International Journal of Applied Science & Environmental Engineering – IJASET 2018
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Volume 1 : Issue 1 Publication Date : 28 December, 2018

The Green Embankment: Using Afforestation as an Instrument Against Coastal Disasters

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Abstract **-** In this article, the multifaceted linkages between environmental disasters, poverty and vulnerability is investigated through a case study carried out in one of the most remote areas of Bangladesh. Because of its geographical location, Bangladesh is dreadfully susceptible to disasters, such as cycles of flash floods, storm surges and cyclones. Afforestation is recommended as a means of embankment in the flood-prone area. The authors therefore place conducted literature review on coastal afforestation as a sustainable option for protection against the natural hazards. Also, qualitative approaches, such as in-depth interviews, focus group discussions and observations were held for understanding people's responses to and the impact of a disaster in vulnerable sites. The field research compared a combination of participant observations and non-participant external interactions with coastal communities. The study shows afforestation as having great promise to not only be an effective method of protecting communities from major storm events, but also provide a steady flow of income to the struggling local economy. However, even though the system is relatively inexpensive, it is still a complicated system to run.

Keywords: Afforestation; Embankments; Disaster; Vulnerabilities.

I. Introduction: Disasters around the world

Not long ago, the greater part of the population in the world assumed that the disasters linked to floods, hurricane, cyclones, earthquakes and further natural hazards were caused due to natural disasters and it was established that their impact could be abridged through mitigation, preparedness and post-event humanitarian actions, but the focus even in much academic and policy work then was on the naturalness of the disasters [2].The current warming trend is of painstaking significance because most of it is extremely likely (greater than 95 percent probability) to be the result of anthropocentric activity since the mid-20th century because of the industrial revolution and proceeding at a rate that is unparalleled over decades to millennium. [9], [12], [14], [15].

II. Bangladesh's Vulnerability

Despite good advancement in cyclone and flood preparedness, exemplified by the existing comprehensive disaster management policies made by the Government of Bangladesh, localized vulnerability factors in cyclone hazards questionably hang about.

According to respondents, the vulnerabilities include:

- Vulnerability due to location and pattern of settlement
- Vulnerability due to inappropriate land management systems
- Vulnerability due to means of livelihood and a lack of infrastructure
- Vulnerability due to late responses to warnings and a complex decision making

III. Effects of Embankments in Bangladesh

The design and constructive methods of the earth embankments were not stable and alongside the erosive forces of water and the non-cooperation of the local people contributed to a high amount of instability. The underwater type embankments built on the eastern part were subjected to turbulent water current and changes in river courses. The estimate prepared by BWDB in 1984 showed that about 1200km of bank length of rivers were subjected to erosion, 565 of which faced severe erosion problems [6].

a. Natural Forces in the way of Embankments:

Natural forces cause erosion of the embankments in the following way:

1. Rainfall Impact
2. Wave Impact
3. Turbulent water currents
4. Wind Impacts

IV. Afforestation as a defense mechanism in Bangladesh

4.1 The EEA report 'Water-retention potential of Europe's forests' shows that water withholding plays an important role in buffering the effects of heavy rainfall and droughts. Forests can saturate up excess rainwater, preventing run-offs and harm from flooding. By releasing water in the dry season, forests can also help provide clean water and alleviate the effects of droughts.

Partial yearly plantations of mangroves were undertaken on newly accreted land in the Patuakhali, Barisal, Noakhali and Chittagong coastal district in 1966.

4.3 Species selection:

Even though approximately 27 species of mangroves and a similar number of mangrove associates crop up in Bangladesh, most are rare, or of little economic importance [3], [8]. Merely 10 or so species arise frequently adequate to carry on silviculture. As a result of the early trial and error approach to plantations, only two species, Sonneratia apetala and Avicennia officinalis, showed hopeful endurance rates and, therefore, these two species control the mangrove plantations in general as mono specific stands. These species are moderate quality timbers used for fuel wood, constructions and furniture [16], [17]. Around 80% by area of the premature plantations consisted of mono specific stands of S. apetala, about 15% consisted of stands of A. officinalis with the residual areas consisting of Excoecaria agallocha, Bruguiera spp. and Ceriops decandra, more precious species for timber or paper pulp production. Polybag culture of a range of other mangrove species has been experimentally developed although field assessments of the performance of these species are as yet unfinished [13].

