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RESEARCH ARTICLE

COST ECONOMICAL COASTAL EROSION PROTECTION SCHEME A CASE STUDY

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ABSTRACT

Climate variability, change in environment conditions and its resulting extreme events has caused serious disasters over the past decades. Flooding became more severe in low lying coastal areas due to increase in sea level. Growth of urbanization towards coastal regions has caused depletion in green areas such as mangroves, coral reefs; which otherwise its presence act as storm and sediment barrier. Wide range of coastal protection system such as sea wall, break water, various attracting and repealing groynes are used. Green coastal protection solutions such as re-nourishment of coastal areas, beaches should be used in conjunction with these hard solutions. Mechanism, factors affecting, sensitivity and intensity of erosion process should be known in depth before selecting appropriate protection system. Present case study represents the coastal region of Andhra Pradesh, where coastal erosion has caused serious misery to the local habitants. Land encroachment of about 15m has been recorded every year based on collected data from time lapse tool in Google Earth Pro. It is estimated that if suitable measures will not take to prevent this continuous coastal erosion. Then this may lead to serious disaster in the area. Accordingly, suitable cost economic coastal erosion technique has been presented to reduce this encroachment impact.

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INTRODUCTION

Coastal erosion is recurring process which continuously reshapes the landforms/shorelines due to wave, winds, tidal movements, near-shore currents, dynamic environment conditions and other factors such as beach material type, bathymetry, and rise in sea level. In our subcontinent, 45% Indian Coastline has been affected by erosion problem with varying magnitude. Indian Maritime states like Kerala, Tamil Nadu, Andhra Pradesh and Gujrat coastlines are chronically affected by erosion. The cumulative coastal erosion creates additional land encroachment which keeps on adding with time.

Places where contributory rivers join Sea, poses further challenges in terms of data requirements to account for discharge, silt load etc. Common problems faced by Indian coast includes siltation of natural drainage channels, flood during sudden surge, formation of sand bar at the inlets of river mouths, coastal erosion.

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Several soft (Green) and hard engineered coastal protection solution are widely used across sea shore regions for coastal erosion protection. In India, itself wide range of measures have been undertaken for coastal protection such as sea wall, break water, various attracting and repealing groynes etc. still suitability of these preventive measures are debatable issue, however it has been now felt that soft (Green) coastal protection solutions such as re-nourishment of coastal areas, beaches should be used in conjunction with these hard solutions. Before reaching to coastal erosion control scheme, it is required to get idea of mechanism, factors affecting, sensitivity and intensity of erosion process. Some of the key physical parameters are to understand geomorphology of coastal line, forces generated through wind creating high intensity wind waves. The wind and tidal generated waves are main factor causing coastal erosion. These takes birth in mid ocean, collect and bring enormous amount of energy with them and travel towards coastal area. This energy is then dissipated through breaking of wave and creates turbulence, sediments deposition and movements based on generated currents. Andhra Pradesh shares 3% rocky coasts, 52% muddy flats, 7% marshy coasts and 38% sandy beaches. The east coast becomes active during the cyclones of the northeast monsoon period. Case study of Yekuvuru Village, Near Sompeta, Andhra Pradesh has been undertaken, where increased sea level and wave heights have created miseries to localities. Shore boundary has been recorded to be continuously declining year by year.

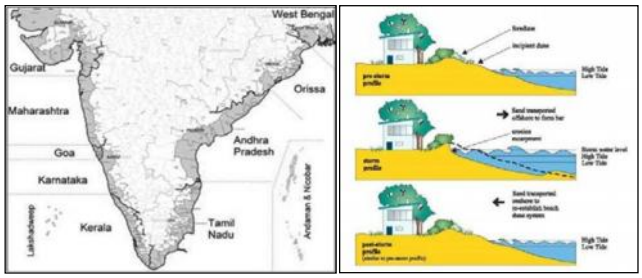


Figure 1. Coastal region of India (Left side), Coastal erosion mechanism (Right side)

Some of reasons behind this may be rise in sea water due to global warming and climatic variability. Local affecting reason noticed due to river flowing adjacent to the habitant area responsible for the aggradation and degradation issue, littoral drift created direct impact on the coast as shown in figure 2. Figure 2.

