A Study on Effect of Coastal Erosion in Dakshina Kannada using Remote Sensing Technique

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Abstract- *Coastal erosion being one of the most dynamic processes occurs when wind, waves and long shore currents move sand from the shore and deposits it somewhere else. This dynamic process occurring in Nethravathi-Gurpur estuary, Mulki-Pavanje estuary and Udyavara estuary over a period of time is efficiently and accurately analysed using remote sensing technique by using topographical map of 1969 and IRS image of 2000 with the aid of GIS software. The vector layers generated with the help of Arc Map software are integrated and significant changes are demarcated on the maps. On the whole the overall dynamic changes occurred in and around the estuary points of Dakshina Kannada and Udupi Districts have been studied under this project. The geological pattern, meteorological parameters, salt water intrusion and aquifer characteristics of the study area are also covered under this project.*

Keywords- Coastal Erosion, Remote Sensing, GIS, Estuary.

I. INTRODUCTION

Every land mass on Earth has miles of coast at the interface between the hydrosphere and the lithosphere. Natural forces such as wind, waves and currents are constantly shaping the coastal regions. The combined energy of these forces moves land materials. The landward displacement of the shoreline caused by the forces of waves and currents is termed as coastal erosion. It is the loss of sub-aerial landmass into sea or lake due to natural processes such as waves, winds and tides, or even due to human interference. While the effects of waves, currents, tides and wind are primary natural factors that influence the coast the other aspects eroding the coastline include: the sand sources and sinks, changes in relative sea level, geomorphological characteristics of the shore and sand, etc. other anthropological effects that trigger beach erosion are: construction of artificial structures, mining of beach sand, offshore dredging, or building of dams or rivers.

Coastal erosion occurs when wind, waves and long shore currents move sand from the shore and deposits it somewhere else. The sand can be moved to another beach, to the deeper ocean bottom, into an ocean trench or onto the landside of a dune. The removal of sand from the sand-sharing system results in permanent changes in beach shape and structure. The impact of the event is not seen immediately as in the case of tsunami or storm surge. But it is equally important when we consider loss of property. It generally takes months or years to note the impact of erosion; therefore, this is generally classified as a "long term coastal hazard".

II. PHYSIOGRAPHY AND GEOLOGY OF THE STUDY AREA

The study areas considered in this work includes two major regions viz. Mangalore and Udupi which is a part of undivided Dakshina Kannada district.

Mangalore is located at 12°87' N 74°88' E with the Arabian Sea in the west and the Western Ghats in the east. It is being one of the major cities on the Karnataka coast gaining economic importance due to urbanization and industrialization. The Netravathi and Gurpur (N-G) rivers encircle the city by flowing around its south and north respectively and debouch into the Arabian Sea at its southern side. It is estimated that out of 290 Km length of Karnataka coastline, about 80 km (27.5%) is vulnerable to severe erosion during the SW monsoon. The areas covered under this region for our study purpose are mainly Netravathi-Gurpur and Mulki-Pavanje estuary and the climate of these two estuaries is same as that of the Dakshina Kannada district. Udupi coast in Karnataka state, along the west coast of India, selected as a study area, is well known for sandy beaches, aquaculture ponds, lush greenery, temples and major and minor industries. It lies between 13°–13°45' north latitudes and 74°47'30''–74°30' east longitudes, the length of the coastline is 95 km, and is oriented along the NNW–SSE direction. It is vulnerable to accelerated sea level rise (SLR) due to its low topography and its high ecological and touristy value. The area covered under this region for our study purpose is Udyavara Estuary.
Mangalore city is located in the confluence of Nethravathi and Gurupura rivers. It is bound in the east by the Western Ghats and in the west by the Arabian Sea. It has an average elevation

of 45 m with reference to the mean sea level (msl). The Netravati and Gurpur (N-G) rivers encircle the city by flowing around its south and north respectively and debouch into the Arabian Sea at its southern side. Udupi District has an elevation of 43m with reference to the mean sea level. This city is encircled by Sita and Nandini rivers.

