

Role of Environmental Impact Assessment (EIA) In Protection of Marine Biodiversity

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ABSTRACT

Marine biodiversity forms the foundation of ecological balance, coastal livelihoods, and global sustainability. However, rapid industrialization, port expansion, coastal infrastructure, and resource exploitation increasingly threaten fragile marine ecosystems. Environmental Impact Assessment (EIA) has emerged as a critical preventive tool to safeguard marine biodiversity by integrating ecological concerns into development planning. Through systematic identification, prediction, and evaluation of potential impacts, EIA ensures that projects are designed and implemented with minimal harm to marine habitats. Baseline ecological studies, risk assessments, and stakeholder consultations provide the scientific and social foundation for informed decision-making. In coastal and marine contexts, EIA addresses issues such as habitat destruction, pollution from effluents, dredging impacts, shipping activities, and cumulative pressures on fisheries and coral reefs. International frameworks like the Convention on Biological Diversity (CBD) and national regulations, including India's EIA Notification (2006), mandate rigorous evaluation of projects affecting coastal zones. Case studies of port modernization, aquaculture expansion, and offshore energy projects highlight both the strengths and limitations of current practices. While EIA has succeeded in raising awareness and enforcing mitigation measures, challenges remain in terms of data gaps, enforcement, and meaningful public participation. Strengthening ecosystem-based approaches, cumulative impact assessments, and adaptive monitoring can enhance EIA's effectiveness. From the author's perspective, EIA is not merely a regulatory requirement but a governance instrument that balances development imperatives with ecological stewardship. Its role in protecting marine biodiversity is pivotal for ensuring that modernization and expansion proceed without compromising the long-term resilience of ocean ecosystems.

Keywords: Marine Environment, Oceans, Environmental Impact Assessment, CRZ, Biodiversity

INTRODUCTION

Coastal and marine ecosystems in India are highly productive and diverse, supporting fisheries, climate regulation, and livelihoods. However, rapid urbanization, port expansion, offshore energy exploration, industrial discharge, and tourism have degraded these environments, causing habitat loss, declining fish stocks, and pollution.¹

In this context, Environmental Impact Assessment (EIA) has become a vital tool for balancing development with environmental protection. EIA helps evaluate the likely environmental consequences of proposed projects, identifying potential impacts, assessing risks, and recommending mitigation measures to prevent irreversible damage. This process is especially important for coastal and marine ecosystems, where localized impacts can have far-reaching consequences.²

¹ Ministry of Environment, Forest and Climate Change, Environmental Impact Assessment Notification, 2006, available at https://www.moef.gov.in/sites/default/files/2006_EIA_Notification.pdf

² UNEP, Marine and Coastal Ecosystems: Threats and Conservation Measures 14 (2019), available at <https://www.unep.org/resources/report/marine-and-coastal-ecosystems-threats-and-conservation-measures>

In India, the EIA process is governed by the EIA Notification 2006 and the Coastal Regulation Zone (CRZ) framework, incorporating principles like sustainable development and the precautionary approach.³ Through mandatory environmental clearances, public consultations, and expert review, EIA regulates activities such as port development, offshore installations, and aquaculture. When properly implemented, EIA helps prevent environmental degradation, integrating ecological considerations into planning and promoting sustainable coastal development.⁴

Despite its significance, the effectiveness of EIA in protecting marine biodiversity remains uneven, due to challenges such as inadequate baseline data, limited cumulative impact assessments, weak monitoring, and insufficient community participation. However, advances in scientific tools, ecosystem-based management, and judicial oversight offer opportunities to strengthen EIA as a key instrument for marine environmental governance.⁵

This study is anchored in the global sustainable development framework, particularly SDG 14 (Life Below Water), which seeks to conserve and sustainably use oceans, seas, and marine resources. The role of Environmental Impact Assessment (EIA) directly aligns with SDG 14.2 (sustainable management and protection of marine and coastal ecosystems) and SDG 14.5 (conservation of coastal and marine areas).

At the national level, the study resonates with India's commitments under the National Biodiversity Action Plan (NBAP), Coastal Regulation Zone (CRZ) Notifications (2011/2019), the Environment (Protection) Act, 1986, and India's obligations under the Convention on Biological Diversity (CBD). EIA operates as a key governance instrument translating these policy commitments into project-level decision-making.

Problem Statement

Despite the existence of a legally mandated Environmental Impact Assessment framework in India, marine biodiversity continues to face degradation due to coastal infrastructure development, port expansion, offshore energy projects, and aquaculture activities. While EIAs are intended to function as preventive tools, their effectiveness in safeguarding marine ecosystems remains inconsistent due to data limitations, weak cumulative impact assessment, inadequate post-clearance monitoring, and procedural gaps in public participation.

This raises a critical question: To what extent does the existing EIA framework effectively protect marine biodiversity, and what structural limitations constrain its performance in coastal and marine contexts?

