

Comparative Legal Approaches to Wetland Conservation in India, the United States and China

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Abstract

Wetlands have long-standing economic and socio-cultural benefits and provide essential ecosystem services; yet they are amongst the most administratively vulnerable habitats on the planet. Despite their widely recognized worth, they are significantly collapsing due to governance failure, rapid economic and population growth and land-use policies. Through a comparative legal analysis of India, the United States (US), and China, this article examines how differing legal and regulatory frameworks shape wetland conservation outcomes. The study has four primary objectives: to compare the governance structures of the three jurisdictions; to analyze the role of ecological attributes in legal protection; to evaluate implementation challenges and best practices; and to propose an integrated governance model. The analysis reveals that while each country has developed distinct legal instruments- from India's decentralized Wetland Rules and the U.S.'s permit-based Clean Water Act to China's centralized Wetland Protection Law- effectiveness is consistently undermined by fragmented enforcement, regulatory ambiguity, and inadequate community integration. The article argues that sectoral approaches are insufficient to ensure wetland resilience and inter-generational equity. Instead, it contends that wetlands must be incorporated into legal, economic, and socio-cultural frameworks through an "integrated governance model" that combines robust regulation, participatory stewardship, scientific monitoring, and climate-adaptive planning.



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Introduction


In June 2025, the Coorong wetland in South Australia- a globally recognized Ramsar site- faced an exceptional ecological sag due to a toxic algal bloom (*Karenia mikimotoi*), intensified by excessive

nutrients and a marine heatwave, thereby killing thousands of Coorong's polychaete worms, crabs, and fish.¹ Simultaneously, the Sahebbandh wetland in India's Purulia, West Bengal also appeared severely degraded due to untreated wastewater

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inflows, eutrophication, poor aquatic vegetation management, and human encroachment, resulting in diminished migratory bird population from 3700 to below 70 within a year.² These simultaneous events indicate a broader pattern of global wetland loss, jeopardizing ecological integrity and biodiversity, compromising local livelihoods and weakening the ability of ecosystems to mitigate the effects of climate change.

Wetlands are ecologically distinct systems defined by their hydrological attributes, which determine soil conditions, vegetation structure, thereby supporting higher biodiversity levels. Ecosystems like bogs, marshes, and swamps are characterised by persistent water saturation, that establishes legally and ecologically identifiable habitats that support a variety of life forms. Wetlands stabilize broader ecological systems while sustaining cultural, recreational, and livelihood activities such as fishing, bird-watching, and community traditions. In addition to their biodiversity significance, wetlands perform essential regulatory activities, including water purification, flood mitigation, and carbon storage, which are fundamental to ecological stability and human welfare.

Wetlands have seen persistent and disproportionate degradation compared to other ecosystem types, indicating their increased susceptibility within contemporary socio-ecological systems. This situation has been acknowledged in global environmental evaluations, which identify wetlands as some of the most severely degraded ecosystems globally.³ The drivers of this decline are wide-ranging including urban expansion, intensive farming, industrial operations, and climate-related pressures that collectively affect hydrological regimes, land-use patterns, and ecosystem resilience. Despite the statutory recognition of certain wetlands within conservation frameworks, public understanding and awareness of their ecological functions frequently remains inadequate, undermining local participation and stewardship. In settings where wetlands are not seen as ecologically significant systems, conservation initiatives often remain disjointed or merely symbolic, reliant on designation rather than sustained participation. In these situations, protection based solely on formal recognition, lacking informed public involvement and knowledge-

based governance procedures, is improbable to prevent continuing wetland degradation.

The socio-economic development driven by industrial growth, intensive agriculture, and weakly regulated land-use practices has become a primary contributor to the global degradation of wetlands. These pressures alter landscapes and hydrological regimes in ways that gradually reduce wetland extent, ecological integrity, and functional resilience. The consequences of this degradation surpass environmental loss, as deteriorating wetland conditions threaten ecosystem services intimately associated with public health, especially in settings where sanitation, water quality, and livelihood security are already precarious. The intensification of urbanization, tourism, and commercial land uses without sufficient ecological safeguards exacerbates water quality deterioration and contamination risks, thereby increasing social vulnerability. These dynamics emphasize the inadequacies of reactive or fragmented interventions and stress the necessity for continuous monitoring, institutional oversight, and adaptive management strategies that can address cumulative ecological stressors.

Drawing upon the above discussed sweeping degradation of wetlands, and associated risks, the article is divided into five parts. With regard to the introduction, the article first glances through the economic, ecological, and socio-cultural importance of wetlands, forming the conceptual foundation for the issues and challenges surrounding their conservation. The key ecological attributes are then examined- specifically hydrological indicators and vegetation attributes that ascertain wetland functionality and resilience. Based on this foundation, the article proceeds to have comparison of wetland governance in India, the U.S., and China. It analyses the recognized best-practices for wetland conservation and moving with the legal and governance challenges that hinders wetland restoration. The research then places wetland protection within comprehensive legal, economic, and socio-cultural imperatives, directing towards specific recommendations. The article then concludes by integrating these insights and points out the necessity of a coherent, participatory, and adaptive approach.

Importance of Wetland Conservation

Wetlands have long been recognized in the literature as ecological infrastructures of exceptional value that sustain socio-economic equilibrium and biodiversity on a variety of scales. Nearly 40% of all known species either live in or rely on wetland habitats for essential life-cycle activities, according to the intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment Report on Biodiversity and Ecosystem Services, making them extraordinarily important for the conservation of biodiversity globally.⁴ Concurrently, wetlands have experienced persistent and disproportionate degradation in recent decades, highlighting their susceptibility to land-use alterations, habitat transformation, and developmental pressures. Global environmental assessments consistently attribute this decline to accumulating ecological consequences, such as the disruption of migratory species networks and the degradation of ecosystem functions that underpin ecological stability at both regional and global scales.⁵ Studds *et al.*, highlight robust empirical evidence from Yellow Sea tidal mudflats indicating substantial drops in shorebird population directly linked to habitat loss at key stopover sites, thereby demonstrating how localized reclamation can result in extensive, transboundary consequences.⁵ The scale and persistence of these losses have drawn increasing attention within international biodiversity governance, where wetland conservation is no longer viewed as a peripheral environmental concern but as a foundational requirement for preventing further species loss and ecosystem destabilisation.³ The Kunming–Montreal Global species Framework, which requires states to repair at least 30% of degraded ecosystems, including wetlands, by 2030, has made wetland conservation a fundamental need for preventing the loss of species.⁶

