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Study of Geoinformatics for East Coast of India- Along the AP Coast (Andhra Pradesh) India

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ABSTRACT: East Coast is one of the most densely populated regions of the world. It is an important region for agriculture and economic activities. It is about 3500 km long and stretches covering four states. The state of Tamil Nadu is the most Southern and it is followed by Andhra Pradesh, Orissa and the state of West Bengal in the North. There are 32 coastal districts (13 in Tamil Nadu, 9 in Andhra Pradesh, 7 in Orissa and 3 in West Bengal). The State of Andhra Pradesh is strategically located in the Indian sub continent. It has the second largest coast line in the country with a length of 974 Km. In my study to study with Remote sensing applications and Geographical information system techniques of coastal geomorphology along the coast of Andhra Pradesh. A detailed geomorphic maps showing the various coastal landforms is prepared in this study based on the interpretation of satellite images (IRS IB LISS II, AWiFS Images data from 2006). The AP coast like the entire east coast of India is predominated by depositional landforms such as beach ridge-swale complexes, mangrove swamps, mudflats, spits, barriers, lagoons, estuaries, and tidal inlets except in a few localities on both sides of Visakhapatnam city where a number of rocky headlands are fringed by cliffs, wave-cut benches, sea stacks and other related erosional landforms The Krishna-Godavari twin deltas in the central parts and the Penner delta and Pulicat Lake to the south along the AP coast are very low-lying as evident from landforms like beaches, mudflats, mangrove swamps and tidal channels/creeks that spread up to more than 10-15 km inland even in this microtidal environment. The Andhra Pradesh coast is about 1035 km long. The shoreline comprises of 105 km from a little north of Vainateyam estuary to north of Kakinada town. The information helps the geologists and Geographers, hydrologist. Environment and Disaster Management research scholars and students and management of data whenever it is required.

KEYWORDS: geomorphology, deltas. IRS IB LISS-II, Andhra Pradesh coast.

I. INTRODUCTION

The global coastal changes are concerned with the rock formation and the structures seen in cliffs, shore out crops, and the sediment have been deposited on the coastal region. (Eric Bird, 2007). Coastal geomorphology provides vital knowledge for the active work of preserving of costal landmarks and communities. The formation and development of beaches, cliffs, sand dunes, salt marshes, reefs and other coastal landforms reflect the pressures and forces acting upon a coastline, both natural and manmade. Coastal geomorphology focuses on explaining landforms in the coastal zone by examining the form, sediments and the depositional history at the modern shoreline (Wood roffe, 2002). There is an urgent need for action now in order to limit the adverse effects of climate change upon

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Issue 11, November 2015

ecosystems and human society. Coastal erosion happens primarily as a result of sea level rise, intense storm action, and changed or more intensive wave action. In the upland areas, the increased intensity of rains leads to the Erosion of forest land. In the coastal areas, there is less evidence for sea level rise, but intense Storms and increased wave action have certainly accelerated the rate of erosion in several coastal areas. Erosion of the shoreline has reduced space for living and for fisheries, Stalinized freshwater sources, and increased population pressure in the hinterland. (Guru Prasad and Narasimha Rao 2013).

II. STUDY AREA

The coastline of Andhra Pradesh is between the Godavari and the Krishna delta. Andhra Pradesh coast area north of the Godavari delta the coast are quite intensive and have been highly productive both from food production and economy points of view while on the other the coast has been subjected to a number of natural hazards which are quite frequent, sudden and unwarranted. The summer monsoon depressions and severe storms cause extensive loss of life, apart from severe damage to property and crops across the Andhra coast. In addition to these unwarranted events, a regular and cyclic phenomena like erosion and deposition is prevalent in many parts of the A.P. coast, the state has 900 km of coastline on the east coast of India and living mainly in fishing communities. (Guru Prasad.2013).

III. METHODOLOGY AND DATA COLLECTION

The preset study is based on the application of modern technology including GIS and Remote Sensing a proper methodology has been adopted to choose the ways and means for collection of data from the Department of Indian Space research organizations, Survey of India and Space Applications Centre. And are fallows objectives to know the presence of the Geomorphology in the study area and to identify the shore line changes, sea level changes.

Coastal geomorphology

Coastal geomorphology by definition is the study of the morphological development and evolution of the coast as it acts under the influence of winds, waves, currents and sea level changes. Coastal geo-morphological behavioral relates to landform features and land forming processes that are shaped by atmospheric, terrestrial and marine processes. In order to measure the geo-morphological evolution of a stretch of coastline, it is necessary to analyze the system state in terms of nature of the coastline and its composition, Origin of the coast (antecedent conditions), Forces controlling and forcing mechanisms along the coast and behavioral characteristics of the coast.

Deltas regions in study Area and Bay

Godavari delta

The second largest river in India, Godavari is often referred to as the Dakshin ganga. The Godavari originates near Triambak in the Nashik district of Maharashtra, and flows through the states of Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh.