The geology of Mangalore city is characterized by hard laterite in hilly tracts and sandy soil along seashore. The underlying geological formation is of archaic origin and consists of metamorphic schist and crystalline gneiss with granite and quartzites outcrops, which readily decomposes into reddish felspharic clayey soil, which is deep and supports valuable evergreen and semi-evergreen forest. The soils mostly lateritic and are well drained with moderate erosion. Udupi coast is well known for the coastal ecosystem such as mangroves, coastal forest, aquaculture ponds and long sandy beaches. All these activities will be increasing the vulnerability of the Udupi coast. The basement rocks of the district are banded gneisses of the Archaean period. They are highly weathered, jointed, and sheared. They are overlain by ferruginous latérites which are highly permeable and which favor heavy leaching during the rainy season. Clay layers found below the beach sand are associated with sand and silt.

III. METHODOLGY

The Indian remote sensing data in digital mode was processed using different functions available on ERDAS software. The base map generated based on the Survey of India topographical maps pertaining to the study area was scanned and converted into digital format. The satellite image was rectified in such a manner that the spatial co-ordinates correspond to its geographical co-ordinates and the image was reset using nearest neighborhood method. The projection applied in the study was geographic latitude/longitude. The registration was carried out by assigning permanent, sharp, corresponding, and well spread adequate number of Ground Control Points on digital data and swiped vertically and horizontally to check any shift in the corresponding permanent features. Various image processing techniques like contrast stretching, edge enhancement , principal component analysis, band ratioing, resolution merge, density slicing, supervised and unsupervised classification were carried out to extract maximum information on various themes like geology, geomorphology, structural features, shoreline detection, land-use land-cover etc. basic information such as transportation network, tank, rivers etc. were taken from SOI topographical maps. The GPS values were used for validating the maps.The secondary data collected from various departments have been used directly or indirectly. The secondary data like rainfall, temperature, humidity, waves, currents etc. are collected from following departments (i) Indian Meteorological Department (ii) Statistical Department.

The study area has a tropical climate with very heavy rainfall in the rainy season almost eroding all the sediments towards the sea, due to which excessive erosion takes place in the estuary regions of the study area. The rainfall in our study area is 3787.7mm and the total runoff is 3712.733mm. The area has a very high temperature during the summer season which rises up to 40°C to 42°C. The values of the meteorological parameters and their characteristics do not vary much with time. Since there is a heavy rainfall in the monsoon season the relative humidity is also quiet high in this region. The rate of evaporation in the study area is drastically high and the wind velocity near the shore is also considerably high.

The study area has rich groundwater resources and fertile soil which can be properly developed and managed for better returns. The water supply in the basin is more than adequate to harness additional yield from the basin. The chief adverse effect, namely the salinity problem, can be mitigated with precautionary measures such as avoiding the over exploitation of groundwater, confined and unconfined aquifers and interlining of the deep wells and bore wells with impermeable membranes.

The distribution of fresh water aquifers is controlled by the dynamic equilibrium between hydrostatic heads in the fresh and saline water zones, influx of sea water into the streams and lagoons and the relative mound of sea with respect to the land mass. A number of unconfined aquifers are seen in and around the estuary regions where water is obtained at a depth of 5.5m to 8m from the surface.

IV. RESULTS AND DISCUSSIONS

Beaches are the most changeable of landforms and most if not all, of the material in them is periodically acted upon by waves. Together will the adjacent near-shore zones beaches act as buffers to wave energy (Kumar). Their response to the energy variations may be traced to changes in morphology and sediments.