Besides their ecological contribution, wetlands are essential for maintaining economic systems by facilitating various ecosystem functions that support production, livelihoods, and public welfare. Their ability to manage water flows, mitigate floods, purify water, and cycle nutrients enhances economic stability across various sectors, including agriculture, fisheries, and urban water management. The degradation of these regulatory functions leads to economic consequences that surpass mere environmental loss, influencing income security,

infrastructure resilience, and public expenditure. The cumulative degradation of wetland functions reveals the intrinsic connection between ecological integrity and economic sustainability, emphasizing that wetland conservation is not solely an environmental issue but a fundamental necessity for enduring socio-economic resilience. By highlighting our heavy economic dependence on wetlands, Global Wetland Outlook 2025 forecasted that persistent wetland degradation might result in the annual loss of up to \$39 trillion in ecosystem services.⁷

Moreover, they serve as essential elements of climate adaptation and mitigation efforts, especially with rising climatic unpredictability. The degradation of wetlands exacerbates the frequency and severity of flooding, whereas their restoration mitigates the socio-economic costs linked to disasters, establishing wetland conservation as a fundamental component of comprehensive resilience-building initiatives. Moreover, wetlands also serve as a catalyst from a socio-economic approach. Wetlands directly support the livelihoods of more than a billion people globally, primarily through agriculture, fishing, and water supply. Additionally, they act as “natural infrastructure”. Mangroves and saltmarshes, for example, can reduce wave energy by up to 66% within the first 100 meters, shielding millions of people living along the coast from storm surges and lowering the cost of disaster recovery.⁸ Consequently, wetland conservation need prioritized attention owing to its ecological, economic, and governance significance. The ongoing extensive degradation of wetlands has intensified pressure on ecological stability and human reliance on these systems, resulting in long-term consequences for biodiversity conservation and climate resilience. These trends threaten to compromise overarching environmental and developmental goals. In this context, wetland conservation serves not just as environmental protection but also as a fundamental investment in human well-being, climate resilience, and sustainable development.

While wetlands possess high and long-standing economic, ecological, and socio-cultural importance, their conservation still carry steady and allied issues and challenges. The gap between acclaimed utility and potent conservation stresses the need to draw attention to analyse the systemic and socio-economic factors that impede wetland conservation efforts.

Wetland Conservation Issues and Challenges

Notwithstanding, widely recognized importance, wetlands are largely seen as amongst the most endangered ecosystems, with lasting causes—pollution, eutrophication, human encroachment, and sewerage—persistently degrading aquatic systems, evidenced in declining number of bird population in Purulia's Sahebbandh wetland over the decennium.² These pressures are exacerbated in locales influenced by industrial operations, intensive agriculture, and aquaculture, where chemical inputs, waste disposal, and modified hydrological systems gradually weaken ecological balance and functional resilience. Evidence from extensive wetland systems indicates that even prolonged restoration efforts may fail to mitigate accumulated nutrient loads and legacy effects, highlighting the inadequacies of fragmented or narrowly technocratic approaches in the presence of persistent governance deficiencies.⁹ Habitat degradation due to reclamation and swift urban development contributes to these issues, demonstrating that formal protection or international designation alone does not ensure effective conservation without consistent enforcement and institutional coordination.¹⁰ Empirical research illustrates that extensive wetland degradation, especially the loss of intertidal habitats, generates cascading ecological effects that transcend localized impacts, disrupting migratory networks and regional biodiversity systems. Their findings highlight that governance failures and lenient land-use decisions may have ecological consequences that are widespread and challenging to remediate, emphasizing the necessity for preventative and cohesive conservation strategies.⁵ Governance limitations—specifically, redundant regulatory mandates, inconsistent enforcement, and inadequate accountability mechanisms—interact with climate-related stressors, including fluctuating salinity levels, severe flooding, droughts, and marine heatwaves, heightening the strains on already vulnerable wetland ecosystems. The above-mentioned incident from Coorong clearly demonstrated how nutrient enrichment and climate extremes collectively lead to ecological collapse¹ and endangering biodiversity, ecosystem stability, and human livelihoods simultaneously reiterating threat to estuary wetlands. These dynamics highlight the intricacy of wetland conservation, wherein ecological degradation and socio-economic instability stem not from isolated pressures but from the cumulative interplay of

environmental change and fragmented governance responses, emphasizing the necessity for integrated approaches that harmonize scientific knowledge, legal frameworks, and community engagement.

The presence of continuous ecological and governance-related challenges stipulates that an effective wetland conservation approach has to be more than mere policies and regulations. It is imperative to have a thorough understanding of the “biophysical” characteristics of wetland systems that govern their resilience and degradation. Consequently, the article further outlines the ecological attributes of wetlands, particularly hydrological and vegetation dynamics which strengthens wetland structure, functions, and rehabilitation. Comprehending these attributes lays down the scientific foundation required for wetland conservation, restoration efforts, and regulatory and policy intervention.

Objectives of the Study

This article intends to conduct a comparative legal analysis of wetland conservation frameworks in India, the U.S., and China. The study aims to:

- Examine and compare the primary legal and institutional frameworks governing wetlands across the three jurisdictions;
- Identify and assess the key ecological attributes of wetlands that determine legal protection and management approaches;
- Analyze the implementation challenges, best practices, and socio-ecological outcomes associated to each regulatory model;
- Propose a cohesive governance system that aligns legal, economic, and socio-cultural imperatives for the resilient conservation and restoration of wetlands.

Materials and Methods

This study employs a doctrinal and comparative legal research design to examine the wetland conservation frameworks of India, the U.S., and China. The study is qualitative and non-empirical in nature, relying upon textual and interpretive analysis of legal and policy documents.

Data Collection

The primary sources comprised the fundamental legal documents regulating wetlands in each jurisdiction

India

The Environment (Protection) Act, 1986; National Environment Policy, 2006; Biological Diversity Act, 2002; Wetlands (Conservation and Management) Rules, 2017; and relevant judicial pronouncements.

United States

The Clean Water Act, 1972 (particularly Section 404); Food Security Act, 1985 (Swampbuster provisions); and leading Supreme Court cases defining jurisdictional scope (e.g., *Riverside Bayview Homes*, *Sackett v. EPA*).

China

The Wetland Protection Law, 2021; National Wetland Protection Plan (2022-2030); and associated regulatory guidelines.

Secondary sources comprised government reports, policy documents, scholarly articles, legal commentaries, and expert comments to provide context, interpretation, and critical assessment of the primary materials.

Analytical Framework

The analysis proceeded in three consequential phases:

Doctrinal Analysis

A systematic review and synthesis of the legal rules, principles, and institutional structures within each national framework was conducted. This involved analyzing the statutory language, regulatory mandates, enforcement strategies, and policy objectives to comprehend the formal architecture of wetland governance.

Comparative Legal Analysis

A structured comparison across the three jurisdictions was undertaken based on the established criteria drawn from the research objectives – primary legal framework; governance structure; community participation; monitoring tools; scope of protection; prohibited activities; and enforcement challenges. A comparative table (Section 3.2.4) synthesizes these findings.