V. Mangrove forest's link to Flood/Cyclonic Defense

5.1 Importance of Mangrove Forests

Mangrove are crucial coastal ecosystem for many tropical and sub-tropical countries [4], providing various timber and non-timber products to the coastal dwellers [11]. In spite of their economic and ecological importance, coverage and quality of the mangroves are declining in many places for various reasons [5]. According to the World Wildlife Fund [10], "the impenetrable root systems of mangrove forests lock in sediments flowing down rivers and off the land. This helps stabilizes the coastline and prevents erosion from waves and storms. In areas where mangroves have been cleared, coastal damage from hurricanes and typhoons is much more severe. By filtering out sediments, the forests also protect coral reefs and sea grass meadows from being overpowered in sediment."

Case Study: Gangamatir Char

Gangamatir Char is a small island residing in Kuakata located at 21.9861°N 90.2422°E . [7]. It limits about 25-30 families living in the area. This particular area was selected because of its location being far away from the city and being close to the shore.

Methods: Qualitative approaches, such as in-depth interviews, focus group discussions and observations were held for understanding people's responses to and the impact of a disaster. The field research compared a combination of participant observations and non-participant external interactions with coastal communities. Questionnaires included reasons for vulnerability, adaptation strategies, and pre-during and post cyclone measure. The methodology also included risk scoring which will be explained presently.

The people interviewed were first asked to draw a map of their village. They were given pen and paper but the drawings were later illustrated in the following way:

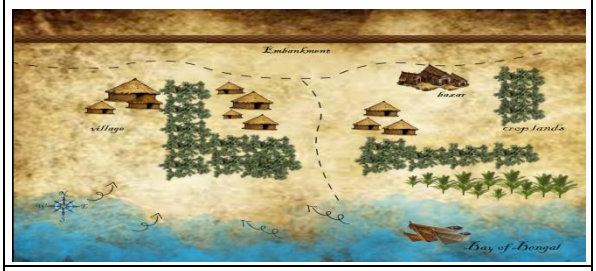

Figure1: Map of Gangamatir Char

Findings: Overall the findings of this study indicated that the inhabitants were fully dependent on crops and fisheries but due to their geographical location they were prone to flood. Interviews and focus group discussions showed that apart from monsoon or rainfall floods, tidal surges occurred in the area frequently over a period of 1.5 years. They received little to no early warning because they were too far from the mainland. After cyclone Aila in 2009, an embankment in 1.6 km inland was built, but due to lack of permission they had to live afar from the embankment and close to the shore as shown in Figure 2. They mentioned that their vulnerability grew increasingly as the tidal surges were accompanied by wind storms and inundation.

Loss and damage: because of the aforementioned vulnerabilities and lack of cyclone shelters (only 2 cyclone shelters in the area) resulted in loss of crops, destroyed homes and deaths. As the island is away from the town, there were no clinic centers or hospitals, therefore immense number of people died while they were being taken to a nearby hospital.

Socio-economical Vulnerability: According to the local people, farmers faced the most nuisances because after the flood, their crops were destroyed and due to saline intrusion it took them months to plant new crops. Fishermen came in second rendering financial loss, after losing their homes; they had to take loans from different venders to buy

fishing nets and boats. For calculating more vulnerability, we formulated risk factors.

Risk Factor Formula and results:

Risk Score = Likelihood of occurrence*seriousness of the incident occurred.

This information was collected from the inhabitants and they responded as follows:

	Seriousness	Likelihood	Risk Score
Tidal Surges	**7/10**	**4/5**	**28**
Floods	**9/10**	**3/5**	**27**
Cyclones	**10/10**	**2/5**	**20**

Local and Expert Adaptation Techniques: Included embankment along the beach using stones to avoid erosion and plantation of trees. Experts suggested Village Community Fund (so loans can be avoided and vulnerabilities can be decreased) and building Artificial Sand Dunes. Relocating the locals if possible as due to Sea level Rise soon the land will be flooded by the Sea also due to climate change intensity of disasters are increasing.

VI. Conclusion and Recommendations

As a lack of infrastructure limits the options that can be employed in tropical coastal regions such as in South-west Bangladesh to provide protection from cyclonic events,

Afforestation measures have shown great promise to not only be an effective method of protecting communities from major storm events, but also provide a steady flow of income to the struggling local economy.

However, even though the system is relatively inexpensive, it is still a complicated system to run, as the mangrove ecosystem requires careful balance - too much focus on the expansion, species diversification and strengthening of the forest due to a focus on maximizing protection and there would be no one to protect as the local economy will suffer. On the other hand, allowing the local communities to have heavy access to the mangrove forest to stimulate the local economy will lead to a vulnerable green embankment and potential for heavy property damage, not to mention unsustainable practices such as excessive resource extraction and/or focusing on specific species due to ease of access or simply being profitable "cash plants" will destroy the green embankment beyond recovery and the economy will be on the brink of destruction.

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