

Protecting the Sundarbans: Climate Change, Thermal Power, and International Legal Obligations

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Abstract

The Sundarbans, the world's largest mangrove forest and a UNESCO World Heritage and Ramsar site, is increasingly threatened by climate change and nearby industrial activities. Rising sea levels, stronger cyclones, and rapid erosion are degrading its biodiversity and weakening the livelihoods of millions who depend on its ecosystem services. These climate pressures are intensified by coal-based thermal power projects such as the *Rampal* plant, which pose risks of air and water pollution, dredging impacts, and increased salinity—raising concerns from UNESCO, IUCN, and environmental experts. This paper examines Bangladesh's obligations under key international environmental instruments, including the UNFCCC, the Paris Agreement, the Convention on Biological Diversity, the *Ramsar* Convention, and the World Heritage Convention. It assesses whether industrial activities near the Sundarbans align with these commitments and explores relevant customary principles such as the no-harm rule, precaution, and the duty to conduct impact assessments. The study finds significant gaps between international obligations and national actions, arguing that stronger compliance with global environmental norms is essential to safeguard the long-term ecological integrity of the Sundarbans.

Keywords

Sundarbans, Mangrove Forest, Environmental Impacts, *Rampal*, Thermal Power, Biological Diversity

1. Introduction

The Sundarbans, located within the Ganges–Brahmaputra–Meghna delta and spanning nearly 10,000 km², is the world's largest continuous mangrove forest and a UNESCO World Heritage Site as well as a *Ramsar* wetland of international importance. It serves as a natural buffer against cyclones, storm surges, and sea-level rise, while supporting rich biodiversity, including the Royal Bengal tiger, estuarine crocodiles, river dolphins, and over 300 bird species. Millions of people in both Bangladesh and India depend on its fisheries, forestry resources, and ecosystem services for their livelihoods, making the Sundarbans an ecological and socio-economic lifeline for the region. However, the Sundarbans is undergoing rapid ecological deterioration driven largely by climate change. Rising sea levels in the Bay of Bengal, intensifying cyclones, saline intrusion, and widespread erosion have caused significant habitat loss—estimated at over 210 km² since the 1960s. Severe storms such as Cyclone *Amphan* in 2020 caused devastating environmental and economic damage, highlighting the extreme vulnerability of both the ecosystem and surrounding communities. These climatic pressures threaten biodiversity, food security, cultural heritage, and the long-term viability of human settlements across the region.

Compounding these climate-related threats are industrial developments, most notably coal-based thermal power plants situated near the Sundarbans. The 1320 MW *Rampal* coal-fired power plant in Bangladesh—located only 14 km from the forest—has drawn widespread criticism for its potential to release mercury, coal ash, sulfur and nitrogen oxides, and other pollutants into the air and river systems (**Figure 1**, **Figure 2**). Conservation bodies including UNESCO and IUCN have warned that increased dredging, shipping activities, and pollution associated with such projects pose serious risks to the Outstanding Universal Value of the Sundarbans. Despite environmental restrictions in India on establishing coal plants near ecologically sensitive areas, comparable protective frameworks remain weak or absent in Bangladesh.



Figure 1. Rampal power plant [1].

This situation underscores the significance of international environmental law as a framework for safeguarding vulnerable ecosystems. Bangladesh, as parties to the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement, and the Convention on Biological Diversity (CBD), are obligated to reduce emissions, protect biodiversity, and ensure the sustainable management of critical habitats. Additionally, their commitments under the *Ramsar* Convention and UNESCO World Heritage regime impose duties to preserve the ecological integrity and Outstanding Universal Value of the Sundarbans. Principles of customary international environmental law—including the no-harm rule, the precautionary principle, and the obligation to conduct environmental impact assessments—further reinforce these responsibilities.