Krishna delta

The River Krishna rises in the Western Ghats at an elevation of about 1,337 m just north of Mahabaleshwar, about 64 km from the Arabian Sea, flows eastwards for about 1,400 km before joining the Bay of Bengal at Hamasaladeevi in Andhra Pradesh, on the East coast.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

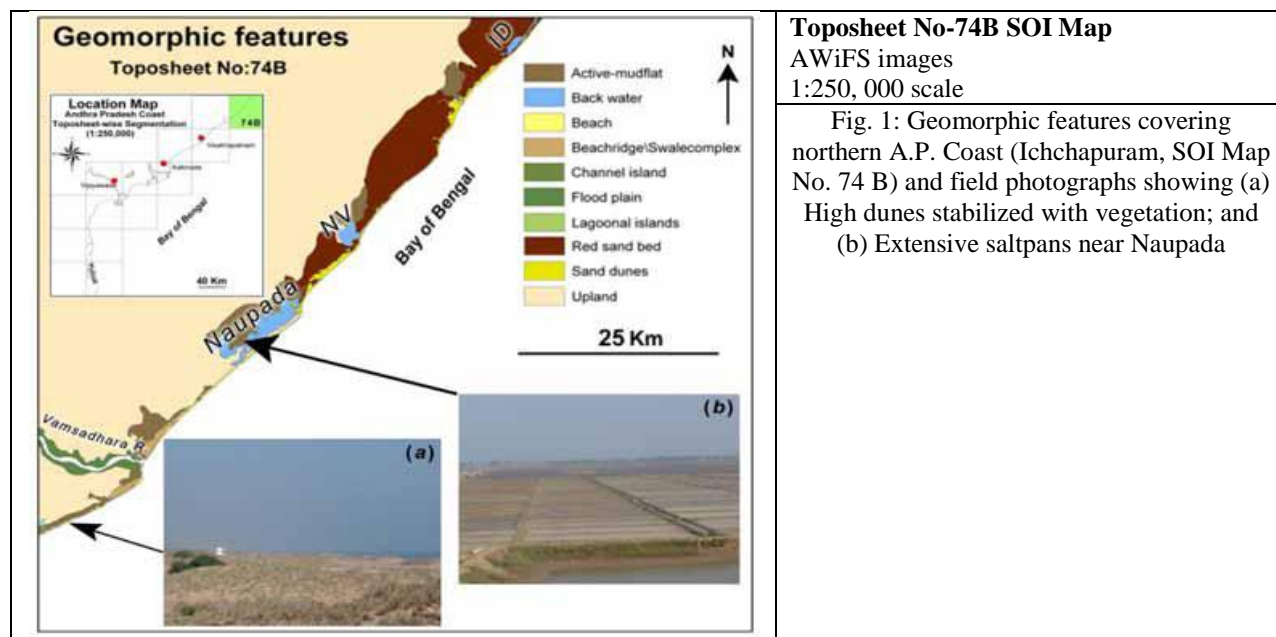
Kakinada Bay

Kakinada Bay situated in the east coast of India is made up of estuary of river Godavari covers an area of about 29.sq.kms. The Godavari delta has undergone phases of erosion and accretion through fluvial and marine changes during its growth in recent times.

Geomorphologic features of the Andhra Pradesh Coastal areas:

Ichchapuram area

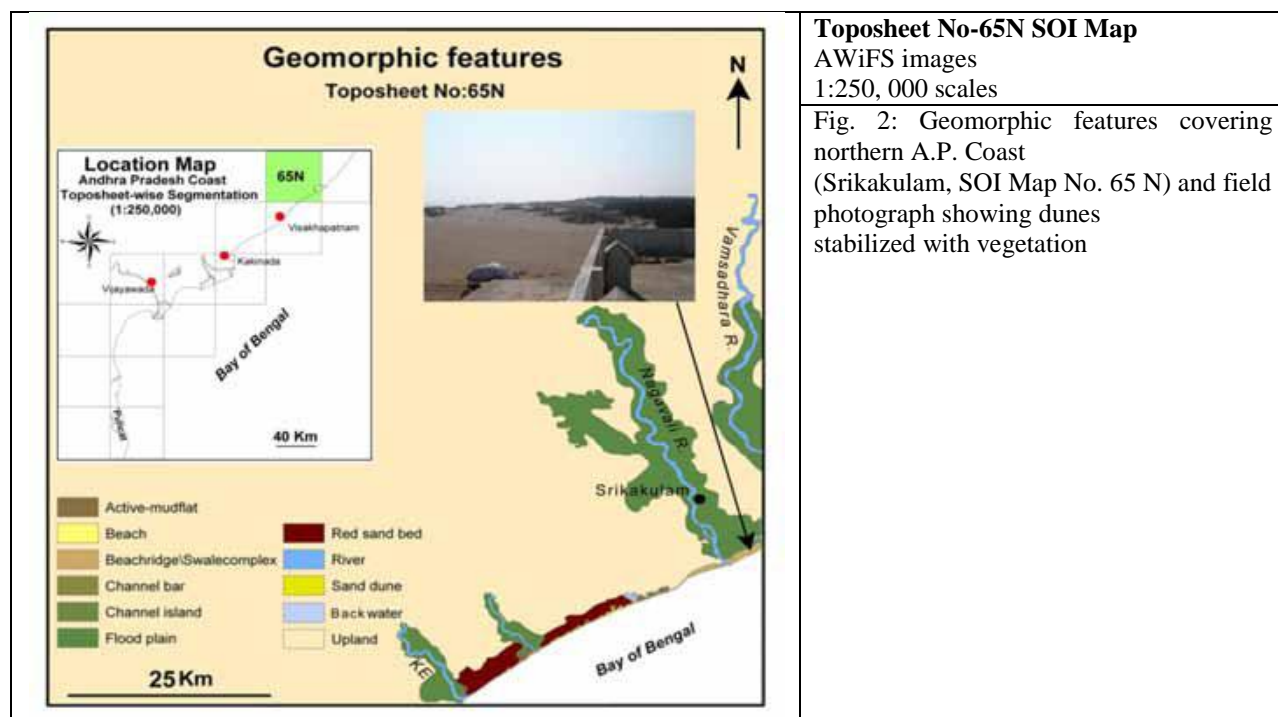
This map covers a 117-km-long coastline of AP from a little south of Vamsadhara estuary to a few kilometers north of Iduvanipalem (I) which is the northernmost boundary of the state. The area is characterized by a number of backwater bodies namely Naupada, Nuvvalarevu (N), and Iduvanipalem (I), out of which Naupada is the largest spreading over an area of 8 km².(fig.1)The presence of such large tidal water bodies indicate that extensive areas along this coastal section are below the sea level accommodating the floods, storm and tidal surges. Possibly, these areas are controlled by tectonic activity. The area is also characterized by extensive red sand deposits of pre-Holocene origin



