

Wetland Ecosystems of Bihar - Biodiversity, Ecological Integrity, and Conservation Challenges

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Abstract: *Wetland ecosystems of Bihar constitute one of the most ecologically significant landscapes in the Indo-Gangetic Plain, supporting rich biodiversity, maintaining ecological integrity, and providing indispensable ecosystem services essential for environmental sustainability and human well-being. These wetlands, including oxbow lakes, floodplain wetlands, marshes, reservoirs, and riverine ecosystems, serve as critical habitats for diverse flora and fauna, including numerous endemic, endangered, and migratory species along the Central Asian Flyway (Islam & Rahmani, 2008, p. 320). They play a vital role in groundwater recharge, flood mitigation, carbon sequestration, nutrient cycling, water purification, climate regulation, and sustaining the livelihoods of millions through fisheries, agriculture, livestock rearing, and other wetland-dependent activities (Millennium Ecosystem Assessment, 2005, pp. 4–5; Mitsch & Gosselink, 2015, p. 15). However, rapid urbanization, agricultural intensification, industrial and domestic pollution, encroachment, hydrological alterations, invasive alien species, siltation, overexploitation of natural resources, and the increasing impacts of climate change have severely undermined the ecological integrity and resilience of these ecosystems (Davidson, 2014, pp. 937–939; Finlayson et al., 2018, pp. 18–20). This paper critically examines the biodiversity, ecological functions, socio-economic significance, and conservation challenges of Bihar's wetlands through an extensive review of scientific literature, government reports, policy frameworks, and environmental studies (Gopal, 2016, pp. 82–83; Space Applications Centre, 2011, p. 8). It highlights the urgent need for integrated wetland management based on scientific monitoring, ecosystem restoration, community participation, strengthened institutional governance, GIS and remote sensing-based assessment, and effective implementation of national and international conservation frameworks, including the Ramsar Convention (Government of India, 2017, pp. 14–15; Ramsar Convention Secretariat, 2021, p. 16). The study argues that conserving Bihar's wetlands is fundamental not only for protecting biodiversity but also for enhancing climate resilience, ensuring water and food security, achieving the Sustainable Development Goals, and promoting long-term ecological sustainability and inclusive regional development (United Nations Environment Programme, 2021, pp. 112–113).*

Keywords: Wetlands, Bihar, Biodiversity, Ecological Integrity, Ecosystem Services, GIS

1. Introduction

Wetland ecosystems are among the most productive and ecologically significant natural systems on Earth, providing a wide range of ecosystem services that sustain biodiversity, regulate hydrological processes, and support human livelihoods (MEA, 2005, pp. 4–5). Recognized as transitional zones between terrestrial and aquatic environments, wetlands play a crucial role in water purification, groundwater recharge, flood mitigation, carbon sequestration, nutrient cycling, and climate regulation (Mitsch & Gosselink, 2015, p. 15). In India, the state of Bihar possesses an extensive network of wetlands, including oxbow lakes, floodplain wetlands, marshes, reservoirs, and riverine ecosystems associated with the Ganga and its major tributaries such as the Kosi, Gandak, Burhi Gandak, Son, and Bagmati. These wetlands harbor diverse flora and fauna, including several endangered species and migratory birds along the Central Asian Flyway, while simultaneously sustaining agriculture, fisheries, livestock, and rural livelihoods (SAC, 2011, p. 8). However, increasing anthropogenic pressures such as rapid urbanization, agricultural intensification, pollution, encroachment, hydrological modifications, invasive species, and climate change have significantly degraded the ecological integrity and biodiversity of these fragile ecosystems (Davidson, 2014, pp. 937–939). Despite their ecological and socio-economic importance, many wetlands in Bihar continue to experience habitat loss, declining water quality, biodiversity depletion, and inadequate conservation management. Against this backdrop, the present study examines the biodiversity, ecological integrity, and conservation challenges of Bihar's wetland ecosystems,

emphasizing their environmental significance, current threats, and the need for integrated, science-based, and community-oriented conservation strategies to ensure their long-term sustainability and resilience (Finlayson et al., 2018, pp. 18–20).