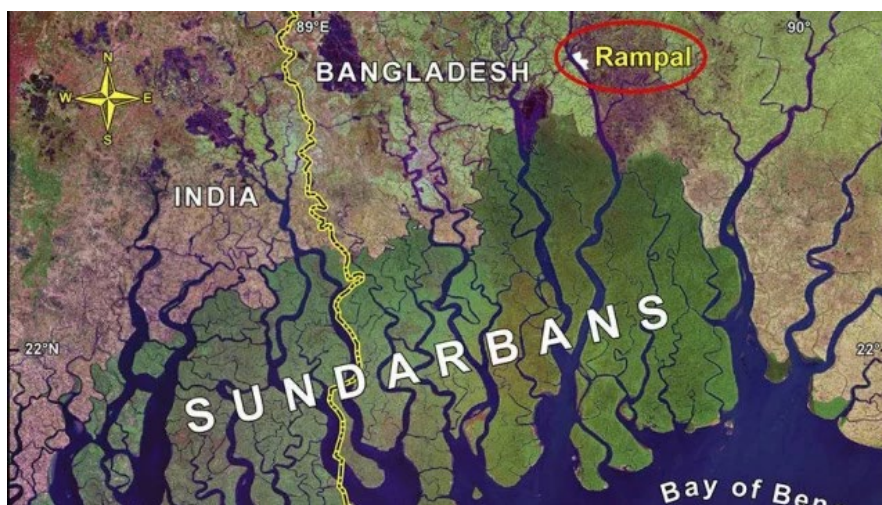


Figure 2. Location of Rampal from Sundarbans area [2].

Against this backdrop, this article examines the legal obligations of Bangladesh under key international environmental agreements in relation to climate impacts and industrial activities near the Sundarbans. It evaluates whether projects such as the *Rampal* thermal power plant align with these commitments and assesses how international legal standards can guide stronger conservation and regulatory practices. Through this analysis, the paper seeks to clarify the extent to which global environmental norms can—and should—shape national decisions affecting the future of one of the world’s most critical and fragile ecosystems.

2. Methodology

This study employs a doctrinal legal research methodology, the primary method for examining the development, interpretation, and application of international environmental law. Doctrinal analysis enables a systematic examination of legal rules, principles, and obligations contained in treaties, case law, and authoritative scholarship. It is particularly suitable for assessing state responsibilities concerning the protection of ecologically sensitive areas such as the Sundarbans.

The research focuses on the international legal commitments of Bangladesh with particular attention to how these obligations apply to climate risks and the establishment of thermal power plants near the Sundarbans. The United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement, the Convention on Biological Diversity (CBD), the *Ramsar* Convention, and the World Heritage Convention, have been used as research corpus in this study to identify binding duties relevant to the conservation of the area.

The study also evaluates foundational principles of international environmental law—such as the precautionary principle, the no-harm rule, the obligation to conduct environmental impact assessments, and the principle of sustainable development. Through this approach, the methodology provides a rigorous legal framework for understanding the obligations of Bangladesh in safeguarding the Sundarbans.

3. The Sundarbans under Threat: An Environmental and Socio-Legal Overview

The Sundarbans, stretching across coastal Bangladesh and India, is the world's largest mangrove ecosystem and holds dual recognition as both a UNESCO World Heritage Site and a Ramsar wetland [3]. Home to Bengal tigers, freshwater dolphins, estuarine crocodiles, and countless other species, the forest provides extensive ecological services and substantial carbon storage—an estimated 56 million metric tons valued at USD 280 million annually [4]. More than 3.5 million people in Bangladesh depend directly on its fisheries, timber resources, and ecosystem goods for their livelihoods [5]. The Sundarbans therefore represents both an ecological stronghold and an essential socio-economic resource.

Climate change has sharply intensified risks to the region. Rising sea levels, altered freshwater flows, stronger cyclones, and increasing salinity are accelerating land degradation [6]. Model projections indicate that a sea-level rise of 88 cm could drastically reduce mangrove habitat and significantly diminish forest productivity [7]. The IPCC estimates that a 10 cm sea-level rise alone may result in the loss of 15% of the Bangladesh Sundarbans (approximately 750 km²), with severe consequences for biodiversity, livelihoods, and ecosystem stability [8]. UNESCO assessments further highlight that upstream water withdrawals have reduced freshwater inflow, increasing salinity and siltation and disrupting ecological balance [9]. Combined with repeated cyclones and habitat destruction, these trends pose long-term threats to both wildlife and human communities [10].

