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Studies on morpho-dynamics of the Coastal Environment and Management using remote sensing technology on some part of the Prakasam district coastal zone , Andhra Pradesh, East Coast of India

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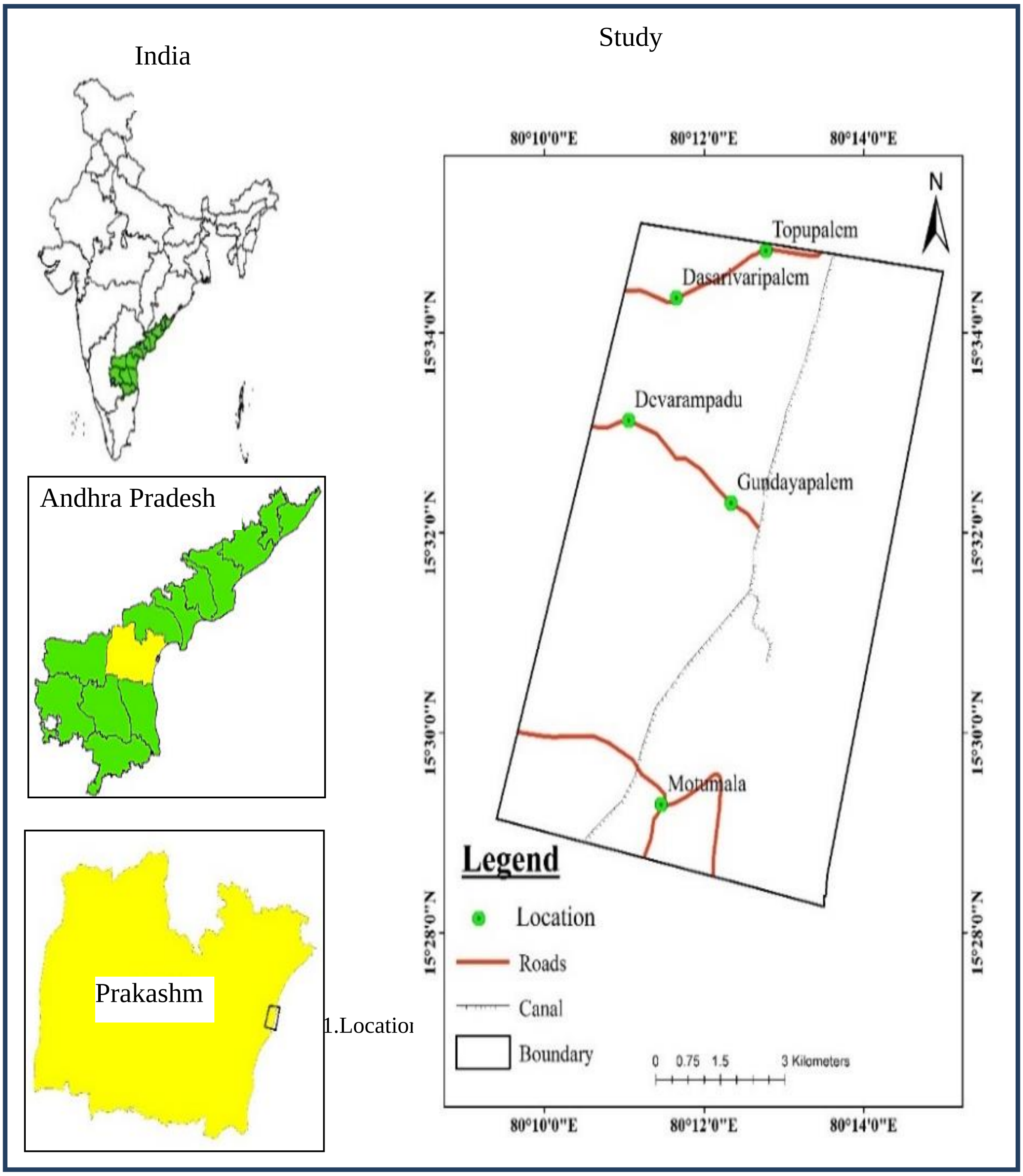
Abstract - Now a days the coastal changes are create lot of problems and it impact on all the environments including natural, social, economic and geological environments. The present study deals with the morphological changes are occurred along the Prakasam Coast South-East Coast of India. the Geomorphologic changes are here because of the natural disaster and anthropogenic activities are more and also rapid growth of population. It is immediately required to shield this coastal fragile ecosystem from further damage to make sure for property development. The coastal morphological changes and its impact on coastal ecosystem in the study area. it is also useful for further action plans for the policy makers to frame ideologies for the protection of the coastal environment. This study was carried out using multitemporal satellite images of IRS P6 LISS-III and Landsat 8 OLI/TIRS data from 2000 to2015. The subsequent short-term river mouth dynamics, coastal erosion and accretion rates were calculated for the years between 2000 and 2015. The erosion rate from 2000 to 2015 was slightly increased from 5.71173Sq.km. The total net rate of accretion was estimated at 6.352077 Sq.km. The accretion is more than the erosion and the high fluctuation of erosion and accretion were characteristics for the short-term scale at the river mouth.

Key words: Geomorphology, Coastal environment, Ecosystem, River mouth dynamics, coastal Erosion and Accretion.

Introduction: Ongole has an extreme weather Summers are hot and it is not advised to visit Ongole during summers. The minimum temperature during summers is 32 ^{0}C and maximum goes up to 38^{0}C, humidity is also high. Both Northeast and Southwest monsoons bring in a significant amount of rainfall. This region is also prone to cyclonic formations and thunderstorms and it is the reason to this area to have good rainfall. At a distance of about 25 km from Ongole is the Kothapatanam beach and the Vadarevu Beach is located at 6 km from Chirala town. This study of physical processes and responses in the coastal zone is often applied in nature, more than half of the population lives within 60 km of the coast, and the Human activities also impact on the coastal zone of Prakasam Thus, there is an urgent need to conserve the coastal ecosystem geological environments like sand habitats including individual plant species and communities and settlements, recreation, environment and Agriculture. In order to ensure the sustainable development is necessary to develop accurate, up to date and comprehensive scientific databases on habitats, protected areas, water quality, environmental indicators are carry out and periodic assessment of the health of the environment system. The modern scientific tools of remote sensing, GIS and GPS are extremely valuable in development of databases and to analyse in the integrated manner and derive management action plans. Availability of repetitive, synoptic and multi-spectral data from various satellite platforms, viz. IRS, LANDSAT, SPOT, have helped to generate information on varied aspects of the coastal and marine environment.

