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From the Director's Desk...

Dissemination of information on various issues related to environment of the State is the main objective of establishment of our ENVIS Centre. We have discussed on various issues in our earlier publications. In this issue we have focused on one of the important topic "*Tropical Odisha Coast, Eastern India: its Ecosystem, Natural Hazards and Coastal Erosion*". This issue has been prepared on the basis of reports presented by various experts during the workshop on coastal erosion held in the State Odisha. I hope the information will be useful to all.

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TROPICAL ODISHA COAST, EASTERN INDIA : ITS ECOSYSTEM, NATURAL HAZARDS AND COASTAL EROSION

Introduction

Odisha is a maritime State on the eastern edge of the Indian Peninsular Shield and the coast is bordered by the Bay of Bengal on the east and the Eastern Ghats hill ranges on the west. Tectonically, Odisha Coast lies in a passive continental margin (Atlantic Type), setting without any submarine trenches and therefore, does not have any direct possibility of Tsunami generation.

Odisha Coast extends ca.500km from Andhra Pradesh border in the southwest to the West Bengal border in the northeast. Six districts of Odisha share the coastal Zone and these are Ganjam,Puri, Jagatsinghpur, Kendrapara,Bhadrak and Balasore.The principal rivers that flow though the coastal tract to the Bay of Bengal from north to the south are: Surbarnarekha, Budhabalanga, Brahmani Baitarani combining to form Dhamra River with its mouth opening to the Bay of Bengal, Mahanadi, Devi & Rushikulya, river.The Mahanadi River mouth is microtidal with a mean tidal range 1.29 m which gradually increases towards mesotidal range in the northeast. Presently, northeasterly littoral drift transports 1.5 million cubic metres of sand annually on the Mahanadi deltaic coast. A high amount of fluvial transport along with a strong component of littoral drift has built a complex of sand shoals, bars and spits and barrier-islands near the Mahanadi River mouth. The Chilika Lagoon, the largest brackish water lake of Asia is located on the southerly part of Odisha coast shared by Puri and Ganjam district. A large part of the coast is formed by the Mahanadi River and Brahmani-Baitarani River compound Delta System having a vast alluvial delta plain traversed by ramifying distributaries opening through their estuaries to the Bay of Bengal. The upper and lower delta plain have their distinctive geomorphological landforms which have been shaped by fluvial, fluvio-marine, marine and aeolian agencies. From the shoreline, the hinterland deltaic terrain extends ca. 100 km which supports a large part of the population of Odisha.

The population of Odisha State after Census 2011 is reported to be 4.19 crore (4,19,69,509 people) which, has grown around 14% more adding over 51.42 lakh people in a span of 10 years. The teeming millions of people mostly subsist on cultivation where paddy is the staple crop of deltaic fertile soil.

The deltaic coastal tract has been formed during the Middle-Late Holocene ca . 6000yrs, B.P. when sea-level decelerated and was stable. Abundant fluvial supply of sediments under favourable monsoonal climate, tectonic subsidence,

sea-level situation and suitable accommodation space augmented delta formation on Odisha coast.

ECOSYSTEM :

Mangrove Wetland :

Odisha is endowed with rich biodiversity. Mangrove ecosystem is of outstanding importance in the costal ecosystem. Mangroves are salt-tolerant vegetation distributed mainly in the tropical and sub-tropical intertidal coastal tract. These mangrove forest systems are usually dominated by salt-water loving halophytic seed plants which range in size from trees to shrubs including palms. They grow above mean sea level in the intertidal zone and marine coastal environments or estuarine banks. The term 'mangrove' often refers to both the plants and the forest community. It has been considered that 'Mangal' should cover the entire forest community while 'mangrove' should refer to the individual plant species. Mangrove forests are highly productive ecosystems. It is a 'detritus-based' ecosystem. The detritus supplied by this ecosystem triggers planktonic community in the adjacent water bodies which sustains the fishery resources. Greatest concentration of mangrove species are found in areas where tidal creek and fresh water of rivers mix.

Mangrove forests from eye-catching wetland of Odisha coast. Estuarine wetlands of Odisha coast are characterized by mangrove fringes, tidal marshes and saline grass. Mangroves fringe tidal channels/ creeks of the Mahanadi River estuary and Dhamra estuary in the lower deltaic region of Brahmani-Baitarani river deltaic-complex.

