Coastal Erosion at Uppada Along Kakinada-coast, Andhra Pradesh - a Study from Remote Sensing

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Abstract

Large scale coastal erosion often termed "long term coastal hazard" is prevalent along the ~ 30 km long coast between Kakinada in the south and Antarvedipeta in the north. The worst affected locality is Uppada (17° 04' 53": 82° 20' 03") located ~15 km north of Kakinada town. The impact of sea erosion at Uppada is so intense that the sea walls and groins erected south of it have proved ineffective in protecting the beach road which has suffered damage at several places. More than half of the village, predominantly a fishermen's colony, has gone in to sea. Study of temporal remote sensing data indicates that the coast line has eroded more than 370m over the last three decades. Historical evidences point towards loss of more than 600 acres of coastal land during the same period. At several places, wave-cut platforms have been formed exposing the tidal marsh/mud flat, the geomorphic unit underlying the sandy beach ridge.

Major geomorphic units found in the area include beach ridge, younger beach dune complex, older beach ridge, tidal marsh/mud flat and tidal creek. The most vulnerable geomorphic unit is the long and extensive beach ridge/younger beach dune complex for its proximity to shore and weak geologic formation. The long shore current has caused maximum erosion to the stable beach ridge and at the same time has widened the mouth of small rivers like Pedda and Upputeru draining in to Bay of Bengal north of Uppada. Presently, these rivers act as the tidal inlets and carry sea water inland particularly during the period of high tide.This, in turn, has accentuated inundation of more and more low-lying flats. Though long shore current and wave action seem to be responsible for such large scale sea erosion, the possibility of land subsidence vis-à-vis sea level rise can not be ruled out. The recurved spit extending from the mouth of river Goutami to Kakinada port in the north forms a bay and at the same time allows the longshore currents to deflect and cause erosion at Uppada.

Key words: *Coastal erosion. Longshore current. Beachridge. Spit.Uppada.*

Introduction

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 to sea due to natural processes such as waves, winds and tides, or even due to human interference. Besides the 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 Sea Level Rise (SLR). Other anthropological effects that trigger beach erosion include construction of artificial structures, mining of beach sand, off shore dredging, or building of dams on rivers.

Coastal erosion is the most common among the coastal hazards and affects the entire coastal zone of India. While it is more pronounced along silisiclastic or sediment coast, its effect along rocky or cliff coast is no less significant. Coastal erosion occurs when wind, waves and long shore currents move sand from the shore. The removal of sand results in changes in beach shape and structure. The impact of the event is not visible immediately as in the case of tsunami or cyclonic storm. It generally takes months or years to note the impact of erosion;

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therefore, this is generally classified as "Long Term Coastal Hazard".

The Kakinada coast in East Godavari district of coastal Andhra Pradesh is facing large scale coastal erosion. Over 600 acres of land in the Kakinada suburbs have disappeared in the last four decades because of sea erosion.The worst affected villages include Uppada, Komaragiri, Subbam Peta and surrounding areas in the Kothapally mandal. As a humid tropical area with very active geomorphological processes, the coastal tract is subject to rapid erosion and inundation. Uppada and nearby villages also suffer heavily whenever cyclones and storms hit the Kakinada Coast. In the recent cyclone, tidal waves destroyed 1200 houses including pucca buildings. The 50km long coastal road from Kakinada to Addaripeta too has been affected by the sea erosion and has been repaired about 20 times. Presently, it faces serious threat from the advancing shore at several places south of village Uppada. During high tide, waves invariably reach the road surface and cause serious erosion to it.

In view of the above background, it is necessary to learn from the historical record of coastal erosion and inundation to address issues of comprehensive mitigation plan at mandal/village level. This paper is intended to provide information on the magnitude and behaviour of coastal erosion at Uppada and adjoining areas and information based on geological and geomorphological parameters for decision makers and hazard response community.

Study area

Andhra Pradesh is one of the largest maritime states in India. The ~ 980 km coastline extends from the Bahuda River mouth at the border with Orissa state in the north to Pulicat, a large brackish water lagoon, in the south bordering Tamilnadu state. The northern coastline is predominantly rocky with few sandy beaches, the central coast houses deltas of river Godavari and Krishna and mangrove swamps, and the southern coast is largely sandy.