River mouth is a natural and tectonically checkpoint that exhibits large scope of physical, sedimentological, optical and biological conditions and also creek entrance is one of the most critical variables controlling the hydrodynamics and broader environmental processes of the creek in the Ongole area. The change on shore line is mainly associated with waves, tides, winds, periodic storms and sea-level change. The geomorphologic processes such as erosion and accretion and human activity impact on the changes of coastline can directly impact on the shoreline positioning. On an average, about 40% of Indian coastline is facing varying degree of erosion from last 15 years data (2000-2015), it observed that about 25-33% of Andhra Pradesh shoreline is experiencing erosion of various magnitudes. In this study, IRS P6, LISS-III and Landsat 8 OLI/TIRS multispectral data were used to delineate the changes of Gundlakamma River and Shoreline changes in spatial and temporal aspect were analysed using remote sensing and GIS technology.

Study Area - The present study area is located in the south east coast of Prakasam district of Andhra Pradesh, India. It spreads over 110 sq km. geographical coordinates are longitudes "80° 10′ 0″ to 80° 14′ 0″and 15° 34′ 0″ to 15° 28′ 0″ latitude. The objectives of study are changes on the coastal Geomorphology and their effective management of Coastal environment for future development, the river mouth dynamics, coastal erosion and accretion rates.



METHODOLOGY

The Data was used from the Survey of India toposheet no 66/A2, 66/A3/ 1, 2,3,5,6 and 7 with scale 1:50,000 and Multi-Spectral imageries from Landsat-8 Satellite data and IRS-P6, LISS III data were used and the Coast was digitized for the extent of

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the Agriculture, Aquaculture, Barren land, Mangroves, Open Scrub, River, Saltpans, Water ponds and Sand area were extracted using ArcGIS. The baseline map was prepared using Survey of India (SOI) Top sheet map Nos. 66A2 and 66A3 on 1:50000 scale. The multi temporal Landsat 8 OLI/TIRS images acquired for the period between February 9, 2000, March 18, 2005, May 27, 2010, and April 30, 2015 were used as primary data source for shore line extraction. The images are used for the analyses, different satellite types with different sensors and spatial resolutions and each image were cropped using area of interest cropping method. The cropped images were geometrically corrected by using the auto-sync tool in ERDAS Imagine 2010 and applying the UTM-WGS 84 projection coordinate system. After geometric corrections, all the images were processed digitally using the Water Index Method. Ongole South east coast was digitized manually with Arc GIS for the identified years, i.e. 2000, 2005, 2010 and 2015. Morphological position was exported to ArcGIS with attribute fields that included object ID, name, date, area and feature characteristics. These multi dated shape files of Coastal morphology were overlaid together for the identification of morphological changes. Then, coastal morphological change maps were prepared by using Arc GIS Software.

The Indian Remote Sensing Satellite IRS-1C, LISS III data, image processing and Geographical Information System techniques were used to identify the Land use categories such as Plantation, Sandy area, Water logged area, Scrub Forest, Crop Land, Water bodies, Land with scrub, Reserve forest, Land without Scrub, Salt area, Beach Ridge, Settlement and Fallow land. Scrub Land, Crop Land, Land with Scrub Land, Settlement and etc.

Table-1: Salient characteristics of satellite data used.

Name of the Satellite	**Time of data**	**Sensor**	**Resolution**	**Path**	**Row**	**No. of Bands**
IRS-P6 (Resourcesat-2)	May ,2000	LISS III	24m	102	64	4
Landsat 8	May,2005	OLI/TIRS	30 m	142	050	11
Landsat 8	May ,2010	OLI/TIRS	30 m	142	050	11
Landsat 8	May ,2015	OLI/TIRS	30 m	142	050	11