International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015



Srikakulam area:

The coastline in this particular toposheet area extends from the Kandivalasa estuary (KE) to a little north of Nagavali estuary. Srikakulam is the largest town in this area. The shoreline in this area is about 54 km-long.(fig-2)

Visakhapatnam area:

Visakhapatnam, a million plus city are in this part of AP. It is surrounded by Kailasa hill range (KHR) in the north and Yarada hill range (YHR) in the south which is 10 km apart. (Fig.3)



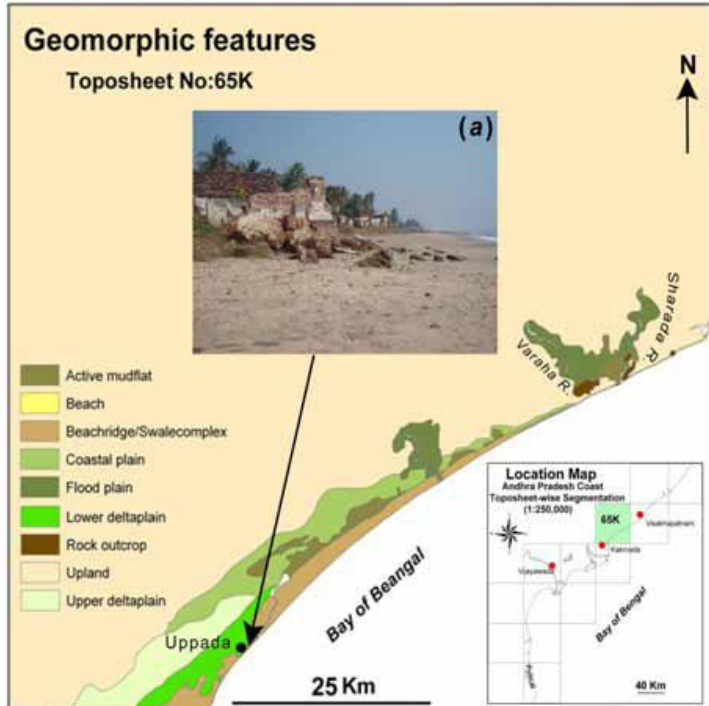
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

	<p>Fig. 3: Geomorphic features covering northern Visakhapatnam, A.P. Coast (SOI Map No. 65 O) and field photographs showing (a) Headland and bay configuration of Visakhapatnam coast; and (b) Beach in the city proper</p>
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The shoreline is about 90 km from Pudimadaka (P) to few kilometers north of Gosthani estuary (GE). Predominantly, the coastal strip of Visakhapatnam is rocky with several promontories jutting into the sea creating a headland and bay configuration to the coast. The shore zone is characterized by the presence of sea cliffs, wave-cut terraces and sea stacks. Wide spread coastal red sands also occur at several locations in the Visakhapatnam region.

 <p>Geomorphic features Toposheet No:65K</p> <p>(a)</p> <p>Legend:</p> <ul style="list-style-type: none"> Active mudflat Beach Beachridge/Swalecomplex Coastal plain Flood plain Lower deltaplain Rock outcrop Upland Upper deltaplain <p>Uppada</p> <p>25 Km</p> <p>Bay of Beangal</p> <p>Varaha R.</p> <p>Sharada R.</p> <p>Location Map Andhra Pradesh Coast Toposheet-wise Segmentation (1:250,000)</p> <p>65K</p> <p>40 Km</p>	<p>Toposheet No-65K SOI Map AWiFS images 1:250, 000 scale</p> <p>Fig. 4: Geomorphic features covering Uppada, A.P. Coast (SOI Map No. 65 K) and field photograph showing Uppada beach under severe Erosion</p>
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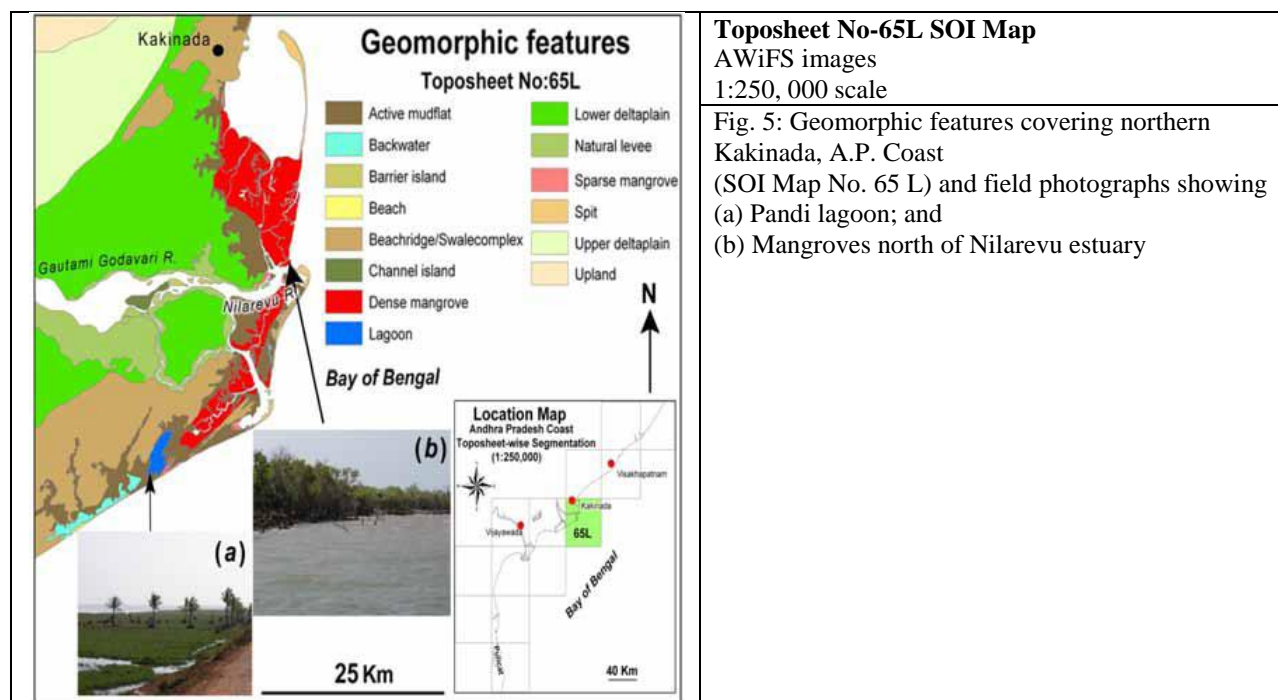
Uppada Area:

