



MANGROVE AS A SOURCE TO CONSERVE, PRESERVE AND PROTECT MARINE BIODIVERSITY

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ABSTRACT

Mangrove forests constitute a unique and legally significant ecological class of coastal ecosystems, occurring at the interface of land and sea, and distributed across approximately 123 tropical and subtropical nations. These ecosystems are biologically adapted to saline and brackish environments and form an integral component of the broader blue ecosystem continuum. From an environmental governance perspective, it is submitted that mangroves render indispensable ecosystem services of both ecological and socio-economic importance. Despite occupying less than one per cent of global tropical forest cover, they directly and indirectly sustain the livelihoods and well-being of an estimated 2.4 billion people residing within 100 kilometres of coastal regions. Their functions include, inter alia, provision of food and timber resources, attenuation of coastal hazards such as storms, erosion, and flooding, enhancement of water quality through natural filtration processes, and significant carbon sequestration, thereby contributing to climate regulation. Further, mangrove ecosystems serve as critical ecological support systems for adjacent marine habitats, including coral reefs and seagrass meadows, and provide habitat and nursery grounds for over 1,500 species, including commercially important fisheries. In this regard, mangroves are not isolated ecological entities but form part of an interconnected blue ecosystem network, encompassing both saline and freshwater systems, which collectively perform essential planetary functions such as regulation of temperature, oxygen generation, freshwater storage and purification, and biodiversity conservation. However, it is a matter of grave concern that these ecosystems are increasingly threatened by the “triple planetary crisis”—namely climate change, biodiversity loss, and pollution—aggravated by anthropogenic pressures such as unsustainable coastal development, extractive activities, energy generation, aquaculture expansion, and indiscriminate resource exploitation. Such degradation directly

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impairs the ecological balance and undermines the continued provision of life-supporting ecosystem services. In this context, international institutional mechanisms, including the United Nations Environment Programme, have emphasized the urgent necessity of adopting integrated conservation strategies aimed at the protection, restoration, and sustainable management of blue ecosystems across the water continuum. In conclusion, it is respectfully submitted that mangrove ecosystems, as a critical component of blue infrastructure, warrant the highest degree of legal recognition and protection. Their conservation is not merely an environmental objective but a legal and ecological imperative, essential for safeguarding biodiversity, ensuring climate resilience, and securing the rights and livelihoods of present and future generations.

KEYWORDS: Nature, Restore, Habitat, ecosystem, carbon sink, coral reef, flood barriers, moderates temperature, humidity, wind, mitigate climate change, restoration, Sustainable, Mangrove Forest.

INTRODUCTION

A mangrove is a tiny tree or shrub that thrives in brackish or salty coastal waters. The tropics and subtropics are where mangroves are most common. Mangrove trees have a sophisticated salt-filtration mechanism and can withstand high salt levels. Because mangrove roots are uniquely suited to low oxygen levels, they are submerged in saltwater during high tide and exposed to air and high temperatures during low tide. Knotted mangrove roots promote the slow flow of water and frequently cover a wide region. In addition to giving many animals on the reef vital early habitat, this promotes the deposition of contaminants from the land before they reach the open ocean.

Mangroves are prized for their ability to stabilise and protect low-lying coastal areas as well as their significance in the food chains of estuaries and coastal fisheries. In addition to serving as flood barriers, mangroves moderate temperature, humidity, wind, and even waves, which helps to stabilise the environment. They may thrive in unfavourable soil conditions and are uniquely suited to tolerate saline and wave activity. In fact, they shield the land from the sea's influence.

Mangrove forests have the potential to be a very successful natural remedy. They contribute significantly to climate change mitigation even though they comprise less than 1% of all tropical forests worldwide. Large volumes of carbon are stored in mangrove soils, making them extremely efficient carbon sinks. They store two to four times as much carbon per hectare as terrestrial forests, according to estimates, and their destruction releases a significant quantity of carbon back into the atmosphere.