Flow chart

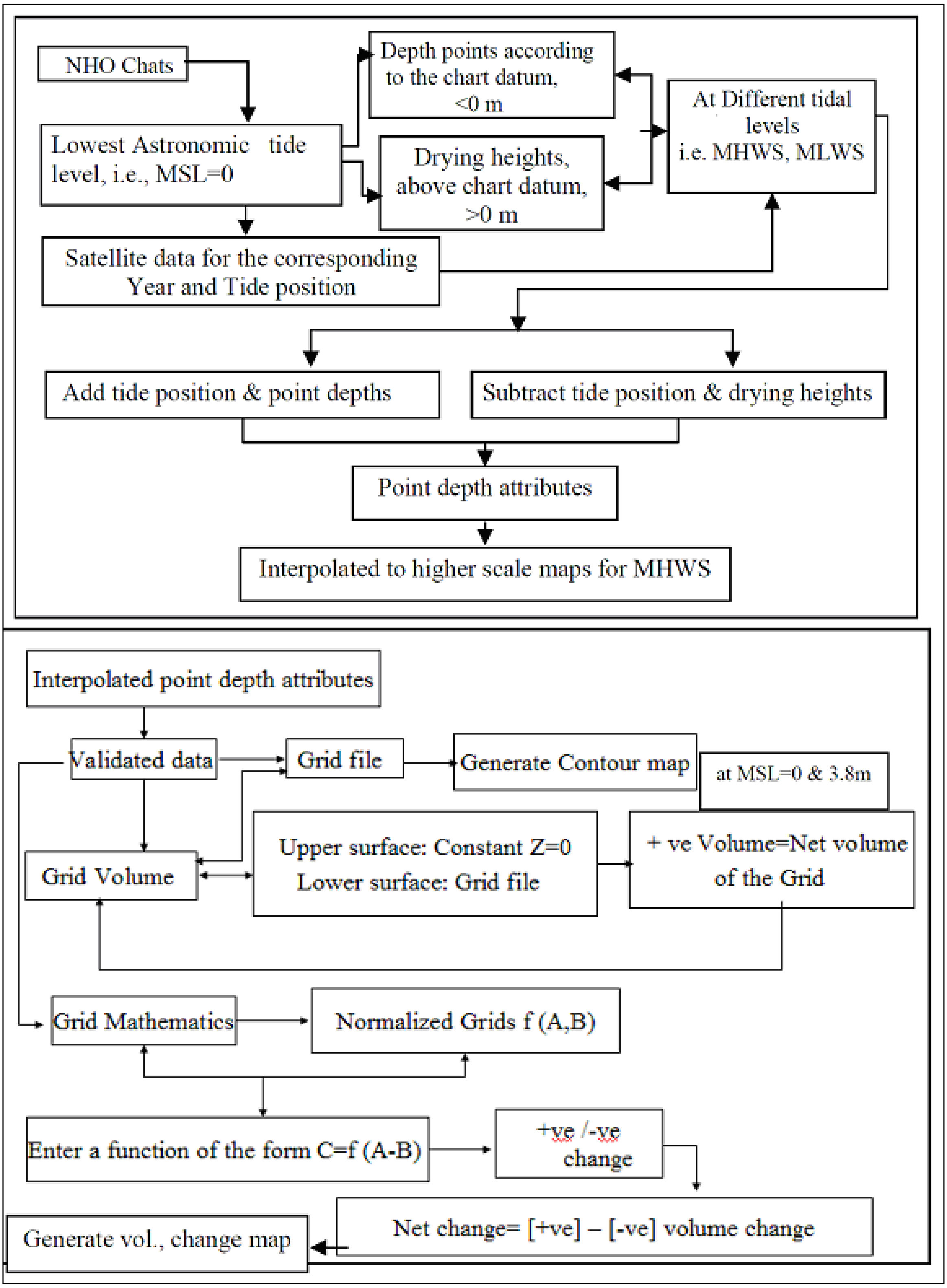
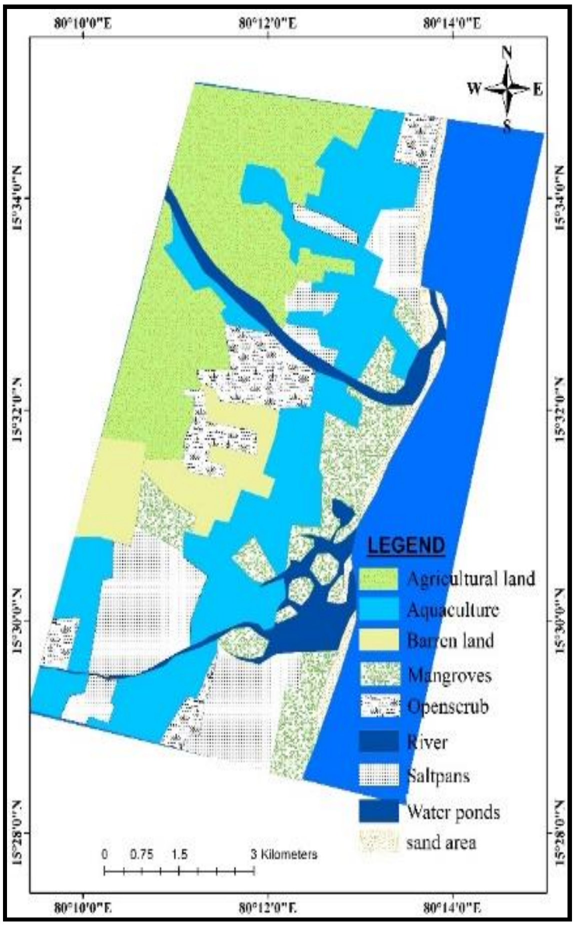


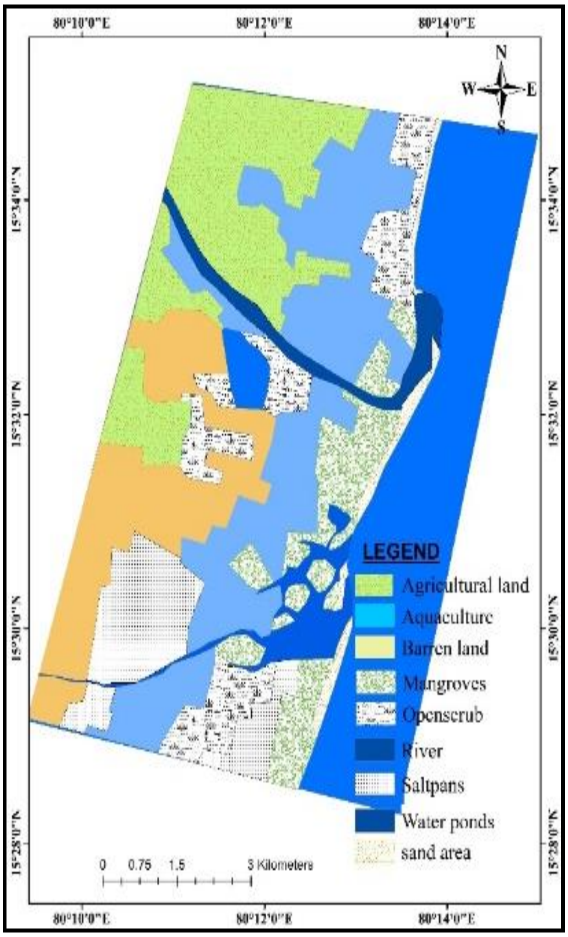
Fig.2 flow chart of the methodology.