Purpose and Objectives of the Study

Purpose

The purpose of this study is to critically examine the role and effectiveness of Environmental Impact Assessment (EIA) as a regulatory and governance tool for the protection of marine biodiversity in India.

Objectives

1. To examine the legal and institutional framework governing EIA for coastal and marine projects in India.
2. To analyze how EIA processes identify, assess, and mitigate impacts on marine biodiversity.
3. To evaluate selected Indian case studies to assess strengths and limitations of current EIA practice.
4. To assess alignment between EIA, sustainable development goals, and national biodiversity policies.

³ Ministry of Environment, Forest and Climate Change, Coastal Regulation Zone (CRZ) Notification, 2011, available at <https://www.moef.gov.in/sites/default/files/CRZ-Notification-2011.pdf>

⁴ Id.

⁵ Indian Journal of Environmental Law: An article used for discussing environmental governance in India, which is an academic journal.

5. To propose recommendations for strengthening EIA as a mechanism for marine biodiversity conservation.

Significance and Scope of the Study

Significance

This study contributes to environmental governance literature by linking project-level EIA practice with marine biodiversity conservation and sustainable development objectives. It is significant for policymakers, regulators, environmental practitioners, and researchers seeking to improve the ecological effectiveness of EIAs in coastal and marine environments.

Scope

The study focuses on coastal and marine projects in India, including ports, offshore oil and gas exploration, aquaculture, and coastal infrastructure. It does not involve primary ecological sampling but relies on secondary data, legal instruments, and documented case studies.

EIA Framework: Legal and Procedural Context in Coastal and Marine Projects

The Environmental Impact Assessment (EIA) framework in India is primarily established under the Environment (Protection) Act, 1986, which empowers the Central Government to regulate activities that may significantly impact the environment. In exercise of this authority, the EIA Notification, 2006, along with its subsequent amendments, provides a legally binding mechanism requiring prior environmental clearance for projects likely to have substantial environmental effects. Coastal and marine projects—including ports, harbours, offshore oil and gas exploration, coastal industrial units, and aquaculture activities—fall under this framework due to their potential to affect marine ecosystems, water quality, and coastal processes.⁶

Under the EIA Notification, projects are categorised into Category A and B based on their scale and potential environmental risk. This categorisation determines the level of scrutiny and appraisal required. The EIA process involves several critical stages:

1. **Screening:** Identifies whether a project requires a full EIA based on its size, nature, and potential ecological impact.
2. **Scoping:** Determines the key environmental issues, focusing on critical ecological components such as water quality, benthic biodiversity, fisheries resources, and sensitive coastal habitats.
3. **Preparation of EIA Report:** The project proponent prepares a detailed report incorporating baseline environmental data, predictive impact assessment, and proposed mitigation measures to minimize ecological disturbance.
4. **Public Consultation:** Provides an opportunity for local communities, particularly fishing and coastal populations, to raise concerns regarding livelihood, resource access, and environmental risks.
5. **Appraisal by Expert Committees:** The **Expert Appraisal Committees (EACs)** evaluate the EIA report and public inputs to recommend environmental clearance with specific conditions or modifications.¹

Alongside the EIA Notification, coastal projects are also governed under the Coastal Regulation Zone (CRZ) Notification, 2011/2019, which classifies coastal areas into zones based on ecological sensitivity and permissible development. CRZ-I areas, including mangroves, coral reefs, mudflats, and breeding or nesting grounds, are afforded the highest level of protection, restricting or prohibiting most developmental activities. Projects located in CRZ areas typically require dual compliance with both EIA and CRZ provisions. However, for certain projects where the EIA Notification is not applicable, proponents may obtain standalone CRZ clearance from the State

⁶ **Environment (Protection) Act, 1986**, Act No. 29 of 1986, Government of India.

Coastal Zone Management Authority (SCZMA) and the Ministry of Environment, Forest and Climate Change (MoEF&CC).³

Applications for CRZ clearance are submitted via the PARIVESH portal, accompanied by detailed project documentation, including the Environmental Impact Assessment (EIA) report (either Rapid or Comprehensive), Disaster Management Plan, Risk Assessment, CRZ Maps demarcating the High Tide Line and Low Tide Line, Project Profile, and No Objection Certificates as required. The process involves scrutiny by District or State Coastal Zone Management Authorities (CZMA), site inspections, and recommendations by expert committees where necessary. Final approval is granted by the State or Central authorities depending on the CRZ category: while the State CZMAs handle CRZ-II and III clearances, the MoEF&CC retains authority over CRZ-I and IV.³

