International Journal of New Media Studies (IJNMS), ISSN: 2394-4331
Volume 10 Issue 1, January-June, 2023, Impact Factor: 7.786

Protection of Coastal Area by using Seawall & Mangrove Trees

Mr. Shubham Badave[1], Mr. Parth Aitwade[2], Mr. Ninad Chougule[3], Mr. Farhan Nadaf[4], Mr. Aniket Pujari[5]

[1,2,3,4,5]B.Tech Students, Department of Civil Engineering, Sharad Institute of Technology College of Engineering, Ichalkaranji, Maharashtra, India

ABSTRACT

The role of mangroves in protecting our coasts against natural hazards such as storms, tsunamis and coastal erosion has been widely acknowledged. Even so, the level of protection provided by mangroves remains subject to debate. Numerous mangrove restoration projects were instigated after the 2004 East Asian tsunami in the belief that replacing lost mangroves would reduce future risk, but others raised concerns that not all of these projects were well conceived, and that some might create greater risks by inducing a false sense of security. Can mangroves reduce waves and storm surges? How will they influence the forces of a tsunami? Do they actually contribute to stabilizing coasts and build-up of soils? Can they keep up with sea level rise? A rich scientific literature exists describing many of these processes, but careful scrutiny is needed to determine what is known or unknown, and what remains uncertain. To understand the local threats from the sea it is important to consider the everyday conditions that may cause gradual slow-onset events, as well as the rare high impact events that cause massive damage. As every coastline is different, this assessment needs to be undertaken on a case by case basis. Often local communities have good insights into the local risk profile and any changes that have occurred over time. Other sources of information include coastal engineering reports, government records of past events and their effects, and historical media reports or other historical accounts. Various risk assessment tools may help to organize this assessment process in a structured manner

INTRODUCTION

The role of mangroves in protecting our coasts against natural hazards such as storms, tsunamis and coastal erosion has been widely acknowledged. Even so, the level of protection provided by mangroves remains subject to debate. Numerous mangrove restoration projects were instigated after the 2004 East Asian tsunami in the belief that replacing lost mangroves would reduce future risk, but others raised concerns that not all of these projects were well conceived, and that some might create greater risks by inducing a false sense of security. Can mangroves reduce waves and storm surges? How will they influence the Forces of a tsunami? Do they actually contribute to stabilizing coasts and build-up of soils? Can they keep up with sea level rise?

Coastal Erosion a physical process where the sediments of the shoreline are weared off and redistributed by natural forces such as waves, tidal and currents. Erosion occurs when the material removed exceeds the supply, which results in the reduction of beach line and landward shifting of the shoreline. However, relatively few studies have quantified the level of coastal defense service provided, or provided information on how the level of service varies with local conditions and hazard characteristics. An understanding of how such factors affect service provision is needed by coastal communities, planners, managers and engineers to aid them in making appropriate use of mangroves in coastal defense strategies. In particular, they need to know when they can rely on mangroves to reduce risk from coastal hazards, what level of risk reduction will be provided (and hence whether this will be adequate), and what limits there are on the provision of this service (i.e. if the provision of the service will fail beyond certain thresholds, such as a critical storm surge height).

Coastal protection structures such as seawalls and rock revetments have been used for centuries to protect and prevent further loss of coastal lands that are bases of economic activities. Whilst successful in preventing shoreline retreat, preserving the dynamic coastal landscape, but their presence often contributes to the denigration of natural coastal habitats. These concerns were the impetus for research into alternatives to hard protection. Seawall is a parallel structure constructed along the coastline to prevent any loss or inundation of the landward side by flooding and wave actions. Different types of seawalls are used depending on the site conditions, such as gravity walls, rubble mound walls, stone revetment, stepped face, curved face (concave), combination of stepped and curved face, and filled gravity. With the beginning of the last century, the environment impact assessment revealed and new concepts as the environment protection and sustainable development have been established. With this new approach, the concept of coastal protection is changed from hindering the natural forces to building with nature.

