosion/accretion, siltation in the river mouth, which reduces the navigation depth and capsizing of fishing boats and loss of fishermen's lives etc. In view of these problems, Netravati-Gurpur river mouth is considered for the present study, where in integration of conventional data and numerical modeling techniques has been employed. Database of the present study includes beach face sediment samples and in-situ water samples. These data were analyzed by using statistical analysis, Sediment Trend Matrix Analysis (STMA), modeling techniques and arrived at the conclusions (i) net sediment transport is negligible and it works out to be 0.225 Mm^3/yr towards South and (ii) there is no large scale erosion/deposition.*

Keywords: *River mouth; Sediment Trend Matrix; Sediment Transport Path; Hydrodynamic modeling;*

INTRODUCTION

Coastal engineers, planners and managers need to understand one of the important coastal processes viz., the long-term behavior of shoreline configurations. There is ever increasing demands near the shoreline for recreation, industry, marine transportation, agricultural production and marine resources of various kinds. The aesthetic advance of siting residential areas and practical advantage of setting up industries related to fishing, ports and harbours etc, close to the shoreline have focused the attention on preserving and maintaining the shore against the destructive forces of the nature, which are sometimes aggravated by human interference.

The reasons attributing to coastal erosion may be outlined due to loss of littoral material from a specific location on the beach which includes movement to offshore region, losses into submarine canyons, accretion against littoral barriers, removal of sand for construction purpose, action of wind, abrasion by wave action etc

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The increasing reports about the coastal erosion in the last four decades have raised the doubts whether the erosion is a recent phenomenon or not? Dynamic changes have occurred in this fragile boundary between the land and sea, ever since the boundary was formed, but the changes have received public attention only now because of the increased importance and economic impact. Increased human interference also plays an important role in upsetting the delicate equilibrium established by the nature.

The primary causes of coastal erosion in any given area are the following [KREC Study Team (1994)]:

- Direct wave action
- Interception of littoral drift
- Sea level changes
- River mouth changes
- Sand mining.

The present study mainly concentrates on shoreline configuration along Mangalore coast in general and Netravati – Gurpur river mouth dynamics in particular. For the present study, conventional methods, remote sensing and GIS approach and numerical modeling techniques are adopted and only the results of the conventional methods are presented in this paper.

STUD AREA

Mangalore coast which starts from Talapady in the South to Mulky in the North, along the central West coast of India, lies between 12^0 45' - 12^0 07' North latitude and 74^0 45'- 74^0 55' East longitude [Fig.1]. Netravati –Gurpur river mouth is at Mangalore, with Northern Bengre spit and Southern Ullal spit. The study area has a tropical climate and the maximum temperature recorded so far is 36^0C. The average annual rainfall is 3954 mm out of which 87% is received during the southwest monsoon [Murthy et. al. (1988)].

OB ECTIVES

The present study was taken up with a view to understand (i) coastal processes, (ii) sediment dynamics and (iii) morphology of sand spit formation at Netravati-Gurpur river mouth, through integrated approach.

MATERIALS AND METHODOLOG

Data products

Details of the different data utilized for the present study are furnished in Table 1.

Methodology

Statistical Analysis of Beach face sediment data

Foreshore zone is presumed as a good representative to find environmental changes as this region is continuously worked by the waves and more affected by the coastal environmental conditions. Nearly 1kg of surface sediment sample was collected at 15 selected locations.