2. Review of Literature and Methodology

Existing literature, including publications of the Ramsar Convention, the Ministry of Environment, Forest and Climate Change, the National Wetland Atlas, the Zoological Survey of India, the Botanical Survey of India, Wetlands International, and numerous peer-reviewed studies, recognizes wetlands as biodiversity hotspots that provide vital ecosystem services such as water purification, flood regulation, groundwater recharge, carbon sequestration, climate regulation, and livelihood support (Ramsar Convention Secretariat, 2021, p. 16). While previous studies have extensively documented the ecological importance of Indian wetlands and examined selected wetlands of Bihar such as Kanwar Lake (Kabartal), Kusheshwar Asthan, Gogabil, Baraila Lake, and Nagi-Nakti Bird Sanctuaries, most investigations have remained localized or focused on specific aspects such as avian diversity, fisheries, or hydrology (SAC, 2011, p. 12).

A comprehensive assessment integrating biodiversity, ecological integrity, ecosystem services, and conservation challenges across Bihar's wetland ecosystems remains limited (Gopal, 2016, pp. 82–83). Against this background, the present study aims to evaluate the biodiversity, ecological integrity, ecological services, and conservation challenges of Bihar's wetlands, assess the impacts of anthropogenic and

climatic pressures, examine existing conservation policies and management practices, and propose sustainable, science-based conservation strategies. The study area encompasses the major natural and man-made wetlands distributed across the Gangetic floodplains of Bihar, including oxbow lakes, marshes, floodplain wetlands, reservoirs, and riverine ecosystems associated with the Ganga and its tributaries (Finlayson et al., 2018, pp. 51–52). Methodologically, the study adopts a qualitative and descriptive research design based entirely on secondary sources, including peer-reviewed journal articles, books, government reports, Ramsar documents, the National Wetland Atlas, publications, Zoological Survey of India and Botanical Survey of India reports, Bihar State Wetland Authority records, and other authentic scientific databases. The collected information has been critically reviewed and thematically analyzed to examine wetland biodiversity, ecological integrity, ecosystem services, conservation challenges, and policy interventions, thereby providing a comprehensive understanding of the ecological status and sustainable management needs of Bihar's wetland ecosystems (Mitsch & Gosselink, 2015, pp. 701–702).

Biodiversity and Ecological Profile of Bihar's Wetlands

The wetlands of Bihar represent some of the most biologically diverse ecosystems in the Indo-Gangetic Plain, supporting a rich assemblage of aquatic and terrestrial species that contribute significantly to regional ecological stability and environmental sustainability (Zoological Survey of India, 2019, pp. 146–148). These wetlands provide habitat for more than 150 species of freshwater fishes, including economically important species such as *Labeo rohita* (Rohu), *Catla*, *Cirrhinus mrigala*, and numerous indigenous fish species that sustain local fisheries and food security (Jhingran, 1991, p. 45). They also serve as critical wintering and breeding grounds for over 300 species of resident and migratory birds, including the Bar-headed Goose (*Anser indicus*), Northern Pintail, Greylag Goose, Common Teal, Sarus Crane, Painted Stork (*Mycteria leucocephala*), Black-necked Stork (*Ephippiorhynchus asiaticus*), and several species protected under national and international conservation frameworks, particularly along the Central Asian Flyway (Islam & Rahmani, 2008, p. 320).

