World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 7.409

DECLINE OF MANGROVE ECOSYSTEMS AND ITS IMPACT ON COASTAL AND MARINE FAUNA IN ANDHRA PRADESH

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Article Received on 29//04/2025 **Article Revised on 19/05/2025** **Article Accepted on 08/06/2025**

ABSTRACT
India's coastline spans 7,517 kilometers, with 5,423 km along Peninsular India and 2,094 km around the Andaman, Nicobar, and Lakshadweep Islands. Andhra Pradesh boasts the country's third-longest coastline, stretching about 974 kilometers along the Bay of Bengal. This coastal region features diverse natural and man-made ecosystems, including mangroves, mudflats, beaches, estuaries, creeks, marshes, lagoons, and seagrass beds. Mangrove forests in Andhra Pradesh extend from Srikakulam in the north to Nellore in the south, with dense concentrations in the Godavari and Krishna estuaries. These areas benefit from abundant freshwater inflow, rich sediments, and nutrients. Known as tidal or mangrove forests, these salt-tolerant ecosystems are regularly flushed by tidal waters and play a vital role in protecting coastlines from cyclones and erosion. One such popular biosystem is Godavari mangroves. The Godavari mangroves are India's second largest, after the Sundarbans, and serve as critical habitats for a wide range of wildlife. This includes endangered mammals like the smooth Indian otter and fishing cat, numerous bird species such as herons and kingfishers, reptiles like estuarine crocodiles and sea turtles, and many invertebrates including crabs and shrimp. Despite their ecological importance, Andhra Pradesh's mangroves face serious threats from habitat destruction, pollution, encroachment, illegal aquaculture, and climate change. The degradation of these forests leads to biodiversity loss, disrupted food chains, and heightened vulnerability to coastal erosion and storm surges.

KEYWORDS: Coastline, Godavari mangroves, habitat destruction & biodiversity loss.

INTRODUCTION

Mangroves are unique and vital coastal ecosystems found in tropical and subtropical regions around the world. These salt-tolerant trees and shrubs grow in intertidal zones, where they form dense forests along shorelines, estuaries, and river mouths. Known for their distinctive root systems—often exposed above water—mangroves play a crucial role in stabilizing coastlines, preventing erosion, and providing a natural barrier against storm surges and tsunamis.

Beyond their physical benefits, mangrove forests are rich in biodiversity, serving as breeding and nursery grounds for a wide range of marine and terrestrial species, including fish, crabs, birds, and insects. They also offer vital ecosystem services such as carbon sequestration, water purification, and support for local livelihoods through fishing and ecotourism. Despite their importance, mangroves are under threat from deforestation, pollution, and climate change, making their conservation a global priority.

Global Distribution of Mangrove Forests

Mangrove forests are specialized coastal ecosystems found in tropical and subtropical regions around the world. They thrive in the intertidal zones of sheltered shorelines, estuaries, and river mouths, where salty or brackish water meets land. The global distribution of mangroves spans over 120 countries, with the majority concentrated in South and Southeast Asia, followed by regions in Africa, Australia, and the Americas. Countries like Indonesia, Brazil, Australia, Nigeria, and India possess some of the largest mangrove areas. These ecosystems not only support a high level of biodiversity but also play a vital role in protecting coastlines, sequestering carbon, and sustaining local livelihoods. Understanding their global spread is essential for conservation planning and climate resilience efforts.

Mangroves Distribution in India

India hosts a diverse and ecologically significant range of mangrove forests spread across its coastline and island territories. Of the total mangrove cover in the

country, approximately 59.4% is located along the east coast, 27.4% along the west coast, and the remaining 13.2% in the Andaman and Nicobar Islands. Some of the most prominent and spectacular mangrove ecosystems are found in the Sundarbans of West Bengal—the largest contiguous mangrove forest in the world—and the richly biodiverse Andaman and Nicobar Islands.