Normative Analysis

The coherence, gaps, and practical efficacy of the legal frameworks were assessed. This phase entailed the identification of inconsistencies,

overlaps, implementation barriers, and the alignment or misalignment of legal provisions with ecological imperatives and socio-economic realities resulting in the formulation of recommendations.

Limitations

This research, as a doctrinal and comparative study, is limited to the examination of textual and documented legal and policy materials. It does not produce new empirical data on ground-level ecological or social outcomes; however, it engages with the existing empirical studies reference in the literature. The findings are therefore interpretive and analytical, concentrating on legal structure and their reported theoretical and practical implications.

Results**Wetland Attributes**

Wetlands can be understood through fundamental “attributes” that regulate their functionality and ecological importance. These characteristics pertain to the availability of water, composition of the soil, and the variety of flora present in wetland areas, thereby defining the ecological identity of wetlands and affecting their response to anthropogenic activities and environmental alterations. The presence and movement of water are crucial, establishing hydrology as the base for understanding wetland attributes.

Hydrological Indicators

Hydrological indicators elucidate the presence, movement, and retention of water within a wetland, rendering them essential for understanding wetland identity, functions, and legal protection. In regulatory and judicial contexts, hydrological indicators- hydroperiod, table water depth, connectivity- can contribute to assessments of a wetland’s ecological character and protection status.

Hydrological connectivity is fundamental to wetland functionality, thereby supporting essential physical processes and ecological interactions. This interconnectedness facilitates the evaluation of biodiversity and ecological complexity, which guides assessments of a wetland’s ecological character- a fundamental concept under Ramsar Convention.¹¹

Hydrological indicators- water table depth, hydroperiod, soil saturation, surface water extent, flow variability, water retention capacity- shaping essential biogeochemical processes and ecological

conditions in wetlands. Upgrades in remote sensing technologies- such as Landsat, Sentinel, Moderate Resolution Imaging Spectroradiometer (MODIS), and Synthetic Aperture Radar- have augmented detection and monitoring of these indicators, especially in regions where assessments is limited, facilitating spatial and temporal analysis of hydrological alterations in response to both natural and anthropogenic factors.¹² Jafarzadeh *et al.*, demonstrates through meta-analysis that the integration of contemporary remote-sensing and machine learning techniques significantly enhances the detection and classification of hydrological indicators across various wetland types, thereby reinforcing the evidence base for regulatory monitoring and enforcement.¹² This approach is also exemplified in India through platforms like Bhuvan Wetlands and the National Wetland Atlas, which employ Indian Remote Sensing (IRS) satellite data to delineate wetland extents and monitor hydrological attributes- such as surface water flooding and seasonal flooding patterns- facilitating spatial and temporal analysis pertinent to conservation planning and regulatory assessment.¹³

Further, technologies like Light Detection and Ranging (LiDAR) and Unmanned Aerial Vehicles (UAVs) are rapidly employed to analyse intricate wetland topography and hydrological alterations. LiDAR-derived elevation models facilitate the delineation of wetland boundaries and the understanding of micro-topographic effects on water movement, whereas UAVs enhance this by offering high-resolution and routine imagery for monitoring localised hydrological dynamics.¹⁴ Ground-based observations of subsurface water levels and soil moisture conditions improve the precision of remotely sensed information, particularly in climatically variable wetland systems. When incorporated into hydrological modeling frameworks, they facilitate scenario-based evaluations of restoration strategies and adaptive management decisions.¹⁵

Vegetation Attributes

Wetland vegetation is crucial for ecological equilibrium by supporting fauna, water purification, and retaining biodiversity. Vegetative communities affect hydrological and ecosystem conditions through processes like nutrient intake, sediment stabilisation, and pollution absorption. Given their sensitivity to alterations in water quality and pollutant

levels, wetland vegetation functions a significant biological indicator, facilitating information on ecological integrity and environmental strain within wetland ecosystems.

The richness, composition and structural intricacy of wetland vegetation are closely linked to ecological function and habitat integrity, rendering vegetation a valuable indicator of ecological health. Changes in vegetation composition often imply disturbances- nutrient enrichment or altered hydrological regimes and may reflect rising ecological stress. Modification to remote sensing and aerial monitoring have increased the ability to evaluate vegetation structure and biomass at spatial scales, facilitating objective assessment of habitat quality. When incorporated into regulatory evaluative procedures, such vegetation-based information can enhance administrative and judicial oversight in wetland protection and conservation settings.

Recent methodological advancements underscore the necessity of capturing vertical and horizontal vegetation attributes to enhance understanding of wetland structure, functionality, and restoration outcomes, especially in areas with limited ground-access and ecological disturbance.⁶ Besides biomass assessment, aerial technologies like LiDAR are progressively used to acquire vegetation structure and canopy details in wetlands through non-invasive methods.¹⁶ The high-resolution integration of LiDAR with optical and colour-infrared imagery enhances the classification of wetland vegetation types and facilitates the detection of subtle ecological changes over time, especially in palustrine wetland systems where structural variation is essential for ecological assessment.¹⁷ These methodologies provide credible mapping of plant community patterns and ecological transformations, especially within legally protected and Ramsar-designated sites.¹⁷ The increased utilisation of integrated remote-sensing and data-processing platforms has enhanced the uniformity and spatial reach of vegetation monitoring, facilitating regulatory assessment, compliance monitoring, and restoration planning. These technological advancements collectively enhance the evidentiary foundation that vegetation attributes may provide for wetland conservation and rehabilitation, and management within environmental frameworks.

To conclude, the core wetland attributes function as primary indicators for assessing their health and resilience or indications of degradation. These emphasize more on furnishing essential evidence of legal safeguards, laws and regulations, and judgements regarding restoration initiatives. Analysing on how the national policy frameworks have addressed these realities has become crucial, particularly in the context of India, the U.S., and China.

Comparative Analysis of Wetland Policies of India, U.S. and China

International wetland governance has established the normative framework for national conservation regimes, highlighting the identification of significant wetlands, the principle of sustainable use, and the incorporation of wetland protection into comprehensive environmental and developmental planning. Although global instruments delineate shared goals for wetland conservation, their domestic execution significantly differs among jurisdictions, highlighting variations in legal frameworks, administrative capabilities, and enforcement priorities. The persistent degradation of wetlands, despite established international commitments, highlights a fundamental disparity between normative acknowledgment and concrete regulatory outcomes, particularly when conservation frameworks do inadequately incorporate the ecological and socio-economic functions of wetlands or are overshadowed by conflicting land-use and development demands.

