JCARM
Journal of Contemporary Academic Research and Methodologies

An Online Peer Reviewed / Refereed Journal
Volume 1 | Issue 7 | August 2026
ISSN: 3139-7247 (Online)
Website: www.journal.jcarm.in

Original Research Article

Environmental Law in the Anthropocene Delta: Legal and Institutional Responses to Ecological Change in Khulna, Bangladesh

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Article No: 014 | **Accepted**: 26 August 2026 | **Published**:10 September 2026

Abstract: The environmental crisis confronting Khulna cannot be understood through conventional categories of pollution control or climate vulnerability alone. Situated within the southwest Bengal Delta and adjacent to the Sundarbans, Khulna is experiencing interacting pressures arising from salinity intrusion, declining freshwater availability, aquaculture, industrialisation, urban expansion, biodiversity loss and climate-induced hazards. These pressures expose a structural weakness in environmental governance: ecological processes operate across river basins and administrative boundaries, whereas environmental regulation remains largely organised around sectors, projects and individual institutions. This article examines whether Bangladesh's environmental-law framework is capable of responding to this emerging condition, conceptualised here as the Anthropocene delta. Drawing on doctrinal and socio-legal analysis, the article examines the Constitution of Bangladesh, the Bangladesh Environment Conservation Act 1995, Environment Conservation Rules 2023, Environment Court Act 2010, Bangladesh Water Act 2013, Bangladesh Biodiversity Act 2017, climate and delta policies, relevant international environmental instruments and empirical literature on the southwest coastal region. It argues that Bangladesh's principal problem is no longer the absence of environmental legislation but the fragmented implementation of existing norms. The Khulna experience demonstrates the limitations of project-centred environmental impact assessment, insufficient coordination between environmental and water governance, weak integration of climate adaptation with ecological protection, and inadequate recognition of distributive and procedural environmental justice. The article proposes a transition towards integrated delta governance based on cumulative-impact assessment, strategic environmental assessment, ecosystem-based management, institutional coordination and meaningful community participation. Such a transition would allow environmental law to move from regulating individual activities towards governing cumulative ecological change across the delta.

 https://doi.org/10.5281/zenodo.22683914

Keywords: Anthropocene, Environmental Law, Khulna, Bangladesh, Sundarbans, Delta Governance, Environmental Rule Of Law, Salinity, Climate Justice, Environmental Impact Assessment

1. Introduction

Khulna occupies an unusual position in Bangladesh's environmental geography. It is simultaneously an urban centre, an industrial and commercial region, part of the southwest coastal zone and a major gateway to the Sundarbans. Its environmental condition is consequently shaped by processes that do not conform to administrative boundaries. River flows, tidal movements, salinity, sedimentation, land-use change and coastal hazards connect Khulna with a much wider deltaic system. The environmental consequences are equally interconnected. Changes in freshwater availability affect agriculture and fisheries; salinity influences drinking water and food production; aquaculture alters patterns of land and water use; industrialisation generates pollution risks; and changes in the surrounding ecosystem affect the resilience of communities facing cyclones, flooding and sea-level rise.

These relationships have become more significant under conditions commonly described as the Anthropocene. The concept refers, in broad terms, to the scale at which human activity has become a major force influencing planetary systems (Crutzen, 2002; Steffen et al., 2015). For environmental law, its significance is not dependent upon whether the Anthropocene is ultimately recognised as a formal geological epoch. Its analytical value lies in demonstrating that environmental harm increasingly arises from interactions between human interventions and ecological systems rather than from isolated sources of pollution.

The southwest of Bangladesh illustrates this transformation particularly clearly. Scientific research has established the relationship between climate change and increasing soil salinity in coastal Bangladesh, with particularly significant consequences for agricultural production (Dasgupta et al., 2015). Aquatic salinisation also threatens fish habitats and poor coastal communities, while increasing salinity has implications for the composition and ecological functions of mangrove species in the Sundarbans (Dasgupta et al., 2017a, 2017b). More recent research has linked salinity dynamics in the Sundarbans to climate change, freshwater inflow and sea-level changes (Wahid et al., 2025). The consequences therefore extend from ecological systems to livelihoods, food security and human well-being.