These climate threats are compounded by controversial industrial expansion, particularly coal-fired power generation near the forest [11]. Bangladesh is developing two major coal plants—Rampal (Maitree) and Orion—within 15 km of the Sundarbans [11] [12]. The 1,320 MW Rampal plant, a Bangladesh–India joint venture, is the most advanced [13]. Scientists, local communities, and UNESCO warn that these developments risk forest destruction, community displacement, and widespread pollution [14]. A 2016 UNESCO–IUCN mission identified Ram-

pal as a critical threat due to coal-ash emissions, wastewater discharge, increased shipping, dredging, and rapid industrialization [15]. Independent studies corroborate these findings: Greenpeace (2016) projects a 25% rise in regional NO₂ and a 50% rise in SO₂, potentially causing thousands of premature deaths and increased low-birth-weight cases. Mercury contamination affecting 70 km² of the Sundarbans watershed may render fish unsafe for consumption [16]. Overall, the Rampal project poses significant risks to air quality, water systems, and public health [17]. These developments also contradict scientific assessments showing that Bangladesh—one of the world’s most climate-vulnerable nations—is simultaneously planning substantial CO₂ increases by 2030 [18].

Environmental degradation has direct socio-economic consequences. The Sundarbans supports vital fisheries, honey production, timber extraction, and other forest-based livelihoods [13]. Over one million seasonal workers depend on these resources. Pollution and habitat loss threaten these economic activities, exacerbating food insecurity and poverty [19]. Research shows that land acquisition for the Rampal project has disproportionately harmed smallholders and landless workers, leading to displacement and heightened socio-economic vulnerability [20] [21]. Communities in the area already experience respiratory illness and toxic exposure from coal-related pollutants [22], compounding existing climate-induced hardships.

These concerns extend beyond national borders. As a World Heritage Site and Ramsar wetland, the Sundarbans enjoys international legal protection due to its global significance [7]. Scholars argue that cross-border pollution from Rampal may violate the non-harm rule under Article 6(3) of the World Heritage Convention, as emissions could affect the Indian Sundarbans [23]. Bangladesh has also been criticized for failing to conduct a comprehensive cumulative impact assessment, as required for managing development affecting heritage values [12]. UNESCO monitoring missions have repeatedly urged Bangladesh to secure adequate freshwater flow for the Sundarbans and undertake strategic environmental assessments for industrial projects [9]. While Bangladesh’s Environmental Conservation Act designates a 10-kilometre Ecologically Critical Area around the forest, numerous industries continue to operate within this zone due to regulatory weaknesses and economic pressures [13].

The crisis confronting the Sundarbans illustrates the complex intersection of environmental protection, human rights, climate justice, and sustainable development. It exemplifies the broader challenge of balancing economic growth with the protection of irreplaceable ecosystems—an issue that resonates globally. As a test case for international environmental governance, the Sundarbans demonstrates how legal, policy, and scientific frameworks must converge to safeguard vulnerable ecological and human communities against both climate and industrial threats.

4. International Environmental Legal Framework

Multiple international treaties protect the Sundarbans mangrove ecosystem be-

cause Bangladesh has joined them to enforce binding conservation obligations [24]. The UN Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, together with the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, and the UNESCO World Heritage Convention, require Bangladesh to fulfill specific duties for Sundarbans protection [25]. The Sundarbans faces customary law restrictions through general principles of international environmental law, including the “no significant harm” obligation and the precautionary principle [26]. The following section outlines each treaty and principle together with Bangladesh’s obligations and implemented measures.

4.1. UNFCCC (Climate Change) Obligations

The United Nations Framework Convention on Climate Change [27] and its Paris Agreement impose binding climate-related responsibilities on Bangladesh aimed at stabilizing greenhouse gas concentrations at levels that prevent dangerous anthropogenic interference with the climate system [28]. Under Article 4(1) of the UNFCCC, all Parties must develop and periodically update national strategies for climate change mitigation and adaptation, prepare greenhouse gas inventories, promote the sustainable management of sinks and reservoirs, and support ongoing climate research and observation [29]. Article 3 outlines foundational principles, including the requirement that developed countries take the lead in combating climate change, while developing and climate-vulnerable states—such as Bangladesh—are entitled to special consideration [30]. Article 3(3) further obliges Parties to adopt preventive measures that anticipate, minimize, or avoid climate damage, and clarifies that scientific uncertainty cannot be used as a justification for postponing action [25]. These obligations require Bangladesh to formulate adaptation strategies for the Sundarbans in response to sea-level rise and climate-induced hazards, while enabling it to access financial and technical assistance through the Convention [7].