The Bhitarakanika region near Dhamra mouth forms the second largest "Mangal" (mangrove) formation of India and is well recognized as a Wild Life Sanctuary and a National Park of considerable importance. The mangrove cover includes trees, shrub and palm species of Avicennia, Acrosticum Phoenix, Heritiera, Exoecaria, Sonneratia, Rhizophora, Xylocarpus, Brugriera, Aegicearas, Ceriops, Tamarix, Acanthus, Caesalpinia, Kandelia, Suaeda, Sesuvium, Daibergia, Lumnitzera, Merope, Brownlowia and Myriostachya. While mangroves flourish on estuarine banks and creeks near Dhamra and Maipura river mouths and the islands, the salt bush formation of mostly Xeric herbs prolifically occur on the nearshore tract of Satbhaya and Gahirmatha on the scattered sand dunes and ridges. Mangroves apart from forming nutrient-rich habitats for fishes, prawns and crabs are considered as a valuable resource for the coastal communities for getting honey, medicinal plants, tanning materials and wood for domestic purposes. Mangroves stabilize coastal sediments and aid in delta-building processes. They act as protecting barriers for withstanding the wave and storm surge onrush during storms and cyclones. Mangrove forests are presently destroyed by increasing human activities and are depleted at the average rate of ca 3 sq.km/yr. as per reports of last few years. It is a matter of great concern that there is large-scale depletion of mangroves in Asia where more than 60% mangroves have been converted to aquaculture ponds by coastal communities. In Bengkok coast in Thailand, mangrove depletion has led to marine transgression on the coast. In India., on the east coast mangroves cover part of Godavari, Krishna and Cauvery delta. These mangrove forests and the Sundarban mangroves on Ganga-Delta are being destroyed by human activities.

GAHIRAMATHA BEACH/DUNE-COMPLEX: ROOKERY OD OLIVE RIDLEY SEA TURTLES

In the coastal ecosystem of Odisha coast the Gahirmatha Beach-dune-complex close to Bhitarkanika and Maipura River mouth provides a congenial ground for mass-nesting of Olive Ridley Sea turtles (Lepidochelys Olivacea) between December-March. The nearby mangroves and salt bush formation of mostly Xeric herbs maintain a high productivity and rich biotic diversity of coastal waters which in turn is related to the food chain relationship of the marine turtles. Availability of vast sandy beach, food supply and favourable climatic factors ecologically favour mass-nesting. In a year, around 5 lakh Olive Ridleys reach the coast for mass-nesting. Olive Ridleys also gather on sandy beach near Rushikuly River mouth in the southern Odisha coast and are as well found sporadically on other parts of Odisha coast. Olive Ridleys are now being endangered due to rash operation of fishing trawlers on the coast and other detrimental human activities. Many carcasses of Olive Ridleys are seen to be lying on the beach on several parts of the coast and apparently these were killed being hit upon by fishing trawlers. This rookery of global significance on Odisha coast needs to be well taken care of and protected from ruthless human activities by taking legal and administrative measures.

CHILIKA LAGOON WETLAND COMPLEX :

The Chilika Lagoon in southern Odisha coast is the largest brackish water lagoon of Asia and was declared as Ramsar wetland site of International importance. This wetland is an exemplary natural ecosystem. Various fishes, prawns and crabs from are edible resources of the Chilika Lagoon and are of great commercial importance. Chilika Lake is a paradise for about 151 species of various birds out of which about 92 species are migratory birds flying from far-off places like Siberia and the Himalayas to escape the severe cold of these regions . Dolphins of the Chilika Lake are of great tourist attraction. Among the aquatic weeds, Potamogeton is the dominant macrophyte flora of the Chilika Lake. Salinity of the Lake has been raised by opening new mouth in the Chilika Lake sand barrier. The Chilika Development Authority is adopting various programmes for maintaing the ecological sanctity of the Lake for the benefit of the people living around Chilika Lake.