The legal framework, however, has developed through a different logic. Bangladesh possesses a substantial body of environmental legislation. Article 18A of the Constitution establishes a constitutional commitment to environmental protection. The Bangladesh Environment Conservation Act 1995 provides the central statutory framework for environmental conservation and pollution control, while the Environment Conservation Rules 2023 have modernised the regulatory system for environmental assessment and clearance. The Environment Court Act 2010 provides a specialised judicial mechanism, and

legislation concerning water, biodiversity, forests and wildlife supplements the principal environmental statute. Bangladesh has also adopted the Bangladesh Delta Plan 2100 and National Adaptation Plan 2023–2050, both of which recognise the need for integrated responses to climate and environmental vulnerability.

The difficulty, therefore, is not easily characterised as legislative absence. The more fundamental problem concerns the relationship between ecological systems and legal institutions. An ecosystem may operate as a connected whole, while the institutions responsible for its governance remain divided between water, environment, agriculture, fisheries, forestry, land, local government and climate adaptation. An individual development project may comply with environmental requirements while the cumulative effect of numerous projects, infrastructure interventions and land-use changes produces ecological degradation.

This article argues that Khulna demonstrates the need to reconsider the regulatory architecture of environmental law in Bangladesh. The central challenge is the transition from a predominantly project-centred and sectoral model of environmental regulation towards integrated delta governance. Such governance must account for cumulative ecological impacts, climate risks, biodiversity, water systems and the unequal distribution of environmental burdens.

The analysis proceeds through doctrinal and socio-legal examination of Bangladesh's environmental-law framework alongside empirical research concerning the southwest coastal region. The article treats Khulna not as an isolated administrative unit but as part of a wider ecological system encompassing the southwest delta and the Sundarbans. This approach is necessary because the environmental processes under examination do not stop at district boundaries.

2. The Anthropocene Delta as a Legal Problem

Traditional environmental regulation is generally structured around identifiable activities and identifiable environmental effects. Industrial emissions, waste discharge, forest conversion or development projects can be subjected to specific regulatory standards. Environmental impact assessment similarly developed principally as a mechanism for evaluating the anticipated consequences of particular projects.

The delta presents a more complicated regulatory problem. A river does not distinguish between administrative jurisdictions. Salinity does not respect the boundaries of an environmental clearance. Sediment flows are not confined to a development site. Nor can the ecological consequences of multiple projects necessarily be understood by examining each project independently. This creates what may be described as a scale mismatch between ecological processes and legal governance. The ecological scale is frequently regional and cumulative; the legal scale is often project-specific and institutional.

The problem becomes particularly acute where climate change modifies the environmental baseline. Environmental regulation traditionally assumes some degree of

stability in the ecological conditions against which impacts can be assessed. Climate change undermines that assumption. Sea-level rise, changing precipitation, altered river discharge and increasing climatic extremes can change the ecological conditions within which a project operates. An environmental decision that appears reasonable under historical conditions may therefore become inadequate during the project's operational life.

The legal consequence is significant. Environmental assessment in a climate-vulnerable delta cannot be confined to the question of whether a project causes additional harm under present conditions. It must also consider whether the project remains environmentally sustainable under foreseeable future conditions.

The Anthropocene delta thus demands a broader conception of environmental legality. The relevant question is not simply whether a particular activity complies with a particular rule. It is whether the cumulative pattern of legally authorised activities remains compatible with the ecological resilience of the system.

3. Environmental Law and the Khulna–Sundarbans System

Bangladesh's constitutional framework provides a strong normative foundation for environmental protection. Article 18A directs the State to protect and improve the environment and to preserve natural resources, biodiversity, wetlands, forests and wildlife for present and future citizens. Although Article 18A belongs to the fundamental principles of State policy rather than the directly enforceable fundamental rights chapter, its language establishes a clear constitutional orientation towards environmental stewardship and intergenerational responsibility.

The constitutional dimension is reinforced by judicial developments in environmental public-interest litigation. The expansion of standing in *Dr Mohiuddin Farooque v Bangladesh* demonstrated that environmental degradation could be treated as a matter of public concern rather than merely a private dispute. Bangladesh's environmental constitutionalism has consequently developed through an interaction between constitutional principles, statutory regulation and judicial intervention.

The principal statutory instrument remains the Bangladesh Environment Conservation Act 1995. The Act established the Department of Environment and provides powers concerning pollution control, ecologically critical areas, environmental clearance, inspection, environmental standards, penalties and compensation. Its definition of an ecosystem itself reflects an ecological understanding, referring to the interdependent and balanced association of environmental components.