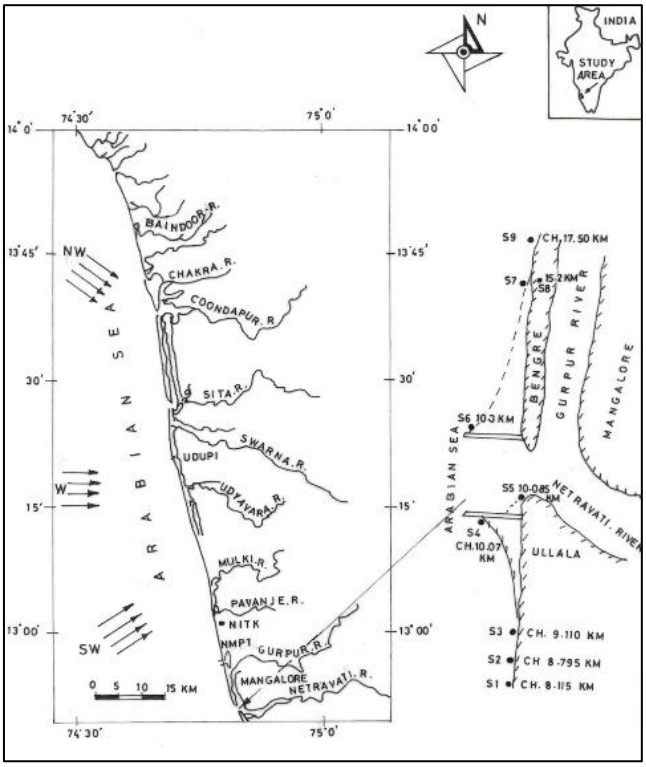

Fig.1. Location Map of Study Area

Table 1: Data Products for the Present Study

Sl.No	Type of data	Source/Location	ear	Purpose
1	Top sheet 48L/13 and 48K/16 of scale1:50,000	Survey of India	1973	To prepare the base map
2	Beach face sediment samples	Collected along the beach	1994, 1996, 1997, 1999, 2000	To determine the direction of movement of the sediment
3	Wind, Wave, Currents and Bathymetry	New Mangalore Port Trust, Panambur	1999, 2000	Used as an input to MIKE-21 Software

The sample was prepared to conduct dry sieve analysis using R0 –Top machine for about 15 minutes as recommended in IS: 2720(PART-IV) 1965. Results of the sieve analysis were plotted on log – probability paper and statistical parameters such as Mean (M_z), Standard deviation (σ_I) and Skewness (S_{kI}) were calculated using the formula given by Folk and Ward (1957, 1966) for 12 locations in the study area and for all the four years. Using these parameters, Sediment Trend Matrix (STM) was prepared. STM is one of the good tools to understand the sedimentary processes such as identification of probable sources and probable deposits, the net sediment transport paths among sedimentary deposits and the location of erosion and accretion [McLaren 2001]. To calculate the statistical parameters and to draw STM, a 'C' program was written. The results of the STM were represented in the pictorial form in Sediment Transport Paths (STP).

RESULTS AND DISCUSSION

Statistical Parameters

Sediment size distribution curves for the beach face sand samples in the vicinity of Netravati – Gurpur river mouth area are shown in Fig 2. The size distribution curves on log-probability paper consist of essentially 3 parts [Folk and Ward 1957].

(i) The top portion consisting of the finer fractions represents the suspended mode of transport

(ii) The middle portion represents the saltation mode of transport and

(iii) The bottom portion consisting of the coarser fraction represents the surface creep mode of transport.

As expected, the samples in the foreshore represent dominantly the saltation mode of bed load transport. This is the transport caused by the wave uprush and wave downrush after the wave breaking has taken place. All the samples show considerable similarities and represent d_{50} = 0.50mm. This is considerably coarser than the medium sediment size on the open