RESULTS AND DISCUSSION

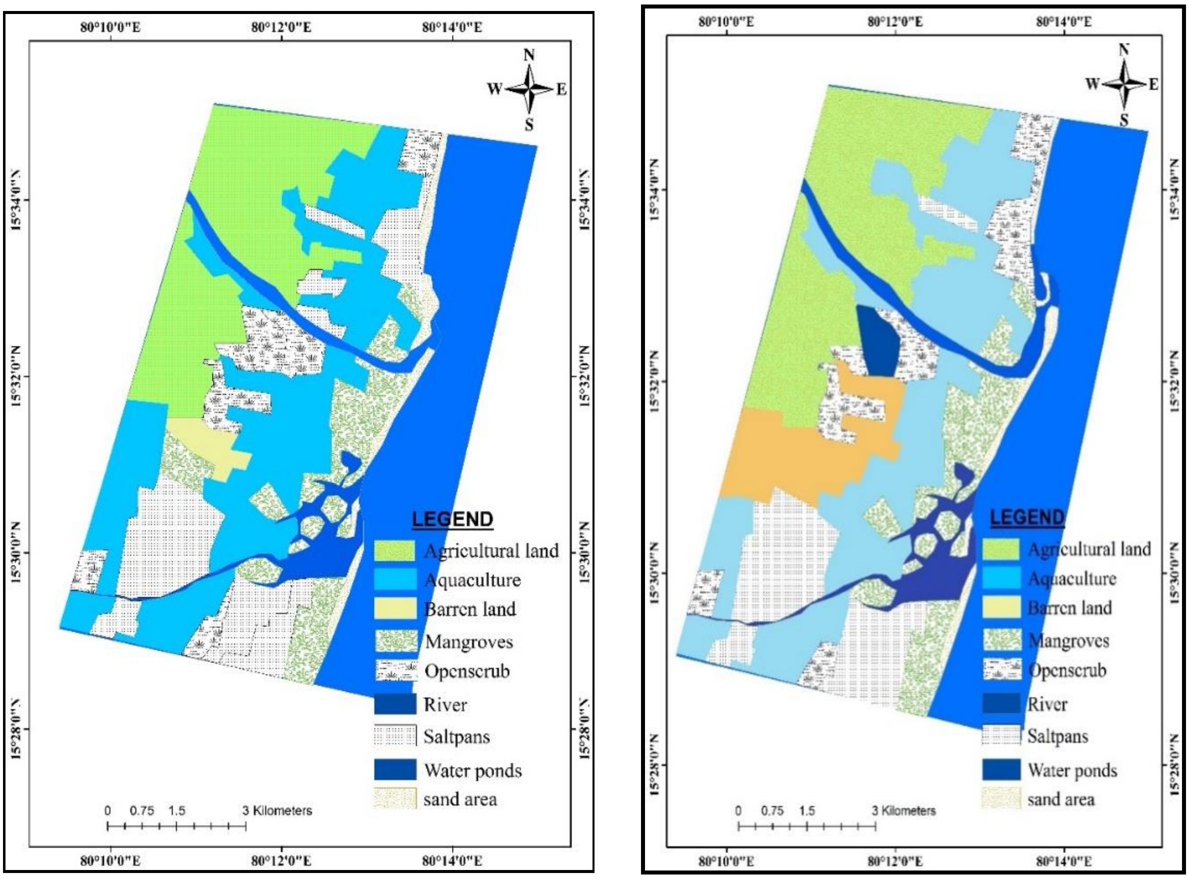
The Prakasam Coast is a very dynamic system influenced by fluvial and marine processes. Some of the Coast features have been changed several times during the past decades. The shape of the deposition tongue in Gundlakamma River at the west part of the area has been eroded consequently, it appears to be more elongated nowadays. The shape of the coastline has been altered during those years due to wave and the current action. The Prakasam Coast has been extensively modified in the past decades these changes are mostly localized in the southern part the study of Ongole Coast evolution showed that the balance of this dynamic system changed due to dam constructions.



(a) February 2000



(b) March 2005



(c) May 2010. (d) April 2015

Fig.2. Land use land cover maps of Gundlakamma River basin, 2000, 2005, 2010 &2015

Table-2 Land use and land cover classification of the study area.

Features class	**2000 area Sq.km**	**Percentage %**	**2005 area sq.km**	**Percentage %**	**2010 area Sq.km**	**Percentage %**	**2015 area Sq.km**	**Percentage %**
Agricultural land	12.96	19.79	13.91	21.24	11.78	17.99	13.95	21.30
Aquaculture	16.23	24.78	17.45	26.64	16.21	24.74	18.02	27.52
Barren land	4.50	6.88	2.14	3.28	12.11	18.49	5.31	8.10
Mangroves	6.87	10.49	6.97	10.64	6.07	9.26	6.07	9.26
Open scrub	4.75	7.26	4.65	7.11	6.26	9.56	7.27	11.10
River	2.10	3.20	2.33	3.55	2.261	3.45	2.20	3.36
Saltpans	9.96	15.21	9.84	15.03	5.93	9.05	7.85	11.99
Water ponds	2.44	3.73	2.64	4.03	3.64	5.56	2.41	3.68
Sand area	5.64	8.61	5.53	8.44	1.21	1.85	2.39	3.65
Total area	**65.50**	100	**65.50**	**100**	**65.50**	**100**	**65.50**	**100**