The Environment Conservation Rules 2023 provide the more detailed regulatory framework. They contain provisions concerning environmental assessment, environmental management plans, environmental standards and treatment facilities, as well as procedures concerning appeals and environmental clearance. Their significance for Khulna lies in the potential to move environmental regulation beyond simple pollution control towards more systematic environmental assessment.

The difficulty is that a legally sophisticated clearance system does not necessarily produce ecologically sustainable outcomes. The effectiveness of environmental assessment depends upon the quality of baseline information, the independence and competence of assessment, the consideration of alternatives, monitoring after approval and the capacity of regulators to respond when environmental conditions change. This distinction between formal legality and ecological effectiveness is central to the Khulna problem.

The Environment Court Act 2010 adds a judicial dimension to the regulatory framework. Specialised environmental adjudication can provide an important mechanism for enforcement, compensation and accountability. Yet courts cannot substitute for effective administrative governance. Where monitoring is weak, information is inaccessible or institutional responsibilities overlap, litigation may occur only after environmental damage has become difficult to reverse.

The Bangladesh Water Act 2013 and Bangladesh Biodiversity Act 2017 further demonstrate the breadth of the national framework. Their importance for the southwest arises from the fact that environmental degradation cannot be separated from water governance and biodiversity conservation. The Sundarbans depends upon hydrological processes extending beyond its formal forest boundaries. Its ecological condition is therefore influenced by decisions taken elsewhere in the river system.

The international dimension reinforces this conclusion. Bangladesh's obligations under the Convention on Biological Diversity, Ramsar Convention and World Heritage Convention create overlapping commitments concerning biodiversity, wetlands and the protection of the Sundarbans. Hossain (2025) has shown that the legal significance of these instruments lies not simply in Bangladesh's formal participation but in the extent to which their conservation principles are translated into domestic implementation. This problem is particularly important where large-scale development and environmental conservation intersect.

The international framework has increasingly emphasised cumulative environmental assessment in relation to the Sundarbans. UNESCO's World Heritage Committee has raised concerns regarding development pressures and the need for strategic assessment in the southwest region. The significance of this approach is that it moves beyond assessing individual projects towards considering the combined consequences of development within a sensitive ecological system.

Table 1: Legal and Institutional Framework Governing the Khulna–Sundarbans Socio-Ecological System

Legal/policy instrument	**Principal environmental concern**	**Relevance to Khulna–Sundarbans**	**Principal institutional mechanism**
Constitution of Bangladesh, Art. 18A	Environmental protection, biodiversity and	Provides the constitutional basis for protecting the ecological integrity of the southwest and Sundarbans	State policy and constitutional interpretation

	natural-resource conservation		
Bangladesh Environment Conservation Act 1995	Pollution control, ecological conservation and environmental clearance	Regulates environmentally harmful activities and provides the principal statutory basis for environmental administration	Department of Environment
Environment Conservation Rules 2023	Environmental assessment, clearance and environmental standards	Provides procedural and technical mechanisms for assessing development activities in environmentally sensitive areas	Department of Environment
Environment Court Act 2010	Environmental adjudication and enforcement	Provides a specialised judicial mechanism for environmental offences and claims	Environment Courts and Special Magistrate Courts
Bangladesh Water Act 2013	Water resources, water use and water management	Particularly relevant to freshwater flows, salinity intrusion, river systems and coastal water management	Water Resources Planning Organization and relevant water authorities
Bangladesh Biodiversity Act 2017	Conservation and sustainable use of biological diversity	Relevant to the Sundarbans, wetlands, fisheries and associated ecosystems	Relevant government authorities and biodiversity institutions
Bangladesh Wildlife (Conservation and Security) Act 2012	Wildlife and habitat conservation	Provides protection for wildlife and habitats associated with the Sundarbans	Forest Department
Bangladesh Forest Act 1927 and subsequent amendments	Forest management and protection	Provides the historical legal basis for forest administration, including the Sundarbans	Forest Department
Bangladesh Delta Plan 2100	Long-term integrated delta management	Directly relevant to the southwest coastal zone, water security, climate resilience and environmental sustainability	Planning Commission and multiple sectoral institutions
National Adaptation Plan of Bangladesh 2023–2050	Climate adaptation and resilience	Addresses climate-induced risks affecting coastal communities, water, agriculture and ecosystems	Ministry of Environment, Forest and Climate Change

			and associated agencies
Ramsar Convention	Wetland conservation and wise use	Provides an international framework relevant to the Sundarbans as a globally significant wetland ecosystem	Government of Bangladesh and relevant national authorities
Convention on Biological Diversity	Biodiversity conservation and sustainable use	Supports ecosystem and biodiversity protection within and around the Sundarbans	Government of Bangladesh
World Heritage Convention	Protection of outstanding natural heritage	The Sundarbans' World Heritage status creates additional international conservation obligations	Government of Bangladesh and UNESCO mechanisms

