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THE SILENT GUARDIANS OF BIODIVERSITY: MANGROVE CONSERVATION THROUGH INDIAN ENVIRONMENTAL LAW

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ABSTRACT:

Mangroves, the "silent guardians" of biodiversity, are vital for coastal protection, carbon sequestration, and sustaining livelihoods. India hosts significant mangrove cover, yet these ecosystems face degradation from urbanisation, industrial projects, aquaculture, and climate change. Despite constitutional directives and multiple environmental statutes, including the Environment (Protection) Act, Forest Conservation Act, and Coastal Regulation Zone (CRZ) framework, implementation challenges persist. Judicial interventions by the Supreme Court and the National Green Tribunal have advanced mangrove protection[1], but weak enforcement and overlapping jurisdictions continue to undermine conservation. This paper critically analyses India's legal and policy framework on mangroves, highlighting ecological importance, governance gaps, and judicial trends. Comparative insights from other mangrove-rich nations demonstrate alternative approaches to conservation. The study recommends stronger statutory mechanisms, community participation, and integration of mangrove[2]s into climate and disaster policies. Strengthening mangrove governance is essential for biodiversity protection, climate resilience, and sustainable development in India.

(Keywords: Mangrove Conservation, Environmental Law, Coastal Regulation Zone, Biodiversity, Climate Resilience.)

Chapter: I: Introduction

[1] S. Chandran et al., *Conservation and Management of Mangroves in Uttara Kannada, Central Western Ghats*, ENVIS Tech. Rep. (Centre for Ecological Sciences, IISc Bangalore, Nov. 2012) Research gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/318316554_Conservation_and_Management_of_Mangroves_in_Uttara_Kannada_Central_Western_Ghats

[2] Abhijit Mitra, *Mangrove Forests in India: Exploring Ecosystem Services*, Springer (September 1, 2025, 8:00 P.M.) https://link.springer.com/book/10.1007/978-3-030-20595-9

Mangroves, often described as the "silent guardians of biodiversity," are unique intertidal ecosystems that thrive in tropical and subtropical coastlines. They provide critical ecological services, such as acting as natural barriers against coastal erosion, cyclones, and tsunamis, while simultaneously serving as carbon sinks that mitigate the impacts of climate change. In India, mangroves occupy approximately 4,992 sq. km, with major concentrations in the Sundarbans (West Bengal), Andaman & Nicobar Islands, Gujarat, and Maharashtra. These ecosystems also support local communities by sustaining fisheries, providing fuelwood, and offering medicinal resources.[3] Beyond ecological benefits, mangroves hold immense socio-economic value, forming the backbone of livelihoods for coastal populations and contributing significantly to national biodiversity conservation goals. One of the most prolific ecosystems in the world, mangroves are currently in danger of disappearing. They offer a variety of products and services, some of which are directly valuable but more frequently offer numerous, seemingly undetectable indirect benefits. The world has seen a significant loss of land due to the indiscriminate and exploitative nature of resource extraction. In the 1960s, mangroves in India were exploited carelessly. Its significance was only gradually understood, as it was formerly regarded as wastelands and rubbish yards. Therefore, from the early 1980s, intensive conservation and regeneration efforts have been carried out; yet, the current area covered represents but a little remnant of the past. Both the government and the local community actively participate in these initiatives through legislative actions. Furthermore, there are worries for its regeneration and restoration due to the challenges posed by global climate change. The variability among living organisms and the ecological complexes of which they are part is how the Millennium Ecosystem Assessment defines biological diversity.[4] Diversity includes species diversity, habitat diversity, and ecological diversity. Given our mutual reliance on the ecosystem for products and services, as well as the fact that it requires our use and care for it to be healthy, it is critical that our planet be in good health and vital in order to ensure sustained life not only for the present but also for the future.[5] In light of the health of our environment, there are four major phenomena that require worldwide attention: the loss of

[3] S. Mukherjee, Legal Protection of Mangroves in India: A Judicial Perspective, ResearchGate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/320849536_Mangrove_Forest_Restoration_and_Rehabilitation

[4] Centre for Science and Environment (CSE), https://www.cseindia.org/ (last visited on September 1, 2025).

[5] Mamta Chaudhary, Sustaining India's Mangroves: Evaluating Law and Policies for Ecological Restoration", 3 Vidya—A Journal of Gujarat Univ. (September 1, 2025, 8:00 P.M.) https://vidyajournal.org/index.php/vidya/article/view/356

biodiversity, the degradation of ecosystems that are essential to life, the ever-increasing population, and some of the adverse effects of climate change. Only when we comprehend the significance of biodiversity can we comprehend its loss. It offers a significant supply of fuel, food, and fodder. Protecting the earth and ensuring the survival of its species, not just of human life, but also of plants, animals, and natural systems, is crucial for a country's economic growth and development. It also helps to lessen the negative risks associated with climate change. One of the main challenges in researching an ecosystem and appreciating its significance is that it is frequently hard to quantify the advantages it offers in comparison to the expense of preserving it, and an ecosystem's significance is typically only fully recognised when it is in danger of extinction.