The coastline between Kakinada and Uppada forms a part of the central coast of Andhra Pradesh and is famous for its erosional history(Fig. 1).The ~15 km long coastline has suffered sea erosion at several locations, prominent among them being Uppada, Komaragiri and Subhampeta. The continental shelf of the study region is relatively narrow. Uppada (17° 04' 53": 82° 20' 03") a major village of fisherfolk and small farmers is located north of Kakinada town and, incidentally, is the first major locality falling outside the northern limit of Kakinada Bay. It is situated on an older beach ridge having an average relief of +3 m from msl. It is delimited by the fast advancing and constantly changing shore in the east and a low coastal plain in the west. A palaeo beach-ridge separates the coastal plain from the vast and expansive alluvial plain of river Gautami(tributary of Godavari) in the west. Two small rivers Pedda and Upputeru join Bay of Bengal north of Uppada. Several tidal inlets flowing in the area carry sea water during the time of high tide and tidal surge and are responsible for inundating low-lying marsh/flats. It receives heavy to very heavy rainfall mostly accentuated by cyclones and storms. The area enjoys humid tropical climate. The relative humidity varies between 75- 90% with average temperature between 25 and 40°C. It is a fertile agricultural area and the primary food crop is rice. Other crops such as groundnuts, sweet potatoes and fruits are also grown on raised surfaces which include palaeo beach- ridge and older beach dune complex.

Kakinada has fast emerged as a major industrial hub of Andhra Pradesh. It is famous for its deep water port and fishing harbor. The other major industrial units that have come up in the reclaimed tidal flats/marsh include Nagarjuna Fertilisers Ltd., Godavari Fertilisers, Bharat Petroleum Corporation Ltd., and Southern Power Generation Ltd. Recently, the Govt. of Andhra Pradesh has identified the Kakinada-Uppada area as a Special Economic Zone(SEZ).

Geomorphology

The area near Kakinada-Uppada coast is a plain and even. The major geomorphic units associated with this coast include beach ridges both recent and paiaeo, tidal marsh/ flat, tidal inlets (creek), rivers and present beach containing mobile sand dunes. The older beach dunes form the highest relief in the area with an elevation of 5m from the MSL. The area is a broad plain and is characterized by the occurrence of alternate ridge and swale. Uppada, Komaragiri and Subhampeta are located on a paiaeo baech ridge and have suffered sea erosion simultaneously. Another palaeo beach ridge separating the coastal plain in the east from the vast alluvial plain in the west runs parallel to it. It houses villages Gorasa, Kattapalli and Nagulapalli which face imminent threat of sea erosion in future.

Two small rivers namely Pedda and Upputeru join Bay of Bengal north of Uppada. Pedda, meaning big in telugu, is the primary stream and is connected to Upputeru through a creek east of Mulapeta. The mouths of both the rivers have suffered extensive erosion by the advancing shore line. They serve as channels carrying sea water landward during the period of hide tide and tidal surge. Several tidal inlets traverse the coast between Kakinda and Uppada and drain the low tidal flats. That part of the beach between Kakinada and Uppada, protected by the Kakinada Bay, is well developed and contains sporadic development of sand dunes. These landforms are small in size and act as the immediate barrier between the sea and land. They are highly mobile in nature and thus need to be stabilized.

Coastal hazards

Sea erosion, inundation and tsunami are the major hazards associated with the coast. While natural and/or anthropogenic causes are responsible for coastal erosion and inundation, tsunami owes its origin to major earthquake on sea bed.

Major Causes of Coastal Erosion are:

1. Natural Causes

- Combined action of waves, winds and tides
- Near shore currents
- Storms
- Slope process
- Sea Level Rise

2. Anthropogenic Causes

Human influence, particularly urbanization and economic activities, in the coastal zone has turned coastal erosion from a natural phenomenon in to a problem of growing intensity. Anthropological effects that trigger beach erosion are:

- Dredging of tidal entrances
- Construction of harbors in near shore
- Construction of groynes, sea wall and jetties
- Destruction of mangroves and other natural buffers like beach barrier dunes

Sea erosion

Coastal lands may experience long-term erosion under different conditions. For instance, if the sea level is rising or the land is sinking, the beach may eventually migrate landward or drown. This causes coastal land behind the beach to erode. Also, if the amount of sand from the seaward side is reduced, a beach will erode the land behind it to maintain a constant sand supply. This creates a condition called coastal erosion.

