International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

A STUDY ON COASTAL EROSION MITIGATION ON ODISHA COASTLINE

Shashanka Sekhar Palai[1], Pranjal Mandhaniya[2]

[1]M.Tech Scholar, Civil Engineering Department, ITER, Bhubaneswar, Odisha, India
[2]Asst. Professor, Civil engineering Department, ITER, Bhubaneswar, Odisha, India

***

Abstract - Coastal erosion is a big problem now a day as development and interest of people to live alongside seashore is increasing. The state of Orissa is one of the most disaster prone states in the Indian Union. Orissa's six coastal districts are often subjected to tropical storm systems like cyclones as well as storm induced flooding and surges. Shore is washed by oceanic waves and dunes, which are natural protection for it are being destroyed by development alongside shores. To counter this problem, artificial structures are created to counter coastal erosion. In this study, various structures are analyzed for their capability and application. Also a response of already built structure is studied to see the effectiveness of these structures. Improvement and suggestions are made to counter coastal erosion along Odisha coastline from the literature. Different coast types are studied to know the appropriate structure for erosion prevention. All this will be shown in this study.

***Key Words*: Coastal erosion, Seashore, coastline, surges, tropical storm.**

1. INTRODUCTION

Coastal erosion is complex process that needs to be investigated from the angles of sediment motion under wind, wave and tidal current action. The geological composition of a coastal region determines the stability of the soil, as well as the degree of rocky material and their break down and removal. Erosion is noticed at Puri, Gopalpur, Chilika and Ersama in Odisha. Growth of long sandspits at Chilika Lake indicates the movement of littoral sediment and subsequent deposition. Coastal erosion is a natural process. They become anomalous and widesoared in coastal zone of Asia. Development of coastal areas has increases interest in erosion problem.

1.1 Types of Coasts Based On Geotechnical Classification of Coastal Region:

There are two types of coast which affect our coastal erosion. They are cliff coast, muddy coast, clayey bank coast. Cliff Coast are known as hard coast because it was formed from resistant material such as sedimentary or volcanic rock. Strom and Tsunami will have a less erosive effect on this type of coast. The Figure 1and 2 represents the Cliff coast and Clayey bank coast respectively. Clayey Bank Coast are known as "semi hard coast". It consists of cohesive soil and its height near about 15m. It is compared to hard coast because it is compose of weaker and lesser existent material.

Fig -1: Cliff coast

Fig -2: Clayey bank coast

1.2 CAUSES OF COASTAL EROSION

1.2.1. Natural Causes Of Coastal Erosion:-

One cause of natural coastal erosion is an increasing gradient in transport rate in the direction of transport. Transport gradient can be due to gradients in wave condition at certain stretches.

The loss of sand to an accumulative beach at the tip of a sand spit and into deep water at the lee ward of the tip of a sand spit at the termination point of a littoral cell. Sand lost in this way causes accumulative shore and shoal features in the deposition areas, but the upstream coast line has lost the sand. An example of accumulative beaches is the Skaw Spit. The natural variation in the supply of sand to a coast line from a river can contribute to erosion.

1.2.2. Artificial Causes of Coastal Erosion:-

Groynes are normally built perpendicular to the shore line with the purpose of protecting a section of the shore line by blocking of the littoral transport, where by sand is accumulated on the upstream side of the groynes. Dredging is a term given to digging, gathering or pulling out material to deepen waterway, create habours. The material removed during dredging can vary greatly and can be combination of rocks, clay slits or sands.


Fig -3:Groynes **Fig -4**:Dredging

Leeve is elongated naturally occurring ridge or artificially constructed fill or wall which regulates water level. It is usually earthen and often parallel to the course of a river in its food plain or along two-lying coastline. Seawalls are vertical or near-vertical shore parallel structure designed to prevent erosion and flooding. Seawalls are generally massive concrete structure a turban beaches. Seawalls can mitigate erosion and defend against the natural elements to improve the safety of their homes and buildings. Like a groyne, the port acts as a blockage of the littoral transport, as it causes trapping of sand on the upstream side in the form of an accumulating sand filet, and the possible bypass causes sedimentation at the entrance. The sedimentation requires maintenance dredging and deposition of the dredged sand. The result is a deficit in the littoral drift budget, which causes lee side erosion along the adjacent shoreline.