Research Problem: Threats, Degradation, and Weak Enforcement of Laws:

Despite their ecological and social significance, mangroves in India face persistent threats from urbanisation, industrial expansion, aquaculture, tourism, and climate-induced changes such as rising sea levels. Large-scale destruction of mangroves for infrastructure projects, ports, and special economic zones has intensified habitat loss. Although India has enacted constitutional provisions (Articles 48A and 51A(g)) and statutory laws like the Environment (Protection) Act, 1986, and Coastal Regulation Zone (CRZ) notifications, enforcement remains inconsistent[6]. Overlapping jurisdictions, lack of coordination among agencies, and inadequate monitoring mechanisms weaken conservation outcomes. Judicial interventions, while progressive, are often reactive rather than preventive. This gap between law and practice underscores the urgent need for a comprehensive examination of India's mangrove governance framework.

Objectives of the Study:

1. To examine the ecological and socio-economic importance of mangroves in India.
2. To critically analyse the legal and policy framework governing mangrove conservation.
3. To assess the role of the judiciary and the National Green Tribunal in shaping mangrove protection.
4. To identify enforcement challenges, policy gaps, and ground realities affecting conservation.

[6] Downtoearth, https://www.downtoearth.org.in/news/environment/mangroves-destruction-violates-fundamental-rights-of-citizens-bombay-hc-61674 (last visited on September 1, 2025).

5. To suggest reforms for strengthening mangrove governance in line with biodiversity protection and climate resilience.

Research Questions:

- How effective are existing environmental laws and policies in conserving mangroves in India?
- What role has the judiciary played in advancing mangrove protection through environmental jurisprudence?
- To what extent do policy gaps and weak enforcement contribute to continued mangrove degradation?
- Can comparative legal perspectives and community-based approaches offer sustainable solutions?

Hypothesis:

Despite a robust constitutional and statutory framework, weak enforcement, institutional overlaps, and competing developmental priorities undermine mangrove conservation in India.

Methodology:

This study adopts a **doctrinal research methodology**, relying on primary sources such as constitutional provisions, statutes, rules, government notifications, and judicial decisions[7]. Secondary sources include books, journal articles, committee reports, and international conventions relevant to mangrove conservation. A **comparative perspective** is incorporated by examining legal frameworks of other mangrove-rich nations such as Bangladesh and Indonesia. The research also employs a **policy analysis approach**, identifying gaps between law and practice, and offering reform-oriented suggestions.

Structure of the Paper (Six Chapters):

- **Chapter I – Introduction:** Background, problem, objectives, research questions, methodology, and structure.

[7] A. Ghosh, S. Schmidt, T. Fickert & M. Nüsser**,** *The Indian Sundarban Mangrove Forests: History, Utilization, Conservation Strategies and Local Perception*, MDPI (September 1, 2025, 8:00 P.M.) https://www.mdpi.com/1424-2818/7/2/149

- **Chapter II – Ecological and Socio-Economic Importance of Mangroves in India:** Significance, biodiversity value, and key challenges.
- **Chapter III – Legal and Policy Framework:** Constitutional provisions, statutory enactments, CRZ regulations, and international commitments.[8]
- **Chapter IV – Judicial Response and Environmental Jurisprudence:** Analysis of Supreme Court and NGT decisions, and the role of public trust doctrine.
- **Chapter V – Policy Gaps, Challenges, and the Way Forward:** Enforcement issues, conflicts between development and conservation, and reform-oriented suggestions.
- **Chapter VI – Conclusion:** Key findings, implications, and reaffirmation of the need for robust mangrove governance.

Chapter II: Ecological and Socio-Economic Importance of Mangroves in India:

2.1 Introduction

Mangroves represent a unique ecological interface between land and sea, thriving in saline and brackish coastal waters.[9] India's mangroves, spread across 12 coastal states and union territories, are of global importance due to their biodiversity richness and role in climate resilience. Recognised by the International Union for Conservation of Nature (IUCN) as vital ecosystems, mangroves contribute not only to environmental stability but also to the sustenance of millions of people living in coastal regions. This chapter discusses their ecological significance, socio-economic benefits, and the challenges they face in India. One type of environment that offers great biological productivity and accessibility is the coastal ecosystem. It offers a wide range of products and services. They are now hubs of human activity as a result. Coastal ecosystems are defined by their physical attributes rather than their biological ones. When compared to other ecosystems, they support a diverse range of habitats. Mangroves are one such ecosystem that is taken into consideration for the study. Mangroves are trees, bushes, or other vegetation found in intertidal zones. They are found in low-oxygen soils where fine sediments are accumulated by slowly flowing water.[10] They offer a wide range of products and