The shoreline corresponding to this particular area starts from south of Uppada to a little north of Sharada-Varaha estuary and is around 95-km-long. Uppada is a small town having population of 11090 (2001 Census). Here, well defined beach ridges are seen covered with casuarinas plantations over 117 km² area. The beach covers 15 km² (Fig. 4). Mudflats are also striking features in this area occupying 62 km² areas. The entire coast abutting Uppada is experiencing severe erosion.

International Journal of Innovative Research in Science, Engineering and Technology

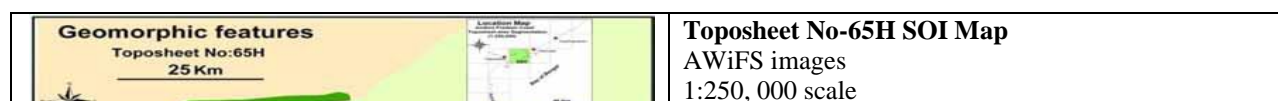
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015



Kakinada Area:

The shoreline comprises of 105 km from a little north of Vainateyam estuary to north of Kakinada town. Kakinada is the largest town in the entire region, having many industries and a sea port. The entire Godavari mangroves covering of 170 km² area are from this part and the famous Kakinada spit having a length of 21 km .(fig-5).



International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

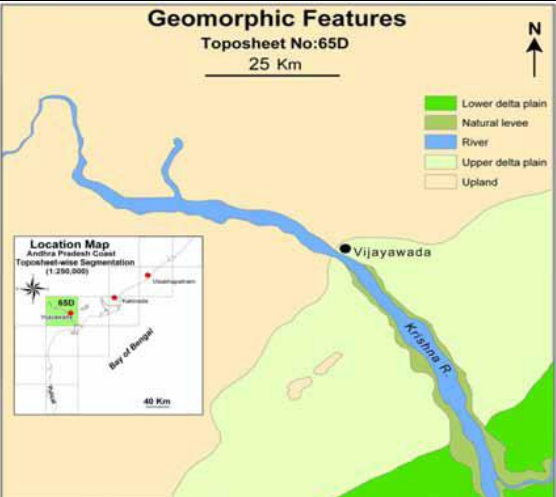
	<p>Fig. 6: Geomorphic features covering Bhimavaram, A.P. Coast (SOI Map No. 65 H) and field photographs showing (a) Wide beach in the Maginapudi area in Krishna delta; and (b) Extensive mudflat area in the Godavari delta</p>
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Bhimavaram Area:

This particular toposheet area has a 120-km-long shoreline representing the western part of the Godavari delta and the inter-delta area including the Kolleru Lake. The beach ridges occupy 35-km wide belt spreading over an area of 1061 km². The dominant land use in this region is agriculture and aquaculture ponds (Fig. 6).

Vijayawada Area:

Vijayawada is the apex of the Krishna delta, shoreline is about 95 km away from Vijayawada. The maximum area 3094 km² comprises of upper Krishna delta plain (Fig. 7).

 <p>The map shows the Krishna River delta with various geomorphologic features. A legend indicates: Lower delta plain (dark green), Natural levee (light green), River (blue), Upper delta plain (yellow-green), and Upland (orange). A scale bar shows 25 Km. A location map inset shows the area's position relative to the Bay of Bengal and other topographic features.</p>	<p>Toposheet No-65D SOI Map AWiFS images 1:250, 000 scale</p> <p>Fig. 7: Geomorphic features covering Vijayawada, A.P. Coast (SOI Map No. 65 D)</p>
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Nizampatnam Area:

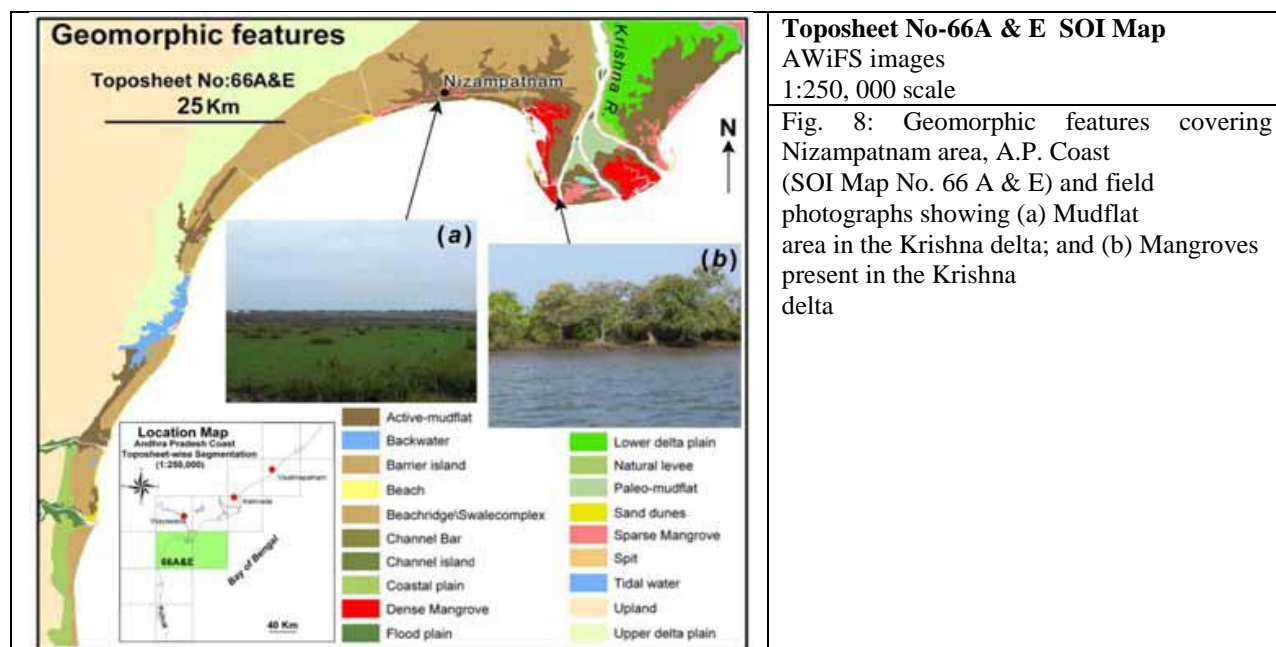
The coastline in both the 66A&E toposheets put together is almost 150-kmlong in which there are different morphological features like mudflats, beach ridges, backwater zones and mangroves etc. The entire Krishna delta

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

bulge with all its four distributaries is covered in this image. The mangrove area is about 125 km², mudflat comprises of 466 km², beach ridges cover an area of 818 km² (Fig. 8). There are number of small estuaries draining into this area, some of them include Romperu, Musi, Gundlakamma, Palleru and Manneru to the south of the Krishna delta (fig-8).



Nellore Area:

The entire Penner delta including the 116-km-long coastal zone is covered in this map with Nellore at the apex, the Penner delta extends from Upputeru River in the south to isukapalli lagoon in the north. Landforms like mudflats, beach ridges occupying about 224 km² and 289km² respectively are the prominent features in the area (Fig. 9).

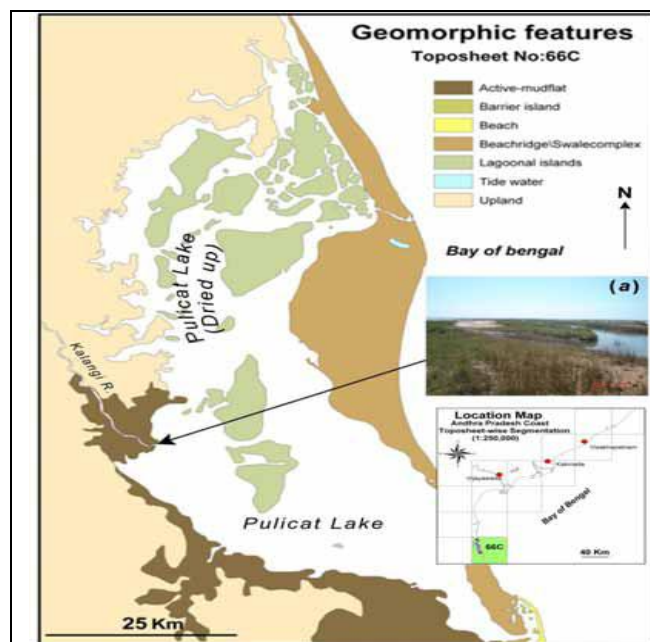


International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

Fig. 9: Geomorphic features covering Nellore area, A.P. Coast (SOI Map No. 66 B) and field photographs showing (a) Beach stabilized by vegetation along the Gangapatnam coast; and (b) Beach stabilized by vegetation along the Krishnapatnam coast



Toposheet No-66C SOI Map

AWiFS images

1:250,000 scale

Fig. 10: Geomorphic features covering Pulicat Lake area, A.P. Coast (SOI Map No. 66 C) and field photographs showing (a) Kalangi delta plain along the western shore of the Pulicat lake

Pulicat Lake Area:

The entire Pulicat Lake covering an area of 620 km² comes into this particular image. The Pulicat Lake is located at the southeastern end of AP. It is the second largest lagoon along the east coast after Chilka Lake (which is in Orissa state north of AP). The Lake extends from Durgarajupatnam in the north to Pulicat village in the south. About 260 km² of the lake in the northern half is dried up (Fig. 10). Quite a number of islands with a combined area of 100km² are present in the lake body including in the dried up portion. The orientation of these islands, more or less, parallel to the coast, shows that these are the remnants of a number of beach ridges spread along the width of Pulicat Lake. Kalangi River decants into this lake creating a small bird foot delta. (fig-10).