4. Salinity, Water Governance and the Limits of Sectoral Regulation

Salinity is perhaps the clearest example of the inadequacy of fragmented environmental governance in Khulna.

The scientific literature establishes that coastal salinity is influenced by several interacting factors. Climate change and sea-level rise increase the risk of saline intrusion, while freshwater inflow, river morphology, rainfall, tidal processes and human intervention shape its spatial and temporal distribution (Dasgupta et al., 2015; Wahid et al., 2025). The consequences are substantial. Soil salinity threatens agricultural productivity, aquatic salinisation affects fisheries and changes in salinity influence mangrove composition within the Sundarbans (Dasgupta et al., 2017a, 2017b).

The social distribution of these effects is equally important. Research has found that salinity affects household food production in southwest coastal Bangladesh, including crop cultivation, gardening, livestock and aquaculture (Lam et al., 2022). The effects therefore extend beyond environmental degradation into questions of livelihood security and distributive justice.

The legal significance of salinity is that it cannot be assigned neatly to a single regulatory institution. Water authorities may focus on river management; agricultural authorities may focus on crop productivity; fisheries authorities may promote aquaculture; environmental authorities may regulate pollution; and climate institutions may develop adaptation projects. Yet the cumulative ecological condition emerges from the interaction of these decisions.

This produces a governance paradox. An intervention designed to address one problem may intensify another. Water-control infrastructure may reduce flooding in one location while altering drainage elsewhere. Saline aquaculture may provide income where agricultural production has become difficult while simultaneously reinforcing changes in land and water use. Coastal embankments may provide short-term protection while

affecting sedimentation and tidal exchange.The appropriate legal response cannot therefore be confined to regulating individual activities. It requires a spatial and cumulative approach capable of evaluating how different interventions affect the same ecological system.

Recent scientific evidence makes this increasingly urgent. Wahid et al. (2025) found significant spatial variation in salinity within the Sundarbans and linked salinity dynamics to freshwater inflow and sea-level changes. The study reinforces the importance of considering hydrological connections rather than treating the forest as an isolated conservation area.

A comparable point emerges from research on fisheries. Dasgupta et al. (2017a) projected that increasing aquatic salinity could produce particularly serious effects on poor communities, with areas inhabited by poor populations more likely to experience fish-species losses than gains. Such findings complicate any environmental policy that treats ecological change simply as a technical management issue. The legal system must also address who bears the consequences.

5. Development, Environmental Assessment and Cumulative Impacts

Khulna's environmental future cannot be separated from infrastructure and economic development. Industrial activity, transport infrastructure, urban expansion, energy projects and aquaculture are all capable of generating economic benefits. Environmental law should not be understood as an automatic prohibition of development. Its purpose is to establish the conditions under which development remains compatible with ecological integrity and social welfare.

The problem is particularly acute where environmental assessment remains centred on individual projects.

Environmental impact assessment is indispensable because it introduces environmental considerations into development decisions before significant harm occurs. The Environment Conservation Rules 2023 strengthen the legal architecture for environmental assessment and environmental management. Yet project-level EIA has an inherent limitation. It may determine whether Project A is acceptable without adequately considering Projects B, C and D operating within the same ecological system.

The distinction between individual and cumulative impact is crucial in the southwest. The Sundarbans and surrounding waterways are exposed not to one source of environmental pressure but to a combination of industrial activity, navigation, pollution, land-use change, water abstraction, climate change and local resource exploitation. The legal assessment of each activity separately may therefore underestimate the total ecological burden.

Research concerning the Rampal power project illustrates the broader controversy. Razzaque (2019) examined the environmental impact assessment of the project in the context of mangrove ecosystem management and raised questions concerning the adequacy of environmental assessment and protection of vulnerable communities. The significance of the debate extends beyond that individual project. It demonstrates the difficulty of

reconciling major infrastructure development with the ecological sensitivity of the Sundarbans landscape.