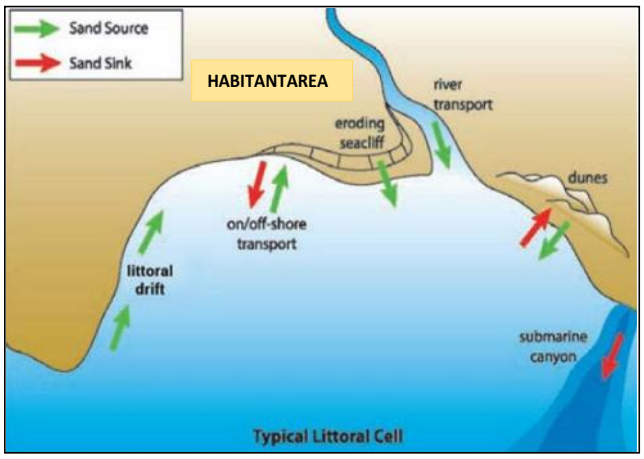


Figure 2. Typical sketch representing factors, sources influencing the erosion process at area under study.

Typical sketch representing factors, sources influencing the erosion process at area under study. Wave heights of more than 9 m usually occur in this region under severe tropical cyclones dueto disturbances in the Bay of Bengal.

Recently Developed Coastal Protection Techniques: Recently developed coastal erosion protection system includes construction of precast panels outside with sandbags and filters wrapped with geotextile inside panels. This hybrid structure act as erosion control and break water. Following coastal protection scheme shows fully submerged breakwater system. Generally, sand containers are used for it. This system increase epibiotic colonisation, which ultimately attracts marine life.

METHODOLOGY

Site Identification: Identification of the erosion problem is primary key step, which helps to know the cause, intensity of source, shoreline condition in the past, present and prediction due to dynamic effect of environment. Accordingly, field observations had been done at Yekuvuru Village, Near Sompeta, Andhra Pradesh and data collected based on questionnaires with local people like historical extent of landmass which was not affected and now due to continuously rise in sea level created miseriesto them.

Figure 3. SPS coastal erosion protection system (Source: SPS)

Other factors being steep sea bed slopes, two monsoons per year, frequency of storms, which is normally five per year. Secondary step was to create the formulation of the extent of sea shore degradation. To know this extent, Google Earth Pro has been used to the lateral extent of seashore erosion. Following images shown in figure. 5 reflects the year wise land encroachment. These investigations provide us idea of future coastal erosion due to sea line approaching to villageand help us to think options that can be implemented for the coastal are protection for the region.

Figure 5. Shows year wise extent of continuously shoreline degradation at Yekuvuru Village, Andhra Pradesh.

Around 15 m load encroachment has been recorded every year from 2012 to 2018; which is clearly visible from the images shown in figure 5. It is estimated that at the end of near 20 years from now it may encroach to the habitant area, if suitable coastal protection system will not adopted.

Understanding the Erosion Problem: The geological composition of soil at Yekuvuru Village, Andhra Pradesh comprises of sandy coast. These types of sandy coastal geology comprises of loose/unconsolidated materials which generally originates from eroded coral branches, headlands, broken shells. Coastal region around the Bay of Bengal are prone to strong winds, dynamic environmental variations with sudden

surge in induced storm surges, coastal erosion due to fluctuating level. Blasco *et al*. (1994) conducted scientific study at Bay of Bengal and reported that the mangrove known as Sundarbans in India and Bangladesh effectively slowed down the cyclonic movements and withstand dynamic adverse environmental conditions. Recently, human interface towards nature has created regression in mangrove cover; converting them for agriculture and aquaculturepurposes.