Fig -5: Leeve **Fig -6**: Seawall **Fig -7**: Ports

2. ORISSA COAST

The 482 km long extend of Orissa coast is a critical division on the East coast of India with regard to physical distinctiveness, biota and marine resources .Almost 2/3 of total population lives in beach front areas and major towns are situated in this zone as it were. The Orissa coast develops from south of Digha in the north to Girisola in the south. The whole coastal strip fluctuates in width from 40 to 50 km involving the locale of Baleshwar, Bhadrak, Kendrapada, Jagatsinghpur, Khurda, Puri and Ganjam. The main agricultural products of the region involve paddy, dark gram, coconuts, betel leaves, cashew nuts and so forth. Fish catch and prawn culture are commanding the scene. The coastal lowland gets around 152 cm rain a year since it comes straightforwardly affected by tropical depression starting in the Bay of Bengal. Orissa coast represents 8 % of the coastline of India. The whole fish catch of Orissa is from within a distance of 10-15 km from the coast.

Table -1: Orissa's Proneness to Various Types of Disasters

Hazard Type	Time of Occurrence	Potential Impact
Cyclone	May, September, October, and November	Loss of Life, livestock, Crop and Infrastructure
Drought	April to June	Crop loss, Water Scarcity
Flood	June to September	Loss of Life, Crop Infrastructure and Animals
Fire Accidents	Summer and Winter months	Human loss and house damage

2.1 NATURAL DISASTER THREATS TO ORISSA COAST

Around 85 % of the coastal zone of Orissa is under exceptionally weak condition because of deforestation and conversion of forest patches to agricultural purposes. Coastal Erosion has expanded because of cyclonic storms that hit Orissa in 1943, 1950, 1965, 1970, 1982, 1984, 1988, 1989, 1991, 1993, 1995 and 1999. Surging waves, strong winds and heavy rainfalls are related with the cyclones. The coastal floods influenced regions lying underneath 3 m and 5m surface statures during low and medium magnitude cyclones.

Coastal Orissa according to the records accessible, experienced 23 larger cyclones during the 20th century and the majority of the extreme cyclones hit the coast in the pre rainstorm months i.e. May - June and withdrawing rainstorm months i.e. October – November. During storms, the high tide line over the raised water level goes straight up to the base of the dune cliff. River bank disintegration in comparative way is likewise articulated by high vitality current flow and wave dash. High wind speed brought about by cyclone increases wave dash and changes the flow outline of rivers. The vegetation which is primarily responsible to ensure the erosion has been under severe threat. At places it has been detached for fuel-wood necessity and at many places it is completely denude in the name of developmental actions such as construction of resorts, hotels, tourist bungalows, guest-houses etc.

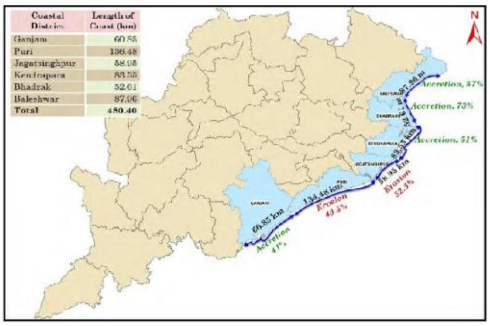


Fig -8: Costal Odisha

Table 2: Notable cyclones affecting the Coast of India[In terms of Casualty / damage figures]

Location	Date/Area	Damages
Orissa	Sept, 1985	84 people and 2600 cattle lost life. Land of4.0 hectare damaged.
Orissa	June, 1989	61 people and 27,000 cattle lost life, 145,000 houses, Communication disrupted
Orissa	Oct, 1999	10,086 casualties, 21.6 Lakh houses damaged.

3. OBJECTIVES

- Determining areas of potential erosion problems.
- Implementing policies to protect beaches, dunes, over-wash fans and erosion hazard areas. (EHA), as well as reducing risks to development in these high hazard areas.
- Facilitating assessment of disaster impacts following future storm events.
- Providing useful background information, when evaluating NJDEP permits applications.
- Providing evidence on dune development at any site.
- Assisting local municipal governments in developing policies or plans for dealing with coastal erosion or improving storm preparedness.

4. METHODOLOGY

4.1. Data Sources

A total of four different data sources were used to obtain historical shorelines for this study. Depending on location and data source, different proxies for shoreline position were used to document coastal change, including high water line, wet-dry line, vegetation line, dune toe or crest, toe or berm of the beach, cliff base or top, and the instantaneous water line as extracted from satellite imagery.

4.2. Rectification/ Correction

The first stage in rectification is the geometric correction to correct the distortion effects due to changes in platform attitude (roll, pitch and yaw), altitude, earth rotation, non-linear response of a detector and the curvature of the earth. Most of these distortions are mathematically corrected but the change in attitude is performed by a procedure called Geometric/ Image Rectification. The major characteristics of the image in Visible and Near Infrared image are:

***a.* Spatial Resolution:** The Spatial Resolution defines the pixel size of the satellite image on the ground.

***b.* Spectral Resolution:** Spectral Resolution refers to the width of the spectral bands as recorded by the sensor. Smaller the spectral width range, the higher will be the spectral Resolution the known higher accuracy planimetric coordinates of Ground Control Points (GCP) are utilized to the corresponding pixel coordinates in the satellite image.