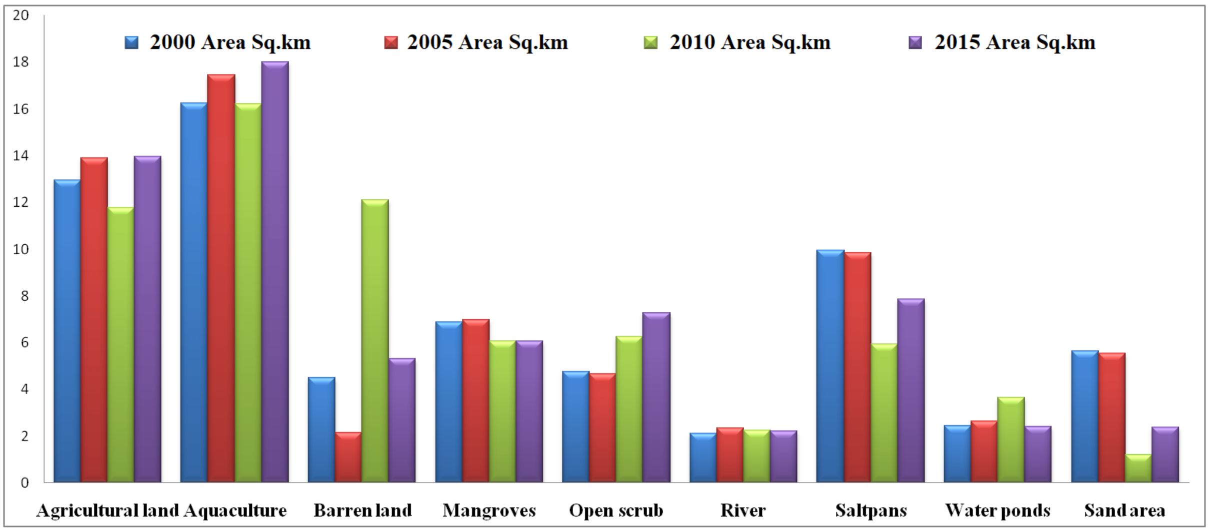


Fig.3. Graphical representation of Land use and land cover coastal dynamics.

The Agricultural land both cultivated and irrigated lands are represented by spring green colour in fig.2, and in table.2 constituted 12.96Sq.km, with percentage of about 19.79% of the total area in 2000 and the area found to be covered by agricultural land became 13.91Sq.km in 2005 and about 21.24 % of the total area in 2010, it decreased to 11.78 Sq.km and about 17.99 %. In 2015, further it increased to 13.95Sq.km and about 21.30%. Because of human interaction, the agricultural lands have transformed to forest plantation, settlement and roads.

Aquaculture is represented by Aqua marine colour in fig.2, and in table.2 constituted 16.23Sq.km, with percentage of about 24.78 % of the total area in 2000 and the area found to be covered by Aquaculture became 17.45 Sq.km in 2005 and about 26.64 % of the total area in 2010, it decreased to 16.21 Sq.km and about 24.74 %. In 2015, further it increased to 18.02 Sq.km and about 27.52 %.

Barren land is represented by green yellow/yellow arrange colour in fig.2 and in table.2 constituted 4.50 Sq.km, about 6.88 % of the total area in 2000 and in 2005 the area covered 2.14 Sq.km. and about 3.28 % of the total area. In 2010, it increased to 12.11 Sq.km and about 18.49 %. In 2015, further it decreased to 5.31 Sq.km and about 8.10 %. Those ecosystems in which less than one third of the area has vegetation or other cover. In general, Barren land has thin soil, sand, or rocks. Barren lands include deserts, dry salt flats, beaches, sand dunes, exposed rock, strip mines, quarries, and gravel pits. Those regions in which a mixture of barren land features occurs and the dominant land use occupies less than two-thirds of the area.

Mangroves are represented by green/yellow green colour in fig.2 and in the table.2 constituted 6.87 Sq.km about 10.49 % of the total area in 2000 and in 2005, the area covered 6.97 Sq.km and about 10.64 % of the total area. in 2010 it was decreased to 6.07 Sq.km and about 9.26 %. In 2015 further it decreased to 6.07 Sq.km and about 9.26 %. There are about 80 different species of mangrove trees are here, these trees grow in areas with low-oxygen soil, where slow-moving waters allow fine sediments to accumulate.

Open scrub is represented by white colour in fig.2 and in table.2 shows the area covered 4.75 Sq.km about 7.26 % of the total area in 2000 and in 2005 the area covered 4.65 Sq.km and about 7.11 % of the total area. In 2010 it decreased to 6.26 Sq.km and about 9.56 %. In 2015 further it increased to 7.27 Sq.km and about 11.10 %. In Gundlakamma river, many parts of the areas having prosopon is Multiflora, it looks like open scrub.

River lands are represented by blue colour in fig.2 and in table.2 shows the area covered 2.10 Sq.km about 3.20 % of the total area in 2000.In 2005the area found to be covered by river-agricultural areas became 2.33 Sq.km about 3.55 % of the total area. In 2010 it decreased to 2.261 Sq.km and about 3.45% whereas In 2015 further it decreased to 2.20 Sq.km and about 3.36%.

Saltpans are represented by white colour in fig.2 and table.2 constituted 9.96 Sq.km, with percentage of about 15.21 % of the total area in 2000. In 2005 the area covered 9.84 Sq.km, about 15.03 % of the total area. In 2010 it decreased to 5.93 Sq.km and about 9.05%. In 2015 further it decreased to 7.85 Sq.km and about 11.9 %. Saltpans. These Saltpans occupied with an area 5.89 sq.km (percent 0.82) of the total area. These are characterized by the presence of excess soluble or high exchangeable sodium. The results for agricultural lands are appear in yellow tone or in some areas light-Yellow tone, they are irregular and discontinuous in shape and occur close to the agriculture areas.

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Water ponds are represented by blue in colour in fig.2 and in the table.2 shows it covers 2.4Sq.km in 2000 about 3.73 % of the total area. In 2005 it was increased to 2.64 Sq.km. About 4.03 % of the total area and in 2010 slightly increased to 3.46 Sq.km about 5.56 % of the total area. In 2015 it was decreased to 2.41 Sq.km, about 3.68 % of the total study area. This fluctuation may be due to the rain fall in the month of May and June in the consecutive years. Water ponds occupied with an area 20.44 sq.km (percent 2.85) of the total area.

Sand area is 5.64 Sq.km, about 8.61 % of the total area in 2000. In 2005 the area covered by agricultural land areas became 5.53 Sq.km and about 8.44 % of the total area. In 2010 it decreased to 1.21 Sq.km and about 1.85 %. In 2015 further it decreased to 2.39 Sq.km and about 3.65 %. these areas are stabilized accumulation of sand formed in-situ or transported by wind. such sandy areas are found in the North Eastern part Several minerals like beach sand, heavy mineral deposits also present. Mostly the silica sand reserves are found along the coastal areas of Prakasam district.