The reptilian fauna comprises freshwater turtles, Indian Flapshell Turtle (*Lissemys punctata*), Indian Roofed Turtle (*Pangshura tecta*), water snakes, monitor lizards, and occasionally the critically endangered Gharial (*Gavialis gangeticus*) in connected riverine habitats. Amphibian diversity includes frogs, toads, and tree frogs that function as sensitive bio-indicators of ecosystem health due to their dependence on clean aquatic habitats (Molur & Walker, 1998, p. 93). Wetlands also support mammals such as the Smooth-coated Otter (*Lutrogale perspicillata*), Fishing Cat (*Prionailurus viverrinus*), Golden Jackal (*Canis aureus*), Indian Fox (*Vulpes bengalensis*), Nilgai (*Boselaphus tragocamelus*), Wild Boar (*Sus scrofa*), and various bat species, many of which depend on wetland ecosystems for feeding and breeding. The aquatic vegetation is equally diverse, comprising emergent, submerged, floating, and marsh plants such as Lotus (*Nelumbo nucifera*), Water Lily (*Nymphaea* spp.), Hydrilla (*Hydrilla verticillata*), *Vallisneria spiralis*, *Typha angustifolia*, *Phragmites karka*, and numerous

phytoplankton and macrophytes that enhance primary productivity, nutrient cycling, and habitat complexity (Cook, 1996, p. 22). Collectively, this exceptional biodiversity underpins the ecological integrity of Bihar's wetlands by maintaining food webs, supporting ecological interactions, enhancing climate resilience, and delivering essential ecosystem services; however, increasing anthropogenic pressures, habitat degradation, invasive species, pollution, and climate change continue to threaten the long-term survival of these biologically rich ecosystems, emphasizing the urgent need for integrated conservation and sustainable wetland management (Dudgeon et al., 2006, p. 163).

Major Key Wetlands of Bihar

Major Key Wetlands of Bihar: Bihar is endowed with a diverse network of ecologically significant wetlands that play a crucial role in maintaining biodiversity, regulating hydrological processes, and supporting the livelihoods of millions of people across the state. Kanwar Lake (Kabartal), Begusarai, recognized as a Ramsar Site (Site No. 2436) and one of Asia's largest freshwater oxbow lakes, is internationally renowned for supporting thousands of migratory birds along the Central Asian Flyway and sustaining rich indigenous fish diversity (Ramsar Convention Secretariat, 2020, pp. 221–222). Formed by a meander loop of the Burhi Gandak River, Kabartal acts as a natural sponge during the monsoon, mitigating flood severity across central Bihar. Kusheshwar Asthan Wetlands in Darbhanga district comprise an extensive floodplain wetland complex (chaurs) that serves as a critical breeding and wintering habitat for numerous resident and migratory bird species while also supporting inland capture fisheries and flood regulation (Islam & Rahmani, 2008, pp. 314–316). Spread over multiple villages, this seasonal complex receives overbank flow from the Kosi, Kamala-Balan, and Bagmati river systems. Baraila Wetland (Barela Jheel) in Vaishali district is an important freshwater ecosystem characterized by high aquatic biodiversity, productive fisheries, and extensive aquatic vegetation that contributes to groundwater recharge and local agricultural livelihoods (Gopal, 2013, pp. 165–167). Gogabeel Wetland in Katihar, designated as Bihar's first Community Reserve in 2019, is well known for its remarkable diversity of migratory waterbirds and its ecological importance in conserving wetland biodiversity through local community participation (Kumar et al., 2019, p. 52). It receives hydrological inputs from both the Ganga and Mahananda rivers.

The Vikramshila Gangetic Dolphin Sanctuary along a 50 km stretch of the Ganga River in Bhagalpur represents one of India's most significant riverine wetland ecosystems, specifically set aside for protecting the endangered Gangetic Dolphin (*Platanista gangetica*) while supporting rich fish diversity, freshwater turtles, aquatic birds, and riparian vegetation (Choudhary et al., 2012, pp. 103–104). Nagi and Nakti Dam Bird Sanctuaries in Jamui district are prominent human-made reservoirs in southern Bihar that serve as critical wintering refuges for migratory waterfowl, particularly ducks and geese. Both reservoirs have been recognized as Ramsar Sites due to their ecological value in the dry hill-terrain landscape of southern Bihar. Collectively, these wetlands regulate hydrological processes, improve water quality, recharge regional aquifers, sequester carbon, sustain inland

fisheries, and strengthen ecological resilience across Bihar. However, increasing pressures from urbanization, agricultural expansion, chemical pollution, land encroachment, invasive species, excessive siltation, and climate change continue to degrade these fragile ecosystems, underscoring the need for

integrated wetland management, habitat restoration, and community-based conservation initiatives (Gopal, 2013, pp. 178–180).

