International Journal of Current Engineering and Technology

ISSN 2277 – 4106

Available at http://inpressco.com/category/ijcet

Research Article

River Mouth Dynamics- View from Space: A case study of the Mulki-Pavanje River, South Kanara

Shalini R[a*], Sowmya M[a], Hedge V S[b] and Krishnaprasad P A[b]

[a]Global Academy of Technology, Bangalore-560098
[b]SDM College of Engineering and Technology Dharwad 580002

Abstract

River mouths are dynamic especially in tropical coast line. Human activities within and around the river mouths such as navigation, agriculture, fisheries, aquaculture, transportation and communication, recreation etc., promote economic growth of the area, and therefore it is essential to maintain stable condition around the river mouth. There are several problems associated with a river mouths such as, sedimentation and siltation, shifting of the river mouth and erosion of the river bank. The Mulki-Pavanje river mouth is one such environment. Sand dredging is going on to overcome the problems due to heavy sediment deposition. In order to understand the causes, mechanism and to infer trends of changes Remote sensing and Geographical information system technology has been employed to understand the dynamic environment. Multi-date image analysis for the period between 1965 and 2013 has been carried out to understand morphological changes around the estuary. Multi-date image analysis revealed a paired spits -one growing from north to south another growing from south to north, of which northern spit is growing dominantly at the expense of southern spit simultaneously with shifting of the river mouth southward. Number of sand bars and mudflats present in the estuary indicate landward and shoreward movement of sediments in different seasons. Further growth of northern spit in the coming years is also expected and hence the river mouth shifting, which affects the habitat nearby and human activity is to be checked.

Keywords: *River Mouth Dynamics, - Space Technology, Central West Coast of India, Mulki-Pavanje River, Spits, mud flats, Submerged bars, Sand Dredging, Multi date images, Sedimentation*

Introduction

River mouths, especially in tropical coast are the area of complex, dynamic and delicate environment and undergo continuous changes in response to natural and anthropogenic activities (Berlanga, and Ruiz Luna, 2002). The rate and scale of the changes are highly variable both temporally and spatially. Space technology such as Global positioning system (GPS) enable to map accurately Aerial photographs and satellite images coupled with GPS, not only enable us to quantify the changes but also enable us to predict trends of changes when multi date images are considered (Ramaswamy *et al*., 1991;, Kunte and Wagle,1993). Also due to its synoptic coverage enable us to relate the dynamic changes to regional phenomena.

Satellite data is available on Indian coast since 1989 and application of these data along with the available Survey of India toposheets and GPS can be effectively used to understand the dynamic coast line like in the tropical climate. Tropical coasts due to seasonal variation in wind, wave, and sediment influx due to variable flow in the river are highly dynamic. Especially, the Southern Karnataka coast where average annual rain fall is ~600mm. is highly dynamic, and land based survey become impossible during monsoon and floods, hence application of space technology is handy. Indian Space Research Organisation, Governemnt of India has launched series of satellites which are pouring enormous amount of data with different temporal and spatial resolution. In the present paper an attempt has been made to use this technology to understand nature and trend of the shore line dynamics taking Mulki-Pavanje river estuary as an example.

Methodology

The river mouth dynamics have been studied by multi-date image analysis. Survey of India Topo sheet of the year 1965 has been used, taken, geo referenced and rectified using PG Steamer software and projected to the WGS 1984 Coordinate system. IRS LISS-III satellite data of 2005 and Google Earth images of 5 years i.e 2004, 2010, 2011, 2012 & 2013 are processed using Digital Image processing software (PG Steamer), and image processing techniques like Edge enhancement, Radiometric Correction, Spectral enhancement etc have been done. The processed images are brought to the Geographic information system environment (ArcGIS 9.3), and

*Corresponding author: **Shalini R**

rectified, projected with reference to SOI toposheet. For each image each separate shape files (Polyline feature) are created and digitized. All the digitized shape files are later overlaid on one above other and compared. River mouth width is measured from all the images for the period between years 1965 and 2013 i.e, 48 years and also river mouth is observed for mudflats, submerged bars. The consolidated map is generated by map composition technique using ArcGIS 9.3.

During the months of monsoon and postmonsoon a field check was done to confirm features observed from the satellite images and using Garmin made GPS, spit on the southern side was mapped. Relevant field photos were taken to compare with the features observed from the satellite imagery.

Study area

The study area is located at latitude of 13° 4' N and longitude of 74° 46' E and is situated about 30 kms north of Mangalore (Fig.1). It comprises tropical monsoon climate and tidal condition is ranging between 1 and 3m which characterize mesotidal condition (Davies, 1980). The area receives annual rainfall of approximately 600cms. Geologically the area consists of migmatitic complex locally capped by laterites and Quaternary alluvium.