[8] D. M. Alongi, *Carbon cycling and storage in mangrove forests*, 6 Annual Rev. Marine Sci. 195 (2014) Annual Review (September 1, 2025, 8:00 P.M.) https://www.annualreviews.org/content/journals/10.1146/annurev-marine-010213-135020

[9] S. N. Gopal & M. Chauhan, *Biodiversity and its conservation in the Sundarban Mangrove Ecosystem*, 68 Aquatic Sciences 338 (2006) Scrip (September 1, 2025, 8:00 P.M.) https://www.scirp.org/reference/referencespapers?referenceid=1225825

[10] M.C. Mehta v. Union of India & Ors., (1996) 2 SCC 353.

services and are only found in tropical or subtropical regions. They also face unique challenges and hazards. In addition to shedding light on the current condition of mangroves in India, including the kinds of species that are present, the area loss over time in five key states, and the hazards associated with this, the study seeks to uncover some of the economic benefits of mangrove ecosystems. Additionally, it examines the shortcomings of the current conservation and management strategies and offers succinct examples of international case studies that India could use and learn from. Mangroves in India are invaluable ecological assets that provide multiple environmental, social, and economic benefits. However, they face constant threats from anthropogenic pressures and climate change, compounded by weak enforcement of conservation laws. Recognising their role in biodiversity conservation, climate resilience, and livelihood support, it becomes imperative to safeguard them through effective legal and policy mechanisms.[11] This sets the stage for the next chapter, which examines the legal and policy framework governing mangroves in India.

2.2 Ecological Significance of Mangroves

- **Biodiversity Hotspots**
  - Home to diverse flora and fauna, including endangered species such as the Royal Bengal Tiger (Sundarbans), saltwater crocodile, and migratory birds.
  - Act as nursery grounds for numerous fish, crustaceans, and molluscs, sustaining both inland and offshore fisheries.[12]
- **Coastal Protection and Disaster Mitigation**
  - Serve as natural barriers against cyclones, tidal surges, and tsunamis.
  - Reduce wave energy and prevent soil erosion, thereby protecting human settlements and infrastructure.[13]
  - Example: During the 1999 Odisha super cyclone and the 2004 Indian Ocean tsunami, areas with intact mangroves suffered significantly less damage.
- **Climate Change Mitigation**

[11] World Wide Fund for Nature (WWF-India), https://www.wwfindia.org./ (last visited on September 1, 2025).
[12] J. Primavera, Development and conservation of Philippine mangroves: Institutional issues, 27 Ecological Economics 333 (1998), Research Gate (September 1, 2025, 8:00 P.M.), https://www.researchgate.net/publication/269576080_Primavera_J_H_Development_and_conservation_of_Philippine_mangroves_institutional_issues_Ecol_Econ
[13] A. K. Singh, Coastal Regulation Zone Notifications and Their Implications on Mangrove Protection, 18 Indian J. Envtl. L. 57 (2016). (September 1, 2025, 8:00 P.M.) https://hindi.icfre.gov.in/UserFiles/File/Books/Indian%20Mangroves.pdf

- Significant carbon sinks ("blue carbon" ecosystems), sequestering more carbon per unit area than terrestrial forests.[14]
- Help regulate microclimates and buffer the impact of rising sea levels.

➢ **Water Quality and Soil Fertility**

- Trap sediments, pollutants, and heavy metals, thereby improving coastal water quality.
- Maintain soil fertility by recycling nutrients and contributing to groundwater recharge.

2.3 Socio-Economic Importance of Mangroves:

➢ **Livelihood Support for Coastal Communities**

- Provide direct resources such as fuelwood, honey, tannins, and medicinal plants.
- Sustain fisheries and aquaculture by serving as breeding and nursery grounds.
- Millions of people depend on mangrove ecosystems for subsistence and income, particularly in the Sundarbans, Gujarat, and Kerala.[15]

➢ **Eco-Tourism and Cultural Significance**

- Eco-tourism potential in regions like Sundarbans (UNESCO World Heritage Site) and Bhitarkanika in Odisha.
- Deeply embedded in cultural traditions, with local communities attributing spiritual value to mangrove forests.[16]

➢ **Economic Value of Ecosystem Services**

- Studies estimate that mangroves contribute billions of rupees annually in terms of ecosystem services such as flood protection, carbon storage, and fisheries.
- According to the Economics of Ecosystems and Biodiversity (TEEB) initiative, the global value of mangrove ecosystem services is among the highest of any ecosystem.[17]

2.4 Mangroves in India: Regional Distribution and Significance:

➢ **The Sundarbans (West Bengal)**

[14] N. C. Duke et al., A world without mangroves?, 317 Science 41 (2007). (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/6223233_A_World_Without_Mangroves
[15] Food and Agriculture Organization of the United Nations (FAO), https://openknowledge.fao.org/server/api/core/bitstreams/72dcc1ff-d92c-4003-b22f-39768d02853c/content (last visited on September 1, 2025).
[16] Food and Agriculture Organization of the United Nations (FAO), https://openknowledge.fao.org/home (last visited on September 1, 2025).
[17] United Nations Environment Programme (UNEP), https://www.unep.org./ (last visited on September 1, 2025).