This disparity is most apparent when comparing the wetland governance frameworks and approaches of India, the U.S., and China. India embodies a hybrid regulatory framework wherein constitutional environmental principles coexist with fragmented sectoral regulations and inconsistent implementation across states. The U.S. exemplifies an early regulatory framework focused on pollution control and permit-based enforcement, with wetland protection primarily achieved through federal environmental legislation and administrative supervision. In contrast, China exemplifies a centrally governed approach marked by robust planning authority and a progressive incorporation of ecological priorities into state-led development strategies. An analysis of these three systems facilitates a critical evaluation of how varying legal frameworks, institutional structures, and policy

priorities influence wetland conservation results beyond formal commitments.

India

India's approach for wetland conservation is organised around an array of inter-related policy and legal frameworks that mirror national priorities and international commitments. Essential elements comprise the National Plan for Conservation of Aquatic Ecosystems (NPCA), the regulatory structure instituted by the Wetlands (Conservation and Management) Rules, 2017, comprehensive mapping initiatives by the National Wetland Inventory and Assessment (NWIA), and commitments under the Ramsar Convention on Wetlands. Collectively, these instruments constitute a multi-tiered governance framework that integrates statutory legislation, spatial data, scientific evaluation, and global conservation commitments.

The Wetlands (Conservation and Management) Rules, 2017, marked a significant step in the nation's wetland governance framework by delegating regulatory powers to State and Union Territory (UT) governments by setting up State Wetland Authorities (SWAs). The rules explicitly bans on activities that compromise wetland integrity, including solid waste disposal, encroachment, release of untreated effluents, and conversion for non-wetland use (Rule 4), transcending advisory conservation to enforceable regulation.¹⁸ It stipulates that the authorities consider the "wise use" of wetlands, which encompasses the integration of traditional knowledge, and obliges the authorities to propose steps for "raising awareness among stakeholders and local communities" (Rule 5(3)).¹⁸ This reflect an acknowledgement of the importance of indigenous and rural knowledge systems in influencing sustainable wetland utilisation and conservation initiatives. In addition to this normative shift, India has invested in enhancing the scientific grounding of wetland governance through the National Wetland Inventory and Assessment (NWIA)-component of Indian Space Research Organization's (ISRO) Satellite-Based Real-Time Information and Transmission for Aquatic Systems (SARITA) initiative. The program utilises uses satellite-based remote sensing to map, monitor, and assess wetlands nationwide, offering a comprehensive, data-driven foundation for informed-decision making and backed conservation policy.¹³

As of end-2025, India's engagement with Ramsar Convention has led to the recognition of 96 sites,¹⁹ resulting in strengthened institutional focus and improved access to ecosystem-based conservation services; nonetheless, effective conservation is hampered by fragmented jurisdiction and delayed formal wetland designation. Data from Ramsar-designated sites, demonstrates the cumulative effects of urbanisation, agricultural runoff, industrial discharges, and encroachments, as evidenced by nearly 1/3rd reduction of Punjab's Harike wetland between 1990-2010²⁰ and the significant decline of Chennai's Pallikarainai Marsh from several thousand hectares to a mere fraction of its original size by the early 2000s.²¹ Notwithstanding their statutory classification, several Ramsar-sites continue to be susceptible, with conservation results further compromised by inadequate community involvement and public awareness.

The Environment (Protection) Act of 1986 (EPA), India's primary environmental legislation, grants the Central Government (CG) extensive powers to prevent environmental degradation, including the authority to formulate and execute policies for the conservation of wetland ecosystems and maintaining the ecological equilibrium (Section 3).²² In this comprehensive environmental governance framework, wetlands are recognized as essential elements of forested and related ecosystems, necessitating cohesive management strategies and enhanced legal protections to avert degradation, encroachment, and ecological disruption.

The National Environment Policy (NEP), 2006, positions wetlands governance as fundamental to preserving ecological equilibrium and biodiversity (Section 4.2.6), pointing out the necessity of mitigating pollution and encroachment by incorporating sustainable management principles into land-use governance and river basin planning, while also underscoring the regulatory limitations surrounding non-Ramsar wetlands and the imperatives for robust institutional and legal frameworks addressing these issues. In India emphasises the value of wetland conservation for preserving ecological balance and promoting biodiversity.²³ With a focus on avoiding pollution and encroachment, the NEP advocates for the incorporation of sustainable management practices into "land use governance and river basin planning" (Section 5).²³ It also highlights the

absence of enforceable measures for non-Ramsar wetlands and calls for legal recourse through an appropriate institutional and regulatory framework (Section 5.4).²³ Ahead of this, India's National Policy and Macro-Level Action Strategy on Biodiversity (1999)²⁴ encouraged the "sustainable use of natural resources and equitable sharing" of their benefits, laying the groundwork for biodiversity protection. To preserve ecological integrity, and essential ecosystem services, the policy recommended habitat-level protection for wetlands, acknowledging them as crucial elements of natural ecosystems. It also supported decentralised governance and community involvement, establishing the framework for laws like the Biological Diversity Act of 2002 that formalised benefit-sharing arrangements.

The United States

Section 404 of the Clean Water Act, 1972 (CWA), which governs the "discharge of dredged or fill material" into "waters of the U.S.", provides the fundamental legal framework for wetland conservation in the U.S. The U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency share jurisdiction under this law. In *United States v. Riverside Bayview Homes Inc.*,²⁵ the Supreme Court upheld precedent broad jurisdiction over wetlands adjacent to "navigable waters". Conversely, in *Sackett v. EPA*,²⁶ limited this reach by denying federal protection to wetlands lacking a "continuous surface connection" to navigable waters. This change has sparked calls for stronger state legislation where federal protections have weakened.

As federal protection narrowed, compensatory mitigation – often through mitigation banking – has become a key component of U.S. wetland protection. As compared to Section 404, some state laws have proven highly effective; for example, New Jersey's Freshwater Wetlands Protection Act (FWPA) reduced wetland impacts by about 67% while requiring compensatory creation/restoration of more land than lost, despite still permitting about 79 acres per year of loss.²⁷ Other safeguards include the Swampbuster provisions of the Food Security Act of 1985, which remove federal agricultural subsidies for converting wetlands on certain lands after December 23, 1985.²⁸ Nonetheless, the efficacy of this mechanism is constrained, as its implementation relies on participation in subsidy programs and is

additionally restricted by categorical exclusions for specific types of agricultural land.

U.S. wetland laws provide a valuable framework overall, but their efficacy is undermined by statutory ambiguity, uneven regulation, reliance on compensation rather than prevention, and varying state capacities. More concise statutory language, improved inter-agency coordination, regular program evaluation, and broader adoption of stringent state-level protections are necessary to strengthen U.S. wetland conservation.

China

The wetland protection regime of China has significantly consolidated, transitioning from desperate administrative actions to a coherent regulatory framework. The People’s Republic of China’s Wetlands Protection Law enacted on December 24, 2021 and effective from June 1, 2022²⁹ represents the nation’s inaugural comprehensive legislation concerning wetlands. The law provides a statutory definition of wetlands, differentiating from artificial water bodies and sets a national classification system based on ecological function, geographical context, and conservation relevance. It aids ecological governance by requiring wetland conservation planning at all governmental tiers, restricting construction on ecologically significant wetlands, banning unauthorised reclamation, and imposing penalties for non-compliance.

