



**Practical
ACTION**

MANGROVE FOR RESILIENCE





Disaster Resilience Through Ecosystem Restoration

Disasters are intimidating as they bring unfathomable devastation and destruction to society, making it hard for community members to absorb the shock. In this context, cyclones are worth mentioning as they bring multiple hazards into the community and pave the way for the slow onset of disasters in coastal areas.

Hazards of Cyclone :



Cyclones generate swell on the sea surface, creating violent waves that thrash the coastline, often resulting in saline inundation in low-lying coastal areas and submergence of agricultural land, drinking water sources, and houses, which generates difficulties in the lives of the locals. It has been noted that pounding of frequent violent waves near the shoreline results in coastal erosion.

A band of dense clouds always precedes the cyclone, bringing torrential and incessant rainfall that causes floods in the region. The low-lying coastal areas, near river mouths, are highly vulnerable to floods as they are caught between saline inundation from the sea and river flooding. These dual floods have a critical impact on the assets and properties of the locals, as well as impairing their food security, health, children's education, and livelihood.

Image 2: Ferocious wind of Cyclone Fani broke down infrastructure in the coastal town of Puri, Odisha



Source- *The Pioneer*, 9th May, 2019

Image 1: Sea inundation in West Bengal, a result of Cyclone Remal



Source 1: *NDTV*, 27th May 2024

Image 3: Ravaging flood created by Cyclone Fengal in Tamil Nadu



Source: *The Hindu*, 7th December, 2024

The most horrifying aspect of the cyclone is the gale of cyclonic wind, which has the ability to cripple and damage all erected objects on land, including trees, buildings, and utility poles, and disrupt life in the affected region. Terrestrial trees are a pervasive prey of cyclonic winds, causing significant damage to the vegetative cover of the area.

Vulnerability of India to Cyclones

India, situated between two major seas and an ocean on its three sides, is prone to cyclone-led devastation and destruction.

The Arabian Sea, located on the west, and the Bay of Bengal, on the eastern side of India, an extension of the Indian Ocean (the warmest ocean

on Earth), are highly prone to cyclone formation. Climate change elements and the increasing phenomenon of ocean warming are contributing to the components of cyclone formation, resulting in devastation in the Indian Subcontinent.

Image 4: India, guarded by three water bodies, a potential risk for cyclonic hazard



Table 1: Some of the Devastating Cyclones in the Arabian Sea

Year	Category	Month of Occurrence	Name of the cyclone	Number of Cyclone Occurrences
1902	Severe	May	-	4
1976	Severe	May	-	1
1998	Extremely Severe	June	-	1
2007	severe	June	Gonu	1
2019	Moderate	June, November	Vayu, Maha, Kyarr	3
2020	Severe	June	Nisarga	1
2021	Extremely Severe	May	Tauktae	1
2023	Extremely Severe	June	Biparjoy	1
2024	Very Severe	August	Asna	1

The *Arbian sea*, on the west-coast front of India that naturally used to receive fewer cyclones due to a smaller number of river mouths and other geographic factors is now a days increasingly facing the wrath of storms, causing immense damage and difficulties in the west-coast Indian states.

The east coast of India, bordered by the *Bay of Bengal*, where a large number of rivers discharge their water into the

sea, is highly vulnerable to cyclonic formation. The funnel-shaped concave structure of the Bay of Bengal, combined with lower water salinity and multiple geographical factors, facilitates the frequent formation of cyclones of extreme severity, resulting in rampageous consequences in the affected eastern coastal states of India. Table 2 shows some of the devastating cyclones that have affected Eastern India, having a consequential impact on the country's economy.

Table 2: Few cyclones in the Bay of Bengal, having devastating impact on the economy

Year	Name of the cyclone	Landfall	Scale of devastation (approximately) in INR million	Number of casualties
1970	Bhola	Ganges delta	6,480	3 lakhs-5lakhs humans
1977	Diviseema	Near Nizampatnam	1,720	More than 10,000 humans
1999	Super Cyclone	Near Jatadhar	62,439.00	More than 10,000 humans
2013	Phailin	Near Gopalpur	89,020	23
2019	Fani	Near Puri	1,60,000	89
2020	Amphan	Near Bakkhali	1,00,00,000	103
2021	Yaas	Near Balasore	6,40,000	< 10
2023	Michaung	Near Bapatla	1,10,000	< 20
2024	Fengal	Near Puducherry	1,500	< 40

In all these cyclones, the same experience of widespread devastation, destruction and loss of life were witnessed up to the catastrophe of Super Cyclone in 1999.