This new approach, which is building with nature, requires the knowledge of the exact behavior of the coastal zone, and hence addresses the main reasons for the problem in order to choose its suitable protective structure. This should be followed by the environmental impact study to identify the side effects of this structure and its mitigation measures. Accordingly, over the last two decades, as the importance of preserving natural coastal resources were realized on a global scale, efforts have been made to migrate from the conventional approach of hard engineering to soft engineering and eco-engineering especially in environmentally sensitive areas. The novelty of these solutions is their ability to sustain natural resources and even add-value to the coastline. In addition, new approaches to deal with the coastal problems appear. Three basic choices are possible: no action, re-planning the coastal zones and relocating the existing structures to be far from the sea, and executing positive corrective measures.

This contribution presents an overview of the various available methods for shore stabilization and beach erosion control, highlight on the new approach in coastal protection in order to recommend a proper solution for the Egyptian coastal problems. Channels and pools are expected to affect rates of reduction as they present less resistance to the flow of water. Krauss et al. (2009) suggest that this may explain the low storm surge reduction rates seen in mangroves bordering the Shark River.

Cyclone and storm surge characteristics are also expected to affect storm surge reduction rates: storm surges with slow forward speeds are expected to be reduced less than faster moving surges (Zhang et al. 2012). Additionally, extreme events with very high winds and very large surges may damage or destroy mangroves, resulting in reduced surge reduction rates (discussed in the " Surviving storm damage" section below).

In order to address the potential risks of climate change to existing assets and people, some form of protection is required for coastal environments, such as cities, ports, deltas and agriculture areas. Although the main focus is only on mitigation measures for climate, adaptation is necessary as climate changes and its effects are now inevitable, especially for coastal areas where there is a strong „ commitment to sea level rise and a commitment to adaptation.

Need of Study: The scope of this study is to protect the offshore area from high level sea waves or some natural hazards like tsunami by using mangrove trees & seawalls.

With rising sea levels and environmental problems caused by population and economic pressures colliding at the world' s coastlines, there are huge risks to people and the environment, but also opportunities to restore natural defenses and help both. Mangroves effectively reduce the height of wind and swell waves over short distances (less than 500 m), and can reduce storm surge water levels over greater distances (several kilometers of mangroves). Thus mangroves can contribute to coastal defense strategies. However, their appropriate use depends on a thorough understanding of the conditions under which they can provide these coastal defense services.

Here we present a literature review of this topic. Small wind and swell waves can be reduced in height by between 50 and 100% over 500 m of mangroves. Wave reduction largely depends on water depth and vegetation structure and density. However, few measurements are available for the reduction of bigger waves (> 70 cm in height) in deeper water (> 2 m). The causes of erosion are natural, man-made, or a combination of both. Natural erosion can be either due to Long-shore or Cross shore sand loss like Breaching and over wash etc. But our cause of alarm is the sea level rise which is due to the climatic change.

Objectives: Usage of land nearby coastal area, Study of behavior of seawalls, Use of mangrove trees as sustainable material

MATERIALS AND METHODS

Location of the Study Area: The length of the beach is approximately 1.5kms and it is very flat and straight. Latitudinal extent of beach is 16º58'1.64" North to 16º58'51.28" North and Longitudinal Extent is 73º17'36.52" East to 73º17'41.19" East. The Ratnagiri light house and the famous Madavi beach of Ratnagiri city are visible from Bhatye beach.

A famous temple of " Zari Vinayak" (Ganesh Temple) is situated at the southern end of the beach. Bhatye is a wonderful beach in the background of the jagged Sahyadri mountain ranges provides a panoramic view of the surroundings. The entire coast of the Bhatye village is covered with casurina trees and is locally known as Bhatyesuru Ban.

On the northern side of Bhatye beach is the Bhatye creek which is at the mouth of ' Kajli Nadi' and to the southern side of beach is the Kurli cliff. Location map for the study area is shown in Fig.1.