- World's largest contiguous mangrove forest; critical habitat for the Royal Bengal Tiger.
- Supports one of the most densely populated coastal regions through fishing and honey collection.

➢ **Gujarat**

- Second-largest mangrove cover in India; significant regeneration efforts in Kachchh and Jamnagar.
- Provides coastal protection against cyclonic storms in the Arabian Sea.[18]

➢ **Maharashtra**

- Mumbai's mangroves are vital in reducing urban flooding and mitigating industrial impacts.
- Despite legal protections, urban encroachment and infrastructure projects pose major threats.

➢ **Andaman & Nicobar Islands**

- Rich mangrove diversity with high endemism.
- Critical to island ecology, disaster resilience, and sustenance of tribal communities.

2.5 Challenges and Threats to Mangroves in India:

➢ **Anthropogenic Pressures**

- Conversion for agriculture, aquaculture (shrimp farming), industrial expansion, and urbanisation.
- Large-scale reclamation for ports, airports, and Special Economic Zones (SEZs).[19]

➢ **Climate Change and Natural Stressors**

- Rising sea levels, salinity intrusion, and extreme weather events.
- Increased vulnerability to pests and diseases.

➢ **Weak Governance and Poor Enforcement**

- Overlapping jurisdiction between central, state, and local authorities.
- Inadequate implementation of Coastal Regulation Zone (CRZ) rules.
- Lack of monitoring, mapping, and restoration initiatives.

[18] Times of India, https://timesofindia.indiatimes.com/ (last visited on September 1, 2025).
[19] M. Spalding, M. Kainuma & L. Collins, World Atlas of Mangroves (Earthscan 2010) Research Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/263265299_World_Atlas_of_Mangroves_Mark_Spalding_Mami_Kainuma_and_Lorna_Collins_eds

2.6 Significance for India's Environmental and Developmental Goals

- Mangroves contribute to India's commitments under the Convention on Biological Diversity (CBD) and Sustainable Development Goals (SDGs).
- Integral to India's climate commitments under the Paris Agreement (Intended Nationally Determined Contributions – INDCs).[20]
- Play a role in disaster risk reduction strategies under the Sendai Framework.

Chapter III: Legal and Policy Framework Governing Mangroves in India:

3.1 Introduction

India's legal system recognises the importance of environmental conservation, including the protection of ecologically fragile ecosystems like mangroves. Although no single legislation is dedicated exclusively to mangrove conservation, a network of constitutional provisions, statutory enactments, judicial pronouncements, and policy initiatives collectively form the governance framework. [21] This chapter analyses the constitutional mandates, statutory framework, coastal regulations, policy measures, and international commitments that influence mangrove governance in India. The legal and policy framework governing mangroves in India is comprehensive on paper but fragmented and inconsistent in practice. While constitutional mandates and statutory enactments provide strong theoretical protection, enforcement gaps and policy relaxations compromise effectiveness. Judicial interventions have emerged as crucial correctives, yet a more integrated and community-driven approach is required. This sets the stage for the next chapter, which explores the role of the judiciary and evolving environmental jurisprudence in protecting mangroves.

3.2 Constitutional Provisions:

- **Article 48A (Directive Principles of State Policy):** Directs the State to protect and improve the environment and safeguard forests and wildlife.
- **Article 51A(g) (Fundamental Duties):** Imposes a duty on citizens to protect and improve the natural environment, including forests, lakes, rivers, and wildlife.

[20] International Union for Conservation of Nature (IUCN), https://iucn.org/ (last visited on September 1, 2025).
[21] Forest Survey of India, https://fsi.nic.in/forest-report-2021 (last visited on September 1, 2025).

- **Article 21 (Right to Life):** Interpreted by the Supreme Court to include the right to a clean and healthy environment (M.C. Mehta v. Union of India, 1987).
- Collectively, these provisions provide a constitutional mandate for mangrove protection, reinforcing both state responsibility and citizen participation.

3.3 Statutory Framework:

➢ **The Environment (Protection) Act, 1986**

- Umbrella legislation empowering the central government to take measures for environmental protection.
- Basis for issuing Coastal Regulation Zone (CRZ) Notifications, which directly regulate activities affecting mangroves.[22]

➢ **The Forest (Conservation) Act, 1980**

- Restricts diversion of forest land, including mangroves classified as Reserved or Protected Forests.
- Requires prior approval of the central government for non-forest use of such lands.

➢ **The Indian Forest Act, 1927**

- Provides for the reservation and protection of forest areas, applicable to certain mangrove habitats.