Comparative Matrix of Major Wetlands in Bihar

Wetland Name	District	Type / Origin	Key Ecological Significance & Biodiversity	Dominant Threat Drivers
Kanwar Lake (Kabartal)	Begusarai	Freshwater Oxbow Lake (Ramsar Site)	Central Asian Flyway bird stopover; 50+ fish species; rare aquatic macrophytes (Scott, 1989).	Eutrophication, siltation, Eichhornia proliferation, land conversion.
Kusheshwar Asthan	Darbhanga	Floodplain Wetland Complex (Chaur)	Waterfowl wintering ground; flood regulation; natural nursery for riverine fishes (Islam & Rahmani, 2008).	Embankment construction, hydrological fragmentation, overfishing.
Baraila Wetland	Vaishali	Freshwater Lake / Marsh	High macrophyte productivity; groundwater recharge; inland capture fisheries (Gopal, 2013).	Agricultural runoff, domestic sewage, agricultural encroachment.
Gogabeel Wetland	Katihar	Oxbow Lake / Community Reserve	Bihar's first Community Reserve; avian haven; riverine connectivity with Mahananda (Kumar et al., 2019).	Uncontrolled siltation, seasonal desiccation, illegal trapping.
Vikramshila Sanctuary	Bhagalpur	Riverine Wetland (Ganga River)	Habitat for Gangetic Dolphin, Smooth-coated Otter, and riverine turtles (Sinha & Kannan, 2014).	Mechanized boats, destructive fishing gear, sand mining, water pollution.
Nagi & Nakti Dams	Jamui	Man-made Reservoirs (Ramsar Sites)	Vital wintering habitat for migratory waterfowl in southern arid/semi-arid terrain.	Agricultural siltation, water diversion for irrigation, seasonal drying.

Ecological Degradation and Anthropogenic Pressures

The wetlands of Bihar are experiencing unprecedented ecological degradation due to a combination of anthropogenic pressures and climate-induced environmental changes that threaten their biodiversity, ecological integrity, and long-term sustainability. Rapid urbanization, agricultural expansion, land encroachment, indiscriminate sand mining, excessive extraction of surface and groundwater resources, industrial and domestic pollution, eutrophication, invasive alien species such as *Eichhornia crassipes* (water hyacinth), and unregulated fishing practices have significantly altered the ecological character of many wetlands (Mitsch & Gosselink, 2015, p. 491).

Furthermore, changes in hydrological regimes caused by embankments, river channel modifications, and declining groundwater levels have disrupted the natural functioning of floodplain wetlands, reducing habitat quality for aquatic flora and fauna (Junk et al., 2013, pp. 158–165). Climate change has further intensified these challenges through irregular rainfall patterns, prolonged droughts, extreme flash flooding, rising ambient and water temperatures, and shifting migratory bird arrival timelines, thereby increasing the vulnerability of wetland ecosystems and dependent rural communities (Intergovernmental Panel on Climate Change, 2022, pp. 1123–1124). Weak institutional coordination among government departments, inadequate enforcement of wetland protection policies, insufficient scientific monitoring, lack of updated wetland inventories, and limited community participation have also constrained effective conservation and restoration initiatives (MEA, 2005, p. 558). Addressing these multifaceted challenges requires integrated watershed management, ecosystem-based restoration, strengthened legal protection, remote sensing-based monitoring, sustainable livelihood interventions, and active participation of local stakeholders to ensure the long-term conservation and resilience of Bihar's wetland ecosystems (Finlayson et al., 2018, pp. 16–17).

