Combating Tropical Cyclones Amphan, Yaas and After: Eco-Restoration of Coastal Zones

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Abstract

The mangrove forests of the Sundarbans provide an important defence in limiting climate change impacts, providing protection to coastal areas from tsunamis and cyclones. For effective ICZM, natural phenomenon of wind and water flow and the interaction with the adaptation procedures of biological systems must be considered. Community-based Ecological Mangrove Restoration (CBEMR) Method supports a holistic, technology-based approach that encourages practitioners mitigate mangrove stressors and facilitate natural mangrove regeneration. By combining traditional and scientific management of coastal ecosystem with mangroves and other plants following triple-tier mechanism and habitat, it is possible to reduce the effects of natural and climate change-induced disasters.

Keywords : coastal vegetation, mangroves, integrated coastal zone management, sustainability

Recent Cyclone Disasters

A week after Cyclone Tauktae wrecked havoc across the west coast of India, Cyclone Yaas made landfall in Odisha and West Bengal on the east coast on 26th May 2021 leaving a trail of death and destruction. India is the seventh most-affected by the devastating impact of the climate crisis globally in 2019, according to the Global Climate Risk Index 2021.

On 20th May 2020 the tropical super cyclone Amphan ravaged about 28% of the Sunderbans (as per government reports). On 5th June, World Environment Day 2020 the Chief Minister announced that five crore mangrove propagules would be sown with the assistance of the local communities.

The mangrove forests of the Sundarbans provide an important defence in limiting climate change impacts, providing protection to coastal areas from tsunamis and cyclones. Each year about eight storms with sustained wind speeds greater than 63km/hr form in the Bay of Bengal, with an average of two becoming tropical cyclones. Tropical cyclones Sidr in 2007 and Aila in 2009 caused extensive damage, prior Amphan (2020) and Yaas (2021). Mangroves serve each year as

a **biological shield** protecting coastal communities from the worst effects of storm surge. Loss of mangroves escalates the disaster risk for local populations from storm surge and flooding.

Integrated Coastal Zone Management (ICZM)

India's coastal zone is endowed with a wide range of mangroves, coral reefs, sea grasses, salt marshes, sand dunes, estuaries, lagoons and a unique marine and coastal flora and fauna. The abundant coastal and offshore marine ecosystems include some 6740 sq.km of mangroves, including part of the Sundarbans and Bhitarkanika, which are among the largest mangroves in the world.

For effective ICZM, natural phenomenon of wind and water flow and the interaction with the adaptation procedures of biological systems must be considered. Protection of coastal lands, forests, shorelines, water-bodies and islands as well as land accretion such as charlands, sand-dunes and reduction of effects of climate extremes especially the tropical cyclones and tidal surges, the laws of hydro- dynamics and wind-forces and the interaction of biological adaptations especially of the trees must be considered and utilized for a sustainable coastal zone management.

ICZN has four main objectives:

1. **Protection of coastal areas**: Planting mangroves can reduce shoreline erosion and can protect coastal communities against coastal and flooding, high winds and waves, tsunamis.
2. **Restoration of mangrove ecosystem**: The aim is to support livelihood without destroying the mangrove forests. This could be achieved by sustainable harvesting of mangrove products such as firewood, timber, and other marine products like crabs, fish and shells.
3. **Conservation of existing mangrove forests**: This provides breeding grounds for fisheries and preserving biodiversity. This can be achieved through the creation of protected sites, national parks, nature reserves, and wildlife sanctuaries.
4. **Carbon absorption** (sink): Mangroves absorb more carbon than the other land-based forests.

Community Based Ecological Mangrove Restoration: An Integrated Approach

India must focus on nature-based solutions (for example, restoring mangroves to reduce the impact of waves and storm surge on the shoreline to prevent flooding and preserving wetlands, forests and floodplains) to reduce disaster risk. It must also ensure that both existing and new infrastructure is climate-resilient [1]

Community-based Ecological Mangrove Restoration (CBEMR) Method supports a holistic, technology-based approach that encourages practitioners mitigate mangrove stressors and facilitate natural mangrove regeneration. The progagules must be monitored as and when necessary and nurtured for the upcoming decades for restoring the green cover of mangroves back in coastal zones including the Sundarban Biosphere Reserve.