Wind approach the coast from South west during monsoon while during other season it is mostly from NW and from west. Waves in the region range between 1-2 m during fair-weather season and 2-3 m during monsoon. Wave approach the coast from North West during January and February and regional sediment transport during the period is towards south whereas during March to May, Wave approach the coast from west and generate many circulating cells in the surf zone (Hegde *et al*., 2009; Murthy & Veerayya, 1985). During monsoon (June to September, Waves approach the coast from South west and generate strong northerly alongshore drift.

Across the river mouth a paired spit is growing from north and from south. Sedimentation and siltation appears to be the major problem in the area. On the northern spit dredging is going on (Fig.2). On either side of the river mouth long sandy shore exists.

Results and observations

A visit to the site during monsoon, revealed severs erosion on the southern side beach while during the post monsoon development the berm and their erosion implying deposition (Fig.3). The size of the berm is larger on the north side suggest that northern side receives more sediments than the southern side.

The river mouth dynamics is studied using Remote Sensing data and field visit. Observation of LISS III image of 2005 reveals presence of curved submerged bar in front of the river mouth and depositional features with in estuary (Fig.4 a and b) . Field observation reveals that these deposits with in the estuary are silty, clay and mud flats with fine sand. Some of the mud flats are stabilized by mangrove vegetation (Fig.5), while some mud-flats are yet to be covered by mangrove vegetation which suggests that their recent development (Fig. 6). These mud flats have been digitized and mapped (Fig.1).

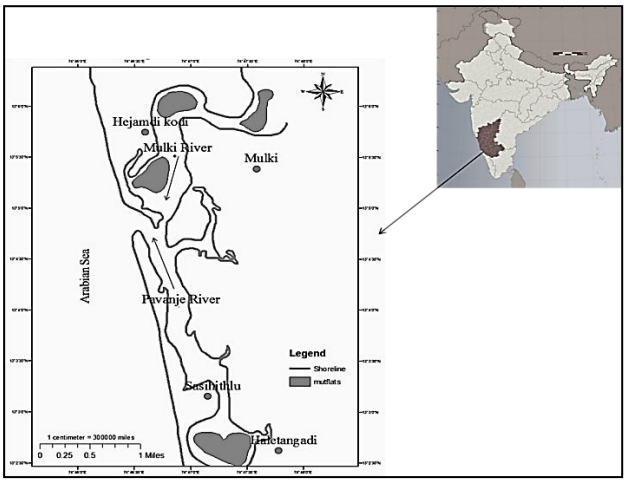

Figure 1 Location map of the study area.

Fig 2 Photo showing dredged sand dumped on the northern spit at Hejmadi

Fig3. Field photo showing erosion of berm on the foreshore at Mulki

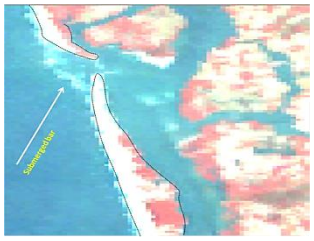

Fig 4a Presence of curved submerged bar (shown by arrow) in LISS III image

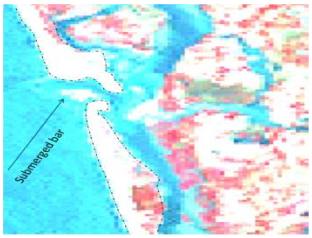

Fig 4b Ditached bar exposed during low tide time in the mouth region at Mulki as shown by arrow