The National Wetland Protection Plan (2022–2030) enhanced the operational momentum by establishing

specific targets to identify 50 nationally important wetlands, secure 20 more Ramsar listings, and elevate the national wetland protection rate to 55% by 2025.³⁰ In conjunction with the Wetland Protection Law, this planning framework reflects a transition from mere declarative commitments to quantifiable ecological actions, being further solidified by judicial practice through the Supreme People’s Court release of 12 guiding environmental cases on June 1, 2023, addressing wetland degradation, poaching, and invasive species to direct Courts across the nation.³¹ Simultaneously, environmental NGOs, such as Friends of Nature, utilised the new legislative powers to contest illegal encroachments and pollution in wetlands, including incidents in Beijing’s Changping wetlands and Lianyungang restoration controversy.³² Collectively, the advancements signal an increasing institutional receptiveness to public-interest litigation and integrate China’s conservation efforts with stronger global trends toward environmental justice accessibility.

Albeit the legal and institutional advancements, numerous limitations exist in effecting practical outcomes. Industrial pollution, rampant urbanisation, and weak enforcement across regions seem to hamper the efficacy of regulatory structure. Wetlands not designated as “important” often get less protection, bringing about fragmentation and deficiencies in conservation planning. This underscores the necessity for more consistent wetland mapping, better territorial regulation, and effective methods for public scrutiny and legal accountability to facilitate implementation.

Table 1: Tri-Jurisdictional Comparison of Wetland Governance Regimes: India, the United States, and China.

Criteria	India	United States	China
Primary Legal Framework	Wetlands (Conservation and Management) Rules, 2017 under the Environment (Protection) Act, 1986	Clean Water Act, 1972 (especially Section 404), Swampbuster (Food Security Act, various state laws 1985),	Wetlands Protection Law, 2021 (in force from 2022) – first dedicated national wetland law
Federal/Decentralised	Strong federal framework with delegated authority to	Federal–state shared authority;	Centralised command with hierarchical

Governance	State Wetland Authorities (SWAs); fragmented Engineers and (implementation)	Army Corps of EPA implement Section 404; states across agencies vary in implementation and stringency	delegation; local governments required to implement conservation plans
Institutional Mechanism	SWAs at the state level; Central Wetland Regulatory Authority; supported by ISRO's National Wetland Inventory and Assessment (NWIA)	US Army Corps of Engineers and EPA (federal); states may have independent wetland regulatory authorities (e.g., NJ DEP)	Ministry of Natural Resources; implementation via local ecological oversight by Supreme Court; People's and environmental NGOs
Community Participation	Rules mandate participatory governance, integration of traditional ecological knowledge	Public consultation required in permit processes; weaker community engagement in enforcement	Emerging use of public interest litigation and citizen lawsuits; NGOs like Friends of Nature actively involved
Mapping and Monitoring Tools	NWIA (SARITA programme) employs satellite-based spatial analysis; links to Ramsar site monitoring	National Wetlands Inventory; GIS-based monitoring; mitigation banking databases	National Wetland Inventory; Redline ecological zoning; integration with land-use master plans
International Commitments	Active Ramsar signatory; 91 Ramsar sites (as of mid-2025); faces implementation challenges	Ramsar signatory with fewer listed sites; enforcement is mostly domestic law-driven	Active Ramsar member; aims to increase Ramsar sites; National Plan (2022–2030) targets 20 new sites
Judicial Activism & Case Law	Courts have invoked Article 21 (right to life) to protect wetlands; PILs recognised as a tool for conservation	<i>Riverside Bayview Homes and Sackett v EPA</i> shaped wetland jurisdiction; judicial interpretation critical to scope of federal authority	Supreme Court released standard environmental cases (2023); legal activism through public interest litigation
Scope of Protection	Wetlands defined; face inclusively; however, only notified wetlands are strictly protected non-Ramsar wetlands legislative gaps	"Waters of the US" defines jurisdiction—often contested; isolated wetlands less protected post- <i>Sackett</i>	National classification law; system introduced in 2022 distinction between important and general wetlands affects degree of protection
Prohibited Activities	Encroachment, solid waste dumping,	Discharge of dredged permit;	Construction, land reclamation, industrial

	untreated effluent discharge, land-use conversion (Rule 4)	/fill materials without landowners may still fill under limited exemption post-Sackett	encroachment in important wetlands prohibited; penalties imposed
Mitigation & Compensation Mechanisms	No structured wetland banking or compensation system yet; relies on administrative action	Mitigation banking mandatory under Section 404; over 1,200 banks; Swampbuster provisions incentivise retention	No explicit banking system; conservation offsetting in pilot stages; penalties used for restoration funding
Integration with Biodiversity and Coastal Laws	Biodiversity Act, 2002; via 2006; National Forest NEP, Commission reports; linkages with EEZ protection Maritime Zones Act, 1981	Endangered Species Act and state biodiversity laws intersect with wetland protection	Ecological redlining, land use master planning, and biodiversity protection integrated in Wetlands Protection Law
Policy Approach	Focus on regulation, inventory, community participation; still evolving towards holistic management	Prevention through permitting and compensation; trend towards state-led innovation post-Sackett	National goal-oriented with planning (2022–2030); centralised planning legal enforceability and model cases
Enforcement Challenges	Inter-agency overlaps, weak monitoring, poor public awareness, political pressures	Jurisdictional ambiguity, uneven state capacity, prioritisation of compensation over prevention	Local implementation inconsistency, urbanisation pressures, weak protection of “non-important” wetlands
Strengths	Integration of local knowledge, strong inventory tools, legal linkage to constitutional rights	Established mitigation systems, clear federal-state interface, landmark jurisprudence	Recent robust framework, judicial model cases, centralised oversight, planning-based execution
Weaknesses	Lack of clarity for, non-notified wetlands, enforcement fragmentation Ramsar site degradation	Eroding federal scope post-Sackett, inequity in state implementation, weak isolated wetland coverage	Classification-based exclusions, urban-industrial encroachment, weak public engagement in some regions

A comparative analysis reveals that wetland governance in India, the U.S., and China has developed distinct and diverse paths shaped

by multiple institutional, legal, and regulatory frameworks and policy goals. India’s wetland governance framework, codified in the Wetlands

Rules, 2017 under the EPA delegates authority to SWAs and serves as a formal legislative base for decentralised administration; however, challenges remain owing to fragmented execution, overlapping mandates, and inadequate monitoring. The judicial recognition of wetlands under Article 21 in addition to growing emphasis on traditional ecological knowledge and public participation, constitutes a development; nonetheless, considerable legislative and regulatory deficiencies persist, including a lack of an exclusive compensation mechanism and inadequate protection for non-notified wetlands.