In actuality, the loss of mangrove forests between 1996 and 2020 resulted in a total decrease of 139 megatonnes of carbon stocks (1 megatonne is equal to 1,000,000 tonnes), which is

roughly four times the world CO₂ emissions from the burning of fossil fuels and the production of cement in 2018. Mangroves are an effective friend in the fight to reach net-zero carbon emissions by 2050 if they are not disturbed.

A variety of fascinating endangered species find a home in seagrass meadows. Seagrass meadows are the primary feeding habitat for manatees (sea Cows) in the Atlantic and Caribbean Seas, They Consume upto 50kgs per day of seagrass, dugongs in the Indian and Pacific Oceans feed on approximately 40kgs per day , and adult green turtles worldwide,2kgs of sea grass per day.

The condition of seagrass meadows has an impact on the fate of dugongs, which are enormous marine animals found in the Pacific and Indian Oceans. Regretfully, they are listed as being at risk of extinction due to the degradation of the seagrass meadows that they rely on, boat strikes, and illicit fishing. Dugong populations must be preserved and restored in order to preserve and restore seagrass meadows.

The Characteristics of Mangroves are Tolerant to Salt ,Mangroves are adapted to survive in areas with frequent flooding and can tolerate being submerged in water for extended periods, Many mangrove species have aerial roots that allow them to breathe oxygen in low oxygen environments, Mangroves are home to a diverse range of plant and animal species that are adapted to live in these unique conditions.

There different types of Mangroves like Red Mangrove Found in tropical and subtropical regions, this is one of the most common mangrove species, Black Mangrove Found in tropical and subtropical regions, this species is known for its distinctive black trunk, White Mangrove Found in tropical and subtropical regions, this species is known for its small white flowers and Grey Mangrove found in tropical and subtropical regions, this species is known for its distinctive grey trunk.

IMPORTANCE OF MANGROVES

1. Mangroves provide important protection against storms and erosion. In the situation of the coastal disaster like Tsunami, Mangroves perform the task of protection of the coastal community from the high waves. Therefore, mangroves help to restraint the highways and can help in reducing the effects on the coast.
2. Mangroves provide a habitat for a diverse range of marine species. Mangroves releases oxygen to coastal environment. This oxygen will be helpful to plankton and microbes such as zooplankton and phytoplankton and to other fauna and to give oxygen to flora in presence of sunlight, the photosynthesis occurs and in turn provides oxygen to all Biota. If there was no releasing of oxygen, then there would have been no photosynthesis and thus helps and works as co₂ absorption and supports the ocean sink.

3. Mangrove are important carbon sinks, helping to mitigate the effects of climate change.
4. Mangroves provide important nursery habitats for many fish species.8 Mangroves harbouring are helpful and are sponging and breeding ground for marine and other marine ecosystem. Some Birds around the marine area such as Flamingo, Stroke, Albatroz, grey igrets rely on mangroves for the their food as there are many fish species in mangroves as they serve as the habitat for many fishes. Also the animal Jackal who is mostly found near coastal area, their excreta also acts as a manure for mangroves. Hence the plantation of mangrove has also helped to run the marine biodiversity naturally.
5. Salinity ingress is the process by which the water or soil becomes increasingly salty in where saline water pushes towards landward side during each high tides where ground water of soil is at deeper level could not resist such push in hydraulic gradient. The Plantation of mangroves helps to reduce salt content in water in the surrounding areas and therefore planting of mangrove helps the coastal community to avail fresh water in the wells. Therefore if the mangroves are planted it will help to marine biodiversity and will also help indirectly to the coastal habitat.

There are serious Threats of Mangroves Ecosystem like Deforestation and habitat destruction: Mangrove forests are being cleared for coastal development, aquaculture and other human activities, Mangroves are Vulnerable to pollution from industrial, agricultural and domestic activities, Mangroves are susceptible to the impacts of climate change, including sea-level rise, increased storm frequency and changes in water temperature and chemistry, Mangroves are overfished, leading to decline in fish populations and impacts on the ecosystem.