In this context, international agreements like the Convention on Biological Diversity (CBD) provide a global framework for marine biodiversity protection. Adopted in 1992, the CBD aims to conserve biological diversity, ensure the sustainable use of its components, and promote fair and equitable sharing of benefits arising from the use of genetic resources. For coastal and marine biodiversity, the CBD emphasizes the importance of integrating biodiversity considerations into development policies and projects, such as those assessed by the EIA process. Countries that are parties to the CBD, including India, are required to take actions that align with the principles of sustainable development and environmental conservation, particularly in ecologically sensitive marine areas.⁷

Overall, the EIA and CRZ frameworks collectively reflect a preventive and participatory approach to coastal and marine governance in India. While legally robust, the effectiveness of these frameworks depends on rigorous scientific assessment, institutional coordination, and meaningful stakeholder engagement, ensuring that marine biodiversity and ecosystem integrity are effectively safeguarded alongside developmental objectives.

Assessment Tools: Baseline Studies, Ecological Indicators, and Risk Analysis

Effective Environmental Impact Assessment (EIA) for coastal and marine projects in India relies on baseline studies, ecological indicators, and risk analysis. Baseline studies document existing conditions, such as water quality, sediment characteristics, and biodiversity, serving as benchmarks for assessing impacts like port expansion or industrial discharge. Ecological indicators, such as species abundance and mangrove cover, help detect early signs of environmental stress and monitor long-term impacts. Risk analysis, using tools like GIS and remote sensing, predicts potential harms like sediment dispersal and oil spills, though limitations like data gaps can affect accuracy. Together, these tools guide decision-making and help design mitigation strategies, but their effectiveness depends on institutional capacity, interdisciplinary expertise, and robust post-clearance monitoring to manage risks effectively.⁷

Case Studies: Coastal EIA in India

Several projects in India provide valuable insights into how the EIA process has been applied, revealing both the strengths and limitations of current practices.

1.) Mumbai Coastal Road Project (MCR) – Port Modernization and Infrastructure Development

The Mumbai Coastal Road Project aims to enhance urban connectivity by constructing a road along Mumbai's western coastline, which is home to critical marine ecosystems. The Environmental Impact Assessment (EIA) process for the project included strengths such as comprehensive baseline studies that assessed water quality, sedimentation patterns, and marine species. Public consultations provided a platform for local communities, particularly fishers, to voice concerns about livelihood impacts. Mitigation measures, such as carefully timed construction activities to avoid critical breeding seasons and sediment control techniques, were recommended to minimize ecological disruption. However, there were notable limitations, including the lack of a thorough cumulative impact assessment, as the project did not adequately consider the broader effects of other ongoing urban developments along the coast. Additionally, while mitigation measures were proposed, long-term

⁷ Convention on Biological Diversity (CBD), adopted 1992, 31 I.L.M. 818.

monitoring and adaptive management strategies to address unforeseen impacts were not robustly implemented, highlighting gaps in post-clearance oversight and adaptive management.

2.) Kandla Port Expansion, Gujarat – Port Modernization

The expansion of Kandla Port (Deendayal Port) in Gujarat involved dredging, reclamation, and new berth construction to accommodate larger vessels. The EIA addressed impacts on water quality, sedimentation, and sensitive habitats, providing comprehensive baseline data on water quality, sediment distribution, and benthic biodiversity. Mitigation measures included limiting dredging during non-breeding seasons, monitoring sediment dispersion, and using silt curtains. Public consultations highlighted concerns from local fishing communities. However, the EIA overlooked cumulative impacts from nearby industrial activities, and enforcement of mitigation measures was inconsistent, leading to unforeseen effects on fisheries. The assessment also lacked an ecosystem-based approach, failing to consider the interconnectedness of marine habitats and local fisheries.

3.) POSCO Captive Port, Orissa – Port Modernization and Ecological Impact

The POSCO Captive Port Project in Orissa, aimed at facilitating iron ore exports, posed significant risks to local marine biodiversity through activities like deep-water port construction, dredging, reclamation, and shipping. The Environmental Impact Assessment (EIA) identified key environmental threats, particularly to fisheries, sedimentation, and coastal erosion. Strengths of the EIA included comprehensive biodiversity assessments, especially of species like the Hilsa fish, vital for local fisheries. Public consultations highlighted concerns about impacts on traditional fishing grounds and livelihoods, leading to project design modifications. However, the project had notable limitations. Habitat disruption remained a major concern, as the development threatened sensitive coastal areas essential for juvenile fish, despite proposed mitigation measures like sand bypassing and erosion control. Additionally, the EIA was criticized for not addressing the social implications, particularly the displacement of communities and impacts on marginalized fishing populations. This lack of social equity led to protests and legal challenges, exposing deficiencies in public participation and consultation.

