



THE IMPACT OF THE 2004 TSUNAMI ON MANGROVE FOREST AND COASTAL COMMUNITIES

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This study takes into account the rich diversity and distribution of mangroves as observed in the Andaman and Nicobar Islands. Additionally, this study focuses on the coastal communities and their close association with mangroves. This study further illustrates the devastating tsunami of 2004 and its impact on the mangroves and their shift in species distribution across various territories. Furthermore, this study depicts the challenges of mangrove restoration and paves a way forward for the future of mangrove plantation, restoration and conservation.

Keywords: Andaman and Nicobar islands, Biodiversity, Tsunami, Challenges, Restoration, Tsunami.

Introduction

Mangroves include a diverse group of woody trees and shrubs that share a common ability to survive in the intertidal region of sea. They are known for their ability to cope with salt-stress in an ecosystem. They are distributed in tropical and sub-tropical intertidal zones across the globe. Andaman and Nicobar islands is home to an astounding diversity of 39 mangrove species. Mangroves of Andaman are considered the best in the country in terms of growth and diversity¹. The Andaman and Nicobar islands have a mangrove area of 612 sq km. making it a major contributor to India's major mangrove cover².

Mangroves are evergreen trees with thick leathery leaves that minimizes the transpiration. Root system of Mangroves shows various adaptations like stilt root,

pneumatophores and knee roots. Mangrove forests offer a great site for migrating birds. Moreover, mangrove presents a conducive environment for the marine fauna for feeding, breeding, nesting and protection from predators³. Mangrove creeks serve as a vital resource for fishing and gathering marine delicacies. In addition to that, mangroves provide shelter to fishermen who are battling fierce winds and waves. Also, they play a vital role as carbon sink and storage to address global climate change⁴.

Despite its beneficial aspects to the environment, mangrove coverage has degraded by 20%-35% in the last 50 years due to several natural and anthropogenic activities⁵. Anthropogenic activities like aquaculture for shrimp, conversion of land for timber extraction and agricultural practices for palm oil and rice are major

contributors that led to 62% of mangrove forest degradation since 2000⁶. In addition to human activities, 38% of mangrove degradation is caused due to natural factors, for instance, shoreline erosion, cyclones, storms and tsunami⁶. The losses incurred post-tsunami are quite devastating, however, regeneration and rejuvenation has been observed in several locations.

The People of Andaman and Their Association with Mangroves

The study area chosen for the study of Mangrove forest include Andaman and Nicobar islands that is an amalgamation of nearly 572 islands. The rich biodiversity of the island is contributed to the humid tropical climate prevalent over these islands. It receives high rainfall (3800mm/year) for about eight months with four months of dry spell from January to April⁷. Rich diversity of mangroves can be seen in Shoal Bay (South Andaman), Yerrata (Middle Andaman) and Austin Creek (Mayabunder). Mangrove forests harbour a diverse assemblage of taxonomically distinct and its unique adaptation to intertidal zones. Out of the 44 species of mangroves found in India, Andaman and Nicobar islands boast an astonishing diversity of 39 species⁸.

The people of Andaman and Nicobar islands along with indigenous tribes like the Onge, Great Andamanese, Jarawa, Sentinelese, Shompen and Nicobarese share a close relationship with the mangroves. Mangrove creeks serve as a vital resource for fishing and gathering marine delicacies. In addition to that, mangroves provide shelter to fishermen who are battling fierce winds and waves. In addition to that, the leaf fall from

the mangroves serve as detritus which supports the coastal fishes. They also provide nesting ground for various birds. Mangroves serve as a recreational site for fishing, boating, bird watching, sight-seeing and photography. This is especially significant for the Andaman and Nicobar archipelago having enormous tourist potential.

The Devastating Tsunami and Its Impact on People and Mangroves

On December 26, 2004, the Andaman and Nicobar islands witnessed the impacts of a tsunami that was triggered by a deadly earthquake of 9.1 magnitude originating off the coast of Sumatra, Indonesia. The human toll of the tsunami in the Andaman & Nicobar Islands was devastating. Approximately 2,000 people lost their lives, although the exact number remains uncertain due to the loss of entire families and remote communities⁹. The tsunami displaced around 40,000 residents, including indigenous tribal communities. The Nicobar group of islands, in particular, suffered heavily, with many coastal settlements completely destroyed¹⁰. The indigenous tribes of the region, including the Nicobarese, Shompen, Onge, and Jarwa, were among the worst affected. These communities, with their unique cultures and traditional ways of life, were particularly vulnerable. The tsunami not only displaced them physically but also led to cultural practices disintegration, as their traditional lands were destroyed. Some tribes, like the Great Andamanese, were relocated to relief camps, which disrupted their social structures and cultural practices⁹. Due to the clash of Indian plate and Burmese plate, the North Andaman and Mayabunder went up (by

1.35m) and the South Andaman sank down (by 1m)¹¹. This in turn led to altered tidal dynamics. As per detailed study of the island, it has come to light that around 97% of mangrove cover has been lost due to the tsunami¹². The tsunami caused extensive environmental damage, with long-lasting consequences. Coastal ecosystems such as mangroves, coral reefs, and beaches were severely affected¹⁰. The tsunami uprooted mangroves, which serve as natural coastal barriers and are critical to the island's ecological balance. The destruction of these ecosystems exposed the islands to increased vulnerability to future storms and erosion. Coral reefs, essential for marine biodiversity and the livelihood of fishing communities, were also damaged. Many reefs were buried under debris or destroyed by the force of the waves. The loss of coral reefs had a cascading effect on marine life, disrupting fishing activities, which are a primary source of livelihood for many residents¹². Changes in tidal regime can lead to serious damage to mangrove diversity as they survive in intertidal zones. The island is home to an astounding variety of 39 mangroves, each thriving in a different tidal zone. A few centimeters change in sea level will lead to a shift in patterns of the Mangrove growth. Additionally, the satellite images obtained after the 2004 tsunami portrayed survival of *Rhizophora* sp. compared to other mangroves maybe due to the prop roots contributing to a dense structure that led to resistance of tsunami flow while other genera without prop roots were easily uprooted¹³. The damage to mangrove trees can be categorized into following 5 patterns¹³:

- Broken at stem or prop roots

- Uprooted and fallen down
- Uprooted and inclined
- Uprooted and swept up by tsunami flow
- Lost bearing capacity due to ground erosion

The Changes in Mangrove Ecology at The Wake of Tsunami and Its Effect on The Locals

About 1150 hectares of mangrove forest were wrecked due to perpetual flooding caused by the devastating tsunami¹⁴. However, the gradual abatement of water in that region after a few years led to the formation of wetlands where mangroves started to draw in. Pioneer species such as *Ceriops tagal* and *Rhizophora apiculata* were the first ones to colonize the wetlands⁹. About 6600 hectares of mangrove forest was wrecked due to tidal flooding. The land on the East Coast rose up to 50cm while that on the West Coast rose up to 135cm. This led to drying off mangrove forests in both the coasts. The loss of mangroves along the West Coast was a whopping 90% while that of the East coast amounted to 40-70%¹⁶. Traditional ways of life, such as subsistence farming and fishing, were no longer viable in the post-tsunami landscape. Many tribes were relocated to relief camps, where their isolation from their natural environment led to the loss of traditional knowledge and practices¹⁰. Moreover, the real crunch was felt by the local people who depended on mangrove forest to earn their livelihood by fishing, crabbing and oyster hunting activities. Fishermen are forced to put double the efforts to catch the same quantity of crabs prior to the tsunami. A

few species of mangroves kept the glimmer of hope alive by colonizing the dead coral reefs and terrestrial plants have come to rescue the barren areas that once were home to a rich luxurious mangrove diversity. Additionally, 70-80 species of crab that were irrevocably dependent on mangroves are adversely affected⁸. A shift in the crab community is clearly visible as few crab species prefer a particular mangrove's leaf to feed on. Coastal ecosystems, including mangroves, coral reefs, and seagrass beds, were severely impacted. Mangroves, which act as natural barriers against such disasters, were uprooted, leading to an increase in coastal erosion in the years following the tsunami¹¹. The tsunami also caused saltwater intrusion into freshwater sources, contaminating drinking water supplies and making agricultural land unusable for years. Coral reefs, which are vital to the marine ecosystem and tourism, were damaged, disrupting marine life and local fishing industries. Some islands, like Indira Point in Great Nicobar, witnessed land loss as entire stretches were submerged under the sea¹⁶.

The Challenges

Mangrove recovery is facing an array of anthropogenic factors. The wetlands formed after the tsunami are majorly on private properties and people are filling them in for other activities⁸. Apart from that, cattle and chital deer from nearby areas are grazing on them further delaying the road to recovery for mangroves. Certain intertidal zones of North Andaman pose a serious challenge when it comes to colonizing them due to strong tides, unsuitable soil and hard calcareous surface

for root penetration. Around 23% of the Mangrove species are highly vulnerable to disasters and other effects of climate change¹⁸. Due to future tectonic displacement, mangrove cover can become more vulnerable. Some species of mangroves like *Rhizophora apiculata* and *Ceriops tagal* show high resilience to drastic sudden alterations in tidal regime¹⁸. Submerged areas are home to flood-tolerant species like *Aegiceras corniculatum* and *Avicennia marina*. Mangroves have an incredible power to regenerate naturally and the only intervention needed from humans is to keep man-made disturbances like introduction of invasive species at bay¹⁸.

The Way Forward

Even though letting mother nature take its course seems like a wonderful idea, however, there is a risk of losing endemic flora and fauna in the meantime. Hence, we need an amalgamation of holistic approaches including the traditional natural regeneration and human assisted plantations. Mangrove replanting projects were initiated to restore these critical coastal barriers. Coral reef restoration programs were also launched, with the involvement of local communities and international conservation organizations. In addition, long-term efforts to reduce the vulnerability of coastal areas were put in place, including the construction of seawalls and the promotion of sustainable land-use practices. These transformations aim to collectively restore ecological balance and protect the environment from future disasters. The restoration of coastal ecosystems, such as mangroves and coral reefs, should continue to be a priority. These

ecosystems act as natural defenses against tsunamis, storm surges, and other environmental shocks. Community engagement practices must be maximized for long term sustainable conservation and regeneration of mangroves. During restoration activities, it must be kept in mind that specific mangrove has some special requirements which if not met will lead to failure of plantation programs. Habitat specificity needs to be carefully considered during plantation.

Conclusion

The 2004 tsunami brought about catastrophic changes to the natural landscape of Andaman and Nicobar Islands. Mangrove forests that act as vital ecological buffer and livelihood sources, experienced unprecedented destruction - losing vast areas of cover and species diversity due to land elevation shifts, flooding and tidal changes. Coastal communities, especially indigenous groups suffered physical displacements along with cultural disruptions. Despite the aftermath, signs of ecological recovery have emerged through natural regeneration and targeted replanting of resilient species. However, challenges such as land-use conflicts, grazing pressure, and unsuitable planting conditions continue to hinder full restoration. For lasting recovery, it is essential to blend traditional knowledge with scientific approaches, ensure community involvement, and tailor conservation strategies to local ecological needs. Only through such integrated efforts can mangrove ecosystems and the communities that depend on them regain resilience and sustainability in a changing climate.

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