A. Netravathi-Gurpur Estuary

The Netravathi river mouth when analyzed using the vector layers reveals that the mouth of the river has shifted northwards to a small extent. The southern spit has gained a considerable amount of land whereas the tip of the northern spit has lost considerable amount of land. The tip of the southern spit has lost considerable amount of land in the eastern side of the mouth. Excessive rate of accretion is

observed in the bottom most part of the southern spit with reference to the eastern direction. There are significant changes in the positions of the mud flats and river islands situated in the eastern part of the northern spit. Most of the river islands have expanded in the same location and these morphological changes have been brought out very clearly in the overlaid vector maps. Development of tidal flats and river islands on the southern bank of the Netravathi estuary clearly shows the shifting of the river mouth from south to north. The extent of area of tidal flats in the Netravathi river in the eastward direction has massively increased. River inlet widens during the monsoon season and gradually narrows during the non-monsoon season.

B. Mulki Pavanje Estuary

The rivers Mulki and Pavanje have a common exit to the Arabian Sea near Mulki. The multidated data study based on 1967 and 2000 indicates that the river mouth has shifted northwards. However the previous study by Dinkar considering 2006 map indicates that the shift is towards south The Hejmadi-Kodi spit has shortened and Mulki spit has lengthened. The Mulki and Pavanje rivers have changed the positions of their river mouth on several occasions in historical times. The earlier study by Bhat, (1995) has indicated that the northern spit had lost considerable land and southern spit has gained considerable land. The shifting of river mouth either to the south or north is also evident in recent images. Sea walls have been constructed to avoid the sea erosion near mouths. Subsequent to this, the Hejmadi-Kodi experienced more erosion. The orientation and further extension (pointing direction) of the spit shows that the littoral currents move dominantly northwards ion the central parts of the study area. There are number of rivers discharging water to the Arabian Sea and during pre-monsoon season, their discharge is very less and during this period, the littoral currents dump the sediments along the river and bay mouths and develop sand bars.

C. Udyavara Estuary

River originates below the Western Ghats and hence contributes lesser amount of sediments to the Arabian Sea. The river runs almost parallel to the shoreline for a considerable length of about 12km. Breakwaters have been constructed near the river mouth to maintain the depth of estuary, as this is one of the major fishing port of Udupi District. This region had no breakwaters in the year 1967, but for the purpose of establishment of the port the breakwaters were constructed in the late 90's in order to prevent the siltation problem. From the overlaid vector maps of the year 1967 and 2000 it is evident that the construction of breakwaters has resulted in widening of the beach in the northern side and also there is significant accretion in the northern side as well as the southernmost portion of the breakwater. The overlaid map also reveals that there is a considerable shift in the position of the spit in the southern side of the breakwater. The river joining the sea had five river islands in the year 1967, but in the year 2000 there is considerable change in the areas of the respective river islands. Not much significant changes are noticed in and around the estuaries, as the St. Mary's group of islands is situated just to the west and north-west of this river mouth and acting as a wave breaker zone and due to this the northern side of the breakwater show more accretion. Northern most island of the St. Mary's group show the presence of sandy beaches in summer season indicates there is an on-shore off-shore sediment movement in addition to along shore sediment movement. The source of the sediments deposited close to breakwater, especially in the northern part of northern breakwater indicating that there is an increase of sedimentation in some area by increase erosion in deltas.