Therefore, in the Coastal Regulation Zone (CRZ) 2019 has provided special measures to Conserve, Protect and Promote Mangrove. Hence the area where mangroves are planted becomes a “NO GO” Area for development and hence it is considered as Gazetted Area IA.

It is very important to make sure that any pollution including the oil spill reaches to mangrove areas, it will be very much detrimental to mangroves and accordingly it will damage the natural ecosystem/cycle of mangroves. Therefore, it is very important to prevent marine pollution by way of port activities, shipping activity, urban activity and anthropogenic activity (those activities that releases sulphur dioxide) hence it is mandatory to follow all regulation that are enforce to protect marine biodiversity.

Mangrove forests are better at storing carbon, supporting fish populations worldwide, and serving as breeding sites for marine biodiversity. Through both regulatory and promotional actions, the government has improved and protected mangrove forests in coastal states and union territories. The Ministry of Environment, Forests, and Climate Change's National



Coastal Mission Program's "Conservation and Management of Mangroves and Coral Reefs" Central Sector Scheme is used to carry out the promotional activities.

NATIONAL GREEN TRIBUNAL'S INTERVENTION IN MAINTAINING MARINE BIODIVERSITY:

A ruling by India's environmental court has provided crucial relief for the indigenous "swimming camels" of Kachchh and the fragile mangrove ecosystem they depend on. To safeguard the mangroves in Gujarat's western district—home to the rare Kharai camel—the National Green Tribunal directed authorities to maintain an uninterrupted and natural flow of estuarine water through the creeks and to prevent any form of obstruction.

The order was issued in response to a petition filed by the Kachchh Camel Breeders Association, which alleged large-scale destruction of mangroves in the Nani Chirai and Moti Chirai areas of Bhachau Taluka. The association claimed that the Deendayal Port Trust had cleared mangrove cover without obtaining mandatory approvals under the Coastal Regulation Zone (CRZ) Notification, 2011, and the Forest Conservation Act, 1980. The tribunal also examined the conduct of the port authority—earlier known as Kandla Port Trust—during the proceedings.

Situated along the Gulf of Kachchh on India's western coastline, the port, established in the 1950s, is among the country's busiest in terms of cargo volume. According to the camel breeders, the affected mangrove regions lie close to the natural habitat of the Kharai camel, a unique indigenous breed that thrives in coastal mangrove environments and supports the livelihoods of many local pastoral families. They further contended that the necessary environmental clearances had not been secured and that both the Coastal Zone Management Authority and the Gujarat forest department had failed to take effective measures to halt the ongoing degradation of mangroves.

The association further alleged that the Deendayal Port Trust had leased out portions of land under its jurisdiction areas falling within coastal regulatory zones—for salt extraction activities. These operations, it claimed, led to large-scale mangrove loss as barriers and embankments were constructed across creeks without obtaining the required permissions from competent authorities.

The Kachchh Camel Breeders Association stated that the region serves as a crucial habitat for nearly 400 Kharai camels, which rely almost entirely on the mangrove islands for nearly eight months each year. This distinctive camel breed is found exclusively in Gujarat within India.

According to Sahjeevan, a non-governmental organisation working toward the conservation and welfare of Kharai camels, the camel population in Kachchh has seen a noticeable

decline—from around 2,200 animals five years earlier to approximately 1,800 in 2018. Current estimates suggest that Gujarat is home to roughly 4,500 Kharai camels, popularly referred to as “swimming camels” due to their unusual ability to move through coastal waters.

In its judgment dated 11 September 2019, the green tribunal bench led by Justice Raghuvendra S. Rathore ordered that no form of obstruction should be permitted in the creeks and that the natural, uninterrupted flow of estuarine water must be maintained at all times.

The tribunal also instructed the state forest department, the Coastal Zone Management Authority, and revenue officials to conduct a joint inspection to identify those responsible for blocking the creeks and to initiate legal action, including recovery of environmental compensation and restoration costs for damaged mangroves, within one month of the order. Additionally, the forest department was directed to undertake immediate measures to rehabilitate the affected mangrove areas within a period of six months.