➢ **The Wildlife (Protection) Act, 1972**

- Protects biodiversity in mangrove ecosystems, including the declaration of protected areas such as national parks and sanctuaries.
- Example: Sundarbans Tiger Reserve under Project Tiger.

➢ **The Biological Diversity Act, 2002**

- Focuses on conservation of biological resources, sustainable use, and fair benefit-sharing.
- Relevant to community rights and traditional knowledge in mangrove regions.

3.4 Coastal Regulation Zone (CRZ) Notifications:

- Issued under the Environment (Protection) Act, CRZ notifications provide the most direct legal protection for mangroves.

CRZ Notification, 1991

[22] CWC Gov., https://cwc.gov.in/sites/default/files/paper-research-work.pdf (last visited on September 1, 2025).

- First framework recognising mangroves as ecologically sensitive areas.
- Restricted industrial and construction activities near mangroves.

CRZ Notification, 2011

- Classified mangroves exceeding 1,000 sq. m. as "CRZ-I" (most ecologically sensitive).
- Imposed a 50 m no-development buffer zone around mangroves.

CRZ Notification, 2019

- Introduced relaxations for development in coastal areas, drawing criticism for diluting protections.
- Still retains mangroves as critical ecological zones, but enforcement challenges persist.

3.5 Institutional Mechanisms:

- **Ministry of Environment, Forest and Climate Change (MoEFCC):** Nodal agency for mangrove conservation.
- **State Forest Departments:** Responsible for protection, afforestation, and management at the state level.[23]
- **National Coastal Zone Management Authority (NCZMA) & State CZMAs:** Monitor CRZ compliance.
- **National Green Tribunal (NGT):** Provides speedy adjudication on environmental matters, including mangrove destruction cases.

3.6 Policy Initiatives:

➢ **National Mangrove Committee (1979 onwards)**

- Established to advise the government on conservation measures.

➢ **National Action Plan on Climate Change (NAPCC, 2008)**

- Recognises mangroves under the National Mission on Sustainable Agriculture and Green India Mission.

➢ **Integrated Coastal Zone Management (ICZM) Programme**

- Supported by the World Bank; aims to balance development with conservation.
- Includes mapping, restoration, and management of mangroves.[24]

[23] K. Kathiresan, *Mangrove forests of India*, 115 Current Science 976 (2018) Research Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/323797949_Mangrove_Forests_of_India

[24] D. M. Alongi, Carbon cycling and storage in mangrove forests, 6 Annual Rev. Marine Sci. 195 (2014) (September 1, 2025, 8:00 P.M.) https://www.annualreviews.org/content/journals/10.1146/annurev-marine-010213-135020

➢ **State-Level Initiatives**

- Maharashtra and Gujarat have established mangrove cell units for dedicated conservation.
- West Bengal Forest Department manages large portions of the Sundarbans under joint forest management.

3.7 International Commitments:

- **Convention on Biological Diversity (CBD):** India is obligated to conserve ecosystems such as mangroves.
- **Ramsar Convention on Wetlands:** Several mangrove areas, including the Sundarbans, are Ramsar sites.
- **Paris Agreement (2015):** India's Nationally Determined Contributions (NDCs) include afforestation and carbon sequestration, where mangroves play a role.
- **Sustainable Development Goals (SDGs):** SDG 14 (Life Below Water) and SDG 15 (Life on Land) cover mangrove protection.

3.8 Critical Assessment:

- **Strengths:** Wide-ranging constitutional and statutory framework; judicial support; recognition under CRZ.
- **Weaknesses:** Overlapping jurisdictions between central, state, and local authorities; lack of coordination; limited community involvement; dilution of CRZ norms.
- **Result:** Despite multiple layers of protection, mangroves remain vulnerable due to weak enforcement and developmental pressures.

Chapter IV: Judicial Response and Environmental Jurisprudence:

4.1 Introduction

Judicial intervention has been pivotal in the development of environmental law in India. The Supreme Court, High Courts, and the National Green Tribunal (NGT) have consistently expanded the scope of environmental rights under Article 21 of the Constitution. In the context of mangroves, the judiciary has invoked doctrines such as the *public trust doctrine*, *sustainable*

development, and the *precautionary principle* to strengthen their protection.[25] This chapter examines landmark judicial decisions, the role of the NGT, and the evolution of environmental jurisprudence concerning mangroves in India.[26]

The judiciary has played a transformative role in recognising mangroves as ecologically sensitive and legally protected ecosystems. By interpreting constitutional provisions expansively and invoking environmental principles, courts have filled critical policy gaps. However, judicial activism alone cannot secure long-term conservation. Stronger enforcement, administrative accountability, and community-based approaches are required to complement judicial efforts. The next chapter examines these governance gaps and policy challenges in detail while exploring reforms for the way forward.