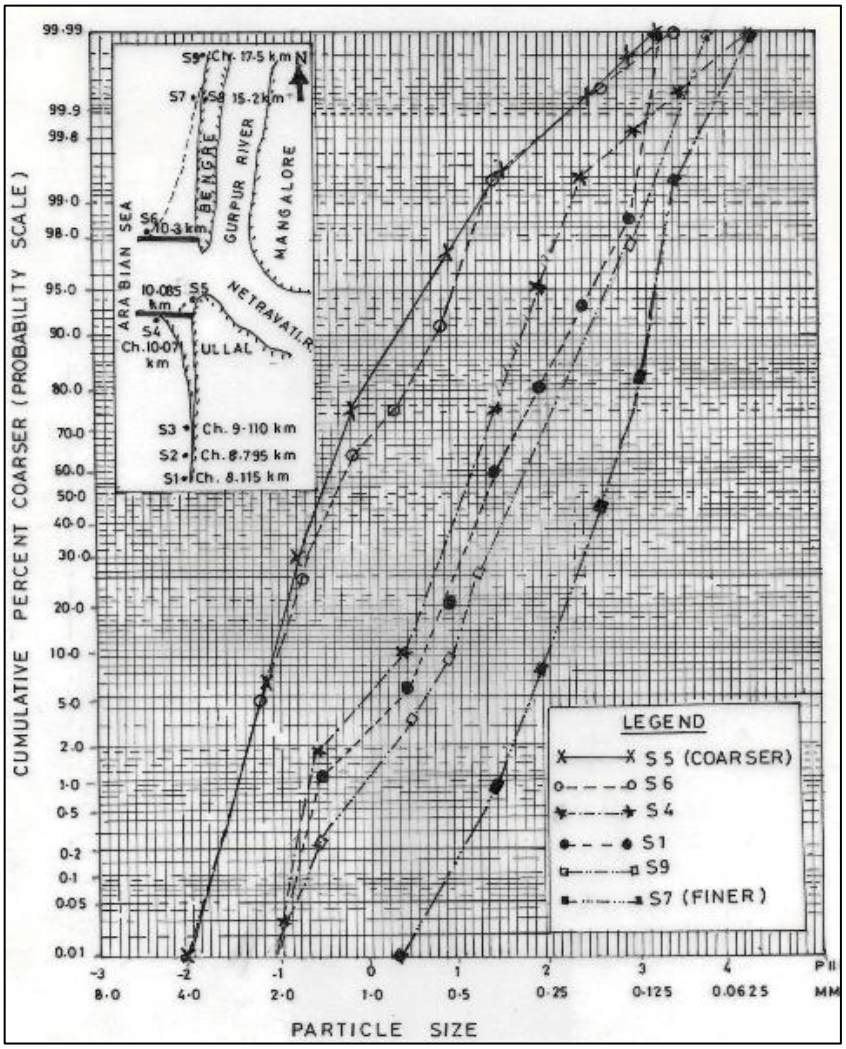

Fig. 2.Grain Si e Analysis of Sand Samples

beaches of Mangalore coast. This indicates that these sediments are those brought by a mode different from the wave induced mode. The only possibility is that these sediments are bought by the rivers Netravati and Gurpur. To confirm this, sediment samples have been collected from inside the river estuary (S_5) and compared with the sediment samples on the beaches adjacent to the river mouth (S_1 to S_4 on Ullal side and S_6 to S_7 on Bengre side).

From the Fig. 2 it is clear that, considerable similarity in the distribution curves indicate that the beach sand on either side of the Netravati – Gurpur river mouth are the sediment brought by these two rivers. When the KREC study team visited Ullal and Bengre during May 1994 and June 1994, when the construction of the two breakwaters were completed, it found considerable deposition of sediment on the northern side of the Bengre breakwater and also on the southern side of Ullal breakwater. The sediment size analysis indicates that the sediment in this deposit is brought by the river and there were clear evidences in the form of shoals to indicate that the sediment brought by the rivers Netravati and Gurpur is moving around the breakwaters and getting deposited on the beaches on Ullal and Bengre side, maximum being on Bengre side. Distribution curve of S_6 is almost matches with S_5 and by comparing the curves S_6 and S_5 with S_4, it is clear that, the sediment at S_6 and S_5 is coarser than that of S_4. Similar observations were made when the KREC study team visited the site during 1997, 1999, 2000, 2003, 2004, 2005 and 2008.