Climate Change and Human-Induced Threats

The wetland ecosystems of Bihar are increasingly threatened by the combined impacts of climate change and anthropogenic activities, which have significantly altered their ecological structure, hydrological dynamics, and biodiversity. Rising temperatures, erratic monsoon patterns, prolonged droughts, frequent floods, and changing river flow regimes have disrupted the natural hydrological cycles of floodplain wetlands, reducing water availability during lean months and affecting the breeding, feeding, and migration patterns of aquatic organisms and waterbirds (IPCC, 2022, pp. 1121–1130).

Simultaneously, rapid urbanization, agricultural intensification, land encroachment, industrialization, excessive groundwater extraction, indiscriminate use of agrochemicals (fertilizers and pesticides), domestic sewage discharge, plastic pollution, and illegal riverbed sand mining have accelerated habitat degradation and water quality deterioration (Davidson, 2014, pp. 934–935). The proliferation of invasive alien species, particularly *Eichhornia crassipes* (water hyacinth) and *Ipomoea carnea*, has further reduced dissolved oxygen levels, obstructed natural water flow, suppressed light penetration, and displaced native aquatic vegetation and fauna (Richardson et al., 2007, p. 318). In addition, overfishing, unsustainable harvesting of wetland bio-resources, and fragmentation of wetland habitats by road construction and flood control embankments have contributed to the decline of several native fish species, amphibians, reptiles, and migratory birds, thereby weakening ecosystem resilience and overall ecological integrity (Dudgeon et al., 2006, pp. 166–167). These interconnected climatic and human-induced pressures not only threaten biodiversity conservation but also undermine the ecosystem services provided by Bihar's wetlands, including flood regulation, groundwater recharge, carbon sequestration, and livelihood security, highlighting the urgent need for climate-resilient wetland management,

ecosystem restoration, sustainable resource utilization, and strengthened environmental governance (Convention on Biological Diversity, 2020, pp. 42–43).

Institutional Framework, Policy Interventions, and Governance

The conservation and sustainable management of wetlands in Bihar are guided by a comprehensive framework of international conventions, national legislation, and policy initiatives aimed at protecting wetland biodiversity and maintaining ecological integrity. At the global level, the Ramsar Convention on Wetlands provides the principal framework for the wise use and conservation of wetlands through the designation of Wetlands of International Importance and the promotion of integrated ecosystem management (Ramsar Convention Secretariat, 2021, pp. 15–16). In India, the Wetlands (Conservation and Management) Rules, 2017, notified under the Environment (Protection) Act, 1986, establish legal mechanisms for the identification, notification, regulation, and management of wetlands by prohibiting activities that degrade wetland ecosystems such as solid waste dumping, industrial discharge, non-aquaculture land conversion, and permanent construction and by strengthening the role of State Wetland Authorities in conservation planning (GoI, 2017, pp. 14–15).

Complementing these regulations, the National Plan for Conservation of Aquatic Ecosystems integrates the earlier National Wetland Conservation Programme and the National Lake Conservation Plan to support scientific management, biodiversity conservation, pollution control, habitat restoration, and community participation in wetland governance (MoEFCC, 2019, p. 18). In Bihar, the implementation of these policies has contributed to the recognition of internationally important wetlands such as Kabartal, Nagi Dam, and Nakti Dam as Ramsar Sites, the preparation of scientific wetland inventories by the Bihar State Wetland Authority, and the promotion of eco-restoration initiatives. However, challenges related to inadequate operational funding, weak inter-departmental coordination, limited field monitoring, ongoing land encroachment, and insufficient community engagement continue to hinder effective conservation outcomes (National Green Tribunal, 2020, pp. 12–18). Therefore, strengthening policy implementation through ecosystem-based management, scientific monitoring, remote sensing technologies, stakeholder participation, and climate-resilient conservation planning is essential for ensuring the long-term sustainability of Bihar's wetland ecosystems (World Wildlife Fund, 2021, p. 29).