Under the Paris Agreement, Bangladesh has submitted its Nationally Determined Contribution (NDC), committing to a 15% reduction in greenhouse gas emissions—5% unconditional and 10% conditional on international support—by 2030 relative to business-as-usual projections [31]. This commitment reflects the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC), which shapes Bangladesh’s mitigation and adaptation obligations [23]. In line with Article 4(1)(g) of the UNFCCC, Bangladesh has also prepared its long-term National Adaptation Plan (2023-2050), prioritizing climate-resilient development and targeted interventions for vulnerable ecosystems such as the Sundarbans.

Bangladesh’s compliance with the UNFCCC framework is further reinforced by its domestic constitutional mandate. Article 18A of the Constitution requires the State to protect and improve the environment and conserve natural resources, including forests. This constitutional provision strengthens Bangladesh’s duty to implement its international climate obligations and to safeguard climate-sensitive

ecosystems such as the Sundarbans.

4.2. CBD (Biodiversity) Obligations

Bangladesh ratified the Convention on Biological Diversity (CBD) in 1994, thereby committing to the conservation and sustainable use of biological diversity within its jurisdiction [7]. Article 8 of the CBD places core obligations on Parties to conserve biodiversity in situ through the establishment of protected areas, the restoration of degraded ecosystems, and the protection of threatened species [32]. Article 8(a) specifically requires Parties to “establish a system of protected areas... to conserve biological diversity,” emphasizing ecosystem-wide protection rather than fragmented conservation measures [33]. In fulfilment of these duties, Bangladesh has designated multiple wildlife sanctuaries across the Sundarbans, now covering nearly half of the forest [7].

Article 8(j) obliges Parties to respect, preserve, and maintain the traditional knowledge and practices of indigenous and local communities relevant to biodiversity conservation [13]. This requirement is directly applicable to the traditional fishing, honey-collecting, and forest-dependent communities of the Sundarbans, who must be included in conservation governance and benefit-sharing arrangements [34]. Similarly, Article 15(7), reinforced by the Nagoya Protocol, mandates access-and-benefit-sharing (ABS) mechanisms for genetic resources [33] [34]. Bangladesh’s Biodiversity Act (2017) establishes prior informed consent procedures and national ABS frameworks to align domestic law with these international requirements [35].

The CBD also obliges Parties to prepare National Biodiversity Strategies and Action Plans (NBSAPs). Bangladesh’s updated NBSAP (2016–2021) incorporates the Aichi Biodiversity Targets, focusing on ecosystem protection, biodiversity monitoring, and sustainable resource use, including specific actions for the Sundarbans [36].

Overall, the CBD requires Bangladesh to expand and effectively manage protected areas in the Sundarbans, regulate biological resource use, and ensure community participation in conservation. Domestic laws—including the Biodiversity Act and forest conservation regulations—provide the legal framework for meeting these obligations, though persistent enforcement challenges weaken their effectiveness.

4.3. Ramsar Convention (Wetlands) Obligations

Bangladesh acceded to the Ramsar Convention in 1987 and designated the Sundarbans Reserve Forest as Ramsar Site No. 560 in May 1992 [31]. Under the Convention, Bangladesh must fulfil a number of core obligations relating to the conservation and wise use of wetlands of international importance. Article 2(1) requires each Contracting Party to identify and nominate suitable wetlands within its territory for inclusion in the List of Wetlands of International Importance [13]. Bangladesh complied with this requirement by listing the Sundarbans—the

world's largest contiguous mangrove ecosystem—as a Ramsar Site [37].

Article 3(1) obliges Parties to formulate and implement planning measures to promote the conservation of listed wetlands and ensure the sustainable use of all wetlands within their jurisdiction [33]. The Convention's "wise use" principle, further elaborated by the Conference of the Parties, requires the maintenance of a wetland's ecological character and the prevention of degradation, alteration or pollution [38]. Accordingly, Bangladesh must ensure sustainable management of the Sundarbans, including controlling deforestation, pollution, and overfishing pressures [33].

Under Article 3(2), Parties must promptly notify the Ramsar Secretariat of any changes or likely changes in the ecological character of listed wetlands [7]. Despite significant mangrove decline, both Bangladesh and India have failed to provide such notifications [5].

Article 5 is particularly relevant for the Sundarbans as a shared transboundary wetland. It requires Bangladesh to cooperate with India in the implementation of Ramsar obligations, especially where a wetland extends across national boundaries [13]. Although the 2011 Bangladesh–India Memorandum of Understanding and the BISRCI initiative represent steps toward cooperation, meaningful institutionalized consultation remains limited [39].