***c.* Radiometric Resolution:** Radiometric resolution refers to the number of digital grey levels. It is the number of bits required to store the grey values. For example Landsat TM data are quantified to 256 levels corresponding to 8 bits.

***d.* Temporal Resolution:** Temporal Resolution refers to the frequency of images that is acquired for a given geographic location (Time Domain).

4.3. Image Enhancement

The rectified and geometrically corrected image was subjected to enhancements in order to improve the quality of image in general to improve the interpretability of the image. Image Enhancement is most useful because when color is displayed on a image it provides adequate information for image interpretation. The study adopts contrast stretching to improve the image for better interpretability.

4.4. Compilation and QA/ QC

In order to verify the accuracy of the demarcated shorelines, various control points were selected on-screen at severely eroding sites, as visually observed from satellite images. Ground control points were selected based on their stability through time and their proximity to the shoreline. Because the points selected were adjacent to the shoreline, they provide a measure of high accuracy near the feature of interest.

4.5. Existing shoreline rate-change calculation methods

Several methods were suggested to estimate the rate of change i.e. End Point Rate (EPR) by Fenster et al (1993)1, Average of Rates (AOR), Linear Regression (LR), and Jackknife (JK) by Dolan et al (1991)2.

a. End Point Rate (EPR): The End Point Rate is calculated by dividing the distance of shoreline movement by the time elapsed between the earliest and latest measurements.

b. Net Shoreline Movement (NSM): The net shoreline movement reports a distance, not a rate. The NSM is associated with the dates of only two shorelines. It reports the distance between the oldest and youngest shoreline.

c. Shoreline Change Envelope: The shoreline change envelope reports a distance, not a rate.

The SCE is the distance between the shorelines farthest and closest to the baseline. This represents the total change in shoreline movement for all available shoreline positions and is not related to their dates.

d. Linear Regression Rate (LRR): A linear regression rate-of-change statistic can be determined by fitting a least squares regression line to all shoreline points. The rate is the slope of the line.

4.6. Analysis in GIS

To measure the amount of shoreline shift along each transect, a buffer line was created along the land. The rates of shoreline variations were calculated using LRR method in GIS software to identify erosion and accretion areas along the coasts.

4.7. Maps and Data Products

A map index for the coastal zone of Odisha was created and plots conforming to the index were created at 1:50,000 scale in GIS and plotted in the same scale (1:50,000) scale on paper. In addition to plots, a GIS database and query interface was designed to analyze the shoreline change results.

5. MITIGATION MEASURES OF COASTAL EROSION

5.1. Structural measures

Groynes:- Groynes may be adopted to stop or decrease shoreline recession and for beach formation. However, extremely adverse effects are observed on downstream side and groynes should be avoided unless their main purpose is to keep a beach at one particular position at the cost of adjoining areas.

Fig- 9: Groynes **Fig- 10:** Off-Shore break water

Offshore break water:- A living shore line approach for sand beach shoreline uses large, gapped store structures placed offshore. Offshore break water system provide shoreline protection by intercepting incoming waves and creating stable pocket beached between fixed stone structures.

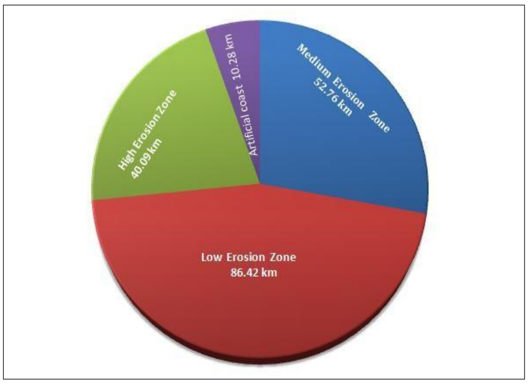
5.2. Soft Structural measures

Severe erosion problem has been experienced due to construction of jetties and/or dredged channels. Sand bypassing at tidal inlets problem can be solved by bypassing of material from the up drift side of inlet to the down drift side. Vegetation cover can restrict sand movement and erosion.