The U.S., on the other hand, embraces a “cooperative federalism approach”, which is based on the Swampbuster provisions of the Food Security Act of 1985 and Section 404 of the Clean Water Act of 1972. States have considerable autonomy in execution, which is divided between the US Army Corps of Engineers and the EPA. The United States is at the forefront of mitigation strategies, especially with its solidified wetland banking system. However, in the wake of the Sackett v. EPA ruling, which narrowed the definition of “waters of the United States”,²⁶ several isolated wetlands are not protected due to jurisdictional inconsistency and undermined federal monitoring. Public participation is required during the permitting process, although community enforcement is still supportive of it.

The Wetlands Protection Law, 2021, which outlines China’s strategy, is a move for centralized, strategy-driven conservation with enforceable procedures. Wetlands are categorised by the legislation as either “important” or “general”, with the former having more robust legal protections. Through local ecological bureaus, the Ministry of Natural Resources supervises implementation. This is in addition to “ecological redlining”, “biodiversity integration”, and “land-use planning”. Even with the Supreme People’s Court’s support and a growing spirit of public interest litigation, enforcement is nevertheless inconsistent between jurisdictions, especially for “general” wetlands. Although China has a strong legal basis owing to its centralised monitoring and focused planning (2022–2030), effective conservation is hampered by urbanisation forces and poor local participation.

Overall, the U.S provides advanced regulatory and compensatory tools but has experienced

legal challenges since Sackett; China exhibits an effective legislative drive and planning coherence, however confined to decentralised execution and public engagement; and India’s strength lies in its constitutional protections and democratic processes but is tainted by enforcement disintegration. Together, these models emphasise diverse approaches to harmonising legal protection, regulatory conformity, and cooperation in wetland conservation.

The comparative analysis of India, the U.S., and China demonstrate that while legal and regulatory frameworks provide the groundwork for wetland protection, their effectiveness is determined by how well they are carried out. Because best practices show how policy commitments are operationalised into real ecological restoration and community-centered conservation, it becomes imperative to examine them.

Best Practices Followed for Wetland Conservation

In addition to legal protections, the systematic implementation of best practices is needed to maintain ecological resilience and community welfare. The following sections discuss some of the most effective approaches in wetland management and restoration.

Integrated Management and Restoration Approaches

A well-known best practice is integrated wetland management, which views wetlands as parts of larger coastal and watershed systems. Such basin-level planning is encouraged by the Ramsar Convention, which calls for wetlands to be managed as components of interrelated ecological and hydrological systems instead of in isolation.³³ Proactive strategies exemplified by ongoing systematic monitoring- such as monthly water quality checks at 33 stations across Chilika Lake’s- support conservation through data-driven management.³⁴

Community-Based and Participatory Governance

Wetland resilience is largely dependent on participatory models. Local stewardship guarantees that conservation efforts align with livelihood needs and encourages compliance. Local stewardship approaches can enhance compliance and adaptive management, illustrated by the Miccosukee tribes’ co-stewardship with the U.S. agencies, which integrates indigenous knowledge into hydrological management, cultural resources retention and restoration planning

in Everglades.⁹ Similar dynamics are seen in citizen-science projects, such as the Delhi Bird Atlas, where community participation contributed in biodiversity monitoring and conservation planning, proving that consistent community participation can improve efficacy of wetland protection initiatives.³⁵

Integration of Science, Technology, and Monitoring

Another intriguing practice entails the utilisation of advanced scientific instruments- such as ecological indicator analysis, GIS-based wetland inventories, remote sensing- which have improved the accuracy and temporal scope of wetland health assessments, albeit continual challenges in implementing these technologies into effective management with the current legal and regulatory structures. Optimising of these approaches calls for regulatory adaptability, inter-disciplinary cooperation, and continuous surveillance to facilitate ecosystem restoration while ensuring socio-ecological benefits. Examples of these applications encompass China's national ecological monitoring network, which combines terrestrial observations with UAVs, and satellite data, and India's National Wetland Inventory and Assessment (NWIA), operated by the Space Applications Centre leads, which delivers geospatial data to facilitate the prioritisation and planning of wetland conservation initiatives.

Policy-Linked Incentives and Economic Instruments

Economic instruments, like Payments for Ecosystem Services (PES) and ecotourism strategies, have been utilised to align conservation goals with developmental standards, evidenced by initiatives in the Okavango Delta that promote low-impact tourism by partnering local authorities to support livelihoods while preserving ecological integrity.³⁶ In the U.S., wetland mitigation banking has been used as a strategy to balance development with ecological restoration, however, its efficacy depends on stringent ecological standards and transparent governance.²⁷

Adaptive and Climate-Resilient Strategies

The increasing variability of climate has highlighted the relevance of adaptive management for wetland conservation. In China, coastal wetlands previously subjected to extensive reclamation are gradually being rehabilitated under the "ecological civilisation" policy, signifying a gradual shift from exploitation

to conservation.³⁷ In India, wetlands have started to be incorporated into climate adaption planning, including projects funded by the National Adaptation Fund for Climate Change (NAFCC), indicating a growing of their significance in bolstering climate resilience. These initiatives include biodiversity restoration in the Gulf of Mannar, and integrated farming in the Kaipad wetlands of North Kerala.³⁸

Whilst best practices demonstrate effective strategies for wetland conservation, their implementation is often impeded by institutional overlap, weak enforcement, and legal ambiguity. Understanding these complexities is important, as they fundamentally govern the sustainability and scalability of effective ecological and community-based strategies within resilient wetland restoration frameworks.

Discussion

Legal Complexities and Governance Challenges in Wetland Restoration

In the sphere of environmental conservation and ecosystem management, wetland restoration appears to be a paramount strategy for biodiversity preservation, water filtration, and decarbonization. Wetland restoration fundamentally constitutes an effort of ecological rehabilitation. It involves restoring ecosystems that have been degraded and drained for agriculture, construction, and contaminated by industry, towards a healthier and more functional condition. However, it is substantially prevented mainly due to economic, socio-cultural, and stakeholder conflicts over mere ecological limitations, for wetlands exists within highly divisive land-use settings where diverse stakeholders- farmers, fishers, developers, and local authorities battle divergent interest- fluidity evidenced in India's East Kolkata wetlands where unregulated economies, invasions, and rooted social practices render it difficult to use traditional restoration strategies.³⁹ Empirical evidence from urban wetlands in India further demonstrates how governance inadequacies exacerbate restoration issues. Jayaprakash *et al.* record the accumulation of trace metals in the Pallikaranai Marsh due to fast and inadequately managed urbanization, illustrating how pollution embedded in wetland sediments limits restoration prospects and heightens environmental and public health hazards.²¹