4.2 Doctrinal Foundations in Environmental Jurisprudence:

- **Right to a Healthy Environment under Article 21:** Judicial interpretation of Article 21 includes the right to a clean and healthy environment (M.C. Mehta v. Union of India).
- **Public Trust Doctrine:** State holds natural resources like forests and mangroves in trust for the public (M.C. Mehta v. Kamal Nath, 1997).
- **Precautionary Principle & Polluter Pays:** Mandated preventive measures for environmental harm and accountability for ecological damage (Vellore Citizens' Welfare Forum v. Union of India, 1996).
- **Sustainable Development:** Balance between development and ecology (Narmada Bachao Andolan v. Union of India, 2000).

4.3 Landmark Supreme Court and High Court Judgments on Mangroves:

- **Bombay Environmental Action Group v. State of Maharashtra (2005, Bombay HC)[27]**
- Landmark case where the Bombay High Court declared mangroves as "protected forests."
- Prohibited destruction, dumping, or construction on mangrove lands.

[25] S. E. Hamilton & D. Friess, Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012, (2016) ArViv (September 1, 2025, 8:00 P.M.) https://arxiv.org/abs/1611.00307
[26] Wetlands International South Asia, https://south-asia.wetlands.org/blog/mangroves-right-life/ (last visited on September 1, 2025).
[27] Bombay Envtl. Action Grp. v. State of Maharashtra, (2005) 107 (3) Bom. L.R. 382 (Bom. HC).

- Directed the state to prepare a mangrove conservation plan.

➢ **Bombay Environmental Action Group v. State of Maharashtra (2018, SC)[28]**

- The Supreme Court upheld the 2005 High Court ruling, reinforcing the protection of mangroves as forests under the Forest (Conservation) Act, 1980.

➢ **Goa Foundation v. Union of India (2006, SC)[29]**

- Affirmed mangroves as ecologically sensitive areas.
- Emphasised strict enforcement of CRZ norms to prevent construction and industrial activity near mangroves.

➢ **Public Interest Litigations in Gujarat and West Bengal[30]**

- Gujarat High Court directed strict enforcement of CRZ restrictions to prevent industrial encroachment.
- Calcutta High Court intervened in Sundarbans cases to protect mangroves from illegal shrimp farms.

4.4 National Green Tribunal (NGT) and Mangrove Protection:

➢ **NGT's Expanding Jurisdiction**

- Established under the NGT Act, 2010, with powers to provide effective and speedy remedies for environmental harm.
- Recognises mangroves as critical coastal ecosystems.[31]

➢ **Notable NGT Orders**

- *Paryavaran Suraksha Samiti v. Union of India (2014)*: Directed closure of industries discharging untreated effluents into mangrove regions in Gujarat.
- *Shri Pankaj Mahajan v. Maharashtra Coastal Zone Management Authority (2015)*: Ordered demolition of illegal constructions near mangroves in Mumbai.
- *NGT (Western Zone) 2017 Orders*: Reiterated buffer zones of 50 metres around mangroves, prohibiting reclamation or construction.[32]

[28] Bombay Envtl. Action Grp. v. State of Maharashtra, (2018) 14 SCC 753 (India).
[29] Goa Found. v. Union of India, (2006) 8 SCC 212 (India).
[30] Tech. & Nat. Res. Policy v. Union of India, (2007) 15 SCC 193 (India).
[31] Research Gate, https://www.researchgate.net/publication/223961734_India's_Rare_Inland_Mangroves_Deserve_Protection (last visited on September 1, 2025).
[32] N. H. Ravindranath, N. V. Joshi, R. Sukumar & A. Saxena, Impact of Climate Change on Forests in India, (2005), (September 1, 2025, 8:00 P.M.) https://arxiv.org/abs/q-bio/0511001.

- **Judicial Monitoring of CRZ Implementation**
- NGT regularly monitors compliance with CRZ notifications, often stepping in when state authorities fail to prevent encroachments.

4.5 Trends in Judicial Reasoning:

- **Pro-Environment Stance:** Courts have consistently leaned towards environmental protection, even when it restricts economic activity.
- **Recognition of Mangroves as Forests:** Judicial rulings have clarified that mangroves fall within the definition of "forest," ensuring statutory protection.
- **Shift from Reactive to Preventive Justice:** Courts and the NGT are increasingly invoking the *precautionary principle* to prevent future harm rather than merely compensating for past damage.
- **Integration of Climate and Disaster Resilience:** Recent rulings recognise the role of mangroves in climate adaptation and disaster risk reduction.

4.6 Challenges in Judicial Enforcement:

- Judicial directions are often undermined by weak enforcement at the administrative level.
- Frequent conflicts between development projects and judicial orders (e.g., infrastructure in Mumbai, ports in Gujarat).
- Lack of community participation in litigation despite their dependence on mangrove ecosystems.