The Ramsar framework further requires Bangladesh to integrate wetland conservation into national land-use planning and to promote community participation, awareness, and education to support the wise use of the Sundarbans [34]. Despite these obligations, Bangladesh's limited progress on transboundary cooperation and ecological character reporting reflects partial non-compliance with the Convention's requirements [33].

4.4. World Heritage Convention Obligations

The UNESCO World Heritage Convention (1972) aims to protect sites of *Outstanding Universal Value* (OUV). Bangladesh became a State Party in 1983 and secured World Heritage status for The Sundarbans (Bangladesh) as a natural site in 1997 [40]. Under Article 4, each State Party recognizes its duty to identify, protect, conserve, present and transmit cultural and natural heritage within its territory to future generations [34]. Accordingly, Bangladesh bears the primary responsibility to safeguard the Sundarbans due to its OUV.

Article 5 requires States Parties to adopt comprehensive heritage protection policies, integrate heritage conservation into national planning processes, and take all appropriate legal, scientific, technical, administrative, and financial measures necessary for effective conservation [9]. Bangladesh has taken several steps toward this obligation, including the establishment of protected zones, a wildlife monitoring program, and regulatory restrictions in the Sundarbans Ecologically Critical Area [41].

The Convention also contains an implicit no-harm principle through Article 6(3), which mandates that each State Party refrain from deliberate actions that

could directly or indirectly damage World Heritage sites located within the territory of other Parties [42]. Concerns regarding the Rampal coal power plant—approximately 14 km from the Sundarbans—prompted criticism from international bodies and India due to its potential transboundary ecological impacts on the World Heritage site [11]. This provision therefore provides a legal basis for preventing cross-border harm to heritage sites [40].

Under Article 11(4), a site may be placed on the List of World Heritage in Danger when it faces “serious and specific dangers.” Since 2016, the World Heritage Committee has repeatedly issued warnings to Bangladesh regarding threats to the Sundarbans and has required strengthened enforcement and conservation measures [40]. As a State Party, Bangladesh must implement the Committee’s recommendations to ensure that no activities—domestic or transboundary—jeopardize the OUV and integrity of the Sundarbans [43].

4.5. Customary International Law Principles

The Sundarbans is governed by general obligations under customary international environmental law that extend beyond treaty provisions [41]. Central among these is the *no-harm rule*, which requires states to prevent significant environmental damage that may cross borders [44]. This principle is supported by the Stockholm (1972) [45] and Rio (1992) [46] Declarations, reinforced by judicial decisions such as the *Trail Smelter* case, and explicitly reflected in Article 6(3) of the World Heritage Convention [26]. Practically, Bangladesh and India must ensure that development activities do not cause pollution or ecosystem degradation within the shared Sundarbans region [47]. Bangladeshi analysts argue that coal plant operations and oil spills affecting the area contravene the no-harm principle [48].

The *precautionary principle* further obliges states to adopt preventive measures even when environmental threats are uncertain [44]. Article 3(3) of the UNFCCC explicitly endorses this principle, requiring action in the face of a risk of “serious or irreversible damage” [49]. Given the growing threats from cyclones and sea-level rise, Bangladesh must take a cautious approach in managing Sundarbans resources [50].

Finally, the general principles of equity and sustainable development under the UNFCCC (Articles 3.1 and 4.5) affirm that states have the right to pursue development while meeting climate objectives [49]. Customary international law therefore obliges Bangladesh to manage the Sundarbans sustainably, engage with India on shared environmental concerns, and take anticipatory measures to prevent environmental harm [51].

5. Bangladesh’s Commitments in Practice

Bangladesh has integrated its international environmental obligations into domestic law and policy [52]. The Constitution explicitly mandates environmental protection and biodiversity conservation [53]. The government has designated the Sundarbans as an Ecologically Critical Area (ECA) with buffer zones, enacted

strict forest protection laws, and developed disaster management plans to address cyclone impacts [54].

The Biodiversity Act (2017) operationalizes the obligations of the Convention on Biological Diversity (CBD) and the Nagoya Protocol on access and benefit-sharing [33]. The Sundarbans Reserve Forest is legally protected under the *Ramsar* and World Heritage Conventions, with Bangladesh submitting regular ecological reports [41]. The National Climate Change Policy, along with the forthcoming National Adaptation Plan, underscores Bangladesh's climate commitments under the UNFCCC, while the updated Nationally Determined Contribution (NDC) pledges a 15% emissions reduction by 2030 [55]. The Environmental Conservation Act (1995) and its subsequent rules embody the *no-harm principle*, prohibiting activities that could damage ecologically critical areas through pollution or unsustainable development [56].