Compliance of court’s direction:

During the course of the investigation, a joint site inspection was carried out in April 2018 by a team comprising officials from the Gujarat Pollution Control Board and the Central Pollution Control Board at locations where the alleged violations had occurred.

In its findings, the committee reported that earthen embankments had been built in phases to develop salt pans and level the land, a process that involved the uprooting of mangrove vegetation. These activities also blocked several minor creeks and disrupted the natural flow of seawater, ultimately causing the mangroves in those areas to wither and die.

A separate assessment conducted in March 2018 by a sub-committee appointed by the Kachchh district collector similarly recorded extensive ecological damage. The report highlighted the destruction and removal of mangroves across nearly 750 acres of land, of which about 250 acres consisted of moderately dense mangrove cover while the remaining 500 acres were sparsely vegetated. For context, the Government of India’s State of Forest Report 2017 estimated Gujarat’s total mangrove area at approximately 1,140 square kilometres.

TRIBUNAL’S OBSERVATION:

In its observations, the tribunal also pointed to the absence of clear boundary demarcation between land controlled by the port authority and state revenue land, a lapse that contributed to encroachments on both sides. Insufficient supervision further enabled the construction of salt pans through bunds erected across creeks, leading to widespread mangrove loss.

Mangroves, which thrive in estuaries and intertidal coastal zones, were described by the tribunal as one of the planet's most productive natural ecosystems. Beyond filtering water and preventing shoreline erosion, they play a crucial role in carbon sequestration, biodiversity conservation, and the supply of timber resources. They also act as natural wind and wave barriers, shielding coastal regions from cyclones and tidal surges. Moreover, mangrove habitats function as breeding and nursery grounds for numerous fish species and marine life, thereby sustaining the ecological balance and vitality of coastal environments.

Emphasising the ecological significance of mangroves, the tribunal observed that their preservation is a collective responsibility. It noted that, apart from regions such as the Sundarbans and the Andaman and Nicobar Islands, only a limited number of places in India support thriving mangrove ecosystems, with the Kachchh coastline being one of them. In this context, the tribunal stated that the Gujarat forest department and the state's coastal zone authorities carry a particular duty to safeguard and conserve mangroves wherever they exist along the state's shoreline.

The tribunal further instructed the Gujarat Coastal Zone Management Authority to take prompt action in the event of any activity found to be in breach of the Coastal Regulation Zone Notification, 2011. Welcoming the ruling, Mahendra Bhanani, the camel programme coordinator at the non-governmental organisation Sahjeevan, remarked that the decision would help secure and preserve the region's entire ecological framework.

He added that the order would not only aid in protecting the Kharai camels and the mangrove forests but would also support the livelihoods of thousands of people, including fishing communities and families dependent on camel rearing. Beyond these immediate benefits, he noted, conserving mangroves would also contribute significantly to the protection of marine biodiversity in the area.

SIGNIFICANCE OF THE MITHAPUR REEFⁱ

The coral reef ecosystem near Mithapur, situated along the Gulf of Kachchh, possesses immense ecological, economic, and scientific importance within India's coastal landscape. Despite surviving in relatively extreme conditions marked by high salinity and temperature fluctuations, these reefs remain among the few flourishing coral formations on the country's western shoreline.

The Mithapur reefs nurture a rich variety of marine organisms, including hard and soft corals, reef fish, molluscs, crabs, sea cucumbers, marine algae, and seagrass beds. They serve as vital spawning and nursery habitats for numerous fish and invertebrate species, thereby sustaining regional marine biodiversity. In addition, coral reefs function as natural wave barriers, absorbing the force of tides and storms before they reach land. This protective capacity helps

reduce shoreline erosion, safeguard nearby settlements and infrastructure, and lower long-term disaster risks.

Local fishing communities rely heavily on the health of these reefs, both directly and indirectly. A thriving reef ecosystem supports stable fish stocks, shellfish and seaweed resources, and opportunities for eco-tourism and guided coastal activities, all of which contribute to economic security in coastal areas. Beyond livelihood benefits, coral reefs assist in carbon sequestration, improve water quality through natural filtration, and maintain balanced marine food chains, thereby preserving the ecological harmony of the coastal zone.