Strategic Recommendations for Integrated Management and Restoration

The long-term conservation and sustainable management of Bihar's wetland ecosystems require an integrated, science-based, and community-oriented approach that balances ecological integrity with socio-economic development. Comprehensive wetland mapping and continuous ecological monitoring should be undertaken using Geographic Information Systems, Remote Sensing, and drone-based spatial technologies to assess habitat degradation, hydrological changes, land-use/land-cover dynamics, and biodiversity trends (Finlayson et al., 2018, p. 45). The

effective implementation of the Wetlands (Conservation and Management) Rules, 2017, along with the principles of the Ramsar Convention, should be strengthened across all districts to prevent encroachment, chemical pollution, illegal land conversion, and unsustainable resource exploitation while enhancing institutional coordination and governance (Ramsar Convention Secretariat, 2021, p. 39). Habitat restoration programmes should prioritize selective desiltation, mechanical and biological control of invasive alien species, restoration of natural river-floodplain hydrological connections, and re-vegetation with native aquatic plants to improve ecosystem resilience and biodiversity (Mitsch & Gosselink, 2015, pp. 723–724). Active participation of local communities through community-based wetland management, sustainable cooperative fisheries, environmental awareness, community reserves, eco-tourism, and livelihood diversification should be promoted to ensure long-term conservation success (Barbier et al., 1997, pp. 69–70). Climate-resilient wetland management should be integrated into state environmental planning by strengthening scientific research, biodiversity monitoring, environmental education, inter-agency collaboration, and adaptive conservation policies that support climate change mitigation, water security, and the achievement of the Sustainable Development Goals (SDGs 6, 13, 14, and 15) (UNEP, 2021, pp. 112–113).

The wetlands of Bihar are indispensable ecological resources that support rich biodiversity, maintain ecological integrity, and provide essential ecosystem services such as flood regulation, groundwater recharge, climate regulation, water purification, and livelihood security across the Indo-Gangetic Plain. Despite their immense ecological and socio-economic importance, these ecosystems are increasingly threatened by climate change, pollution, habitat degradation, fragmentation, land encroachment, and unsustainable resource use. Therefore, their long-term conservation requires integrated watershed management, scientific monitoring, effective policy implementation, habitat eco-restoration, and active community participation. Protecting Bihar's wetlands is essential not only for conserving biodiversity but also for ensuring environmental sustainability, climate resilience, water and food security, and the well-being of present and future generations.

References

- [1] Barbier, E. B., Acreman, M. C., & Knowler, D. (1997). *Economic valuation of wetlands: A guide for policy makers and planners*. Ramsar Convention Bureau.
- [2] Choudhary, S. K., Dey, S., Dey, S., Sagar, V., Nair, T., & Sinha, R. K. (2012). River dolphin distribution in Bhagalpur stretch of the river Ganga, Bihar, India. *Journal of Threatened Taxa*, 4(7), 2700–2705.
- [3] Convention on Biological Diversity. (2020). *Global biodiversity outlook 5*. Secretariat of the Convention on Biological Diversity.
- [4] Cook, C. D. K. (1996). *Aquatic and wetland plants of India*. Oxford University Press.
- [5] Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research*, 65(10), 934–941.