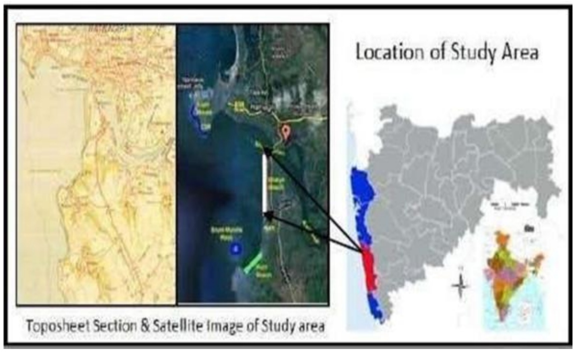

Fig. 1: Location Map

According to the Forest Survey of India, 2019, Mangroves' cover in the country increased by 54 sq.km (91.10 percent) in comparison to the 2017 assessment. The significant points put across by the State Forest Report 2019:

Mangroves face limiting factors like: Lack of Oxygen, High Salinity, and Diurnal Tidal Inundations

Mangroves adapt the following to live with their limiting factors: •

- Succulent Leaves
- Sunken Stomata
- Pneumatophores (Aerial Roots)
- Vivipary
- Stilt roots
- Mangroves make 1 percent of the tropical forests of the world.
- India has 3 percent of the total mangrove cover in South Asia.

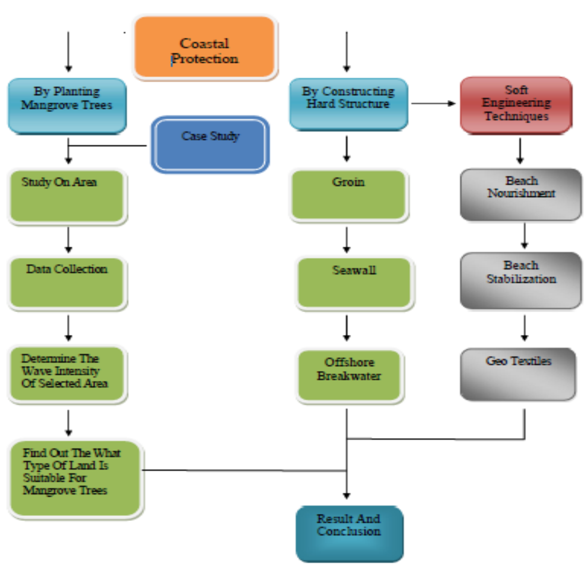

Fig.2: Flow Chart for Methodology Followed

Modeling and Prediction Of Wind Wave Reduction

Two numerical models have been used to represent wave reduction within mangroves: the WAPROMAN model, developed by Vo-Luong and Massel (2008), and the SWAN model (Booij and Holthuijsen 1999), adapted to include mangroves by Suzuki et al. (2011). Both models are based on a simplified representation of mangroves as a series of cylindrical elements with different densities per unit area at different heights above the ground. The two models have been validated using a wave height reduction dataset through mangroves on the Red River Delta, Vietnam (Vo-Luong and Massel 2006, 2008); the results of both models show a reasonable fit with the observed data (however the observed data show a high level of variation between measurements).

Narayan et al. (2010) used Suzuki et al.s (2011) modified SWAN model to explore the effect of a mangrove island (Kanika Sands mangrove island, Orissa, India) on waves reaching Dhamra port, which lies behind the island. They found that for cyclone induced wind and swell waves with a return period of 25 years approaching the port at a 90º angle, wave height at the port was reduced by nearly 50%. They also estimated that 2.5 m high waves have a return period of 60 years at the port, compared with a return period of 20 years if the mangrove island were not present. They found that an extension of the island to the north would further decrease wave height at the port. This example demonstrates the use of a numerical model to predict mangrove wave reduction and to determine which forms of mangrove management will optimize risk reduction from wind and swell waves.