To confirm the fact that these sediments are brought in by the rivers and not due to the littoral drift, samples were collected on either side of breakwater, further North and South of river mouth. It can be clearly seen from the Fig. 2, that these samples show distinctly different size distributions with the Bengre sample (S_6) being considerably coarser than the sample further north of it (S_7 and S_9). If it is the littoral drift that is getting trapped at Bengre, by the breakwater, then the sand at S_6 must be slightly finer or at least the same as the sand at S_7 and S_9, but this is not the case. Size distribution curves alone cannot provide all the evidence but are definite indicators of the mode of transport and depositional environment of the beach sediments. To strengthen this fact, different analysis were carried out and the results of the same are not discussed in the present paper, due to the restriction on number of pages.

Sediment Trend Matrix Analysis

As a part of continuation of the research towards finding the causes of deposition on Bengre sand spit, Sediment Trend Matrix Analysis was carried out and the results of the same are discussed in the following section. Out of 12 sample locations around the Netravati – Gurpur river mouth, only 6 representative locations (to reduce the size of the matrix) were selected to prepare STM as shown in Table 2 and then to draw Sediment Transport Paths (STP) as shown in Fig. 3. To show STM and STP in the present paper, only 1994 data was considered. The mean grain size is finer (F), the same (S), or coarser (C); the sorting is better (B), the same (S), or poorer (P); the skewness is more positive (+), the same (S), or more negative (-), when a possible deposit is compared to a possible source. For explanation the following examples are considered.
The beach face sample at location 15 (Possible deposit) is finer, better sorted and more negatively skewed than the sample at location 4 (possible source) and hence the trend (FB-) indicates CASE I total deposition (dotted line in STP).

- The location 9 is not a source for any other locations, since the trend (FP-) is rejected.

- If the sorting and skewness values are same in both the locations, then also the trend is rejected.
- Shaded boxes indicate trends that are impossible between a deposit and its source. The above points are represented pictorially in STP (Fig. 3).

Table 2.STM around Netravati Gurpur River Mouth November 1 4

		SEDIMENT SOURCE							
	Location	**4**	**7**		**1**	**13**	**15**	**Grain si e characteristics**	**Inferences**
S E D I M E N T D E P O S I T	**4**		C P -	F P -	F P +	C P -	C P +	M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	4 → 7,9,13&15
	7	F B +		F P -	F B +	C P +	C P +	M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	7 → 9,13&15
		C B +	C B +		C B +	C B +	C B +	M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	
	1	C B -	C B -	F P -		C P -	C P +	M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	10 → 7,9,13&15
	13	F B +	F B -	F P -	F B +		F P +	M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	13 → 9
	15	F B -	F B -	F P -	F B -	C B -		M_Z (Φ) σ_I (Φ) S_{KI} (Φ)	15 → 9

STM and STP drawn for beach sand around Netravati –Gurpur river mouth for the year 1994 indicates 13 possible source deposit relationships. Out of 13 relationships, 9 trends are towards northward and 4 trends are towards southward in direction. These relationships perfectly suits with the sedimentation processes around Netravati – Gurpur river mouth. This indicates that sediment from the Netravati- Gurpur river mouth is moving towards both Ullal (South) and Bengre (North) sand spits with predominant northern direction. The supply of

sediment for the growth of these spits is from river discharge. Since the Netravati-Gurpur river is tropical in nature the discharge mainly depends on the monsoonal rainfall. Also, 87% of the annual average rainfall is during Southwest monsoon, during this season, both river discharge and the supply of sediment to the shore are maximum. Similar observation were made in [Dwarakish et. al. (1998)], where it was concluded that Netravati –Gurpur river acts as a source for beach sand of Ullal and Bengre with maximum sediment movement towards Bengre side. Since there is no large scale erosion or deposition is observed around Netravati – Gurpur river mouth, it is clear that the deposition of sand on the Bengre side is mainly due to the sediment brought by the Netravati –Gurpur Rivers [Dattatri.J et.al. 1997; Dwarakish et.al 1997; Dwarakish and Natesan 2005].

Location 13 (possible deposit) is finer, better sorted and more positively skewed than the sample at location 10 (possible source) and hence the trend (FB+) indicates CASE IIIA selective deposition (solid line in STP).