Chapter V: Policy Gaps, Challenges, and the Way Forward:

5.1 Introduction

While India's legal and judicial frameworks for mangrove protection appear comprehensive, ground realities reveal persistent challenges. Fragmented laws, weak enforcement, institutional overlaps, and conflicting development priorities undermine effective governance.[33] This chapter identifies the major policy and governance gaps, highlights structural challenges, and

[33] S. N. Gopal & M. Chauhan, Biodiversity and its conservation in the Sundarban Mangrove Ecosystem, 68 Aquatic Sciences 338 (2006), Research Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/225225900_Biodiversity_and_its_conservation_in_the_Sundarban_Mangrove_Ecosystem

proposes a roadmap for strengthening mangrove conservation in India. Mangroves in India face the dual challenge of anthropogenic exploitation and natural vulnerability. While the judiciary has acted as a safeguard, governance remains riddled with policy gaps, weak enforcement, and developmental conflicts. The way forward lies in adopting a comprehensive, multi-stakeholder approach that balances ecological protection with economic needs. [34] Dedicated legislation, stronger enforcement of CRZ norms, community participation, integration into climate policies, and technological monitoring are essential reforms. Only through such holistic measures can mangroves truly be preserved as the "silent guardians of biodiversity" and climate resilience in India.

5.2 Policy and Governance Gaps:

- **Fragmented Legal Framework**
- Multiple legislations (Environment Protection Act, Forest Conservation Act, CRZ notifications, Wildlife Protection Act) apply simultaneously, creating overlaps.
- Absence of a **dedicated Mangrove Protection Act** leads to ambiguity in enforcement.
- **Weak Enforcement of CRZ Regulations**
- Despite being the strongest protective tool, CRZ norms are frequently diluted for economic projects.[35]
- Example: Relaxations under CRZ 2019 raised concerns about compromising ecological security.
- **Overlapping Jurisdictions**
- Central government (MoEFCC), state forest departments, State CZMAs, and local authorities share responsibilities without clear demarcation.
- Jurisdictional conflicts delay conservation measures.
- **Lack of Community Participation**
- Local communities, who depend on mangroves for livelihoods, are often excluded from decision-making.

[34] R. N. Mandal & K. R. Naskar, Diversity and classification of Indian mangroves: A review, 49 Tropical Ecology 131 (2008), Research Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/285914340_Diversity_and_classification_of_Indian_mangroves_A_review

[35] V. A. Kulkarni et al., Biological and environmental characteristics of mangrove habitats from Manori creek, West Coast, India, 168 Environmental Monitoring and Assessment 587 (2010), Springer Link (September 1, 2025, 8:00 P.M.) https://link.springer.com/article/10.1007/s10661-009-1136-x

- Top-down governance ignores traditional knowledge systems.

➢ **Insufficient Mapping and Monitoring**

- Mangrove cover assessment is periodic, not real-time.
- Inadequate use of technology (satellite imagery, GIS, AI tools) hampers early detection of encroachments.[36]

5.3 Development vs. Conservation Dilemma:

➢ **Industrial and Urban Expansion**

- Ports, SEZs, power plants, and urban housing projects often encroach upon mangrove lands.
- Example: Ongoing disputes in Mumbai, Kachchh (Gujarat), and coastal Andhra Pradesh.

➢ **Aquaculture and Agriculture**

- Shrimp farming leads to large-scale mangrove destruction, particularly in Andhra Pradesh and West Bengal.
- Conversion of mangrove wetlands to paddy fields and salt pans continues despite regulations.[37]

➢ **Tourism and Infrastructure Projects**

- Unregulated tourism, road construction, and illegal resorts threaten fragile mangrove ecosystems.

5.4 Climate Change and Natural Challenges:

- Rising sea levels, salinity intrusion, and extreme cyclones threaten mangrove survival.
- Mangroves are highly sensitive to changes in hydrology; climate variability accelerates their degradation.
- Despite their role as "climate shields," mangroves are not fully integrated into India's climate adaptation policies.[38]

[36] K. Kathiresan, Mangrove forests of India, 115 Current Science 976 (2018) rsearch Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/323797949_Mangrove_Forests_of_India

[37] S. Hamilton & D. Casey, Creation of a high spatiotemporal resolution global database of continuous mangrove forest cover for the 21st Century, (2014), ARXIS (September 1, 2025, 8:00 P.M.) https://arxiv.org/abs/1412.0722

[38] ISFR- India State Forest Report (2021), Forest Survey of India, Ministry of Environment, Forest and Climate Change (MoEF & CC), Government of India. (last visited on September 1, 2025) https://fsi.nic.in/forest-report-2021-details

5.5 Institutional and Administrative Weaknesses:

- **Lack of Coordination:** Poor synergy between central, state, and local institutions.
- **Funding Constraints:** Mangrove afforestation and restoration programmes receive limited financial support.
- **Short-Term Projects:** Conservation efforts are often project-based rather than sustained programmes.
- **Corruption and Encroachments:** Illegal reclamation of mangrove lands often goes unchecked due to administrative lapses.