In post-Super Cyclone the state Government of Odisha extensively focused on the **Early Preparedness** and was able to arrest the human casualties due to cyclones. The Odisha model got replicated in rest of the coastal

states across the country to reduce the death toll during the cyclonic events and other disasters. However, focus on disaster management and early preparedness could only save human lives not the asset losses, damage to livelihood and agriculture. Each climate catastrophe added to the people's helplessness, impoverishment, and wretchedness, potentially driving distress migration of coastal youth.

Cyclone Dana, an Eyeopener:



Crop loss, property loss, and infrastructure loss associated with the cyclone were deviated this time with the unfolding of Cyclone Dana, which hit the state of Odisha in the late night of October 24, 2024, at the Bhitarkanika dense Mangrove Forest in Kendrapada district. The IMD issued different levels of early warning signals for various locations across the coastal districts

of Odisha, depending on the potential exposure to Cyclone Dana. However, people in Odisha experienced a different cyclone with minimal damage despite the enormity of the wind speed of the cyclone.

The cyclone made landfall in the dense mangrove forest area. In the process, the magnitude of the wind was absorbed by the saline-tolerant vegetation, confined to the estuarian ecosystem. The mangrove canopy coverage remained undisturbed, yet significantly reduced the ferocity of the wind speed and protected the locals of the Bhitarkanika areas. Simultaneously, the pneumatophore root system of the mangroves checked the big waves and restricted saline inundation in the low-lying agricultural regions of Bhitarkanika, providing respite to the inhabitants. Cyclone Dana demonstrated that the loss of assets and property caused by cyclones can be minimized if focus is given to restoring the mangrove ecosystem near estuaries and deltas.

Image5:

Cyclone Dana brought devastation to the neighbouring District with a thinner mangrove canopy coverage



Photo: Bhadrak, 26th October 2024

Image6:

Happy smiles on the face, as Cyclone Dana failed to generate losses against the mangrove forest



Photo: Gupti Panchayat, immediately after the cyclone Dana

Mangrove Ecosystem :

Mangrove forests are complex vegetation ecosystems that consist of sturdy, woody trunks with an intertangled branch system found in intertidal areas where freshwater meets saline water through the natural forces of tidal activity. Saline-tolerant abilities characterize these species of vegetation, making them thrive in the hot, humid environments of tropical and subtropical regions. Saline resilience is not a single focal property of mangroves, but rather a host of characteristics that enable them to survive in the harsh climate, including regular inundation.

Regular inundation of the mangrove floor with saline water makes the roots of the mangrove plants crop-up to breathe in oxygen from the air, for which these specialised roots are called pneumatophores. This kind of root system facilitates the necessary aeration, which is vital for the survival of hydrophytic trees. These complex root systems trap soil sediments from the freshwater flows of the river channels, creating a slimy, salty mud that is conducive for

Image 7: Holding the soil by the pneumatophore roots



small sea creatures, such as various fish, crabs, and prawns, to take shelter and breed their offspring. Many reports indicate that around 80% of the world's marine creatures breed in the mangrove ecosystem, as the mangrove floor protects their young from predators and provides them with nourishment. The soil of mangrove floors is loaded with nutrients due to the presence of organic material and the activity of organisms. It helps sustain a robust biodiversity of interdependent ecosystems that consist of birds, aquatic animals, terrestrial animals, amphibians, and a large number of microorganisms that coexist under one umbrella.

Mangrove Ecosystem Services for Human Society :

➤ Storm Barrier

Tightly packed, arching prop roots and low-lying branches of the mangrove trees create solid obstacles to waves and wind during storms. The woody, sturdy trunks, along with the dense canopy coverage of the trees, reduce the impact of the wind and create a hindrance in

Image 8: Bio-shield against storms and flooding



the path of the cyclone that otherwise would have a devastating effect on the habitation.

High-density mangrove branches, trunks, and pneumatophores root systems slow down the height and intensity of wave energy during cyclones, protecting low-lying coastal areas from saline inundation. It acts as a bio-shield for the low-lying coastal regions and protects the residents from the ordeals of flooding that include the river flooding and saline flooding as well, and helps to minimise the damage of assets, properties, agricultural land, and coastal infrastructure.