River mouth dynamics

The multi data image analysis revealed that the sandbar across the river mouth is highly dynamic. The remaining images of different periods showing that the river mouth was opened with significant displacement of opening point. In 2000 the displacement was measured 0.347624 km (Fig.5&Table 4), 2005, 2010, and 2015 shows that the river has three mouth opening points and these are separated by an island the distances are 0.417414 km, 0.225665 km and 0.150989 km respectively, these deposits across the river mouth are silt, clay and mud flats with fine sand. Instability of the sandbar motion under the action of water waves is the main factor for this river mouth dynamics. The prevailing northern wind causes an oblique wave approach to the shoreline and it also causes shifting the position of the river mouth.

Erosion and accretion

The erosion and accretion rates along the study area was estimated from the satellite images shown in Table 3. In Fig. 4(a) Yellow shows the erosion from 2000-2015, 1.27838, 2.048596, 1.11553 and 1.259219 respectively. The highest erosion occurred at river mouth and the total net amount of erosion was estimated at 5.71173, and the sand bars and beach ridges along this coastal zone have been formed due to wave action. In Fig. 4(b) the blue colour shows the accretion is 1.756207 in 2000. 2005 black colour shows the accretion1.476856 in 2010, Red blue colour shows the accretion1.523408 and 2015 Blue colours shows the accretion 1.595608 respectively. The total net rate of accretion was estimated at 6.352077Sq.km. The Wind direction, wind speed and wave action play a significant role in the sand deposition along the coast in the study area. During the last fifteen years (2000-2015) comparatively accretion is more than the erosion shown in Fig. 5.

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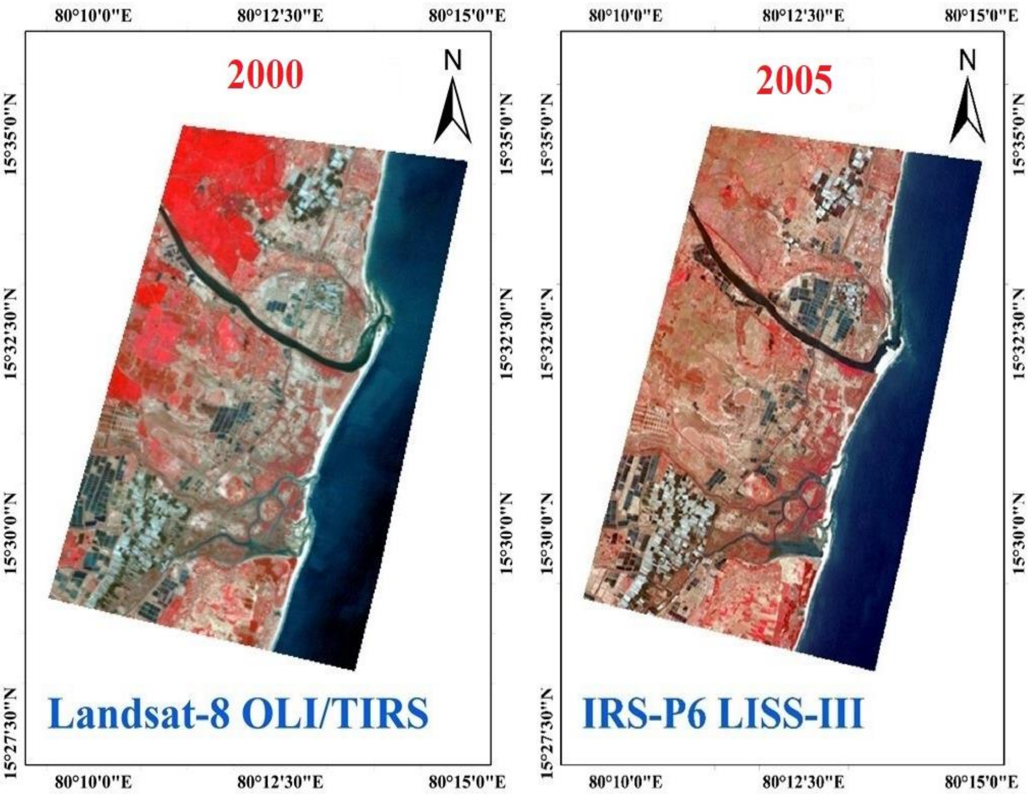
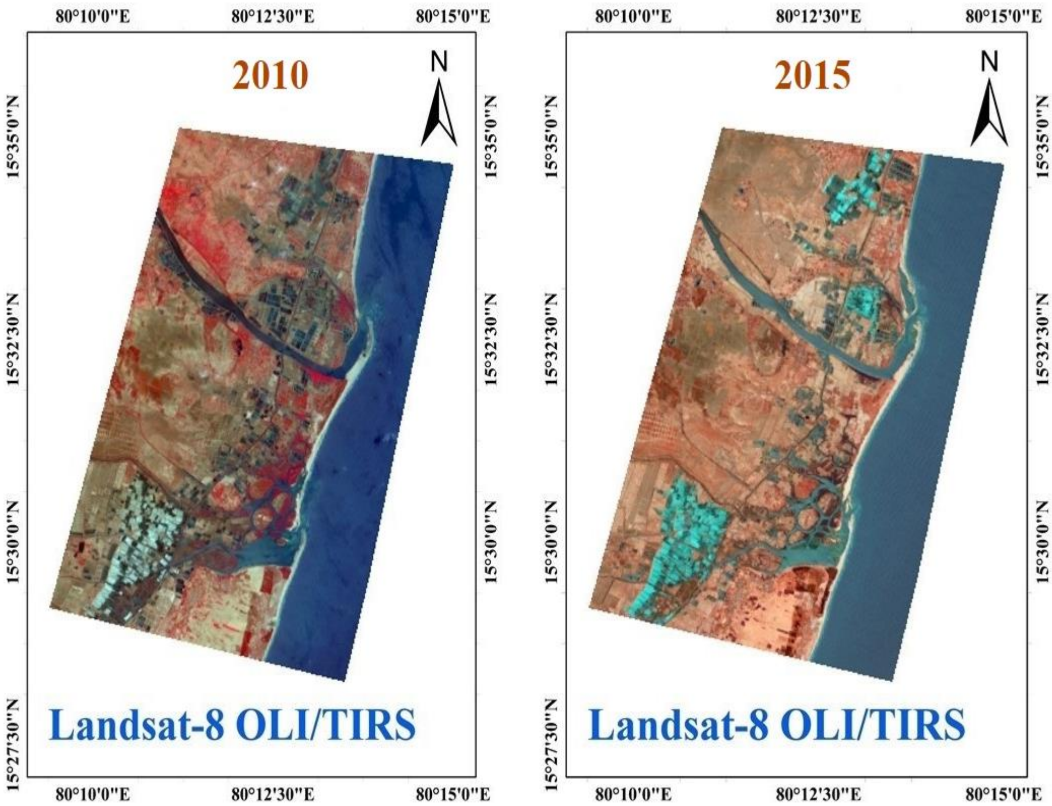