From a research perspective, the Mithapur reef is particularly valuable because its corals endure extreme temperature shifts, elevated salinity, and strong tidal movements. These characteristics make the region an important site for studying climate resilience and understanding how coral ecosystems may adapt to global climate change. The reef system also holds national environmental significance as it falls within the broader conservation framework of the Marine National Park, Gulf of Kachchh—India's first marine national park. Its protection supports national biodiversity objectives and marine conservation policies.

In essence, the Mithapur reef is more than just a marine habitat; it functions as a natural coastal defence, a source of livelihood, and a living laboratory for climate science. Safeguarding it ensures long-term ecological balance and economic well-being for coastal communities.

RECOMMENDATIONS / WAY FORWARD

In light of the ecological significance of mangrove ecosystems and the evolving jurisprudence under environmental law in India, the following recommendations are proposed to strengthen conservation, restoration, and sustainable management of mangroves as critical components of marine biodiversity:

1. Integrated Coastal Ecosystem Governance

A comprehensive coastal management framework should be adopted integrating mangroves with coral reefs, seagrass beds, mudflats, and estuarine ecosystems. This aligns with the ecosystem-based approach recognised under the Environment Protection Act, 1986 and the Coastal Zone Management Plans (CZMPs) prepared under CRZ Notifications.

2. Strengthening Protection under CRZ Framework

Mangroves exceeding 1000 sq. m. are classified as CRZ-I (ecologically sensitive areas) under the Coastal Regulation Zone Notification, 2019, wherein no developmental activities are permissible except those of strategic importance. Strict enforcement of this provision is essential, along with accurate demarcation through high-resolution mapping.

3. Enforcement of “No Obstruction to Natural Tidal Flow” Principle

Judicial precedents have emphasised the necessity of maintaining natural hydrological regimes in mangrove areas. In *Kachchh Camel Breeders Association v. Deendayal Port Trust*, the National Green Tribunal directed that, no obstruction shall be created in creeks, and Natural flow of tidal water must remain uninterrupted. This principle should be codified into regulatory practice, prohibiting bonding, reclamation, and salt pan development that disrupt tidal exchange.

4. Application of the Precautionary Principle and Public Trust Doctrine

The Hon’ble Supreme Court in *M.C. Mehta v. Kamal Nath* recognised the Public Trust Doctrine, holding that natural resources like forests, rivers, and coastal ecosystems are held in trust by the State for public use. Similarly, the Precautionary Principle has been consistently upheld in environmental jurisprudence, including by the NGT. Mangroves, being critical ecological assets, must therefore be protected against irreversible damage even in the absence of complete scientific certainty.

5. Mandatory Mangrove Impact Assessment for Coastal Projects

All coastal infrastructure projects including ports, jetties, pipelines, desalination plants, and industrial zones—should be subjected to: Pre-project mangrove impact assessment and Post-clearance compliance audits. This is consistent with the Environmental Clearance regime under the EIA Notification, 2006 read with CRZ provisions.

6. Blue Carbon Financing and Climate Policy Integration

Mangroves should be formally integrated into climate mitigation strategies due to their high carbon sequestration potential. Policy frameworks may be developed to, Enable blue carbon credit markets, Incentivise restoration projects, Link conservation outcomes with climate finance mechanisms. This aligns with India’s commitments under international climate frameworks and biodiversity conventions.

7. Development of a Mangrove Health Index (MHI)

A standardised Mangrove Health Index should be developed incorporating, Canopy density and species diversity, Soil salinity and water quality, Tidal connectivity and creek integrity, Carbon sequestration capacity. Such an index would support evidence-based decision-making and periodic regulatory review.