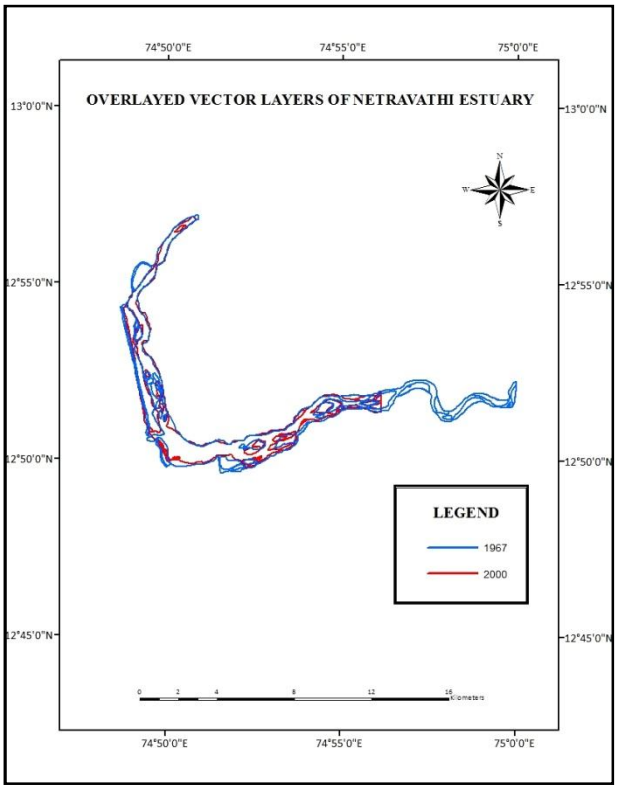

Fig 4.1: Overlaid vector layers of Netravathi estuary

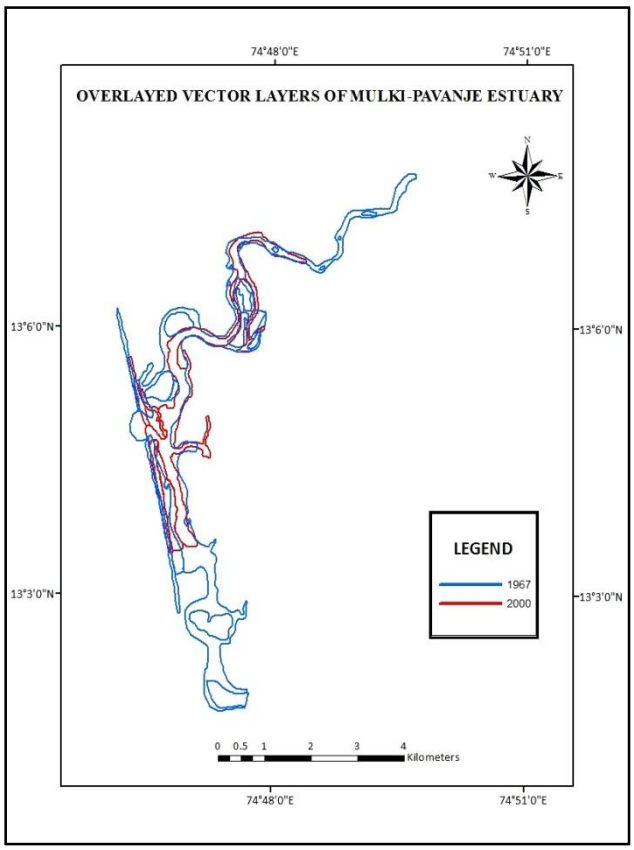

Fig 4.2: Overlaid vector layer of Mulki-Pavanje estuary

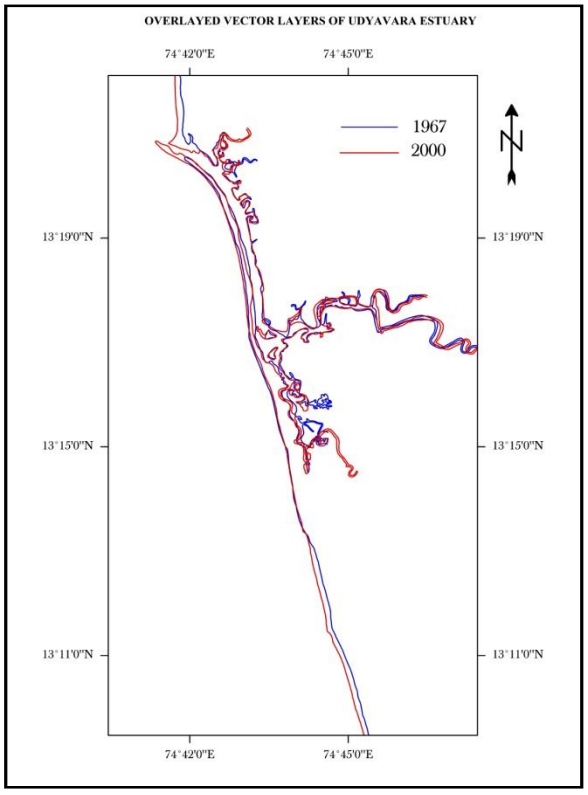

Fig 4.3: Overlaid Vector Layer of Udyavara Estuary
(Source: H.G.Bhat)

