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Review Article

Resilience in wetland conservation: A review on comparative study of high-altitude and low-altitude wetlands in India

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Abstract
India is home to a wide variety of natural and manmade wetlands. They are of utmost significance, providing multiple functions, including ecosystem services, which are essential for sustaining local communities. India has undertaken several efforts to conserve, protect, manage, and restore its wetlands. However, owing to anthropogenic and non-anthropogenic factors, India's natural wetlands are under severe environmental stress and are declining steadily. This study undertakes a comparative assessment of the high-altitude and low-altitude wetlands of India, elucidating the similarities and differences they face in terms of threats and management challenges. Characterized by cold, dry alpine climate and extreme temperature variations, high-altitude wetlands are mostly comprised of Himalayan lakes situated 3,000 m above mean sea level. They are sensitive to climate change, possess unique biodiversity, and serve as water regulators of major Himalayan rivers. Low-altitude wetlands are typically located 1000 m below mean sea level and are found in the floodplains of major river systems, coasts, and in arid and semi-arid regions. These densely populated regions support the livelihoods of millions of people. Drawing lessons from this comparative study, the paper further emphasizes the relevance of an integrated social resilience perspective, suggesting the need to move beyond the nature-society divide. It aims to inform policy guidelines for efficient wetland management, arguing that conservation, which prioritises preservation, protection, and restoration alone, fails to achieve the objectives. A social resilience perspective recognizing the interconnectedness of nature and society, and their adaptive capacities can strengthen institutions managing natural resources. This approach ensures sustainability, representing the way forward.

Keywords: Conservation, Environment, Resilience, Sustainability, Wetlands

INTRODUCTION

Wetlands are considered to be one of the earth's most coveted ecosystems. They are significant as they recharge groundwater, help in flood control, sequester carbon, are home to many endangered plant and animal species and operate as the life support systems of several communities by providing them with food and other essentials. Increasing industrialization, urbanization, and intensification of agriculture, which reduce land use areas, habitat degradation due to the overexploitation of marine resources, and global climate change have led to a steady decline in natural wetlands worldwide, including in India (Rode 2020; Brinkmann et al., 2020; Space Application Centre (SAC); National Wetland Decadal Change Atlas, 2022). India joined the Ramsar Convention in 1982, and as early as 1985, the Ministry of Environment, Forests, and Climate Change (MoEFCC) identified wetland conservation and its sustainable management as a key agenda. India had 85 Ramsar sites in 2024, with approximately 1.35 million hectares of designated land for conservation (Research Unit, Press Information Bureau (PIB), MoEFCC, August 14, 2024). Although India has made several attempts through various national and international efforts, including enacting policies, signing treaties, and implementing conservation programs, its natural wetlands continue to decline (Prasad *et al*., 2002; Shan *et al*., 2021; Ahmad *et al*., 2024). In February 2013, recognizing the need for a unified conservation approach, the Union Cabinet introduced the 'National Plan for Conservation of Aquatic Ecosystems' (NPCA). This policy document integrates previous initiatives undertaken by the Government of India, such as the National Wetlands Conservation Programme (1986) (NWCP) and the National Lake Conservation Plan (2001) (NLCP), into a multidisciplinary regulatory framework. The NPCA guidelines for implementation came into force in

April 2019, and the revised guidelines were introduced in 2024. The latest initiative on wetlands is the Amrit Dharohar Scheme 2023 (Amrit Dharohar 2023; NPCA, 2024; Wetlands of India Portal, 2025).

The present study compares India's high-altitude wetlands (HAWs) and low-altitude wetlands (LAWs), analyzing the threats, challenges, and management strategies associated with each. It argues that traditional conservation approaches, which focus solely on protection and restoration, are inadequate. Instead, a resilience perspective is needed, recognizing ecosystems as complex adaptive systems governed by multiple institutions and property rights. Wetland policies should incorporate social resilience, acknowledging issues related to power, culture, justice, and equity.