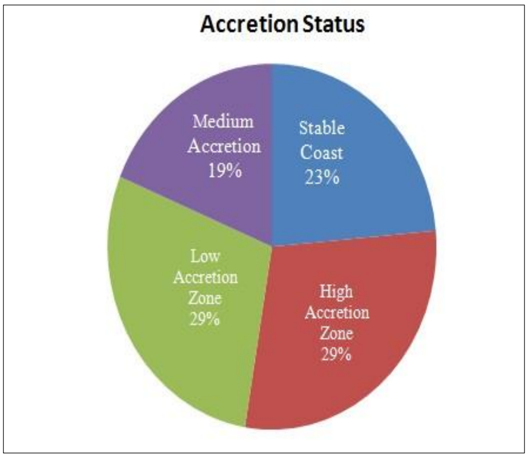
Fig-11: Palm plantation

6. OBSERVATIONS

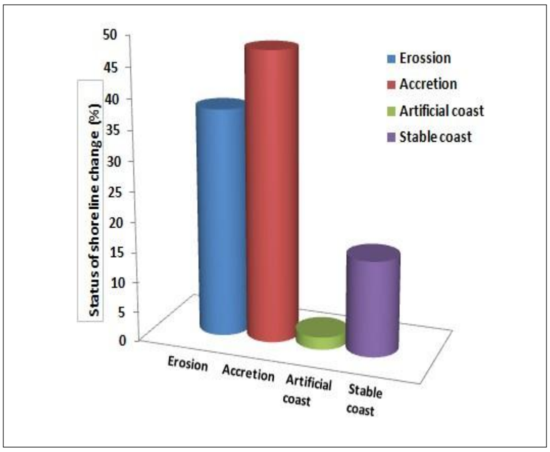
Shorelines change pattern for the Odisha coast has been generated with a total of 48 maps using 700 transects at 300m interval and rates of shoreline changes have been computed. In Graph 1 represent the erosion status of Odisha coast with four different zones such as medium erosion zone, low erosion zone, high erosion zone and artificial coast. In Graph 2 shows that % of accretion status of Odisha coast with four different zones. In Graph 3 described the overall shoreline changes (%) for Odisha coast.



Graph.1. Erosion Status of Odisha Coast



Graph. 2 Accretion Status of Odisha Coast



Graph. 3. Overall Shoreline Changes (%) for Odisha coast

7. CONCLUSIONS

Thus it is observed that the state of Odisha needs to attain an effective disaster management network at the earliest. Accelerated erosion, progressive siltation and overall degradation of coastal belts are a common sight throughout India. There is an urgent need for their protection as the coastal resources are of immense value for present and future populations. The threat of the natural disasters can only be curtailed through a hybrid approach where a confluence of technology and social acceptance is evolved and practiced. The capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods can no longer be taken for granted. Rather, socio-ecological resilience must be understood at broader scales and actively managed and nurtured. Incentives for generating ecological knowledge and translating it into information that can be used in governance are essential.

REFERENCES

[1] C. Charles, and E. Mark, “Design, Implementation and Operation of a Modular Integrated Tropical Cyclone Hazard Model,” Univ. of Central Florida, Orlando, 1999.

[2] D. Bowman, & E. Pranzini, “Erosion within a segmented detached breakwater (Gombo Presidential Villa Beach, Tuscany, Italy), (E. Özhan, Ed.),” Proc. of the Fifth International Conference on the Mediterranean Coastal Environment, MEDCOAST 01, MEDCOAST Secretariat, Middle East Technical University, Ankara, Turkey, v: 3, pp: 1479-1488, 2001.

[3] G. Prasetya, “The role of coastal forests and trees in protecting against coastal erosion.”1999.

[4] J.Nott, and M. Hayne, “High frequency of ‘super-cyclones’ along the Great Barrier Reef over the past 5,000 years.” Nature, 413, pp- 508-512, 2001.

[5] L. Cipriani, F. Pellicia, and E. Pranzini, “Beach nourishment with nearshore sediments in a highly protected coast,”Proc. of the MEDCOAST 99 – EMECS 99 Joint Conference: Land-Ocean Interactions – Managing Coastal Ecosystems, MEDCOAST Secretariat, Middle East Technical University, Ankara, Turkey, v: 3, pp: 1579-1590, 1999.

[6] R. Ramesh and A. Senthil Vel, “National Assessment of Shoreline Change Odisha Coast” Institute for Ocean Management Anna University, Chennai,2002.

BIOGRAPHIES

Shashanka Sekhar Palai has completed his M.TECH degree from ITER College, SOA university in the year 2017.His area of interest are Soil stabilization, ground improvement techniques and soil liquefaction, strength of reinforced soil .

Asst. Prof. Pranjal Mandhaniya was working at SOA university in the department of Civil Engineering. He pursues his P.HD in IIT Delhi. His areas of interests are soil liquefaction, strength of reinforced soil.