Bangladesh is thus legally bound to preserve the Sundarbans' ecosystems, adapt to climate impacts, and prevent transboundary environmental harm in line with climate, biodiversity, wetlands, and heritage regimes [43]. The interplay of treaty obligations and customary principles forms a robust legal framework for sustainable management [57]. These international commitments also provide clear benchmarks to evaluate national policies and projects, despite ongoing enforcement challenges [58].

6. Analysis—Legal Perspective

Bangladesh is a party to multiple international environmental agreements, including the UNESCO World Heritage Convention (1983), *Ramsar* Convention (1992), Convention on Biological Diversity (CBD, 1994), and the Paris Agreement (2016), reflecting its formal commitment to protecting the Sundarbans [13]. These agreements impose three principal duties on the state: conserving biodiversity, preventing transboundary harm, and integrating environmental protection into development planning [59].

Despite these formal commitments, significant implementation gaps persist. Bangladesh has established legal and policy instruments, including the Environmental Conservation Rules (2023), the Bangladesh Climate Change Strategy and Action Plan, and landmark judicial decisions recognizing environmental rights [18]. Nevertheless, enforcement remains inconsistent. For example, hundreds of projects were approved within the Sundarbans Ecologically Critical Area (ECA) despite the 2023 Strategic Environmental Management Plan (SEMP). Between 2013 and 2023, 320 industrial facilities were authorized within 10 kilometers of the Sundarbans core, violating UNESCO Article 4 requirements to protect Outstanding Universal Values [9]. Although new industrial approvals were eventually suspended in 2025, existing projects continued without adequate safeguards, demonstrating a clear implementation gap.

The 1,320 MW coal-fired *Rampal* power plant, located 14 kilometers from the Sundarbans World Heritage site, exemplifies this failure. UNESCO World Herit-

age Convention Articles 5 and 6(3) require integrated planning and avoidance of transboundary harm. Bangladesh approved *Rampal* without conducting a comprehensive cumulative-impact assessment, violating Article 5 obligations [9]. Scientific evidence from the 2016 UNESCO-IUCN monitoring mission indicates that *Rampal's* emissions, coal ash, wastewater discharges, and increased shipping threaten the entire Sundarbans ecosystem, including areas across the Bangladesh-India border [60]. Despite UNESCO recommendations to cancel or relocate the project, Bangladesh proceeded with construction, breaching the transboundary no-harm rule under Article 6(3) [43].

Enforcement mechanisms under international law remain weak. The World Heritage Committee can list threatened sites on the “Danger List” under Article 11(4), but diplomatic delays have limited effective action [14] [26]. UNESCO monitoring missions consistently report “serious and specific dangers” to the Sundarbans due to industrialization and hydrological changes, yet recommendations have largely relied on technical progress reports rather than compulsory measures [41].

Under the *Ramsar* Convention, Bangladesh similarly falls short. *Ramsar* requires parties to designate important wetlands and establish management plans through public consultation under the “wise use” principle (Articles 2(1) and 3) [61]. Although the Sundarbans was designated a Ramsar site in 1992, enforcement is weak. Illegal activities—including shrimp farming, sand mining, and palm plantations—continue, indicating non-compliance with both Ramsar obligations and the Environmental Conservation Act (2010) [62] [63].

CBD obligations are also inadequately implemented. Article 8(a) mandates protected area systems, while Article 8(j) requires protection of indigenous knowledge, and Article 15, together with the Nagoya Protocol, governs benefit-sharing of genetic resources [64]. Bangladesh has expanded the Sundarbans protected area to 317,949 ha by 2017, yet mangrove canopy coverage declined by 50% from 2000 to 2020 [60]. Article 8(j) remains largely unfulfilled, as 6.5 million residents depend on the Sundarbans for livelihoods, yet there are no formal programs documenting traditional knowledge or ensuring community participation in management [65]. Benefit-sharing under Article 15(7) has not been operationalized, and CBD reporting remains superficial due to insufficient funding and institutional capacity [66].