NATURAL HAZARDS :

Odisha coast is threatened by seasonal and episodic natural hazards like storms/cyclones and monsoonal river floods. During the pre-monsoon period of May-June and Post-moonsoon period of October-November depressions may be generated in the Bay of Bengal leading to cyclonic storms of great severity which may bring havoc to parts of the coastal stretch of Odisha. During severe tropical storms, the wind speed mounts to 89-116 km/hr. A severe storm with a core of hurricane wind is characterized by wind speed which may exceed 117 km/hr. The severest storm recorded in the later part of the 19th century battered the coast near Paradip during September 1885 when storm velocity mounted upto 250 km/hr. Severe cyclonic storms have swept the coast in October, 1971 and June 1982. Cyclone of 1971 accompanied by a storm surge of 6-7 m high caused a death toll of about

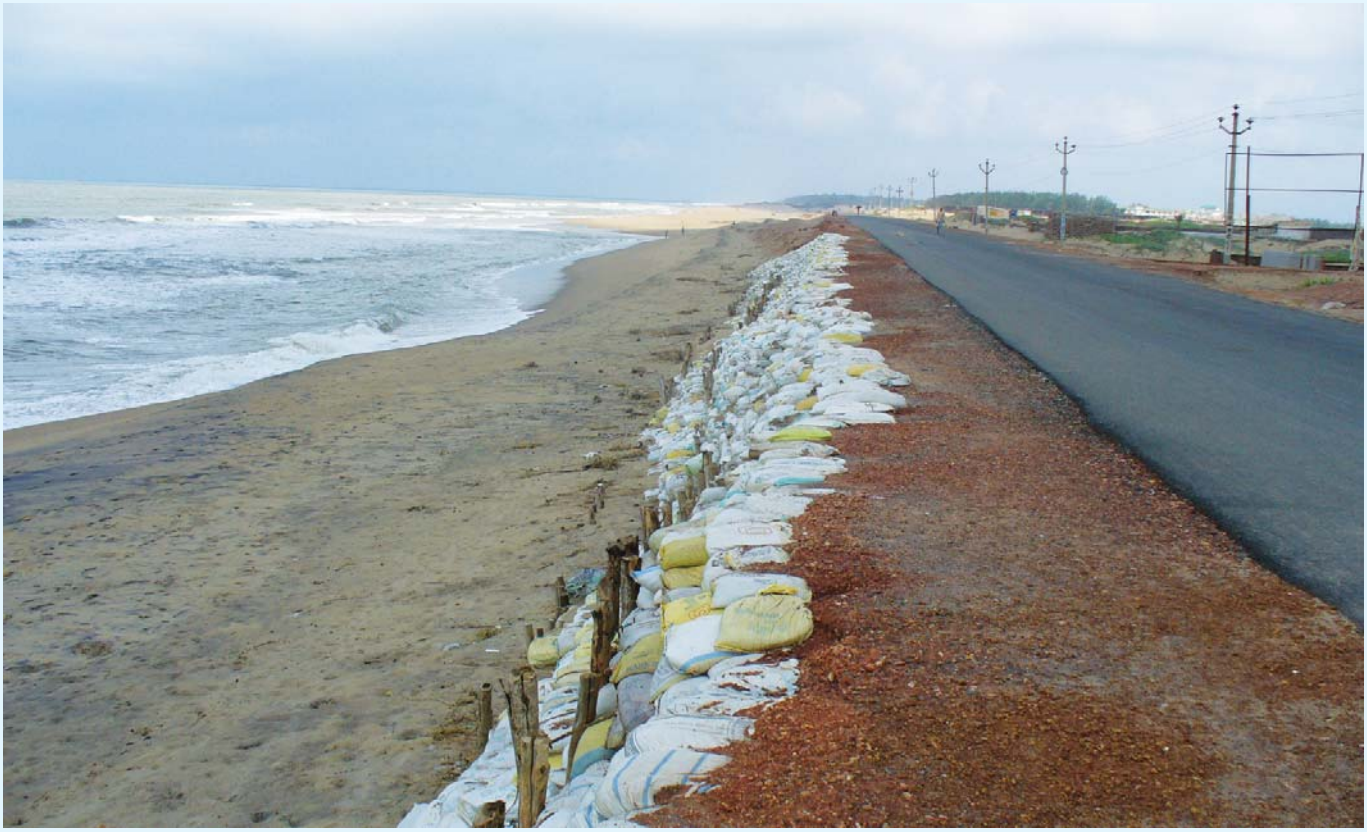
10,000 persons near Jambu River mouth close to the Mahanadi River .Storm-surge-generating cyclones develop in the Bay of Bengal Particularly during the post-monsoon period. Cyclones are usually accompanied by heavy rainfalls which may cause river flooding. Fluvial and storm-surge flooding eventually coinciding with spring Tide situation may lead to disastrous coastal flooding/ inundation bringing heavy loss of life and property in parts of the coastal tract. Strom-surge incidence on Chandipur coast in Balasore District caused tremendous devastation in August 1997. In the low-lying coastal tract, sea water spreads to tens of kilometers inland and the surging sea waters transgresses into marshes swamps creating vast open expanse of water bodies, where waves generated by wind action may further transport greater amount of saline water inland which take time to return to the sea. Agriculture fields sustain heavy loss due to spread of salinity and rotting of crops. In the Chilika Lake, storm surge rushing through the inlet/ mouth endangers populated islands and lake margin.