Sea erosion at Uppada is primarily due to strong wave action causing beach to erode and eventually migrate landward. There is least evidence of deposition here which suggests that the long shore current does not carry enough material from the seaward side. This indirectly points towards the reduced sediment influx by river Godavari and its tributaries in to the sea. Kakinada Spit, the famous geomorphic feature in Bay of Bengal is also considered responsible for

rapid beach erosion at Uppada. It is a major sand bar extending over more than 12 km in the sea and separates the Kakinda bay from Bay of Bengal.The widest part of the spit is its apex which resembles a snake's hood and projects landward(NW) . This is the point where the long shore current after crossing the spit moves towards the land and hits the shore at high speed. As the long shore current carries minimum sediment from seaward, it hits the shore with great impact and causes maximum erosion. Moreover, the shore is predominantly composed of unconsolidated to semi-consolidated marine sand which further exacerbate the process of erosion.

The tidal inlets and the two small rivers meeting the sea north of Uppada have also contributed to sea erosion in the area. The tidal inlets with their close network carry sea water during the period of high tide, surge and storm and eventually inundate the low-lying tidal flat/marsh. In the process, they erode the adjoining beach ridge and coastal dunes. The small rivers, Pedda and Upputeru, on the otherhand, do not carry much sediment and more or less act as tidal inlets. The advancing shore has widened the river mouth there by facilitating more sea water entering in to the land through it and causing bank erosion and inundation (Fig.).

Preventive and Mitigation measures:

The remedial measures should be selected after proper investigation of the area. It must be ensured that protection measures do not shift erosion problem from one site to some other site. The measures to control sea erosion include structural, non-structural or their combination.

A. Structural measures
   - Through construction of sea wall
   - Groynes

B. Non-structural measures
   - Vegetation cover
   - Dune stabilization

Structural measures used for coastal erosion prevention are as follows:

Sea Wall: Sea wall will be useful to protect village Uppada and the adjoining localities from erosion and storm surges. The huge concrete cubes used to protect the coastal road south of Uppada have met with limited success as they are not properly aligned and there exist wide gaps between them (Photo). The road at several places south of Uppada has suffered erosion with removal of underlying soil by current. Though adverse effect is likely on downstream side, this seems to be the most plausible mitigation measure.

Groynes: Groynes may be adopted to prevent or decrease shoreline recession and for beach formation. At Uppada it must be avoided going by the intensity of sea erosion and the least chance of fixing the beach at this position.

Non-structural measures generally adopted to reduce/prevent erosion are:

Vegetation cover: Vegetation cover such as mangrove in the estuary and palm/cassurina/ eucalyptus grown on beach ridges can restrict sand movement and erosion.

Dune stabilization: The incipient dunes formed on the beach surface need immediate stabilisation through growth of salt resistant plan species on them as they are highly mobile in nature. Once stabilized , they start acting as walls and help in reducing the damage to the structures landward.

Conclusions

The ~ 15 km long Kakinada-Uppada coast experiences coastal erosion, inundation and possible tsunami causing loss to property, and infrastructure facllitities. Comprehensive multi-hazard and risk assessment studies with participation of local communities and scientists need to be initiated by the government.

The sea erosion causing rapid migration of shoreline towards land and inundation of low-

lying flats need greater attention in view of potential rise of sea level and its impact on communities. Continuing erosion of coast line has eaten away more than 600 acres of land in the Kakinada suburbs during the past three decades. The shore line during the corresponding period has migrated more than 375m landward.

Though Kakinada spit is considered responsible for sea erosion at Uppada, it is the same island which saved Kakinada from the Tsunami attack in 2004. Tsunami assessment in Kakinada-Uppada area is equally important. The knowledge about tsunami among the local coastal communities should be improved through public education and training to support mitigation and evacuation.

References

Prudhvi Raju, K.N. and Vaidyanadhan, R. (1978) : Geomorphology of Visakhpatnam, Andhra Coast, Jour. Geol. Soc. of India, Vol.19,No.1,pp.26-34.

Prudhvi Raju et al. (1993) : Sea Level along Visakhapatnam Coast: A Geomorphic Explanation, Jour. Geol. Soc. of India, Vol.42, pp.337-348.

Marfai,M.A. et al.(2007) : Natural hazards in Central Java Provonce, Indonesia: an overview, Environ Geol, DOI10.1007/s 00254-007-1169-9.