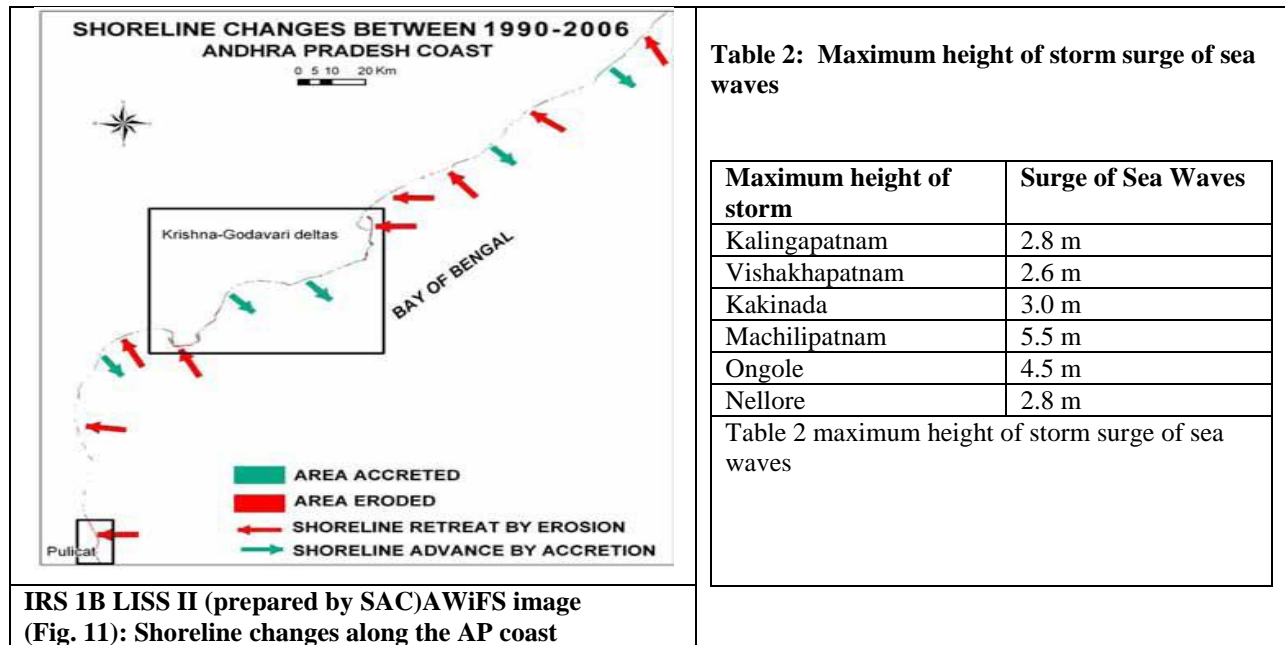
Shoreline change

The broad trends in the shoreline behavior in the recent past can be attributed to several reasons like reduction in the sediment supply due to dam construction in the upper reaches and thereby sediment compaction in the down coast leading to the sea-levels to rise, besides local tectonics that might lead to subsidence or uplift in the region.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015



In the absence of data on tectonic activity, especially its effect on the coastal zone, the trends of shoreline change through time, which reflect the interaction of various phenomena that characterize the coastal zone, helps in assessing the coastal vulnerability. Therefore, the shoreline change history has been studied by comparing the shoreline position in 1990 traced from the with that traced from the 2006. In addition, extensive field observations have been made to corroborate the results. The shoreline change map showed significant changes along the AP coast (Fig. 11). Interestingly, erosion seems to be the dominant phenomenon along the AP coast, both in terms of the length of coast affected as well as the areal extent. About 418-km-long sections of AP coast were eroded with a loss of 87 km² area, while deposition occurred along 275 km coastal sections where the area added was 57 km². Thus there was a net loss of 30km² area in 16 years.

Table 1: Coastal Landforms as per 1:250, 000 scale SOI Map grid of A.P. Coast.

Coastal landforms	(km ²)
COASTLINE LENGTH	911 KM
Mangroves	331
Mudflats	1695
Paleo mudflats	17
Spit	18
Beach ridges	2845
Dunes	76
Back water	2845
Natural levee	712
Beach	79.3
Delta plain	6569
Flood plain	798

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

Lagoon	810
Red sand beds	326.7
Coastal plain	237
Total area(km ²)	14640
Table 1 Coastal Landforms as per 1:250, 000 scale SOI Map grid of A.P. Coast.	

Above the table 1 and table 2 display the coastal land forms along the coastal Andhra Morphology of the coast plays an important role in determining the impact of sea-level rise. Landforms and the material that compose them reflect their relative responses to sea-level rise since every landform offers certain degree of resistance to erosion (Thieler and Hammer-Klose 1999). While the rocky cliffs and wave-cut benches offer maximum resistance and therefore very less vulnerable, the soft sandy and muddy forms such as dunes, mudflats, mangroves, etc., that offer least resistance, on the other hand, are extremely vulnerable to sea-level rise. The various coastal landforms is prepared in this study based on the interpretation of satellite images (IRS P6 AWiFS data from 2006). The AP coast like the entire east coast of India is predominated by depositional landforms such as beach ridge-swale complexes, mangrove swamps, mudflats, spits, barriers, lagoons, estuaries, and tidal inlets except in a few localities on both sides of Visakhapatnam city where a number of rocky headlands are fringed by cliffs, wave-cut benches, sea stacks and other related erosional landforms as noted in some previous studies as well (Nageswara Rao and Sadakata 1993; Nageswara Rao et al. 2005).