Overall, Bangladesh demonstrates strong treaty participation on paper but struggles with enforcement in practice [64]. The *Rampal* plant and hundreds of ECA projects illustrate how development priorities often override treaty commitments, undermining precautionary and preventive principles central to international environmental law [67]. Institutional weaknesses, limited funding, political preferences for industrial development, and inadequate agency capacity further constrain compliance [68]. Domestic environmental courts and constitutional public trust obligations have not yet established a systematic defense mechanism for the Sundarbans [41].

In conclusion, while Bangladesh maintains extensive international commitments, actual implementation is inconsistent. Sustainable development remains a formal principle, yet ongoing industrialization and governance deficits prevent treaty obligations from being effectively realized, leaving the Sundarbans vulnerable to ecological degradation [36].

7. Discussion & Policy Recommendations

Our analysis demonstrates that, despite multiple legal frameworks, the Sundarbans region remains poorly protected in practice. Bangladesh has ratified numerous international environmental agreements, yet ongoing deforestation, weak implementation of *Ramsar* “wise use” policies, and projects such as the *Rampal* coal plant show a persistent gap between formal commitments and actual outcomes. *Rampal* violates international standards by producing harmful cross-border pollution and threatening cultural and ecological heritage, despite UNESCO recommendations to halt construction. Weak enforcement, reliance on reputational pressure, and non-binding programs have proven insufficient. Institutional constraints, conflicting policies, limited authority of environmental agencies, and financial shortfalls have hindered the practical realization of conservation goals, often prioritizing industrial development and energy expansion over ecological protection.

To address these challenges, policy interventions must integrate environmental, legal, and socio-economic dimensions:

7.1. Strengthen Legal Frameworks and Regulatory Systems

- a) Fully enforce the Environmental Conservation Rules of Bangladesh and elevate EIA/SEA procedures to meet international standards.
- b) Conduct a comprehensive review of all industrial approvals in the Sundarbans ECA, rescinding or modifying projects that threaten mangrove carrying capacity.
- c) Develop a detailed Sundarbans management plan that incorporates flood-control measures, pollution monitoring, and development limits consistent with CBD and *Ramsar* obligations.
- d) Establish a cross-ministerial, empowered Sundarbans Authority, including local communities, to ensure accountability and oversight.

7.2. Enhance Transboundary Cooperation with India

- a) Activate the 2011 India–Bangladesh Sundarbans MoU by operationalizing the Joint Working Group for joint mangrove restoration, coordinated freshwater releases, sanctuary management, and shipping safety regulations.
- b) Implement transboundary Prior Informed Consent (PIC) arrangements under the Nagoya Protocol for projects affecting shared delta resources, including joint reviews of industrial discharges.

7.3. Mitigate or Cancel *Rampal* Impacts

- a) Halt expansion and coal imports for *Rampal* while implementing emission-control technologies, such as flue-gas desulfurization and ash capture.
- b) Establish strict monitoring protocols for effluents and ash disposal, with transparency to domestic courts and international bodies.
- c) Suspend all coal-based projects in the Sundarbans region until cleaner energy alternatives are operational.
- d) Explore compensatory conservation measures, such as establishing new high-protection zones along the rivers, and implement a public, transparent oil-spill and disaster response plan as recommended by UNESCO in 2016.

7.4. Invest in Sustainable Energy and Climate Adaptation

- a) Accelerate the transition to renewable energy, including solar, wind, biogas, and energy-efficiency measures, aligning with Bangladesh's NDC targets of 15% - 21.85% emissions reduction by 2030.
- b) Provide climate finance support to Sundarbans communities via the Green Climate Fund and Clean Technology Fund for microgrids and renewable infrastructure.
- c) Expand and replant mangrove forests as natural buffers against flooding and storm surges while sequestering carbon.
- d) Modernize coastal embankments, cyclone shelters, and early warning systems using climate projection data, prioritizing the most vulnerable villages.

7.5. Empower Local Communities

- a) Recognize community forest user groups and integrate traditional knowledge into conservation strategies, per CBD Article 8(j).
- b) Permit regulated honey and fishery harvests under shared management plans.
- c) Develop microfinance and sustainable livelihood initiatives, such as eco-tourism and sustainable shrimp farming, ensuring no loss of mangrove cover.
- d) Engage NGOs and academic institutions to implement open, satellite-based monitoring of forest cover, water quality, and tiger populations, publishing results for public transparency.