Geographically, mangroves in India are distributed between 69°00′ and 89°05′ East longitude, and 7°00′ to 23°00′ North latitude, encompassing three distinct ecological zones:

1. **Deltaic Mangroves (East Coast – Bay of Bengal)**

These are the most extensive and luxuriant mangrove formations in India, supported by large river deltas such as those formed by the Ganges, Mahanadi, Godavari, Krishna, and Cauvery rivers.

2. **Backwater-Estuarine Mangroves (West Coast – Arabian Sea)**

These mangroves occur along funnel-shaped estuaries of major west-flowing rivers like the Indus, Narmada, and Tapti, as well as in backwater creeks and neritic inlets typical of the western coastline.

3. **Insular Mangroves (Andaman and Nicobar Islands)**

These forests thrive in tidal estuaries, small river mouths, neritic islets, and coastal lagoons, supporting an especially rich and diverse mangrove flora due to the islands' relative isolation and undisturbed ecosystems.

The distribution pattern reflects both geographical and hydrological factors that influence the establishment and growth of mangrove species. This zonal classification helps in region-specific conservation strategies to preserve these critical coastal ecosystems.

Significance of Mangroves

Mangrove ecosystems offer a wide range of ecological, economic, and social benefits, particularly to coastal communities. They provide valuable wood products such as minor timber, poles, posts, and firewood, as well as non-wood resources including fodder, honey, wax, tannins, dyes, and thatching materials.

Mangroves also support rich fisheries, offering habitat and breeding grounds for fish, prawns, crabs, mussels, clams, and oysters. These resources are vital for the livelihoods of poor fishing communities in tropical regions (Hossain, 2009; Chan et al., 2012; Jayakumar, 2014). The high biological productivity of mangroves—characterized by rapid leaf fall and decomposition—creates detritus that nourishes juvenile bivalves, shrimps, and fish, attracting them to these nutrient-rich waters.

Beyond fisheries, mangroves are essential biodiversity hotspots, providing nesting and shelter for numerous species such as shorebirds, crab-eating monkeys, proboscis monkeys, fishing cats, lizards, sea turtles, and bats. These unique habitats also support the ecotourism industry, as visitors can explore mangrove areas via boardwalks or boat tours, gaining awareness of their ecological value (Lee, 2003; Sonjai, 2007; Jayakumar, 2014).

Mangroves play a crucial role in coastal protection, serving as natural barriers against erosion, tidal surges, storm waves, and rising sea levels. Compared to artificial structures like seawalls, mangroves offer a cost-effective and sustainable solution for shoreline stabilization (Coastal Zone of India, 2012; Chan et al., 2012).

In terms of climate regulation, mangroves are significant carbon sinks, sequestering an estimated 22.8 million tons of carbon annually (Giri et al., 2011). They also contribute over 10% of the dissolved organic carbon that enters the global oceans from terrestrial sources (Dittmar et al., 2006).

Moreover, mangrove plant species are donors of salt-tolerant genes, which are utilized in biotechnology to develop salinity-resistant crop varieties (Selvam, 2003). Given their multifunctional benefits, the conservation and restoration of mangrove ecosystems are now recognized as critical for ecological sustainability and climate resilience.

Mangrove fauna of Andhra Pradesh

Andhra Pradesh's mangrove forests, particularly in the Godavari and Krishna deltas, harbor a diverse fauna, including endangered species. This includes mammals like smooth Indian otters and fishing cats, various bird species like kingfishers and herons, reptiles such as estuarine crocodiles and sea turtles, and a wide array of invertebrates like crabs and shrimp.

Elaboration of major animal groups

- **Mammals**

Smooth Indian otters, fishing cats, and jackals are among the mammalian inhabitants of the mangrove forests.

- **Birds**

A large variety of birds, including kingfishers (like the Black-capped kingfisher), Brahminy kites, sea gulls, herons, and sandpipers, find the mangroves to be a suitable habitat.