Geographic profile of the new Andhra Pradesh state				
SI. No	District (13)	Average Rainfall in mm (preceding 5 years average)	Major cities	Visakhapatnam, Vijayawada, Kakinada, Tirupathi, Guntur, Nellore, Kurnool
1	Srikakulam	1213	Coastline length	974 kms
2	Vizianagaram	1190	Major rivers	Krishna, Godavari, Tungabhadra
3	Visakhapatnam	1224	Climate	
4	East Godavari	1182	Max Temperature	44.8 ⁰ C in summer
5	West Godavari	1063	Min Temperature	1138 ⁰ C in winter
6	Krishna	1054	Annual Rainfall (Average)	940 mm
7	Guntur	911	least Rainfall	521 mm in Anantapur
8	Prakasam	809	Total surface water available	2764 TMC.
9	Nellore	1107	Godavari basin	1480 TMC.
10	Chittoor	969	Krishna basin	811 TMC
11	Ananthapur	595	Tungabhadra basin	98 TMC
12	Kadapa	747	Other basins	375 TMC
13	Kurnool	735		
Table 3. Source of data: From Directorate of Economics and Statistics, A.P.				

Table 3 represent the details of the rainfall in Andhra Pradesh is influenced by both South-West and North-East Monsoons. The normal annual rainfall of the State is 940 mm. Major portion (68.5%) of rainfall is contributed by South-West Monsoon (June-Sept) followed by (22.3%) North-East Monsoon (Oct-Dec). The rest 9.2% of the rainfall is received during the winter and summer months. In spite of availability of abundant water and considerable cultivable area, the State has to face distressing conditions due to drought as the available waters are in surplus in some areas and joining sea, while in other areas water is scarcely available even for drinking. Due to dwindling flows, and indiscriminate use of water in the upper regions, the irrigation is in decline.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

IV. RESULTS AND DISCUSSIONS

1. The Andhra Pradesh coast is about 1035 km long. It extends from Srikakulam district in the north to Nellore district in the south. It is marked by spits, wide beaches, mangroves and tidal flats. The coastline of Andhra Pradesh is between the Godavari and the Krishna delta. Andhra Pradesh coast area north of the Godavari delta comprises of tidal creeks, small patches of coastal wetlands at the mouth of rivers and inlets. The residual hills and ridges are close to the sea and some of ridges extend beyond the coast in to the sea.
2. The coastal Andhra Pradesh follows the other rivers, Bahuda, Vamsadhara, Gosthani, Sarda are in this region, but it does not have any major delta.
3. The deltaic type of coastal area between Godavari and Krishna and inter deltaic region comprises of bay, tidal creeks, mudflats, spits, mangroves swamps and marshes. Inter tidal mudflats are extensive to the east of Coringa, The Corangi mangrove region, including the creeks and channels, is also found to be shallow near the Bay, with depths varying between 1 and 3 meters. During low tide, large areas of mud flats are exposed in Kakinada Bay. coastal area, and its associated open sea ecosystems, including Kakinada bay, are rich in floral and faunal diversity, and also generate other ecological and economic benefits such as shoreline protection, ecosystem based livelihoods, and carbon sink services there are 35 species of mangroves of which 16 are true mangroves and the rest are associated mangrove species
4. Mangrove swamps occurs in abundance in the intertidal mudflats on both sides of creeks. Narrow beaches are found on the delta fronts except on both sides of the Vainateyam and the Vasisth- Godavari mouths. A spectacular spit (Hope Island) has been developed at Kakinada. A bay has been developed between the shore land and the spit. Large block of dense mangrove can be seen near Coringa.
5. Beaches, sand dunes and dune sands are widely distributed in the region of south of Krishna delta up to the Pullicat lake. It mainly occurs between Suryalanka to Tutipalem, Kuruvatipalem, durgarajupatanam and the Shriharikota Island. Sandy plain has spread over a wide area in Chirala Vetapalem and chinagunjam.
6. Sand dunes occurred at Vetapalem, Krishnapatanam, Kotapalem and Gopallapalem. Sparse and scattered mangroves are found in the intertidal and high tidal mudflats at the mouth of the river zone.
7. The prominent rivers viz. the Krishna and the Godavari form large deltaic regions. Both these deltas have large mangrove forests. Marsh vegetation is also seen on the islands of the rivers. Mudflat occupies 399.2 sq km, Aquaculture ponds occupy 1535.67 sq km and Habitation with vegetation occupies 698.72 sq km
8. The rocky outcrops are observed in this area. Headland bay and small beaches are seen in the Vishakhapatnam district. Encroachment in mangrove area for agriculture and aquaculture and industrial pollution is making adverse impact on the mangrove of this area. The coastal area is potentially a rich terrain in agriculture, fisheries, commerce and communication. There are a number of intermediate and small ports including a natural harbour at Vishakhapatnam.
9. The Krishna–Godavari delta region is the most vulnerable with almost two-thirds of the total length of the coast in the very high-risk category, while the rest of the coast is also within the immediate next level of high-risk category.
10. East & West Godavari, Krishna and Guntur. The natural processes of erosion are aggravated by the human-induced changes to the Environment. Several coastal villages experience an increase in the intensity of erosion which leads to loss of long stretches of coastline and damage to properties annually
11. The southern sector of the A.P coast shows more or less similar conditions with a one half of the length of 285.8 km in this sector are in the very high risk category. The northern sector however has at least 30 km long part of the coast under low risk level due to the presence of number of rock headlands. Neotectonic activity can also cause land subsidence resulting in relative sea level rise and shoreline retreat. Sand spit east of the Kakinada led to erosion along the north-eastern end of the Godavari delta coast at Uppada village.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