Tidal Range

The tidal range is the vertical difference between the highest high tide and the lowest low tide. The tidal range is related to both permanent and episodic inundation hazards of the coastline (Davies, 2012). The Ratnagiri coast can be categorized into an intertidal zone since the long period ocean tides are of mixed and predominantly semidiurnal. The tidal range date was extracted from the Windows Unix program for Tides (WX Tide 32) software for March (pre monsoon) and August (post monsoon) 2019 from the base data which represents predictions about the tidal range for tide stations near the study area. The maximum and minimum amplitudes of the tide were extracted for Rajapur river entry(2.7 m– 0.2 m) and Mormugao (2.1 m– 0.1 m)

The Ratnagiri coast falls under a microtidal environment with an average tidal range of nearly 2.5 mduring January February with 1.9 m as an average spring tidal range. The maximum range of 2.3 m as average is recorded during the north-east monsoon, while 2.6 m during south-west monsoon (Samiksha, Sharif, and Vethamony, 2014). Tidal currents are very weak along the Ratnagiri coast. Their velocity rarely exceeds 10 cm/s (Karlekar, 2000). The shoreline is blended with rocky as wellsandy beaches which respond to tidal range varying vertically from 0. 25m to 1.5 m and horizontally about 200 m (Karlekar, 2000). During high tide, the tidal range increases in height along a rocky coastline; on the other hand, along sandy pocket beaches where friction is low, the tidal height is quite balanced. The average predicted tidal level was extracted for the Rajapur river entry (2.7– 0.2 m) and Mormugao (2.1– 0.1 m) for the pre monsoon and pos t monsoon period of the year 2019. The vulnerability rates were assigned only a low to moderate risk rate since the tidal differences are not significantly varying.

Significant Wave Height

Wave characteristics along the west and east coast of India are influenced by three different seasons, viz. pre monsoon (February May), south-west monsoon (June– September), and northeast monsoon (October January) that influence along the west coast of India. Along the Ratnagiri coast, waves are usually higher during south-west monsoon and low during the rest of the seasons. Cyclonic storms are frequent in the Bay of Bengal as compared to the Arabian Sea (Deshpande et al., 2015). The data required was collected from earlier studies and observations recorded by Karlekar (2010), Deshpande, and Joshi (2015). The mean significant wave height of the study area varies from 0.50 mand 0.76 m. Thus, the study of characteristics of wave height becomes crucial for vulnerability assessment and hazard management. The average wave heights along Ratnagiri coast during pre monsoon (March to May) is 0.77– 1.22 m, for monsoon (June to September) is 1.98– 3.08 m, and for post monsoon (October to December) is 0.61– 0.71 m, respectively (Deshpande and Joshi,2015). This shows significant variations in the wave heights. The mean significant wave height of the study area varies from0.50 m and 3.08 m.

RESULTS AND DISCUSSION

Two studies have explored the role of mangroves in reducing the death toll and economic damage from a 9 m storm surge in Orissa, India, in 1999. This storm surge was associated with Cyclone 05 B (also called Odisha Cyclone) which resulted in the loss of 10,000 lives.

Despite the massive loss of life, many lives were saved by the early warning system, evacuation centers, and the presence of mangroves in front of some villages. Das and Vincent (2009) estimated that the early warning issued by the government saved 5.84 lives per village, while the presence of mangroves in some villages prevented 1.72 additional deaths per village. This was based on a statistical study of the death toll in 409 villages, all of which had been fronted by mangroves in 1944, but only some of which still had mangroves at the time of the 1999 cyclone (see also Baird et al (2009) and Vincent and Das (2009) for further discussion of this study). While the early warning system was clearly more effective at saving lives, mangroves helped to save the lives of those people who did not evacuate. Again, this demonstrates the importance of a range of risk reduction measures, of which mangroves can form a part.

In a separate study, Badola and Hussain (2005) investigated the level of damage in three villages caused by the same cyclone. They noted that the village protected by mangroves suffered the smallest economic losses. The village protected by an embankment experienced greater crop damage, because after the embankment was breached, the sea water took longer to flow back out of the breaches, exposing crops to salt water for a longer period. In the village protected by mangroves, the water was able to drain away rapidly, resulting in reduced crop damage.

The measures for protecting coast are of twofold: Hard structural / engineering options and Soft structural /engineering options.

Hard Coastal Protection Structures Include The Following Methods:

Groin

A coastal structure constructed perpendicular to the coastline from the shore into the sea to trap long shore sediment transport or to control currents.

Soft Engineering Techniques

1) Beach Nourishment

In this method, sand and shingle are added to a beach in order to make it wider which increases the travel distance for the waves by when it loses energy and hence have less erosive power when it reaches the cliffs.