- **Reptiles**

Estuarine crocodiles, Olive Ridley Sea turtles, and various snakes like common cobras and rat snakes can be found within the mangrove ecosystem.

- **Invertebrates**

The mangrove ecosystem is home to a rich invertebrate life, including molluscs, gastropods, crabs, shrimps, and

insects.

- **Key Species**

The Coringa Wildlife Sanctuary, which houses the Godavari mangroves, is particularly known for its diverse fauna, including endangered species like the fishing cat and otter. The sanctuary also supports a breeding ground for Olive Ridley turtles.

Degradation of Mangrove Ecosystems

Mangrove forests, while highly resilient to natural stressors such as high salinity, extreme tidal fluctuations, elevated temperatures, and strong coastal winds, remain vulnerable to a combination of anthropogenic and environmental pressures. Despite their adaptability, the cumulative impacts of human interference and climate variability have led to significant degradation in many mangrove regions.

Anthropogenic activities pose the most immediate threat to mangrove ecosystems. These include the extraction of timber for domestic use, conversion of mangrove land for aquaculture, damming of rivers, salt production, agriculture, and tourism infrastructure, as well as overfishing and improper solid waste disposal. Such activities disrupt the structural and functional integrity of mangrove forests, leading to habitat fragmentation, biodiversity loss, and declines in ecosystem services. Introduction of non-native and alien species of plants and animals are causing threat to the endemic species of the region. This has led to imbalance in ecological structure, resulting in their depletion.

In parallel, climatic factors—particularly elevated atmospheric CO_2 levels—affect the growth, physiology, and long-term health of mangrove vegetation. The broader coastal mosaic, which includes mangroves, seagrass beds, coral reefs, and sandy beaches, is increasingly exposed to the compounded effects of sea-level rise, temperature anomalies, and extreme weather events.

Monitoring and mapping of mangrove forests

Historically, the monitoring and mapping of mangrove forests were constrained by the physical complexity of these ecosystems and the lack of suitable technology. However, over the past three decades, advancements in remote sensing and geospatial technologies have significantly enhanced the ability of researchers and policymakers to assess mangrove health and distribution (Ramasubramanian et al., 2006; Selvam, 2003). Modern tools such as satellite imagery, GIS-based mapping, and web-based geospatial platforms have become integral to mangrove conservation and management strategies. These technologies now allow for real-time monitoring, improved data integration, and more informed decision-making at both local and global scales.

Recognizing and addressing the multifaceted pressures on mangroves is essential for their sustainable management. Continued investment in technological innovation, alongside stronger regulatory frameworks and community-based stewardship, is imperative to safeguard these critical coastal ecosystems.

Impact on Coastal & Marine fauna

Mangrove depletion in Andhra Pradesh significantly impacts both coastal and marine fauna. These ecosystems serve as vital nurseries and breeding grounds for numerous species. Depletion leads to habitat loss, reduced biodiversity, and potentially the extinction of species, particularly those reliant on mangrove habitats.

a. Habitat Loss

Mangrove forests are crucial for coastal ecosystems, providing shelter, food, and breeding grounds for various species, including fish, crabs, birds, and reptiles. Their loss directly reduces habitat availability and can lead to population declines or displacement.

b. Reduced Biodiversity

Mangroves support a rich diversity of life. Their destruction can lead to a decline in the number and diversity of species within the ecosystem.

c. Disrupted Food Webs

Mangroves are a critical part of the food chain, supporting a variety of species. Their loss can disrupt these food webs, impacting the availability of food for other animals.

d. Reduced Fisheries

Mangrove forests are vital nursery grounds for many commercially important fish species. Their depletion can lead to a decline in fish populations, affecting fishing communities.

e. Species Extinction Risk

Some species are highly dependent on mangrove habitats and are at risk of extinction if mangroves are lost. Studies indicate that a significant percentage of animal species reliant on mangrove habitats are at elevated risk of extinction.