- [6] DeLoughrey, E., & Handley, G. B. (Eds.). (2011). *Postcolonial ecologies: Literatures of the environment*. Oxford University Press.
- [7] Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z. I., Knowler, D. J., L  v  que, C., Naiman, R. J., Prieur-Richard, A. H., Soto, D., Stiassny, M. L., & Sullivan, C. A. (2006). Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biological Reviews*, 81(2), 163–182.
- [8] Finlayson, C. M., Davies, G. T., Rintoul, M. S., & Mitchell, D. S. (2018). *The wetland book: Distribution, inventory, description, and management*. Springer.
- [9] Gopal, B. (2013). *Wetlands of India: Identification, conservation and management*. National Institute of Ecology.
- [10] Gopal, B. (2016). A review of the status and management of wetlands in India. *Limnology*, 17(1), 81–95.
- [11] Government of India. (2017). *Wetlands (Conservation and Management) Rules, 2017*. Ministry of Environment, Forest and Climate Change, Gazette of India.
- [12] Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press.
- [13] Islam, M. Z., & Rahmani, A. R. (2008). *Important bird areas in India: Priority sites for conservation*. Bombay Natural History Society & Oxford University Press.
- [14] Jhingran, V. G. (1991). *Fish and fisheries of India* (3rd ed.). Hindustan Publishing Corporation.
- [15] Junk, W. J., Piedade, M. T. F., Wittmann, F., Sch  ngart, J., & Parolin, P. (2013). *Central Amazonian floodplain forests: Ecophysiology, biodiversity and sustainable management*. Springer Science & Business Media.
- [16] Kumar, A., Kanaujia, A., & Tripathi, A. (2019). Diversity and conservation status of avifauna in Gogabeel Lake, Katihar, Bihar. *International Journal of Fauna and Biological Studies*, 6(3), 50–55.
- [17] Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Wetlands and water synthesis*. World Resources Institute.
- [18] Ministry of Environment, Forest and Climate Change. (2019). *National Plan for Conservation of Aquatic Ecosystems (NPCA): Guidelines for implementation*. Government of India.
- [19] Ministry of Environment, Forest and Climate Change. (2021). *Conservation and wise use of wetlands: A operational framework*. Government of India.
- [20] Mitsch, W. J., & Gosselink, J. G. (2015). *Wetlands* (5th ed.). John Wiley & Sons.
- [21] Molur, S., & Walker, S. (1998). *Report of the workshop on Conservation Assessment and Management Plan (CAMP) for amphibians of India*. Zoo Outreach Organisation / CBSG.
- [22] National Green Tribunal. (2020). *Order on O.A. No. 325/2015: Enforcement of Wetland Conservation Rules*. NGT Principal Bench, New Delhi.
- [23] Nixon, R. (2011). *Slow violence and the environmentalism of the poor*. Harvard University Press.
- [24] Ramsar Convention Secretariat. (2020). *Information Sheet on Ramsar Wetlands (RIS): Kabartal Wetland*. Ramsar Sites Information Service.
- [25] Ramsar Convention Secretariat. (2021). *Global wetland outlook: Special edition 2021*. Secretariat of the Convention on Wetlands.
- [26] Richardson, D. M., Holmes, P. M., Esler, K. J., Galatowitsch, S. M., Stromberg, J. C., Rieger, J. P., & Hobbs, R. J. (2007). Riparian vegetation degradation and restoration. In *Restoration of aquatic ecosystems* (pp. 309–345). Island Press.
- [27] Scott, D. A. (1989). *A directory of Asian wetlands*. IUCN.
- [28] Sinha, R. K., & Kannan, K. (2014). Gangetic dolphin (*Platanista gangetica gangetica*): Conservation status and threats in India. *Aquatic Ecosystem Health & Management*, 17(1), 27–34.
- [29] Space Applications Centre. (2011). *National wetland atlas: Bihar*. ISRO & Ministry of Environment and Forests, Government of India.
- [30] United Nations Environment Programme. (2021). *Making peace with nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies*. UNEP.
- [31] World Wildlife Fund. (2021). *Living planet report 2021: Building a nature-positive society*. WWF International.
- [32] Zoological Survey of India. (2019). *Faunal diversity of wetlands of Bihar*. Conservation Area Series, ZSI, Ministry of Environment, Forest and Climate Change.