2) Land Management

Sand dunes act as a natural defense against the sea. These dunes are left undisturbed and sections of sand dune systems are marked as out of bounds to the public to reduce the erosion of the dunes by humans.

3) Marshland Creation

Marshlands are used to break up the waves and reduce their speed, whereby energy is dissipated which reduces the waves erosive power. The marshlands are created by growing marshland vegetation such as mangroves, glassworts etc.

Beach Stabilization

The goal is to widen the beach and dissipate the wave energy before it reaches the cliffs. Beach stabilization involves planting dead trees in the sand in order to stabilize it and lower the profile of the beach while widening the beach. The soft solutions are considered to be more environmentally friendly than traditional hard protection works.

C. Special Methods

Other than the above mentioned methods, Ecosystem-based and hybrid approaches combining ecosystems and built infrastructure are also popular.

1) Geo textiles

Geo textile systems utilize a high strength synthetic fabric as a form for casting large units like bags, mattresses, tubes, containers and inclined curtains by filling with sand or mortar. These allow the bigger waves to dissipate energy and allows the smaller waves to reach the cliffs.

2) Beach Drainage Systems

The Beach Drainage Systems (BDS) works on the principle of keeping the groundwater level low. Percolation of 'swash water' into the beach reduces the energy, which helps the suspended sand to settle out on the beach face.

3) Ecological engineering

Ecological engineering integrates engineering principles with ecological and geo morphological processes to create or restore ecosystems that have experienced degradation.

4) Artificial reefs

They are equivalent to submerged breakwaters, and are made up of coils or bags of geo textile, sand, large blocks, concrete.

5) Artificial Mangrove Root Systems

Plantation of mangrove trees, act as live sea walls and bind the soil together preventing coastal erosion by minimizing the action of waves.

In a healthy mangrove ecosystem, waves take sediment away and the tides bring sediment in. The mangroves' aerial root systems help to dissipate the waves and to capture and stabilize the sediment. By contrast, hard structures, such as breakwaters and also the earthen or concrete dykes surrounding aquaculture ponds, only protect against wave impacts in the short term, and may need rebuilding frequently as they are undercut by erosion. This occurs because waves can get 2 – 4 times bigger when they reflect off a hard structure. These bigger waves increase erosion in front of the structure, and can eventually lead to its collapse. Such collapsed sea walls are then useless in reducing waves or preventing erosion. Moreover, hard structures disturb the balance of incoming and outgoing sediment because they block the flow of water and sediment into areas that were previously flooded by the tides.

Mangroves for the Future

India had a mangrove cover of 6000 sq. km during year the 1960s, and it has reduced by 21%, i.e. 4740 sq. km. However, since 1995, the mangrove cover has got stabilized close to 4500 sq. km with an increasing trend, despite increasing pressures. There was an increase of 112 sq. km mangrove cover between 2013 and 2015, significantly in Maharashtra, Odisha, Andhra Pradesh and, Andaman and Nicobar Islands10. It is necessary to achieve a target of 6000 sq. km by restoring the mangroves in potential areas within a period of 10 years. In this regard, the best proven practices of participatory management can be suitably replicated in other mangrove areas. Mangrove planting efforts have largely been a failure, due to death of planted seedlings. In this regard, ' Ecological Restoration' is suggested in which right conditions are provided for the mangroves to grow back naturally. It is necessary to understand local ecological conditions and hydrological regimes to restore the hydrology and remove the barriers to natural regeneration.

It is also necessary to select appropriate species for planting, and assessment of success and functionality (vegetation, succession, faunistic recruitment, environmental factors and process) in the restored areas. This approach is more effective to ensure the restored mangroves survive and function better. Afforestation refers to the plantation in new areas, whereas restoration refers to the planting in damaged, degraded and destroyed areas. Of the restoration types, natural restoration and hydrological restoration are more preferable than artificial restoration by planting (Fig 3).