In several wetland contexts, restoration efforts tend to be impacted by legal and institutional ambiguity, characterized by fragmented regulatory authority, disputed land tenure, and overlapping jurisdictional duties, especially in estuarine or coastal wetlands where fluctuating territorial limits complicate further governance. In recent years, few science-based guidelines have emerged to inform decision-making regarding the wetland impacts to avoid and where avoidance is paramount. This institutional fragmentation typically complicates the translation of ecological knowledge into a precise, science-driven, rationale decision-making criteria rendering weak and limited guidance concerning which wetland impacts should be addressed and prioritisation of avoidance is necessary. This gap can be seen in the wetland policy implementation, where mitigation hierarchy's main focus on avoidance is often compromised by compensatory methods, affecting ecological results and regulatory consistency. Such methods contradict fundamental tenets of environmental governance that prioritize sustainability, water quality, and the maintenance of hydrological and ecological integrity. When activities violate these principles, they impair the ability of wetland systems to operate as stable ecological units and diminish the efficacy of conservation-focused regulatory frameworks.

Certain wetland restoration measures function at the convergence of multiple regulatory regimes, especially when interventions disrupt previously altered or polluted environments. Remedial actions that disturb settled contaminants can create secondary ecological and public health hazards, while physically intensive restoration methods—such as excavation or structural modification—have implications that transcend mere ecological recovery. Inconsistent application of procedural safeguards or lack of thorough examination jeopardizes restoration efforts, leading to regulatory ambiguity and reduced accountability. This accentuates the imperative of aligning ecological goals with explicit legislative frameworks and institutional governance to guarantee that restorative measures do not yield detrimental environmental effects.

These restoration efforts goes beyond ecological measure to include vase legal, political, and institutional facets, where decentralised governance

and inconsistent enforcement may impede results, and have extended consequences for livelihoods, ecological, and economic resilience.

Legal, Economic and Socio-Cultural Imperatives For Wetland Protection

The rationale for wetland conservation transcends ecological factors, covering substantial legal, economic, and socio-cultural impacts as well. Incorporating wetlands within legal frameworks, livelihood systems, and economic governance regimes reflect upon their vitality in fostering societal resilience, distributive justice, and inter-generational equity, thus setting a base for analysing legal and economic imperatives that encourage their conservation.

Legal and Economic Imperatives for Wetland Protection

Through a legal and policy lens, the profound ecological and economic advantages of wetlands—transcending their ecological capacities to bolster livelihoods and national economies—offer a compelling argument for their formal incorporation into development plans and governance frameworks. The economic value of wetland ecosystem services is substantial, as activities centred on wetlands—such as agriculture, aquaculture, tourism, and biogeochemical regulation— not only contribute to regional economies but also preserve biodiversity and support the livelihoods of indigenous and rural communities, thereby underscoring the essential role of wetlands in broader development and governance system. Furthermore, wetland-centered recreational and ecotourism activities yield substantial revenue, boosting economies, and raising public awareness of conservation values. Effectively interpreting these ecological and economic benefits into conservation outcomes necessitates policies and management strategies that can operationalise wetland functions into development plans and restoration. In this context, constructed wetlands are seen as an effective intervention, as they emulate the key characteristics of natural wetlands, additionally improving agricultural productivity and aquatic ecosystems. Parallely, cost-benefit analysis and societal-value assessment can function as analytical frameworks for assessing the socio-economic and hydrological aspects of wetland protection and adaption techniques.

Contemporary restoration policy increasingly prioritizes the evaluation of wetlands based on their broader economic significance, rather than perceiving them exclusively as ecological entities. Wetland valuation techniques translate ecological functions into economic metrics, providing a systematic basis for evaluating restoration priorities, public advantages, and policy trade-offs. Wetlands perform several interconnected functions, including as flood mitigation, water supply, and nutrient cycling, which have significant economic ramifications for planning, investment, and regulatory decisions. When these functions are examined together rather than in isolation, their economic vitality becomes more evident, underscoring the value of valuation as a decision-support instrument rather than merely an accounting task.

Global assessments estimate the economic worth of wetlands at roughly \$26.4 trillion, with an average ecosystem service values at \$140,174 per hectare annually, ranking them among the most economically significant biomes estuaries.⁶ Coastal wetlands are projected to avert storm-related damages surpassing \$447 billion each year and offer protective benefits that are economically competitive with constructed solutions.⁴⁰ Natural and constructed wetland systems contribute to cost-effective water management by filtering pollutants and alleviating the financial burden of water treatment, therefore providing significant economic advantages to public authorities and downstream users. In many emerging economies, wetlands offer substantial economic and livelihood advantages through fisheries, water supply, and flood management, hence playing an essential role in sustaining rural livelihoods and food security. They serve as global carbon sinks, sequestering a considerable portion of terrestrial carbon (35%) and providing climate regulation advantages estimated at around \$1.32 trillion annually.⁴¹

The preservation of such ecosystems providing extensive benefits should be seen as “collective good” rather than a mere environmental issue. In this context, the persistent neglect for wetlands prompts serious issues that extends beyond degradation, impacting notions of environmental justice and sustainable development. Protecting wetlands necessitates preserving their functions while safeguarding ecosystems associated ecosystems and aquatic habitats, involving politicians and regulatory bodies.

Socio-Cultural Linkages in Wetland Governance

In addition to their legal and economic relevance, wetlands are integral to socio-cultural frameworks, establishing sustainable ties between communities and their environments through intangible values- spiritual significance, collective identity, traditional ecological knowledge- intricately linked to common behaviours and local governance structures. They play a crucial role in traditional practices, recreational activities, and historical narratives. The widespread acknowledgement within global wetland governance frameworks- Ramsar Convention- indicate that overlooking cultural dimensions will undermine community participation, stewardship, and limit restoration outputs.

The significance of socio-cultural integration is particularly evident in settings where wetlands sustain everyday livelihoods and social identities. Everard *et al.*, illustrate through localized ecosystem-service assessment that urban and peri-urban wetland provide numerous co-benefits-supporting livelihoods, cultural practices, and flood management- emphasizing the significance of incorporating socio-ecological assessments into local governance frameworks.³⁹ In these contexts, fishing practices, agricultural systems, seasonal rituals, and community norms often adapt to wetland hydrology and ecological cycles. Community-driven conservation practices, including informal use restrictions, collective monitoring, and locally enforced standards, frequently arise from these interactions and can significantly contribute to the sustainability of wetland ecosystems. These traditions demonstrate that the efficacy of conservation is intricately connected to the extent to which governance frameworks align with local values and societal structures.

These observations indicate that resilient wetland governance cannot be attained just by biophysical assessment and legal designation. It necessitates governance arrangements that acknowledge wetlands as both cultural and ecological systems, while incorporating community knowledge, practices, and participation into legal and institutional structures. Integrating socio-cultural factors into wetland governance enhances ecological results and the legitimacy of conservation efforts, thus enhancing their long-term sustainability.