Fig 4c Submerged bar exposed during low tide time in the mouth region

Fig 5 Mangrove vegetation on the old stabilized mud flats in the estuary

Remotely sensed multi-date image analysis revealed that spit across the river mouth is highly dynamic. The satellites images used in the study (2004, 2005, 2010, 2011, 2012 & 2013) to understand spit dynamics are acquired between the period of October & February, and these represent the post monsoonal and pre-monsoonal condition. Across the Mulki-Pavanje River mouth, the spit growing is drastically changing its length and morphology and significant sized sand bars are also common near the river mouths. The interesting feature observed in the study area is the presence and disappearance of the crescent shaped submerged bar in front of the river mouth which appear during depositional phase and disappear during erosional phase (Fig. 7). Sequential multi-date image observation and analysis indicates that the sand bar migrates shoreward and merge with the spit during the depositional phase. Observation of the 2004 image indicates that distal portion of the southern spit is broken and got detached from the main land (Fig. 8). The detached part found to get welded to the northern spit in subsequent image. This can be clearly seen in 2005 image (IRS LISS III) where the river mouth is very narrow because of the welding of the broken spit to the northern spit. It is also observed that river mouth is shifting northward (Fig. 9) and there is corresponding change in river mouth width from 1965 to 2013 (Fig .10). In 9 years i.e. from 2004 to 2013, spit growing from south to north got eroded by 590 m while spit on the northern side grew towards southward by 570m and a balance of eroded sediment is believed to be moved landward and deposited with in the estuary or appear as submerged bar. Presence of many mudflats especially on the northern channel of the river corroborates the facts that sediment movement is landward. Low flow condition in the river during pre-monsoon and strong onshore movement of the materials is believed to be responsible for siltation in the estuarine channels.

Fig 6 Recently developed mud flat uncovered by vegetation

Discussion

Analysis of the multi-date satellite images indicated that between the period 1965 and 2013 northern spit of Mulki-Pavanje River is lengthened toward south whereas the southern spit is shortened which indicates the growth of the spit is at the expense of southern spit. Similar observations are also made by Hegde *et al*., (2012) for the spit growth along the Central west coast of India

Fig 7 Erosion of beach near to river mouth

Fig 8.Images used for Multi-date Image Analysis record changes in different images

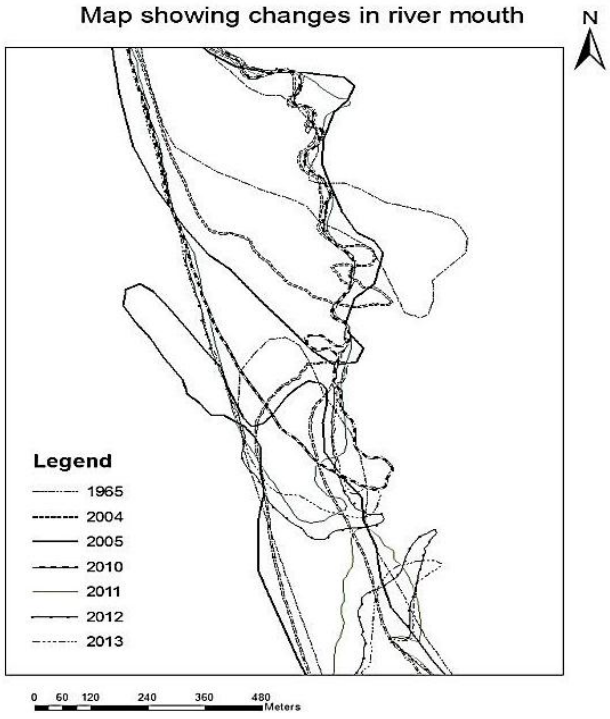

Fig 9 Superimposition of multi-date images showing changes in river mouth

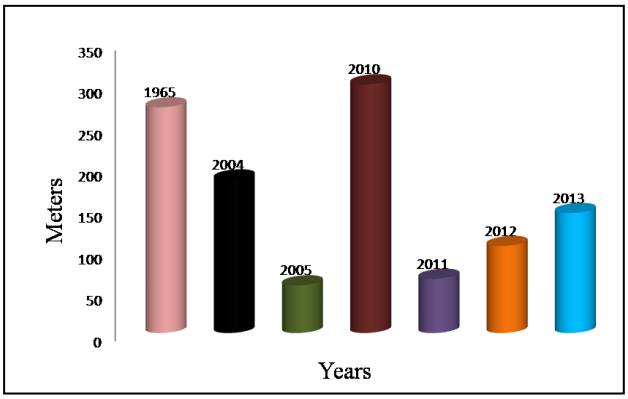

Fig10: Chart showing width of river mouth in 1965, 2004, 2005, 2010, 2011, 2012 & 2013

Due to natural sedimentation process the migration of sand spits leading to narrowing of the river mouth, shifting of the river mouth and often erosion of the opposite bank is accompanied by blocking of the river mouth leading to siltation in the river mouth. Similar process have also been observed at the Sharavati estuary (Hegde *et al*., 2004). The Mulki-Pavanje river mouth, the part of Central West Coast of India is also in such environment, but unlike other river mouths this area is prone to heavy sediment deposition, hence multiple sources could account the sediment budget such as off shore source and alongshore source. At many places alongshore source is attributed to spit growth (Kunte and Wagle, 1991, 2001). Since both siltation and spit growth both are observed in the study area, alongshore could be a significant source. Alongshore transport of offshore materials in the estuarine region are reported for the Sharavati River mouth at Honnavar (Hegde *et al*., 2006) and Netravati Gurpur at Mangalore (Shankar and Manjunath , 1997). Since size of the river is moderate, to explain such heavy sedimentation multiple source viz from inland, alongshore and offshore is visualized. The sequential development of mud flats, erosion of the southern spit, its welding to the northern spit corroborates the above inference. Presence of stabilized mud flat by mangrove and un-vegetated mud flats implying different generation of mud flats suggest that this process is going over a long period and if undisturbed continue to develop similar features. It implies that northern spit will grow at the expense of the southern spit further and river mouth will shift south further.