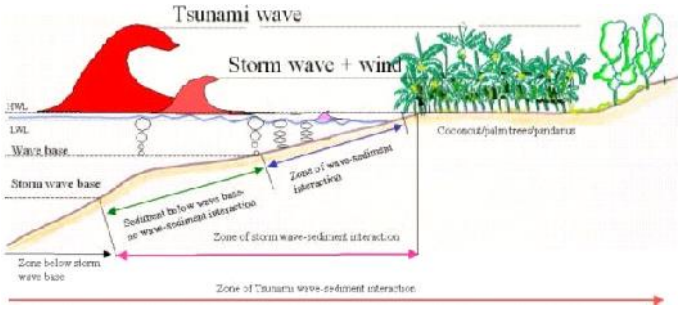
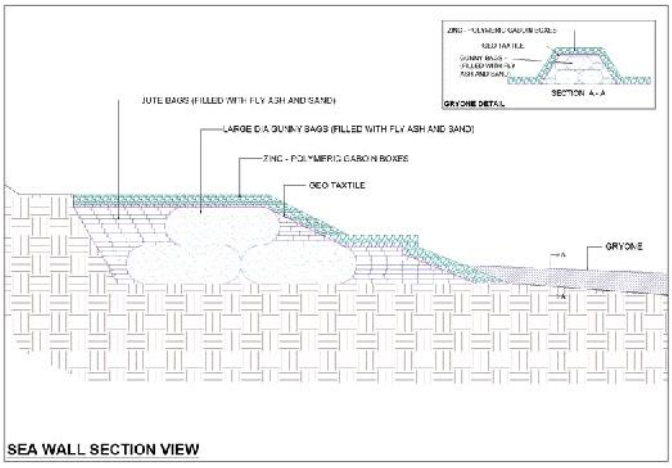


Figure 6. Shows behavior of storm wave approaching sandy coast

Suggested Coastal Erosion Control Scheme: Typical Sea wall system has been proposed after analyzing all wave impacts, wave heights and sudden surge in the level. This section comprises of waste fly ash and locally available sand as infilling material for the inner core which should be filled in large diameter gunny bags and jute bags around it as shown in section view of figure 7.

Armour layer constructed with zinc coated polymeric wires is used on outside supported by toe having a berm of suitable (generally 2m to 5m) width. Gryons with 13m to 15m may be constructedwith sack gabions at the toe of sea wall and gryons junctions to arrest the sediments which will ultimately reduce the erosion and increase shore boundary. To enhance the stability of surrounding series of small diameter perforated pipes (150mm) filtration well in staggered or continuous manner can be installed. Since, existing ground water level restricts infiltration of sea water in to it. Infiltration well draw down the ground water line and water from run up can be percolated easily and tend to relief pressure in the surrounding beacharea, thereby provide stability. This pressure equalizing system is suited for littoral coastlines (present case study) with a natural supply of sand from the coast. Typical diagram shows the schematic and working of pressure relief vertical infiltration wells.



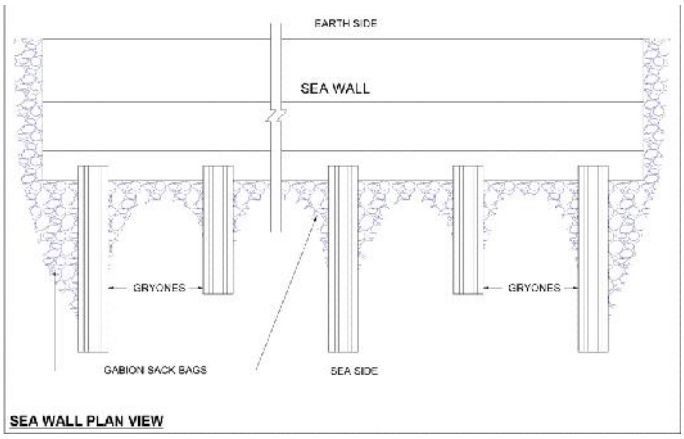


Figure 7. Proposed scheme for coastal protection using cost economic sea wall

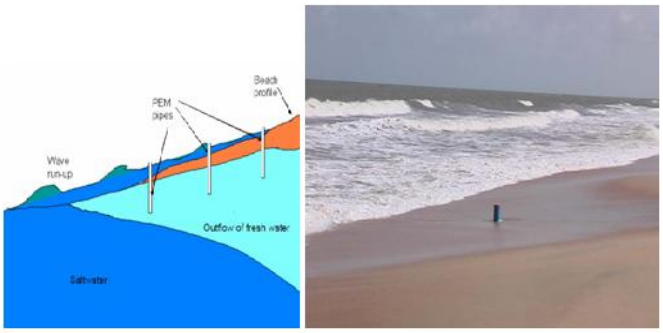


Figure 8. Pressure relief infilteration wells module

Conclusion

Several coastal protection solutions are available. Before judging the final solution, a detailed analysis should be done for wave height, intensity, frequency, yearly encroachment to get prediction of continuous encroachment. Primary data collected from localities helps designer and planner to adopt the type of protection system for its working period. Present case study showed the scheme derived for coastal protection system for the villagers. This solution not only prevent the coastal erosion but also lead the area for the recreational activities due to increased shore landarea.

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