CBEMR programme seeks to empower local communities to restore and steward their mangroves while deriving sustainable mangrove-based livelihoods. Involving local communities in mangrove restoration is essential, as it offers participants a sense of empowerment and involvement in resolving their own environmental, social and economic issues of community development. Traditional mangrove restoration efforts face a fair number of challenges in restoring healthy mangrove ecosystems. Involving local stakeholders right from the outset, this process encourages the mitigation of mangrove stressors and the facilitation of natural regeneration where at all possible. Unlike many planting projects, CBEMR works with nature and takes into account mangrove ecology and biology to restore degraded mangroves by mimicking natural processes. Natural regeneration has the advantage of not only producing more biodiverse mangroves, which increases their resilience to climate change, but is also potentially more economical as it avoids the costs of nurseries and planting out.

CBEMR project was executed on Tanakeke Island, South Sulawesi, where 1776 ha of mangroves were reduced to approximately 576 ha over two decades due to development of 1200 ha of aquaculture ponds [2]. The implementation of gender analyses, gender sensitisation and the development of Womangrove groups have been crucial to ensure the equal involvement of women in the process of mangrove rehabilitation and management, an idea that would be strongly recommended in the Indian perspective post Amphan and currently Yaas [3].

Suitable Species Selection

Sunderban vegetation consists of more than 65 plant species, all with the capacity to combat flooding, salinity, tidal surge and violent winds. The Sundarban mangrove forests with triple tier natural protection mechanisms shield the inland areas from cyclonic storms originating from the Bay of Bengal. Some mangroves such as Baen and Sundari are so strong that they can easily resist 11,100 psi load [4]. Tornado-prone zone areas with specially adapted bamboo clumps which are extremely strong with high elasticity can easily disband tornadoes.

Dense forests can attenuate wave velocity. To protect local, coastal and regional areas from storms, cyclones, tornadoes and tidal upsurges, it is essential to reduce the wind speeds by planting appropriate tree species which can withstand the high speed wind and break the wind speeds. The mangrove reduction effect is most sensitive to changes in hurricane forward speed. A 6.7 m/s to 2.2 m/s decrease in forward speed can result in a decrease in flood area reduction by mangroves which is equivalent to the decrease in flood area reduction by mangroves from Category 3 to 5 hurricanes [5].

Naturally grown halophytic plants such as Sundari (*Heritiera minor*), Geoa (*Excoecaria* agallocha), Goran (*Ceriops sp*.), Kankra (*Bruguiera gymnorhiza*), Khamo (*Rhizophora mucronata*), Baen (*Avicennia officinalis*), Keora (*Sonneratia apetala*) and Kulsi (Aegiceros majus) have the special adaptation for withstanding in the littoral zones with clayey alluvial soil, tides and strong salinity and winds.

Massive plantation was done without paying attention to the habit and habitat requirements and ignoring natural adaptation processes. Millions of exotic trees, especially, *Acacia spp*., *Albizia saman, Swietenia macrophylla*, *Albizia richardiana* and *Eucalyptus spp.* were planted in the

coastal embankments and homesteads replacing the indigenous species. The optimum spacing was not followed during the plantation and proper necessary distances were not maintained. The trees being shallow-rooted could not develop proper anchorage. Thus during cyclonic storms and tornadoes they were uprooted damaging property, infrastructures and crops. Post-Sidr studies showed that about 16.84 million woody and fruit trees were uprooted by cyclone Sidr [6]. After the Phani cyclone of 2019, native species such as *Pongamia pinnata* (Karanj) and *Alstonia scholaris* (Chhatim) were found to have withstood the ferocious wind speed of the cyclone in Bhubaneswar. A similar scenario was reported post Amphan in 2020 in Kolkata and adjoining areas. Hence native species should get preference over exotic ones [7] for successful eco-restoration.