Odisha Coast was hit by an unprecedented Super cyclone one of the most disastrous cyclones of the world, on October, 29, 1999 when wind speed ranging from 220/300 km/hr lashed the coast for long 36 hours causing colossal damage and flooding of the coast when storm-surge raised upto 10-12 m accompanied by torrential rainfall created a deluge on the coast killing many people and thousands of domestic livestock that created a ghastly scenario which can never be erased from memory in the times to come. Thousands of people were marooned whose miseries knew no bounds. Satellite image indicated inundation of 2097sq. km of coastal tract. The coastal between the Mahanadi and Devi River mouth was worst affected. The impact of the Super cyclone destroyed a large part of coastal geomorphic features like splits, barrier-islands and dunes Shelterbelt plantations of the coast were greatly ruined.

The delta-building and coastal stabilization depend upon supply of sediments from the catchments through the river systems. The process is essentially monsoon-driven. With heavy rainfall during the southwest monsoon period, the rivers may swell up with flood waters, the rigorous of which may very depending upon the amount of rainfall. A water discharge of 17, 150cumsecs initiates flood in the Mahanadi River. Damaging Floods may occurs in an interval of 3-5 years when water flow rises upto 28,580 cumsecs. The highest flood of the century in the Mahanadi River passed through on August 31 and September 1, 1982 when water flow mounted upto 44,749 cumsec at the delta head at Naraj. This brought unprecedented devastation in the delta plains. In the recent past, the years 2001 and 2003 were marked by very high floods in the Mahanadi River. In July 2001, very high floods passed for 4 continuous day (July 17 to July 20) when water discharge exceeded 39,000 cumsec and recorded highest discharge was around 40,868 cumsec. In August and September 2003, very high floods passed when water discharge fluctuated between 31,000 to 38,200 cumsec .

COASTAL EROSION

Coastal erosion is wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents or drainage. Waive generated by winds, storms and unusual weather condition cause coastal erosion which may be long-term losses of sediments or merely temporary redistribution of sediments. Erosion at one place may result in accretion in nearby region. Factors affecting the erosion rate depends upon wave climate: prevailing wave direction, wave breaking point. Tidal range, geomorphological setting, groundwater fluctuations and climatic/ meteorological factor also need to be considered. However, catastrophic events like cyclones and storm-surge have great erosional and sediment-



reworking potential. A storm-surge is an onshore gush of water associated with a low-pressure weather system and usually is observed when there is extreme weather event like a severe cyclone. Storm-surge can erode chunks of beach and deposit the sediments at other parts of the shoreline. Coastal subsidence and uplift, sea-level changes under present global warming/climate change scenario and human activities like excessive ground-water pumping (Like Bangkok coast in Thailand) and other human activities in the coastal area are factors which need to be reckoned for assessing the coastal/beach stability and erosional/ accertionary processes.

Delatic coast around the world recently have become sites of serious environmental problems. Erosion of the deltaic coast due to reduction of sediment supply to the coast by the fluvial systems draining from the catchment to the deltaic shore face is a major problem. This is occurring because lot of sediments carried by rivers are trapped in reservoirs behind man-made dams. Another cause of erosion is relative sea-level rise associated with land subsidence due to groundwater pumping. Construction of levees, embankments, diversion of water courses due to digging of irrigation canals, changes in land-use patterns, increasing urbanization, increasing domestic consumption of water, increasing use of water in industries hinder water and sediment discharge to the coast and trigger coastal erosion.