A. February 2000 B. March 2005



C. May 2010 D. April 2015

Fig.4.Satellite images showing the dynamics of River mouth

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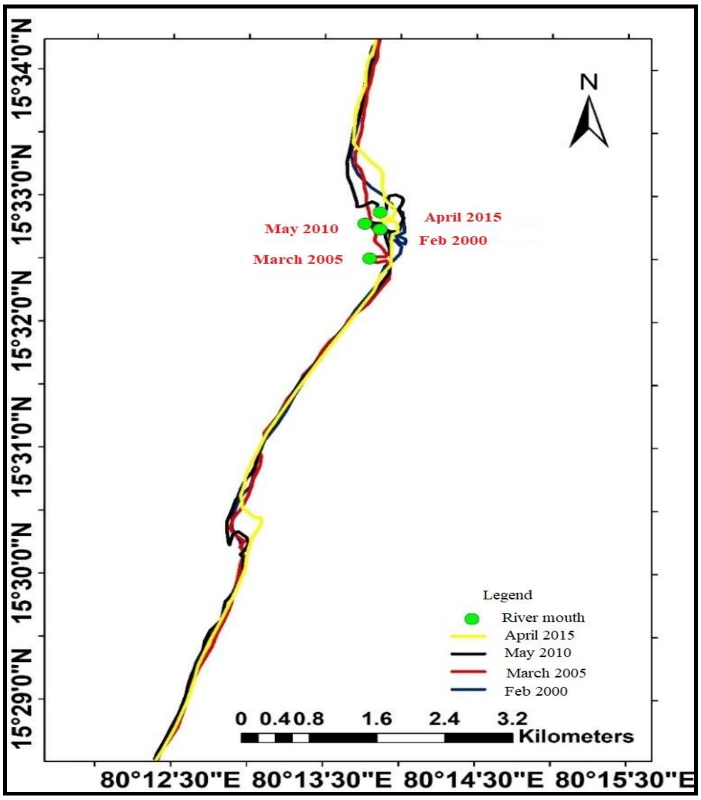

Fig.5. Displacement of the River mouth.

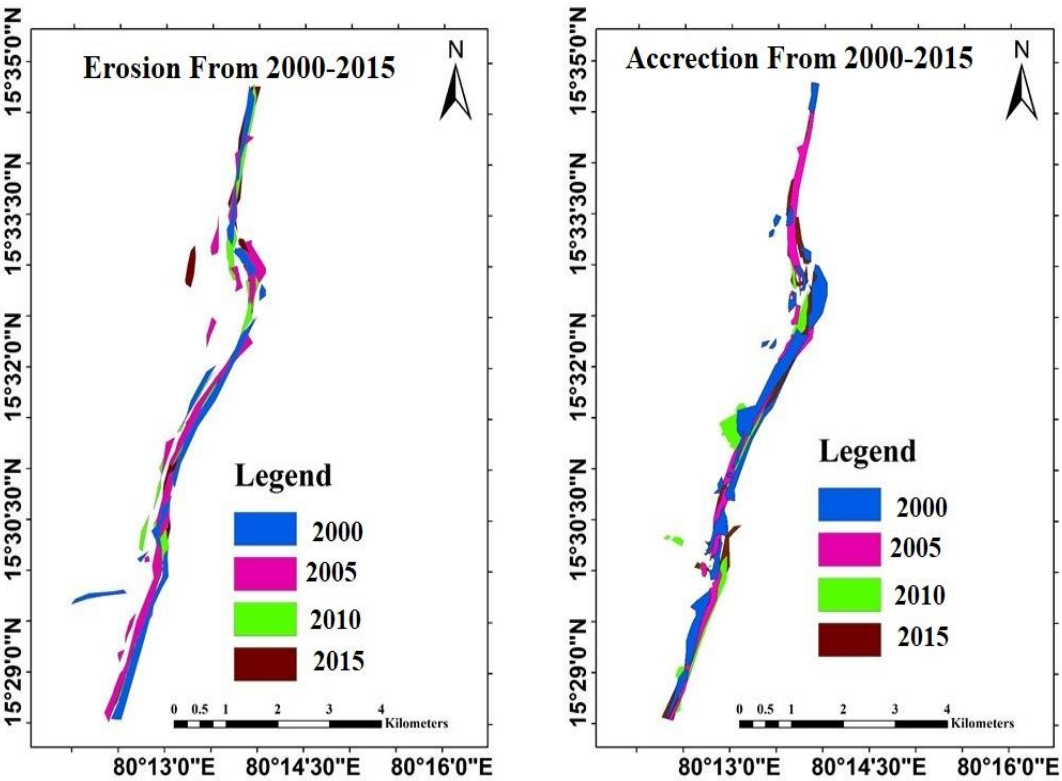

Fig.6. Coastal erosion and accretion from 2000 to 2015.