8. Use of Geospatial and Digital Monitoring Tools

Real-time monitoring through Satellite imagery, Drone-based surveillance, GIS-enabled dashboards. These technicalities should be institutionalised for tracking encroachments, degradation, and restoration progress. Integration with CZMP and national geospatial platforms would enhance regulatory enforcement.

9. Community Participation and Livelihood Integration

The NGT has repeatedly emphasised the role of local communities in environmental protection. Participatory conservation models should be developed involving Fisherfolk and pastoral communities, Local self-governments, NGOs and academic institutions, Livelihood-linked conservation (eco-tourism, sustainable fisheries, mangrove nurseries) will ensure long-term sustainability.

10. Strict Liability and Environmental Compensation Mechanism

In line with NGT jurisprudence, particularly in cases such as Paryavaran Suraksha Samiti v. Union of India, environmental violations must attract Polluter Pays Principle, Environmental compensation and Mandatory restoration obligations. The Destruction of mangroves should be treated as a high-severity ecological offence.

11. Scientific Restoration Using Native Species

Mangrove restoration must be Site-specific, Based on hydrological and soil conditions, Focused on native species, Unscientific plantation without ecological suitability should be avoided. Species diversity should harbour and healthy growth to the mangroves.

12. Creation of Marine Biodiversity Corridors

Ecological corridors linking mangroves with coral reefs and seagrass ecosystems should be established to ensure Species migration, Genetic exchange, Ecosystem resilience. This is consistent with biodiversity conservation principles under the Biological Diversity Act, 2002. Also, dissemination works like in our society difference breeds gives better & healthy generations.

13. Periodic Mapping and Legal Demarcation

High-resolution mapping of mangrove areas should be carried out every 2–3 years and integrated into CZMPs to: Prevent encroachments, Ensure legal clarity of boundaries, Facilitate enforcement actions

14. Institutional Coordination and Specialised Authorities

A multi-agency institutional framework involving State Forest Departments, Coastal Zone Management Authorities, Pollution Control Boards, Research institutions like GEER Foundations and NGOs like Shavjivan, etc should be strengthened. For ecologically sensitive regions like the Gulf of Kachchh, a dedicated coastal biodiversity authority may be considered.

15. Transition from Conservation to Ecological Regeneration

Policy focus must shift from passive conservation to active ecological regeneration through Restoration of natural creek systems, Re-establishment of tidal hydrology, Rehabilitation of degraded mangrove landscapes

CONCLUSION:

Mangroves warrant formal recognition as critical “blue infrastructure” within the framework of environmental governance, not merely on account of their ecological value, but owing to their indispensable role in sustaining coastal stability, biodiversity, carbon sequestration, and socio-economic livelihoods.

From a constitutional and jurisprudential standpoint, Coastal ecosystems constitute the foundational ecological continuum sustaining both marine and terrestrial life, thereby underpinning the environmental integrity of the Earth as a whole. Mangroves, as an integral and vital component of this ecological continuum, perform indispensable functions harbouring diverse flora and fauna, acting as natural coastal defence systems, and serving as significant carbon sinks through sequestration.

In this context, the principles evolved under Indian environmental jurisprudence particularly the expansive interpretation of Article 21 of the Constitution of India mandate that: The right to life encompasses not merely human survival in a narrow sense but extends to the protection and preservation of ecological systems essential for sustaining life.

Accordingly, it can be legally asserted that:

- Conservation, protection, restoration, and afforestation of mangroves are not discretionary environmental measures but form an intrinsic part of the fundamental right to life.
- Any degradation of mangrove ecosystems would amount to an infringement of this expanded scope of Article 21, as it directly impairs ecological balance and, consequently, human well-being. Like Tsunami will hit the populations if mangroves resisting such waves are cut.

- Mangrove ecosystems must, therefore, be accorded the highest degree of legal protection, akin to life-supporting natural assets, warranting strict regulatory safeguards under CRZ and allied environmental frameworks.

Mangroves are not merely components of the environment; they constitute the very substratum of life-support systems. Their protection is, therefore, synonymous with the protection of life itself of human and ecological thus falling squarely within the constitutional mandate of Article 21.

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