Significant reduction of stomatal transpiration during dry period in *Eucalyptus spp*, *Acacia auriculiformis* and *A. mangium* were reported by scientists [8, 9]. It is proved that these exotic species transpire less and impact humidity causing low precipitation in the region. Thus huge *Eucalyptus* and *Acacia spp.* are responsible for causing dryness and changing the climate. Moreover, these exotic species do not provide food and shelter for birds and wild-lives and do not favor undergrowths.

Currently, the preferred selected species include *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Ceriops decandra*, *Bruguiera parviflora*, *Avicennia alba* for their sturdiness and resilience.

Mangrove zonation (and hence species selection) is controlled by the interaction of tidal flooding, and salinity and drainage of the soil. From the open sea to the beach forest area the following zonation can be observed:

The Avicennia zone: Like the *Sonneratia* species, the *Avicennia* species are the pioneers of the mangrove swamp. *A. marina* colonizes more the fringe of the swamp, while *A. alba* grows more along the channels.
The Bruguiera zone: *Bruguiera* forest usually develops behind the *Rhizophora* species on better drained soils.
The Ceriops zone: *Ceriops* develop in areas with intermediate rainfall and well drained soils.
The Nypa zone: *Nypa fruticans* occupies areas along tidal streams flooded by the highest spring tides. It thrives in brackish water [10].

Aegiceras corniculatum or river mangrove as the name reveals, is usually found along rivers, with most varied levels of salinity, in other words rivers that flow into seas or rather into oceans.

Golpatar Jungle

Taki, a municipality town in North 24 Parganas district of West Bengal lies along the Ichhamati River which separates it from Bangladesh. The Golpatar jungle marks the point at which the river being quite narrow brings the two countries closest in these parts. No fencing has been done on either side of the river and the river is treated as the international boundary. People from both sides are free to use the river but crossing over to the land is strictly prohibited. On Dashami, the last day of Durga Puja, the immersion of idols from both the countries take place together mid-river.

Close to Taki lies an eco-spot called Golpatar jungle or Mini Sunderban. As the name suggests, the *Golpatar jungle* is filled with the Golpata trees. The famous *Sundari trees* after which the *Sunderban* is named can also be found here in abundance and maybe it is for this reason that the Golpatar jungle is regarded as the *gateway to Sunderban* or even mini Sunderban.

Golpata tree is scientifically Nipa palm (*Nypa fruticans* Wurmb.) and is a mangrove palm growing naturally in the coastal areas with a brackish water environment. Nipa palm serves as the first line of defense against the impacts of tsunami, hurricanes, and cyclones that reduce the damages in the coastal zones.

There are several species for instance, *Nypa fruticans*, *Phoenix paludosa* (mangrove date palm), *Cocos nucifera*, *Calamus tenuis* (cane palm) and *Typha angustata* and *Typha elephantina* (swamp elephant grasses), *Alpinia allughas* and *Pandanus fascicularis* (screwpine) having the soil-binding capacity which can control erosion. The palms also reduce the speed of tidal upsurges. Moreover, palms maintain a gradual hierarchy and reduce the speed of strong winds. Most of the palms can withstand winds at a speed more than 250km/h. Palms can easily break strong wind -flow [11].

Additional Recommendations for Coastal Sustainability

Sadly, deforestation, land-use change and human activities – including aquaculture and tourism – have reduced the extent and health of coastal zones and mangroves. Experts already think this deterioration played a significant part in Amphan and Yaas effects being as deadly as they were.

The policy of '**right place, right tree**' provides technical support towards intelligent greening [12] along with Public participation *i.e.* **community involvement** [13, 14] can go a long way in sustainable eco-restoration.

Planning is important because trees are very often considered as an afterthought once development has taken place rather than being incorporated as original design phase.

An **integrated approach** implies the participation of many different organizations, local council, municipal and national planning bodies, departments etc.

Systematic management entails regulated tree management, operations such as planting, pruning and felling must be conducted in an organized manner at the appropriate time. **Performance-based incentive programmes** encourage competition and result in better output [15].

There is a need for integration of traditional coping practices and wisdom with modern approaches. By combining traditional and scientific management of coastal ecosystem with mangroves and other plants following triple-tier mechanism and habitat, it is possible to reduce the effects of natural and climate change-induced disasters. Under such a management system, the entire coastal zone can be made more productive and sustainable.

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