MATERIALS AND METHODS

The study uses secondary data obtained from various governmental documents and websites on wetlands such as the NPCA revised guidelines (2024), Management of high-altitude wetlands 2021, Cultural significance of Indian wetlands (2023), Integrated management plan (2017), Report of regional workshop on conservation and Wise use of wetlands for eastern states (2024), Wetlands of India portal, MoEFCC portal etc., in addition to other academic studies on wetlands. While the NPCA guidelines (2019) and (2024) provide a comprehensive view of the extent of wetlands in India, major threats and impacts, management gaps and challenges, and lay out a national plan for the implementation of conservation of aquatic ecosystems, the Management of HAWs guidelines (2021) identifies issues specific to the HAWs and how might management strategies attempt site specific strategies. The Cultural Significance of Indian Wetlands (2023) highlights the spiritual significance of wetlands, suggesting that it is essential to incorporate a spiritual dimension into the conservation approach. The current research is qualitative and exploratory in nature. Drawing lessons from the literature and evidence, it further enhances the relevance of a resilience perspective in understanding the dynamics of natural resource management more effectively (Holling and Gunderson, 2002; Folke, 2006; Grafton and Little, 2017; Yletyinen *et al*., 2024). Resilience ideas emerged in the 1960s, but since 2010 onwards, they have come to dominate debates and discourses around change in general and global environmental change in particular (Brown, 2014). In the context of environmental change, it ordinarily refers to the potential that a socio-ecological system possesses to absorb disturbances without transitioning to another state or phase (Gunderson, 2000). It is closely related to the concept of 'new ecology,' which views eco-variability, disturbances, risk, and unpredictability as integral aspects of ecological dynamics, rather than exceptions to the rule. While ecological resilience refers to the capacity of ecological systems to absorb disturbance while retaining the same populations or state variables and not about the time taken by systems to return to their original stable state (Holling, 1973), social resilience on the other hand is about howgroups or communities endure external stresses or disturbances owing to social, political and environmental change (Adger, 2000). The need for an integrated resilience approach that combines the social and ecological sciences was evident when instances from around the globe demonstrated that human-environment relationships no longer exist in isolation (Cote and Nightingale, 2012). They have long transcended the divide between nature and society. Drawing lessons from a comparative analysis of India's High Altitude Wetlands (HAWs) and Low Altitude Wetlands (LAWs), this study further enhances the relevance of an integrated social resilience perspective that considers issues of power, equity, culture, and justice, along with natural changes, to understand the dynamics of HAWs and LAWs in India (Molla *et al.,* 2021; Lofqvist *et al.,* 2023).

High-Altitude Wetlands (HAWs)

Due to its geographical diversity and varied climatic conditions, India is home to a diverse range of wetland habitats. According to the National Wetland Atlas 2011, published by the Space Applications Centre (SAC), Ahmedabad, India, has approximately 757.06 thousand wetlands, which account for 4.7 per cent of its total geographical area (Bassi *et al*., 2014). Based on the National Wetland Inventory and Assessment-2nd Cycle (2017-18), Level-I wetland categories were classified as inland and coastal wetlands. Level-II categories include natural and manmade wetlands, followed by a hierarchical system of 20 other types of wetlands. According to the National Wetlands Inventory Atlas 2024, India has a wetland area of 16.89 million hectares, which accounts for 5.12 per cent of its geographical area. The National Wetlands Inventory Atlas (2024) also uses a 20-wetland type classification. Table 1 provides the classification of national wetlands (Garg and Patel, 2007; Space Applications Centre (SAC), National Wetlands Inventory and Assessment (NWIA) Atlas, 2024; Wetlands of India Portal, 2025).