Conclusion

1) View from space i.e. Remote Sensing and Geographical Information System accompanied by GPS survey which have wide range of application in every field, can be effectively utilized to understand the river mouth dynamics.
2) We have made use of this technology to its best to have the synoptic view and to understand the changing trend of the dynamic environment. This technology helped in investigating the nature and scale of dynamic Mulki-Pavanje river mouth,

3) A comprehensive solution by modifying of sediment sink, sediment movement, and pattern and sedimentation process to prevent further movement of sand spit and by constructing coastal engineering structures appears to be the viable solution.
4) The investigation helps to carry out the major the research work and build a conceptual model of this dynamic system.

Acknowledgement

The authors sincerely thank the Visveswaraya Technological university for the grant (VTU/Aca/ 2010-11/A-9/11355) during which the present study is carried out. The authors sincerely thank Principal Dr. Narendra Vishwanath, HOD Dr, C. V. Srinivasa and Management of the Global Academy of Technology, Bangalore, for the facility provided to carry out the work and encouragement for the work.

References

A.D. Short, and P.A. Hesp, (1982) Wave, beach and dune interactions in southern Australia, *Mar. Geol*. 48 259–284.

C.S. Murthy, and M. Veerayya, (1985) Long shore currents and associated sediment transport in the near shore areas of Kerala and Goa, West Coast of India, *Mahasagar- Bulletin of the National Institute of Oceanography*. 18(2) 163-177.

Gonzalo Malvarez García, John Pollard and Róisín Hughes. (2002) Coastal Zone Management on the Costa del Sol: a Small Business Perspective, *Journal of Coastal Research*, Special Issue 36,

G. Udhaba Dora, V. Sanil Kumar, C. Sajiv Philip, Glejin Johnson, P. Vinayaraj and R. Gowthaman, (2011) Textural characteristics of foreshore sediments along Karnataka shoreline, west coast of India, *Int. J. Sedim. Res.*, vol.26;364-377

Kunte, P.D and Wagle, B.G (1993) Determination of net shore drift direction of Central West Coast of India using remotely sensed data, *s jour.Coast.Res*., Vol 9, , pp 811-822

Nimalanathan Angusamy, G. Victor Rajamanickam, (2007) Coastal processes of Central Tamil Nadu, India: clues from grain size studies, *Oceanologia*, 49 (1),

P. Chandramohan, V. Sunil Kumar, B.U. Nayak, and N.S.N. Raju, (1994) Surf zone dynamics along the coast between Bhatkal and Ullal, west coast of India,*Ind. Jour. Mar. sci.*, 23, 189-194

Ramasamy, S. M., Bakliwal P.C and Verma, R.P, (1991) Remote sensing and river migration in Western India, *Int. Jour. Remote Sensing* Vol 12, No 12, , pp 2597-2609

Shoreline protection manual, Vol-1, Department of the Army, Waterways experiment station, *corps of engineers, Mississipi* 39180

V.S. Hegde, G. Shalini, S.R. Nayak, A.S. Rajawat, A. Suryanarayana, S. Jayakumar, B.K. Koti, K.H. Girish, (2009) Low scale morphodynamic process in the vicinity of a tropical estuary at Honnavar, Central West Coast of India, *Jour. Coast. Res*. 25(2) 305-314.

Hegde V. S., Shalini, G. and Kanchanagouri, D. Gosavi (2006) Provenance of heavy minerals with special reference to Ilmenite of the Honnavar beach, Central West Coast of India. *Current Science* Vol. 91 No5 pp 644-647.

Y.W. Shaghude, Mmarg-I (2004) final research report: research report no: ims/2004/01 sponsored by western Indian Ocean marine science association (wiomsa), the study of sediment chracteristics and nearshore sediment dynamics in coastal Tanzania, *University of Dar es Salaam. Institute of Marine Sciences Sponsored by western Indian Ocean marine science association (wiomsa)*, December