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Table-3 Coastal erosion and accretion during 2000 and 2015

Name of the year	Erosion (Sq.km)	Accretion (Sq.km)
Feb 2000	1.27838	1.756207
March 2005	2.048596	1.476856
May 2010	1.11553	1.523408
April 2015	1.259219	1.595608
Total net change	5.71173	6.352077

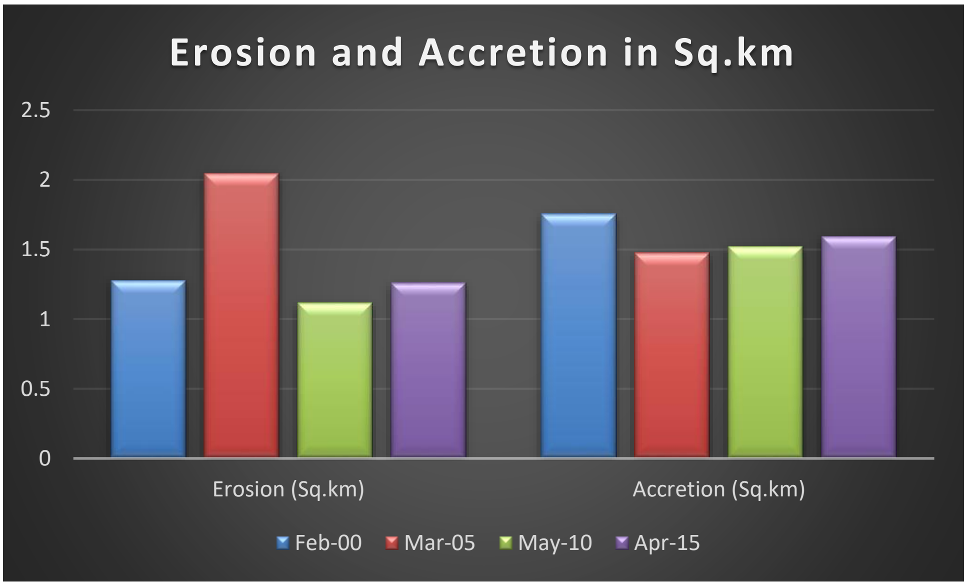

Fig.7.Graphical representations of coastal erosion and accretion during 2000 to 2015.

Factors influencing the coastal dynamics

Coastal dynamics are the marine, physical, meteorological and biological activities that interact with the geology and sediments to produce a particular coastal system environment. Waves and currents are the main factors which play the most significant role in controlling sediment migration and deposition. Both waves and currents are mainly generated by, and dependent on, wind conditions. Wind-generated waves are the most important energy input into the littoral zone and, together with wave-generated currents; they are responsible for coastal erosion and accretion. In order to assess the factors influencing the coastal dynamics (river mouth dynamics, erosion and accretion) of River, we have used meteorological factors like wind direction, wind speed, atmospheric pressure and temperature during the seven days prior to each satellite image. It was shown that wind strength plays a key role in sand volume transport. The prevailing northern wind causes an oblique wave approach to the shoreline and generates a westward littoral transport in Fig. 6. Shows the low atmospheric pressure, strong onshore wind, large waves are the factors to the development of elevated water levels which allow larger waves to transport sand to the shoreline tends to deposit these sediments in the river mouth.

Table-4 Displacement of River mouth in Sq.km during the study years and their trend.

S.No	Name of the year	Distance of displacement in Sq.km	Direction
1	Feb 2000	0.347624	Northern
2	March 2005	0.417414	Southern
3	May 2010	0.225665	Eastern
4	April 2015	0.150989	Northern
	Total change	**1.041692**	

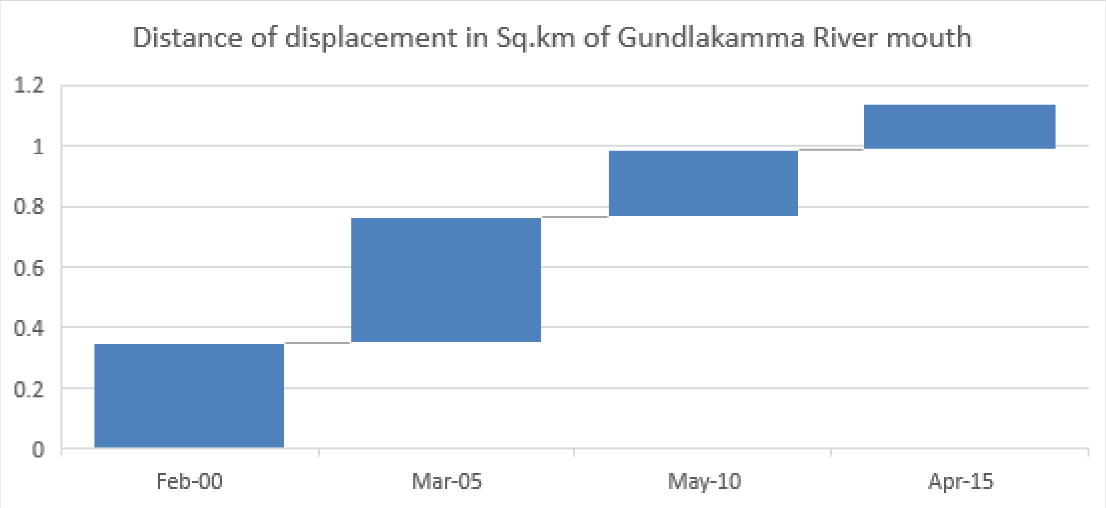

Fig.7.Graphical representations of Gundlakamma river mouth from 2000 to2015.

The results are shows that morphological changes were significant during the 2000 to 2015 and different classes of Agriculture, Aquaculture, Barren land, Mangroves, Open scrub, River, Saltpans, Water ponds and sand area etc. are identified and on the other hand, there is decrease in agricultural area, water spread area. This indicates the significant impact of population and its development activities on the morphological changes in the coastal environment. The GIS and Remote sensing technologies is elective tool for Coastal zone management. Quantification of morphological changes of Prakasam Coast area is very useful for environmental management groups, policy makers and public to understand the surrounding coastal environments. the Coastal dynamics of the River creek using remote sensing data is useful for monitoring and assess the coastal changes, and also the rate of erosion and accretion reflects coastal dynamics.

During the last fifteen years between 2000-2015, the accretion is more than the erosion which tends to deposit of the sediments in the river mouths and also changes of their size and shape of the river mouth. It is observed the prevailing northern wind causes an oblique wave approach to the shoreline and the river mouth position is shifting in the study area the high level of agricultural and aqua cultural activity is more, therefore the protection is must be needed.

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