High-altitude wetlands (HAW) fall under the category of inland, natural wetlands. All lakes of the Himalayan region (Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh) that fall above the contour line of 3000 m above mean sea level belong to this category.HAWs are of various types, including alpine lakes, glacial lakes, alpine ponds, marshes and swamps, peatlands, streams, springs, and geysers. Some prominent HAWs of India are Pangong Tso, Tso Moriri and Tso Kar in the Leh-Ladakh region, Chandertal, Suraj, Bhrigu, Dashair etc.,

Table 1. Classification of national wetlands

Level-I	Level-II Code	Level-III Code
Inland Wetlands	Natural (1100)	1101: Lakes
		1102: Ox-Bow Lakes/Cut-off Meanders
		1103: High altitude Wetlands
		1104: Riverine Wetlands
		1105: Waterlogged (natural)
		1106: River/Stream
	Manmade (1200)	1201: Reservoirs/Barrages
		1202: Tanks/Ponds
		1203: Waterlogged (man-made)
		1204: Salt Pans (inland)
		1205: Aquaculture ponds (inland)
Coastal Wetlands	Natural (2100)	2101: Lagoons/Backwaters
		2102: Creek
		2103: Sand/Beach
		2104: Intertidal mud flats
		2105: Salt marsh
		2106: Mangroves
		2107: Coral Reefs
	Manmade (2200)	2201: Salt Pans (Coastal)
		2202: Aquaculture ponds (coastal)

(Source:WetlandsClassification System, Garg and Patel, 2007; SAC NWIA Atlas 2024; Wetlands of India Portal 2025; https://vedas.sac.gov.in/static/downloads/atlas/Wetlands/wetland_L4_atlas_12March2024.pdf)

in the Himachal Pradesh region, Kedar Tal, Shasra, Vasuki Tal,Roopkund and Hemkund in Uttarakhand and Bhagajang, Nagula, Thembang Bapu and PangchenLumpo in Arunachal Pradesh.Table 2 presents the state-wise distribution of HAWs in India, and Fig. 1 illustrates the HAWs in India on a map.

Recent data from the National Remote Sensing Centre (NRSC) Glacial Lake Atlas 2023, however, maps a total of 28,043 high-altitude lakes covering a total area of 131,070.90 ha (NRSC/ISRO Glacial Lake Atlas 2023).

HAWs are unique in that they are more sensitive to climate change, with hydrological regimes influenced by glacial action, unique species of plants and animals, and limnology that is dependent on local geologies (MoEFCC, UNDP and Wetlands International 'Management of Wetlands, 2021). They are the water regulators that sustain and control the critical base flows of the major Himalayan rivers (Ganga, Brahmaputra, Indus), local climate regulators, and carbon sinks. HAWs have a permafrost layer, a cold and dry alpine climate, strong solar radiation, extreme temperature variations, and endemic grasslands (Chatterjee *et al*., 2010; Sharma *et al.,* 2020). Climate change would impact their spatial extent, distribution, and function in many ways (Patel *et al*., 2009). The Intergovernmental Panel on Climate Change Report (IPCC)disclosed that over 600 glaciers have disappeared globally (Palni *et al*., 2019). In India, as reported by Agrawal and Tayal (2013), the East Rathong glacier in the Sikkim Himalayas has lost around 15 per cent of its area. Permafrost degradation, resulting in declining lake levels, desertification, and soil erosion, has also been observed. It has also been predicted that, since HAWs are subject to high-intensity solar radiation, the rapid expansion of high-altitude lakes at the base of glaciers would lead to increased rainfall and reduced snowfall, resulting in higher floods that impact wetlands (Chatterjee *et al*., 2010; MoEFCC, UNDP and Wetlands International 'Management of Wetlands, 2021; Matta *et al*., 2025).