Strategic Environmental Assessment offers a potentially more suitable legal mechanism for this context. Unlike project-level EIA, SEA examines policies, plans and programmes. It can therefore assess whether an entire pattern of development is compatible with ecological objectives before individual projects become entrenched.

For Khulna, the strongest legal model would not replace EIA with SEA. It would combine them. Strategic assessment should establish ecological limits and development conditions for sensitive areas, while project-level assessment should determine whether particular proposals comply with those broader conditions. Such an approach would bring environmental law closer to the ecological scale of the Anthropocene delta.

6. Institutional Fragmentation and Environmental Rule of Law

The existence of multiple environmental institutions is not inherently problematic. Environmental governance necessarily requires specialisation. The difficulty arises where institutional mandates overlap without adequate mechanisms for coordination.

In Khulna, environmental outcomes may depend simultaneously upon the Department of Environment, Bangladesh Water Development Board, Forest Department, Department of Fisheries, agricultural authorities, land administration, local government and climate-adaptation institutions. Each may possess a legitimate statutory or policy mandate, yet no single decision necessarily captures the cumulative ecological consequences of their combined actions.

Research on protected-area governance in the Sundarbans supports the importance of institutional design and participation. Mollick et al. (2022) found that co-management arrangements created opportunities for improved governance but also exposed limitations in participation and institutional practice. Subsequent research has similarly examined social equity within protected-area co-management, demonstrating that participation cannot be treated as a procedural formality detached from questions of power and distribution.

The broader environmental rule-of-law literature provides a useful framework for understanding this problem. UNEP's global assessments emphasise that the proliferation of environmental laws has not necessarily been accompanied by equally effective implementation and enforcement. Environmental rule of law requires legality, accountability, transparency, participation and access to justice, rather than legislation in isolation.

This distinction is particularly relevant to Bangladesh. The country possesses an environmental statute, environmental rules, specialised courts, biodiversity legislation and climate policies. Yet the existence of these instruments does not itself establish effective environmental governance.

Environmental rule of law in Khulna would require at least three forms of institutional integration. First, environmental information must circulate between agencies.

Second, major decisions concerning water, land, infrastructure and conservation should be assessed against common ecological objectives. Third, affected communities must be able to identify the institution responsible for environmental decisions and challenge failures through accessible mechanisms.

The Bangladesh Delta Plan 2100 already provides an important policy foundation for this approach. Its stated vision is a safe, climate-resilient and prosperous delta, with long-term water and food security, economic growth and environmental sustainability pursued through adaptive and integrated strategies and equitable water governance. The National Adaptation Plan similarly identifies good governance and the integration of adaptation into planning as one of its central objectives.

The unresolved issue is therefore implementation: whether these integrated policy commitments can influence the ordinary administrative decisions through which environmental change actually occurs.

7. Environmental Justice and Participation

The environmental crisis in Khulna is also a question of justice. Environmental degradation does not distribute its costs evenly. Households dependent upon agriculture, fisheries, forests or local water sources generally possess fewer resources with which to adapt to ecological change than commercial enterprises and better-connected urban actors.

This distributive dimension is evident in the literature on salinity and livelihoods. Lam et al. (2022) demonstrate how salinity affects household food production, while Dasgupta et al. (2017a) show the disproportionate vulnerability of poor fishing communities to changes in aquatic salinity. These findings indicate that environmental regulation should not assess ecological impacts without considering their social distribution.

Procedural justice is equally important. Communities affected by development decisions need meaningful opportunities to participate in environmental decision-making. Research on coastal Bangladesh has demonstrated the relevance of public perception, knowledge and participation to climate adaptation governance (Bahauddin et al., 2016). Research on local knowledge similarly indicates that community knowledge can contribute to the design of more locally appropriate adaptation strategies.

Participation should therefore occur before decisions become irreversible. Consultation after environmental clearance has been granted cannot provide the same democratic value as participation during planning and assessment.

This principle has particular importance in the Sundarbans. Local communities are not merely potential beneficiaries of conservation policy; many depend upon forests, fisheries and surrounding ecosystems for their livelihoods. Conservation that excludes local communities may generate resistance or undermine compliance, whereas participatory governance can align ecological protection with livelihood needs.