4.) Aquaculture Expansion in Sunderbans, West Bengal – Habitat Degradation

In the Sunderbans region of West Bengal, the expansion of aquaculture, especially shrimp farming, has significantly degraded mangrove forests and coastal ecosystems. The Environmental Impact Assessment (EIA) aimed to assess the environmental impacts of converting mangrove and mudflat areas into shrimp ponds, crucial for maintaining biodiversity and ecological functions. The EIA's strengths included an in-depth ecological study, which examined the effects of aquaculture on mangrove health, water salinity, and coastal erosion. It also proposed mitigation measures such as sustainable pond management and creating buffer zones between aquaculture areas and sensitive habitats. However, the EIA had notable limitations. It lacked a comprehensive cumulative impact analysis, failing to account for the broader effects of expanding shrimp farming, which was already linked to fish population declines and mangrove loss. There was also a gap in long-term monitoring, with no adaptive management strategy to address unforeseen impacts like disease outbreaks in aquaculture ponds. Additionally, the EIA process was criticized for inadequate public participation, especially from local communities impacted by mangrove loss and reduced fish stocks, raising concerns about social equity and stakeholder engagement.

5. Offshore Oil and Gas Exploration – Marine Habitat Disturbance

Offshore energy projects, particularly oil and gas exploration, can significantly disturb marine habitats through activities like seismic surveys, drilling, and disposal of drilling muds. The Environmental Impact Assessment (EIA) for offshore exploration in the Krishna-Godavari Basin on India's east coast addressed key ecological concerns, such as noise pollution affecting marine mammals, the risk of oil spills, and drilling impacts on benthic ecosystems. The EIA's strengths included the use of advanced risk assessment tools, such as modeling to predict oil spill spread and its impact on sensitive areas like coral reefs and fish breeding grounds. It also proposed mitigation strategies, including real-time monitoring and early-warning systems for oil spills. However, the project had limitations. Despite using predictive tools, uncertainty about long-term impacts remained, especially regarding the effects of seismic activity on deep-sea species. Additionally, post-clearance monitoring was

inadequate, with inconsistent follow-up to track mitigation effectiveness and assess long-term ecological impacts, limiting the ability to adapt to unforeseen environmental changes.

8. Challenges in Coastal Environmental Impact Assessments (EIAs) in India

The implementation of Environmental Impact Assessment (EIA) in coastal resource management has proven effective but faces several challenges that need improvement. These include:

- **Inadequate Baseline Data:** Limited and inaccurate environmental data, particularly on marine biodiversity and socio-economic factors, hinder accurate impact predictions.
- **Limited Assessment of Cumulative Impacts:** EIAs often assess projects in isolation, overlooking the combined effects of multiple overlapping activities on coastal ecosystems.
- **Ineffective Mitigation and Adaptive Management:** Weak post-clearance monitoring and a lack of adaptive management reduce the effectiveness of mitigation measures, limiting responses to unforeseen environmental changes.
- **Fragmented Integration with Strategic Planning:** Coastal development often lacks integration with broader policy and planning strategies, leading to gaps and inconsistencies in environmental management.
- **Insufficient Public Participation and Social Equity:** Limited stakeholder engagement, particularly with vulnerable coastal communities, reduces transparency and may overlook socio-economic impacts.
- **Gaps in Legal and Institutional Enforcement:** Despite legal frameworks, enforcement challenges and resource constraints hinder effective compliance and monitoring, undermining the protective goals of EIA.

RECOMMENDATIONS

To improve the effectiveness of EIA for sustainable coastal development in India, the following measures are recommended:

- **Invest in Environmental Research:** Strengthen baseline data collection through collaboration between government, research institutions, and local communities to improve data quality and accessibility.
- **Incorporate Cumulative Impact Assessments:** Evaluate the combined effects of multiple projects on coastal ecosystems to enable better decision-making and reduce unforeseen consequences.
- **Implement Adaptive Management Plans:** Adjust mitigation strategies based on ongoing monitoring to ensure long-term effectiveness throughout the project lifecycle.
- **Align EIAs with Strategic Environmental Assessment (SEA):** Integrate project-level EIAs with broader SEA processes to address environmental impacts at policy and program levels.
- **Enhance Public Participation:** Promote transparent information sharing and ensure the active involvement of local and marginalized communities to achieve social equity and inclusiveness.

CONCLUSION

Environmental Impact Assessments (EIAs) in coastal and marine projects in India effectively balance development with environmental conservation. They help identify, predict, and mitigate potential impacts, ensuring the protection of sensitive ecosystems like mangroves, coral reefs, and estuaries. A key factor for success is stakeholder engagement. Involving local communities, particularly traditional fishing and indigenous

groups, enhances transparency and ensures their concerns are reflected in decision-making. EIAs also strengthen the regulatory framework for coastal development, promoting compliance with environmental standards.

However, challenges remain, including inadequate baseline data, difficulty assessing cumulative impacts, and varying effectiveness of mitigation measures. Overcoming these challenges is crucial to fully realizing EIA's potential in sustainable coastal resource management.