➤ **Reduce Soil Erosion:**

The complex root system plays a critical role in stabilizing coastal sediments, preventing riverbank erosion near the river mouth. The reduced water velocity in the mangrove forest floor allows soil particles to settle on the ground and accumulate near the tree roots. Microbial activity near roots binds together and stabilises the soil sediments, preventing them from erosion. This activity of the mangrove forest floor helps keep the ocean floor clean, along with fostering the development of other coastal ecosystems, such as coral reefs and seagrass, which contribute to shoreline stability.

Satellite image of Badkote, Kendrapada-2011



Satellite image of Badkote, Kendrapada-2023



The Badkote village of Kendrapada district, which had been slowly experiencing soil erosion due to the river Hansua since the 1971 cyclone, could be stabilized by the plantation of mangroves. The improved soil stability generated confidence among the people, leading to the creation of permanent settlements around the riverbank.

➤ **Increase in Fish Catch:**

The mangrove floor acts as a nursery for the fish population. Muddy floors are rich in nutrients, generating a considerable amount of microbial activity and creating a suitable environment for juvenile fish to grow. The falling of shredded mangrove leaves and other organic material onto the swampy floor creates numerous microorganisms, which are ideal for the young fish to feed on. The slimy mud ground helps young fish hide from predation

by large animals and birds while providing them with sufficient nutrition from the microorganisms that grow in the mud, fed by the detritus of the mangrove trees. The local community experiences an increase in fish population in the river channels after the plantation of mangrove trees in the creeks.

Image 9: Happy Fishing



➤ **Promotion of Biodiversity:**

The mangrove ecosystem supports one of the most complex food webs in the tropical region. The dense canopy coverage of the mangroves reinforces the presence of diverse groups of birds, including migratory birds taking temporary shelter during winter. The branches and trunks of the trees endorse multiple genres of reptiles like snakes, lizards, etc.,

Image 10: Home for multiple species



and mammal primates like monkeys. The forest ground is inhabited by hoofed animals like deer, amphibians like frogs, reptiles like crocodiles, and turtles. Simultaneously, the roots of the mangrove trees uphold a variety of fungi and microbes encapsulating a complex food-

web structure within the ambit of the mangrove ecosystem.

➤ **Carbon Sequestration:**

Mangrove forest plays an incredibly significant role in absorbing atmospheric carbon, converting it to blue carbon, and storing it under their roots. Blue carbon helps bind soil particles and stabilizes soil erosion. The ability of the mangroves to absorb atmospheric carbon is way ahead of the terrestrial plants, and this helps in fighting the cause of climate change.

The coastal plains of Odisha come under the lower elevation zone and comprise multiple deltas, creeks, and estuaries. Six major rivers and their distributaries drain their water into the Bay of Bengal, creating numerous creeks, channels, and other waterways with openings towards the sea, which poses a potential risk to the state from receiving frequent cyclones. These creeks and channels, that give passage to the cyclones to enter the state and bring devastation in terms of physical, economic, and the confidence of people, can be used as an opportunity to create a bio-shield against cyclones.

Image 11: Creeks and Estuaries along the Coastline of Odisha, a potential site for Mangrove Cover

The conservation and promotion of the mangrove ecosystem will surely play a role as a green shield to reduce the impact of disasters and bring sustainable livelihoods through improved marine ecosystems. These channels, which are potential threats, can be converted into opportunities through the restoration of the mangrove ecosystem.



The India State of Forest Report (ISFR)-2023 shows that the mangrove coverage in the country has decreased from 4999.11sqkm in 2021 to 4991.68sqkm in 2023. But the good news is that the canopy coverage of these saline-tolerant trees in Odisha over these periods has increased from 257.51sqkm to 259.06sqkm, protecting the Odisha coastline from the ravage of the cyclonic storms.

The time has come when disaster management needs to take an inclusive approach and incorporate ecosystem restoration as a strategy to protect the lives, livelihoods, and assets of people through mitigation measures. This can be achieved through various community-centric disaster resilience programmes. This also aligns with the **UN's Sustainable Development Goal (SDG) 2030 target of ecosystem restoration**. In the past, Odisha has demonstrated its commitment to protect human lives through the mission of Zero Casualty at Any Cost which has garnered world applaud and now the time has come to facilitate disaster resilience through ecosystem restoration.





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