Recommendations

According to the aforementioned research, it is evident that fragmented or sectoral interventions are inadequate for effective wetland conservation and restoration efforts. We require a governance structure that encompasses legal, scientific, socio-cultural, and economic dimensions. Following recommendations aim to advance this agenda:

Reinforcing Regulations and Enforcement Strengthening

To ensure overarching protection, smaller wetlands must also be recognised and protected for performing crucial functions beyond statutory and Ramsar- designated wetlands. Cohesive and Integrated governance approach can be attained by streamlining enforcement, clearly defined institutional and accountability procedures.

Community Partnerships

Conservation efforts yield stronger and sustainable outcomes when they incorporate the participation of local customs and communities. To ensure lasting stewardship and the credibility of the policy framework, it must incorporate integrated and cooperative governance grounded in civic science, as well as indigenous traditional and ecological knowledge.

Strategic Resource Allocation

National and regional wetland inventories should integrate the latest advancements in remote sensing, GIS technologies, and real-time ecological metrics. Beyond mapping, these technologies must be utilised to oversee adaptive management plans and ensure compliance with legal and ecological norms.

Ecotourism

Wetlands should be recognised and valued as a resource for human welfare. Payment methods like payments for ecosystem services (PES), optimized ecotourism models, and concentrated allocations from climate finance should be employed to integrate conservations goals and livelihood security.

Wetland Inclusion in Development and Climate Plans

Wetlands function as natural filters, accumulating surplus rainfall in monsoons and gradually discharging it during dry periods. They must be incorporated into integrated legislations and regulations to provide periodical impact assessments

for any developments affecting wetlands, and should require mitigation and restoration measures.

Directions for Future Research

Doctrinal Clarification of Jurisdictional and Definitional Gaps

Prospective research should conduct targeted doctrinal analysis of wetlands that are not covered by formal statutory or notification regime, like non-notified wetlands in India, isolated wetlands in the U.S. post-Sackett, and wetlands categorized outside of "important" categories within China's legal framework. Judicial and administrative interpretations of ecological connectivity, hydrological indicators, and ecological character require careful consideration in defining the extent of legal protection.

Comparative Analysis of Enforcement Architectures

There exists potential for more profound comparative analysis about how various enforcement models- centralized versus decentralized, administrative versus judicial- affect regulatory efficacy across jurisdictions. Investigating inter-agency cooperation, administrative discretion, compliance monitoring, and accountability procedures transcend formal statutory frameworks to evaluate the practical implementation of wetland regulations, particularly in rapid urbanizing and climate-vulnerable areas.

Legal Consideration of Scientific and Technological Evidence

As wetland governance largely depends on hydrological, vegetative, and geospatial indicators, additional multidisciplinary legal study is required to assess the evidentiary quality of such data in regulatory and adjudicatory contexts. Future research may examine the integration of ecological indicators obtained from remote sensing, modeling, and digital platforms into EIAs, licensing decisions, and judicial reviews, as well as the sufficiency of existing procedural frameworks in accommodating these types of scientific evidence.

Institutionalization of Socio-Cultural and Community-Oriented Governance

Drawing on the article's findings about participatory governance, further research could investigate how community stewardship, indigenous knowledge systems, and customary practices are acknowledged,

institutionalized, or restricted under statutory wetland structures. A comparative legal analysis of benefit-sharing systems, community consent processes, and local governance institutions will enhance understanding of the socio-legal aspects of wetland conservation.

Incorporation of Wetlands into Climate and Justice Frameworks

Eventually, additional research could establish normative and policy-oriented frameworks that explicitly integrate wetlands into climate adaptation law, disaster risk governance, and environmental justice exchanges. Research that is longitudinal and cross-sectoral, focusing on the integration of wetlands into climate finance systems, adaptation planning tools, and sustainable development strategies, will enhance the integrated governance model proposed in this study.

Conclusion

The study demonstrate, through a comprehensive analysis of ecological characteristics and comparative legal systems that wetlands operate as dynamic socio-ecological systems that reinforce biodiversity, sustainability, and cultural heritage, yet remain consistently vulnerable to industrialisation and urbanisation primarily due to fragmented governance, regulatory uncertainty, and inconsistent enforcement across jurisdictions. Notwithstanding their vital roles in sustaining livelihoods, hydrological regulation, and carbon sequestration, the analysis indicates that wetlands continue to be managed through sectoral and designation-specific legislative frameworks that inadequately address their ecological intricacies. Wetlands are not merely passive ecological sites; they function as systems that offer essential ecosystem services, and their conservation is contingent upon the efficacy of legal frameworks in incorporating ecological attributes like hydrology and vegetation dynamics. The comparative legal analysis reveals that despite differing legal frameworks, the efficacy of wetland laws in these jurisdictions is persistently hindered by three interconnected factors- fragmented governance, inconsistent enforcement, and inadequate legal acknowledgement of traditional and indigenous knowledge systems.

The examination of best practices further show that effective wetland conservation necessitates

integration of statutory safeguards with adaptive management plans, community-based governance, and livelihood-supportive economic incentives. Nevertheless, the study reveals that these approaches are often impeded by overlapping institutional objectives, vague land tenure, and inadequate adherence to legal requirements, therefore restricting their transformative capacity. These limits highlight the necessity to progress beyond fragmented or project-specific interventions towards governance frameworks that can address the ecological intricacies and social integration of wetlands. From this perspective, wetlands are best understood as sites where legal, economic, and socio-cultural systems converge- functioning concurrently as “cultural landscapes”, “economic infrastructures”, and “subjects of legal protection”. The comparative evidence discussed in this article supports the conclusion that effective wetland conservation depends not only on regulatory instruments but also on governance frameworks that explicitly incorporate ecosystem services, scientific monitoring, and community stewardship into decision-making processes.

Wetland conservation transcends a limited environmental mandate, requiring broader inquiries into institutional accountability, environmental justice, and intergenerational equity, especially with climate resilience and sustainable development. Addressing the identified legal and governance deficiencies, integrating wetlands more effectively into development and climate planning frameworks, and enhancing participatory governance structures are crucial for safeguarding wetlands as fundamental elements of sustainable futures, rather than permitting them to remain as residual victims of regulatory fragmentation and ecological degradation.

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Not applicable

Author Contributions

- **Oshin Gupta:** Introduction; Concept of Wetland Conservation and Attributes Analysis; Legal and Governance Challenges for Wetland Conservation for Analysis; Initial Manuscript Structuring.
- **Madhuri Parikh:** Research Problem Guidance; Manuscript Research Methodology And Structuring; Comparative Parameters For Comparative Analysis; Wetland Conservation Strategy & Best Practices.

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