Conservation Efforts in Andhra Pradesh

The state of Andhra Pradesh, with an extensive coastal stretch along the Bay of Bengal, has undertaken several strategic initiatives to conserve and restore its mangrove ecosystems. Recognizing the ecological and socioeconomic value of mangroves, various government-led programs and policy interventions have been implemented in recent years to address degradation and promote sustainable management. Following are the government initiatives.

1. The Forest Department of Andhra Pradesh has actively implemented mangrove afforestation and

reforestation projects along the state's coastal belt. These efforts focus on restoring degraded mangrove areas, enhancing biodiversity, and improving the resilience of coastal communities against natural disasters.

2. Integrated Coastal Zone Management (ICZM) Project

Andhra Pradesh is a participating state under the national Integrated Coastal Zone Management (ICZM) program, which promotes sustainable coastal development.

3. National Coastal Mission (NCMC)

Under the umbrella of the National Coastal Mission, Andhra Pradesh has implemented targeted projects aimed at the restoration of degraded mangrove habitats, protection of coastal biodiversity, and capacity-building of local communities for participatory management.

4. Grow Billion Trees in Andhra

This initiative is replanting degraded mangroves, engaging locals, and using tech to track progress. It's the region's strongest ally for sustainable mangrove conservation.

5. Community-Based Conservation Initiatives

In addition to government-led interventions, community participation has emerged as a critical pillar of mangrove conservation in Andhra Pradesh. Local stakeholders, particularly fishing communities and coastal villagers, are being actively engaged and trained in mangrove restoration techniques, such as seed collection, nursery development, and plantation monitoring.

6. Eco-Tourism and Environmental Awareness Programs

The state has also recognized the potential of eco-tourism as a tool for conservation and community development. Protected areas such as the Coringa Wildlife Sanctuary and the Krishna Wildlife Sanctuary are being developed into eco-tourism hubs, integrating biodiversity conservation with recreational and educational opportunities. These sites attract both domestic and international visitors, thereby generating revenue that can be reinvested into conservation and habitat management.

7. In parallel, environmental awareness campaigns are being conducted across coastal regions, including school-based education programs, community workshops, and public outreach activities. These programs aim to foster a sense of stewardship among younger generations and promote a deeper understanding of the ecological and economic importance of mangrove ecosystems.

Future Strategies for Sustainable Mangrove Conservation

Ensuring the long-term sustainability of mangrove ecosystems requires a forward-looking, integrated approach that combines ecological protection, community engagement, and innovative financing mechanisms. The following strategies are recommended to strengthen mangrove conservation efforts in Andhra Pradesh and beyond:

a) Expanding and Strengthening Protected Areas

Protecting mangroves requires expanding conservation zones and enforcing land-use regulations to prevent encroachment and deforestation. Integrated coastal planning using ecological data should guide these efforts.

b) Promoting Blue Carbon and Sustainable Financing

Mangroves store "blue carbon," offering climate benefits and financial incentives through carbon credit markets. Engaging the private sector via CSR can support conservation and align efforts with climate finance goals.

c) Strengthening Climate Resilience

Mangroves act as natural defenses against climate impacts. Coastal afforestation with suitable species and integrating mangroves into disaster planning enhance resilience for ecosystems and communities.

d) Enhancing Scientific Research and Monitoring

Ongoing research and technologies like remote sensing, GIS, and drones are vital for tracking mangrove health and guiding timely conservation actions.

CONCLUSION

The decline of mangrove ecosystems in Andhra Pradesh poses a significant threat to coastal and marine fauna, particularly sheltered, endemic, and endangered species. To mitigate this impact, it is essential to foster collaborative research among government bodies, academic institutions, and environmental NGOs. Promoting sustainable fishing, reducing pollution, and involving local communities in conservation efforts are crucial steps toward preserving these critical habitats. Multi-disciplinary and cross-sectoral partnerships can support evidence-based policymaking and the adoption of best practices, ensuring the long-term health of mangrove ecosystems and the diverse fauna they support.

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