5.6 The Way Forward: Reform and Recommendations:

➢ **Dedicated Legislation for Mangroves**

- Enact a **Mangrove Protection and Management Act** to streamline responsibilities and provide a clear legal status.
- Establish penalties and community rights provisions similar to the Forest Rights Act.

➢ **Strengthening the CRZ Framework**

- Reverse the dilution introduced in CRZ 2019 and reintroduce stricter ecological safeguards.
- Establish independent monitoring bodies with punitive powers.

➢ **Community-Based Conservation**

- Empower local communities through Joint Mangrove Management Committees (similar to Joint Forest Management).
- Incorporate traditional knowledge in afforestation and restoration programmes.

➢ **Integrating Mangroves into Climate and Disaster Policies**

- Recognise mangroves as critical components of India's Nationally Determined Contributions (NDCs) under the Paris Agreement.
- Include mangrove restoration in coastal disaster management plans.

➢ **Use of Technology and Research**

- Employ GIS, remote sensing, and AI-driven monitoring to track mangrove cover in real-time.
- Support academic and community-based research for better policy design.

➢ **Comparative Learning from Other Countries**

- **Bangladesh:** Community-driven mangrove plantation programmes in the Sundarbans.
- **Indonesia & Philippines:** Integration of mangroves into national disaster management and climate adaptation policies.
- Lessons from these models can be adapted to India's legal and ecological contexts.

Chapter VI: Conclusion:

6.1 Recapitulation of the Study

This research examined the ecological and socio-economic importance of mangroves in India and critically analysed the legal and policy frameworks governing their protection[39]. The study began with a discussion of mangroves as crucial ecosystems that act as biodiversity hotspots, natural barriers against climate disasters, and vital sources of livelihood. It then identified the threats posed by urbanisation, aquaculture, industrial projects, and weak enforcement of environmental regulations. The subsequent chapters assessed existing statutory frameworks, judicial interventions, and institutional mechanisms, before addressing policy gaps and suggesting reforms.

6.2 Key Findings:

- **Ecological Imperative:** Mangroves are indispensable for biodiversity, coastal resilience, and climate change mitigation.[40]
- **Legal Framework:** While India has multiple protective statutes, there is no dedicated legislation exclusively for mangroves.
- **Judicial Safeguards:** Courts, particularly the Supreme Court and National Green Tribunal, have played a proactive role in halting destruction and enforcing accountability.
- **Policy Gaps:** Weak enforcement of CRZ norms, overlapping institutional jurisdictions, inadequate monitoring, and exclusion of communities persist.
- **Development vs. Conservation:** Industrialisation, aquaculture, and tourism projects frequently override ecological concerns.

[39] R. N. Mandal & K. R. Naskar, *Diversity and classification of Indian mangroves: A review*, 49 Tropical Ecology 131 (2008) Research Gate (September 1, 2025, 8:00 P.M.) https://www.researchgate.net/publication/306034379_A_review_of_the_mangrove_floristics_of_India

[40] M. Hema & P. Indira Devi, *Sustainable management of mangroves: Developing a socially acceptable management plan*, 58 Journal of Tropical Agriculture (2021) Journal of tropical agriculture (September 1, 2025, 8:00 P.M.) https://jtropag.kau.in/index.php/ojs2/article/view/982

6.3 Research Contribution:

This paper contributes to environmental law scholarship by presenting a **comprehensive critique of India's mangrove governance regime**, bridging doctrinal analysis with comparative insights. It underscores the urgent need for legal reforms, community participation, and integration of mangroves into broader climate and disaster management policies.[41]

6.4 Future Scope of Research:

- **Empirical Studies:** Field-based studies assessing the socio-economic impacts of mangrove loss on coastal communities.
- **Comparative Analysis:** In-depth research on successful mangrove governance models from Southeast Asia and their adaptability to India.
- **Climate Law Integration:** Exploration of how mangroves can be embedded in India's commitments under global climate agreements.
- **Technology and Conservation:** Further research on the role of AI, GIS, and satellite monitoring in mangrove management.

6.5 Concluding Remarks:

Mangroves are not just ecosystems but **"silent guardians of biodiversity and climate resilience."** India's legal and judicial mechanisms, though significant, remain insufficient to counteract mounting pressures from development and climate change. Strengthening governance through dedicated legislation, robust enforcement, and community-driven management is imperative. The preservation of mangroves must be prioritised not as a mere environmental obligation but as an essential strategy for sustainable development, disaster preparedness, and intergenerational equity. Only through integrated efforts of law, policy, science, and local communities can India ensure that its mangroves continue to thrive as living bulwarks of nature and humanity's shared future**.**

[41] V. A. Kulkarni et al., *Biological and environmental characteristics of mangrove habitats from Manori creek, West Coast, India*, 168 Environmental Monitoring and Assessment 587 (2010) NIH (September 1, 2025, 8:00 P.M.) https://pubmed.ncbi.nlm.nih.gov/19728126/