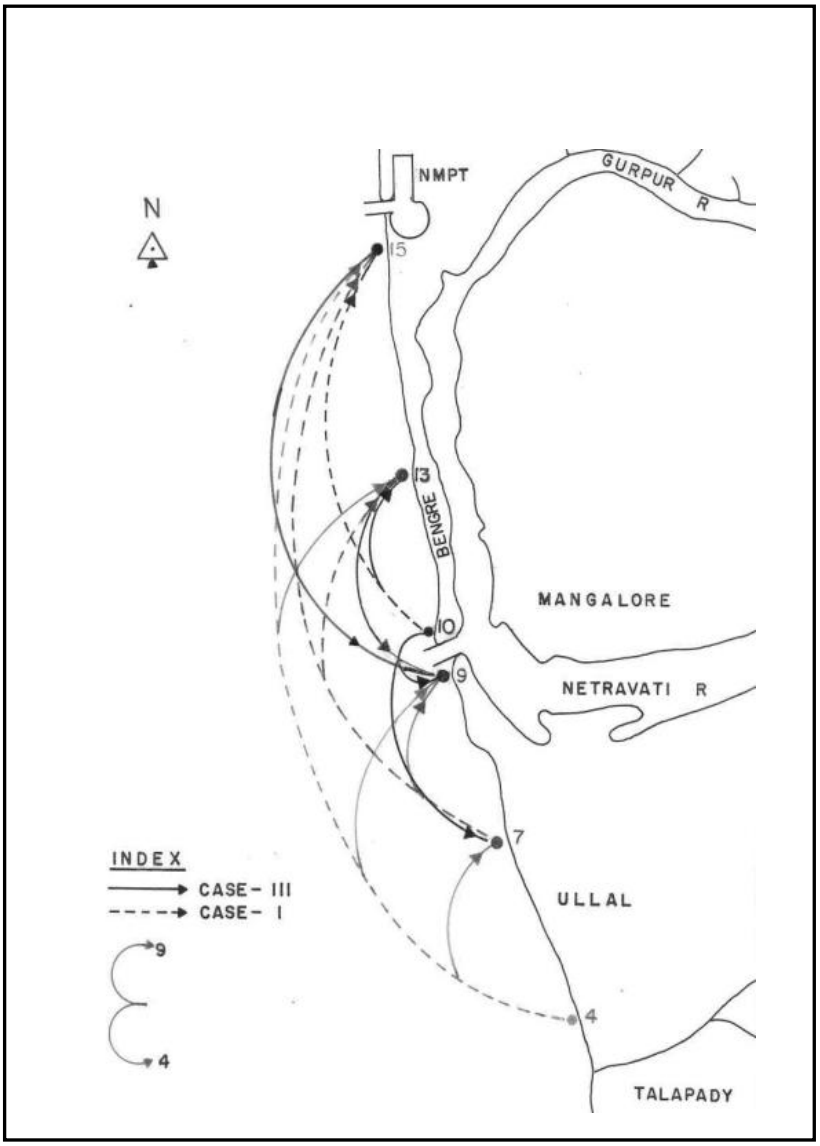

Fig.3. STP around Netravati -Gurupur River Mouth- November 1 4

CONCLUSIONS

In the present study, an attempt was made to integrate different methods to understand the Netravati-Gurpur river mouth dynamics. Based on this study the following conclusions were drawn.

- Deposition on the Bengre spit is due to predominant movement of sediments towards North from Netravati- Gurpur river mouth.
- Sediment transport is from North to South during pre-monsoon season and vice- versa during post-monsoon season, coinciding with general currents pattern.
- The predominant movement of sediment towards North is observed, long before the construction of breakwaters at Netravati-Gurpur river mouth.
- Deposition on the northern sand spit (Bengre) is due to the sediment brought in by Netravati-Gurpur Rivers and not due to the littoral drift.
- Littoral drift in the study area is insignificant. Net sediment transport is towards South and the quantity is 0.225 Mm^3 / Yr.

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