V. CONCLUSIONS

Dakshina Kannada and Udupi districts being the most developing districts of Karnataka are gaining huge importance due to the commercial growth and development of tourism industry. Dakshina Kannada which is located below the Western Ghats is characterized by hard laterite in hilly tracts and sandy soil along seashore. The underlying geological formation is of Archaean origin and consists of metamorphic schists and crystalline gneiss with granite and quartzes outcrops. Udupi coast is well known for its present coastal ecosystem, coastal forests and long sandy beaches which is increasing its vulnerability. The basement rocks of the district are banded gneisses of the Archaean period. The temperature in these regions vary from 30°C to 40°C and has a tropical climate with heavy rainfall in the monsoon seasons. The relative humidity is 81 percent due to which winters are generally warm. The study area has an overall runoff value of 370 cm. The study area has rich groundwater resources and fertile soil which have to be preserved by following sophisticated water withdrawal practices. The salinity problem can be solved if proper precautionary measures are taken such as maintaining adequate distances between the water withdrawal points like wells, bore wells etc. A number of unconfined aquifers are present in and around the estuary regions and water is obtained at a depth of 5.5m to 8m from the ground surface, thus indicating that the area is rich in groundwater sources and these sources can be utilized to a large extent provided we follow conservatory withdrawal practices.

The coastal processes are most dynamic in nature which has been revealed in our study. The estuary points of our study area have been subjected to severe changes over a period of time. The multi-dated data which was used in our study indicated several changes in and around the estuary regions. The mouth of Netravathi-Gurpur estuary has been shifted northwards and the southern spit has eroded considerably whereas there is no remarkable change in the shoreline in this location. The Google earth images reveal that the breakwater constructed in this estuary has collapsed to a large extent which has resulted in the erosion of the southern spit heading towards Ullal. The Mulki-Pavanje estuary has undergone a large amount of erosion as well as accretion. The northern spit, that is, the Mulki-Pavanje spit has experienced accretion whereas the Hejmadi-Kodi spit has lost considerable land resulting in loss of land and property. Temporary sea walls have been constructed in this estuary which is being eroded constantly till date. Break waters have to be constructed in this estuary so that there is no further loss of land in the coastal belt. The Udyavara estuary has not many

distinct changes but the construction of breakwater has widened the beach in the northern side resulting in accretion. There is a considerable shift in the position of the spit in the southern side of the breakwater. The breakwater in this estuary has been efficiently constructed and there is not much loss of land in this area. The presence of St. Mary's group of islands acts as a wave breaker zone which has indirectly resulted in no significant change in this estuary.

5.1 Suggestions

The southern spit of the Netravathi-Gurpur estuary has been subjected to drastic erosion as the breakwater constructed in this location has collapsed. Therefore this location requires the reconstruction of the coastal structures with the aid of which the rate of erosion can be mitigated. The Mulki-Pavanje estuary which has experienced quiet a considerable amount of erosion as well as accretion requires a break water construction so that the unpredictable erosion accretion can be controlled. There is no necessity for the construction of coastal structures in the Udyavara estuary as the existing coastal structure is efficiently working till date. There is immense scope for study in not only this area but along the entire coastal belt of Dakshina Kannada. Further studies can be carried out in Ullal spit which is located in the southern part of Netravathi-Gurpur estuary. Ullal spit is subjected to drastic shoreline changes and this can be observed clearly in the Google earth images. The sea walls constructed in this spit have already collapsed and during the monsoon season there is very large amount of erosion resulting in loss of life and property so further studies can be carried out in this location to calculate the rate of erosion and necessary remedial measures can be suggested for the same.

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