12. The past two and half decades claimed about 18.36 km² of coastal land. Leading to displacement of communities and loss of mangrove vegetation apparently decreased sediment supply through the river caused relative sea level rise under continued coastal subsidence along the delta front region.
13. Ichchapuram area is the predominant land use in this region is aquaculture, salt farming and paddy while a considerable area remains as mudflats. . Some of the dunes are as high as 6-9 m and are stabilized by thick vegetation like casuarina and cashew plantations. Srikakulam area the predominant geomorphic feature in this region is floodplain on both sides of the rivers where the agriculture activity is prominent. Another striking feature is red-sand beds which were stabilized mainly by the cashew plantations. Beaches in this part are very narrow with dunes ranging from 3-5 m. The coastal strip of Visakhapatnam is rocky with several promontories jutting into the sea creating a headland and bay configuration to the coast. The shore zone is characterized by the presence of sea cliffs, wave-cut terraces and sea stacks. Wide spread coastal red sands also occur at several locations in the Visakhapatnam region.
14. In the uppada area the beach covers 15 km² (Fig. 4). Mudflats are also striking features in this area occupying 62 km² areas. The entire coast abutting Uppada is experiencing Severe erosion. The entire Godavari mangroves covering of 170 km² area are from this part and the famous Kakinada spit having a length of 21 km. Mudflats occupy an area of 155 km² and the predominant land use is salt pans and aquaculture ponds. Bhimavaram area is the beach ridges occupy 35-km wide belt spreading over an area of 1061 km². The dominant land use in this region is agriculture and aquaculture ponds.
15. Nizampatnam area in which there are different morphological features like mudflats, beach ridges, backwater zones and mangroves. Nellore area is presence of Landforms like mudflats, beach ridges occupying about 224 km² and 289 km² respectively are the prominent features in the area. Erosion seems to be the dominant phenomenon along the AP coast, both in terms of the length of coast affected as well as the areal extent. About 418-km-long sections of AP coast were eroded with a loss of 87 km² area, while deposition occurred along 275 km coastal sections where the area added was 57 km². Thus there was a net loss of 30 km² area in 16 years.
16. The new dune deposits are increased from south to north part of coast of Bimunipatnam. New dunes are identified at Chapalauppada, Bhimunipatnam, Pedda Nagamayypallem, China Nagamayypalem, Annavaram.
17. The intertidal wetlands of Krishna district contain productive habitats, including marshes, tidal flats and beaches which are essential to estuarine food web. The major part of the Krishna delta is a flat area with gentle slope towards Bay of Bengal. It has some undulations in the middle part of the delta in the form of deltaic lobes, beach ridges and flood plains. The highest elevation is about 16 meter above mean sea level near Vijayawada town and minimum is 3.50m level at Machilepatnam.
18. Coastal wetlands provide habitats for birds, spawning fish, and a diversity of Amphibians, Reptiles, Insects and plants.
19. Mangroves provide protective, productive and economic benefits to coastal communities like flood control, ground control, ground water research and shoreline protection. In the recent years due to encroachment and improper usages of wetlands, they are either lost or are incapable of fulfilling their ecological function.

Remote sensing techniques have been extensively used in inventory, monitoring and management of natural resources in the coastal areas. Due to its repetitive, multispectral and synoptic nature, satellite Remote Sensing (RS) has proved to be extremely useful in providing information on various aspects of the coastal environment, viz. coastal wetlands, coastal landforms, shoreline changes, tidal boundaries (high/low), brackish water areas, suspended sediment dynamics, coastal currents, vital coastal habitats etc. Coastal habitats of the entire Indian coast were mapped earlier on 1:250,000 / 1:50,000 scale using multispectral satellite data (Nayak et al. 1992).

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

V. CONCLUSION

The geomorphological disposition of coastal areas of Andhra Pradesh was prepared by visual interpretation of IRS 1B LISS II (prepared by SAC) AWiFS image, on 1:250, 000 scale and the various units are discussed, the most significant features of the East coast of new Andhra coast is 14640km long with occupy the 331 sq km of the mangroves at the godavari and krishna delta, the marine land forms include paleo beach ridges, active beach and spit, the deltaic plain (6569 sq.km) and coastal plains(237 sq.km) are the flood plain(798 sq.km), lagoon (810 sq.km). Coastal plains forming the inland boundary and running parallel to the shore is the emergent coastal plain whose width varies from 5 to 40 Km. It is characterized by a moderate fluvial activity and occurrence of lakes, tanks and abandoned marshes etc. The material comprises of sandy, loamy and clays. Deltas of major rivers along the coast form an important land form. These deltas are laid down by the rivers Krishna, Godavari which has several paleochannels which are important prolific groundwater yielders. Tidal flats are the depressions either at the back of beach sand ridges or in between beach sand ridge complexes. They get submerged under marine water. They represent two types 1) tidal mud flats and 2) tidal sand, flats both are saline in nature. They get submerged under brackish water periodically and are mostly sandy brackish stretches. Beach and beach ridges along the above line there is an active beach whose width varies from place to place. It comprises of loose sand and single material. The beach ridges are complex of recent origin and comprise of ridges and swales forming an alternate sequence of high and low ground. And Old beach ridges and swale complex.

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Vol. 4, Issue 11, November 2015

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