The environmental-justice approach also complements the emerging human-rights dimension of climate governance. Hossain and Emu (2024) examined climate change and child health in southern Bangladesh, demonstrating how environmental vulnerability can translate into human consequences. Hossain et al. (2026) further connected climate change with international human-rights obligations and emerging jurisprudence. These perspectives reinforce the proposition that environmental governance should not treat ecological harm as an abstract problem of resource management. Its consequences are experienced through health, livelihood, food, water and human dignity.

8. Towards Integrated Delta Governance

The appropriate response to Khulna's environmental challenges is not simply to enact another environmental statute. The existing framework already contains substantial regulatory authority. The more pressing task is to make that framework operate coherently at the scale of the delta.

The first requirement is a stronger cumulative-impact approach. Environmental assessment should consider the combined effects of multiple activities where projects operate within the same ecological system. This is particularly important in sensitive coastal areas and around the Sundarbans. Environmental clearance should also become more explicitly climate-sensitive, requiring consideration of foreseeable changes in salinity, flooding, sea-level rise and ecological conditions over the project's operational life.

The second requirement is greater integration between environmental and water governance. The legal treatment of water cannot remain separate from biodiversity and ecosystem protection. Freshwater flows are an ecological condition for the Sundarbans and a determinant of salinity across the southwest. Decisions affecting rivers and water infrastructure should therefore be assessed against downstream ecological consequences rather than evaluated exclusively according to engineering or economic objectives.

The third requirement concerns institutional coordination. Bangladesh does not necessarily require a new centralised environmental authority. Excessive centralisation could create new bureaucratic problems. What is needed is a durable coordination mechanism through which environment, water, fisheries, forestry, agriculture, land and climate institutions operate on the basis of shared ecological information and agreed regional objectives. The governance literature suggests that adaptive and collaborative arrangements may be better suited to complex socio-ecological systems than rigidly hierarchical approaches.

The fourth requirement is transparency. Environmental impact assessments, environmental-clearance decisions, compliance reports and monitoring data should be accessible to the public in a usable digital form. Environmental rule of law is difficult to realise when communities cannot determine what was approved, what conditions were imposed or whether those conditions have been complied with.

Finally, environmental governance should incorporate justice explicitly. Environmental assessment should ask not only whether a project generates environmental

harm but also which groups bear that harm and whether mitigation measures adequately address their vulnerability. Such an approach would give practical effect to the constitutional concern for present and future citizens while connecting environmental protection with contemporary principles of climate and environmental justice.

The significance of these reforms extends beyond Khulna. If Bangladesh can develop a governance model capable of integrating environmental regulation, climate adaptation, water management, biodiversity protection and participation in the southwest delta, that model could become relevant to other climate-vulnerable regions of the country.

9. Conclusion

Khulna represents a distinctive environmental-law problem because the ecological pressures affecting the region are interconnected while the legal institutions responsible for responding to them remain substantially sectoral. Salinity is simultaneously a climate, water, agricultural and livelihood issue. The Sundarbans is simultaneously a forest, biodiversity, freshwater, climate-resilience and community-livelihood system. Industrial and infrastructure development generates economic benefits while creating cumulative ecological pressures that cannot always be understood through individual project assessment.

Bangladesh has already established much of the legal architecture necessary for responding to these challenges. Article 18A provides constitutional recognition of environmental protection; the Environment Conservation Act 1995 and Rules 2023 establish regulatory mechanisms; environmental courts provide judicial oversight; biodiversity and water legislation broaden the legal framework; and the Delta Plan 2100 and National Adaptation Plan provide an integrated policy vision.The principal weakness lies in the gap between these instruments and the ecological realities they are intended to govern.

The Anthropocene delta requires environmental law to operate at a different scale. The regulatory question must move beyond whether an individual project complies with an individual environmental standard towards whether cumulative development remains compatible with the ecological resilience of the wider system. Environmental impact assessment should therefore be complemented by strategic and cumulative assessment; water governance should be connected to ecosystem protection; climate adaptation should remain subject to environmental accountability; and communities affected by ecological change should have meaningful opportunities to participate in decisions concerning their environment.

The deeper lesson from Khulna is that environmental degradation is increasingly a problem of governance rather than legislation alone. A fragmented regulatory system can produce legally authorised activities whose cumulative consequences are ecologically unsustainable. The challenge for Bangladesh is consequently to transform its existing collection of environmental norms into an integrated system of delta governance. The

Anthropocene does not necessarily demand more environmental law. It demands an environmental law capable of seeing the whole delta.

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