A new study by the University of Colorado recently revealed that most of the world's low-lying deltas are sinking from human activities making them increasingly vulnerable to river and storm-surge flooding and putting millions of coastal inhabitants at risk. About 500 million of people of the world's live in river deltas. As recorded, 24 out of world's 33 major deltas are sinking and 85 % experience severe flooding in recent years resulting in temporary submergence of approx. 100,000 sq miles of land. Flooding in Asian Deltas of Irrawaddy in Myanmar and the Ganga-Brahmaputra Delta in India-Bangladesh have recently claimed thousands of lives. Global delta flooding could increase by 50% under current projection of about 18 inches sea-level rise by end of the century as forecast by IPCC.

Sinking of deltas from Asia and India exacerbated by the upstream trapping of sediments by reservoirs and dams, man-made irrigation canals and levees and other human activities. Large

scale global processes like flooding coastal erosion and submergence are factors for deltaic wetland loss and stand as impediments for delta growth and sustainability. World deltaic plains having some of the most productive and sensitive ecosystems are getting modified at astonishing rate due to human-induced changes and natural causes. There have been 2 major causes of wet-land loss : (1) expansion of open water / flooding on delta plain.(2) agricultural, industrial expansion and urbanization in the delta plain. Delta sustains people and their resources if delta grows or progrades but constrains life system if delta shrinks.

The Odisha coast is presently subject to serious erosion at several locations. According to Shoreline Change Assessment Atlas of Odisha compiled by Institute of Ocean Management of Anna University, Chennai and released in April 2011, it is reported that around 36.8%coastline is bearing the brunt of erosion. Zones of erosion are more pronounced at Gopalpur Port, Puri beach, Konark-Chandrabhaga-Ramchandi beach, Astaranga towards Devi river mouth, Paradip-Jatadhar Muhan and South of Dhamra Port. High erosion was observed at river mouths along Odisha coast. Near Mahanadi river mouth, while breakwaters were constructed for the Paradip Port, the southern part of the breakwaters showed accretion while the northern part of breakwaters showed serious erosion which lead to raising a sea wall on the northern side. Serious coastal erosion near Sathbhaya/Pentha village has been creating great concern since 2004. Between Satbhaya and Gahirmatha (celebrated Olive Ridley rookery) the entire coast is facing high erosion at the rate of nearly 80 to 100 m/year at certain stretches and as a result the High water Line (HTL) is shifting towards the land. Nearly 200-300m of the coastline has receded landward. The coast close to Pentha village is continuously eroding. In July 2007, the saline embankment was in great danger of collapsing. As a long-term solution to the problem of erosion; an anti-erosion control and for the lost beach recovery strategy, use of geosynthetic tubes at a depth of 4-5 m in the sea to dampen the wave energy has been planned. It will be undertaken under the World Bank assisted Integrated Coastal Zone Management Project (ICZMP) carried out in Orissa. Under this project , coastal erosion, hydrodynamic processes on the coast, vulnerability to coastal hazards, biodiversity conservation , conservation of cultural/ archaeological heritage sites, livelihood security and pollution problems will be addressed . In addition to geosynthetic tubes being a soft engineering measure, coastal vegetative shelter belt plantations as a 'bio-shield' towards the land, buttressing existing mangrove forests on the coast to mitigate storm /cyclone disasters and raising saline embrankment upto 7.4 m above MSL with a top width of 5.0 m filling with compacted earth fill as a defense against sea water intrusion into the nearby agricultural fields need to be undertaken with official administration and community participation.

Puri beach is also facing staggering erosional problems. Human activities encroaching CRZ norms seem to be an outstanding cause of beach erosion apart from meterological and other causes. Erosion has been observed at Sipasarubali-Balukhanda Abhayaranya coast between Konark and Puri .

Summarily, present day global warming/ climate change, natural hazards, sea-level rise and anthropogenic activities are impacting the coast and delta-building.

However, CRZ notification has been implemented and experts are working to prepare hazard line maps to help the stakeholder in making decision on various projects in this area. Odisha Coastal Zone Management Authority & ICZMP are functionary to like after issues related to coastal environment.

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