7.6. Strengthen Institutional Capacity and Enforcement

- a) Provide adequate funding from Parliament to the Department of Environment and Forest Department, and create specialist positions with necessary training and monitoring technology. Current staffing covers only 38% of essential roles.
- b) Empower environmental courts under the 2017 Environmental Court Act to impose substantial penalties, including criminal sanctions, for violations.
- c) Convert strategic planning instruments like the SEMP into legally binding instruments, enabling the Supreme Court to revoke projects that violate international obligations.

7.7. Engage with International Institutions for Oversight

a) Invite UNESCO to conduct additional monitoring missions and support the creation of a UNESCO-IUCN-Bangladesh technical panel for Sundarbans assessment.

b) Ensure timely reporting to *Ramsar* and CBD secretariats and integrate donor and multilateral funding requirements, such as World Bank and Asian Development Bank loans, with mandatory environmental compliance conditions.

c) Establish shared satellite monitoring systems using climate finance mechanisms for real-time oversight of the delta.

These recommendations advance Sustainable Development Goals by integrating ecological protection (SDG 14 and 15) with poverty reduction and socio-economic development (SDG 1 and 8). Investments in mangrove restoration and renewable energy build resilience against climate change while maintaining biodiversity and safeguarding the livelihoods of over seven million Sundarbans residents. The World Bank indicates that failure to act risks biodiversity loss, economic productivity decline, and increased poverty, while resilience-oriented interventions are cost-effective.

By implementing international environmental law and adopting a holistic, cross-sectoral strategy, Bangladesh can fulfill its legal obligations, achieve climate adaptation and development goals, and protect the Sundarbans as a globally significant ecological and cultural treasure.

8. Conclusions

The Sundarbans is both a national treasure of Bangladesh and a global common, serving as the world's largest mangrove forest, a UNESCO World Heritage site, a critical carbon sink, and a natural shield for coastal communities. Our research demonstrates that, despite Bangladesh's ratification of multiple international environmental agreements, the country has repeatedly fallen short in translating these commitments into effective protection. The *Rampal* coal power project exemplifies this failure, as it proceeded near the Sundarbans in disregard of the precautionary and no-harm principles under the World Heritage Convention, causing substantial environmental and transboundary harm. Similarly, *Ramsar* recognition has not prevented ongoing mangrove degradation, deforestation, or delays in cross-border cooperation with India. These legal gaps are compounded by institutional weaknesses, underfunded agencies, and expired or inadequate environmental reviews.

The urgency for action is both ethical and legal. International law is not merely advisory: conventions such as UNESCO, *Ramsar*, CBD, the Paris Agreement, and customary rules like the no-harm principle impose mandatory obligations that require implementation. Bangladesh, as a State Party, has a clear duty to ensure that development in the Sundarbans is sustainable, ecologically responsible, and free from harm to neighboring states. The Sundarbans provides critical habitat for tigers and endangered species, buffers communities against cyclones and storm

surges, and sequesters significant carbon. Failure to protect this ecosystem constitutes not only a breach of international obligations but also a violation of inter-generational justice.

Our analysis emphasizes that the survival of the Sundarbans depends on fundamental changes in governance, enforcement, and policy. Sustainable development opportunities—including renewable energy, ecotourism, and nature-based coastal defenses—remain attainable, but only if legal frameworks are implemented with dedication and accountability. The international community and future generations will judge Bangladesh by its compliance with treaty obligations and its ability to safeguard this irreplaceable ecosystem. Immediate and decisive action is essential: further delay risks irreversible damage to the Sundarbans and to the global environmental heritage it represents.

Author Contributions

First author MD. MOHAJMINUL ISLAM primarily wrote the manuscript. Second author (Corresponding author) MD. MONJUR HASAN prepared it as a research article. Third author SHIJUN ZHANG provided the suggestion and clarified the concept. Fourth author MD. ABU HANIF reviewed the manuscript along with other authors.

Declaration of Generative AI and AI-Assisted Technologies in Manuscript Preparation

During manuscript preparation, the authors used Claude (Anthropic) solely for limited language editing of selected sentences to improve clarity. No AI tool was used to generate research content, analyze data, interpret results, or prepare references. The ideas, arguments, and intellectual contributions of the paper are entirely original. All AI-assisted suggestions were reviewed, revised where necessary, and approved by the authors, who take full responsibility for the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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