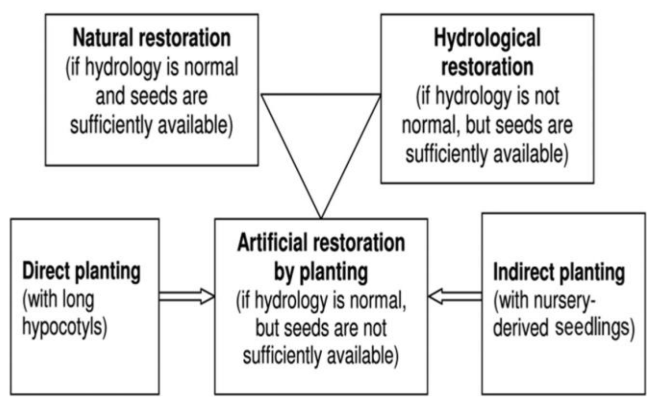

Fig.3: Restoration Plan

Mangrove species are highly vulnerable to developmental activities. In Bhitarkanika (Odisha), there is an island named Kalibhanji dia' situated adjacent to Dhamra Port, and this small island is endowed with most of the mangrove species of India. There are several such areas with rich plant diversity which should be identified along the country and managed as Mangrove Germplasm Preservation Centers' . A few species of mangroves are at a high risk of extinction. It is necessary to collect information about the extinct, rare and fast disappearing species of specific areas and understand biology and limiting factors of population reduction in those species.

This will help in implementing the recovery of species in the specific areas. More studies are required to understand the interactions between animal and plant communities in the mangrove ecosystem, especially the interdependence between mangrove plant components and pollinators, as well as ants, crabs, gastropods and birds. Much more efforts are necessary to alleviate the stress factors for the loss of mangrove forests.

India is a global leader in mangrove research and management. Our country is ranked third position in mangrove research publications, next to China and USA. Twelve per cent of the total publications on mangroves during 2000– 2010 were from India, as against USA and China with 17% and 14% respectively. Among the top 10 highly cited mangrove research publications in the world, two are from India. Our country has the potential to attain the top position, only if high quality publications are increasingly contributed in the years to come. In addition, the Annamalai University has offered training and capacity building for over 250 coastal managers of 28 countries on the management of mangrove ecosystems, with the support of UNU-INWEH and UNESCO since the year 2000.

CONCLUSION

Mangroves can reduce wind and swell waves over relatively short distances (500 m) and can reduce storm surge water levels over much greater distances (several kilometers) although this depends on storm surge characteristics (slow moving surges are reduced less). Mangroves can contribute to coastal risk reduction strategies alongside other measures, such as dykes and evacuation plans. The ability of mangroves to respond dynamically to rising sea levels may ensure the continued provision of coastal defense services into the future.

One of the more significant findings to emerge from this study is that you can't stop the invasion of the sea by putting obstacles in front. It is shown from above cases that most traditional ways of protection which were used around the world, and our Egyptian coast have side effect on the environment and beach morphology. Also it has a relatively high construction and maintenance cost. The case studies suggest that usage of eco friendly measures produces significant result on the problems faced without impacting the environment. Moreover, further development of the threatened regions should be held until the issues are resolved. Also, experimental and numerical investigation needs to be done in order to validate these techniques.

REFERENCES

[1]. Anu Murali-Department of Civil Engineering Vidyavardhini' s College of Engineering, Vasai, India 2020.

[2]. C. Wiki, "Hard coastal protection structures," 4 Sep 2019

[3]. Ali Masria, Abdelazim Negm, Moheb M. Iskande, Oliver C. Saavedra 2015

[4]. H.J.Verhagen and Tran ThiLoi 2012

[5]. McIvor, AL., Möller I., Spencer, T. and Spalding, Natural Coastal Protection, M. 2012

[6]. Marchand, M. (2008) Mangrove restoration in Vietnam: Key considerations and a practical guide. Deltares report for WRU.TUD

[7]. Nicholas C. Kraus and William G. McDougal Coastal Education & Research Foundation, Inc. 1996

[8]. E. C. F. Bird, Coastline changes. A global review. John Wiley and Sons Inc., New York, NY, 1985.

[9]. S. W. A. USACE, " United States Army Corps of Engineers," Swaziland: Water and related land resources, 1981