Apart from natural changes, anthropogenic factors such as unregulated tourism, overgrazing, and defective management strategies are impacting the HAWs. A recent study on Loktak Lake in Manipur found that the construction of the Ithai barrage has led to severe ecological impairment in its surrounding areas, resulting in flooding of agricultural lands, the disappearance of indigenous fish, and disruptionof livelihoods (Sharma and Meitei, 2020). In Arunachal Pradesh, the overexploitation of forest resources, pressures to create grazing grounds, solid waste dumping, and unauthorized constructions pose severe threats (Medhi and Saikia, 2020). The conversion of marshes near Wular Lake of the Jammu and Kashmir region for agricultural and afforestation purposes has led to increased floods and droughts (NPCA, 2024). Recognizing the spiritual beliefs prevalent among Buddhists in Arunachal Pradesh, Sikkim, and Manipur surrounding the HAWs, the WWF study (2007) suggests integrating cultural frameworks

Table 2. State-wise distribution of high-altitude lakes in India

State	Jammu and Kashmir	Himachal Pradesh	Uttarakhand	Sikkim	Arunachal Pradesh	Total
Total no. of Lakes	2104	271	118	534	1672	4699
Area (ha)	110131	575	231	3324	11804	126125

into conservation (Gujja *et al*., 2007; Chatterjee *et al*., 2010). More recently, the Government of India's 'Amrit Dharohar Scheme' 2023 attempts to integrate cultural and spiritual beliefs into wetland conservation strategies (Cultural Significance of Indian Wetlands, 2023; Amrit Dharohar, 2023).

The Government of India's NPCA 2024 identifies a fragmented approach to conservation as one of the primary challenges that it faces. Most states do not recognize wetlands as a distinct land use category (NPCA, 2024). Often departments have contradictory goals. For instance, while the water resources department's primary objective is to enhance water-holding capacity, the tourism department aims to develop tourist potential. Limited research exists on HAWs ecosystem services and community livelihoods. Livestock herders residing in the HAWs use the catchment areas as pasture land, which leads to debilitating ecological consequences. Jayachandran (2013) contends that there is no long-term scientific management plan in place for the conservation of these wetlands, making their assessments difficult. A case study of the Bhagajang Wetland Complex in Arunachal Pradesh, by Upadhyay *et al*. (2016), raised similar concerns, emphasizing the need for integrated conservation strategies, intensive research, effective waste management, and the adoption of sustainable energy sources Recent studies on HAWs that elucidate the need for an integrated management strategy that adresses the above mentioned concerns are the studies by Bhatta *et al.* (2018) on 'Wetlands in the Himalaya: Securing Services for Livelihoods' and Ritika *et al.* (2024) study on 'Wetlands in the Hindu Kush Himalayan Region: Eco-economic Function and Conservation strategies'. While Bhatta *et al*. (2018) advocate for a participatory management strategy involving better communication between scientists and policymakers, Ritika *et al*. (2024) emphasize the need to integrate conservation with sustainable livelihoods, energy, and efficient waste management systems in the region.

Low-Altitude Wetlands (LAWs)

Due to its varied topography and diverse climatic regimes, India is home to a wide range of wetland habitats. While its natural HAWs mostly comprise the Himalayan lakes, its natural LAWs comprise wetlands situated in the floodplains of major river systems, saline and temporary wetlands in arid and semi-arid regions, and coastal and marine wetlands. India has a coastline of 7516 km along its east coast, west coast, and the Andaman and Nicobar Islands. It has coral reefs, rocky coasts, mangroves, lagoons, and creeks. Its coastal wetlands alone number 3497, occupying an area of 3,880,569 hectares (Garg and Patel, 2007). According to the National Wetland Inventory Assessment Atlas 2024, the total coastal wetland area of India is 3.62 million hectares (SAC 2024). Natural LAWs, due to favourable climatic conditions, are biologically the most productive but they are also the most threatened. Unlike the HAW areas, which are sparsely populated, the LAW areas are densely populated, supporting the livelihoods of millions of people, many of whom exist below the poverty line and are directly dependent on these wetlands for their survival. Overpopulation, along with low literacy and poverty, exerts pressures that make them more vulnerable (Das and Bhattacharjee, 2020; Pandit *et al*., 2023; Kundu *et al*.,2024). Figure 2 illustrates the state-wise distribution of wetlands in India, while Fig. 3 is a map that displays the wetlands in India, including the Ramsar sites.

Often agricultural demands conflict with the protection of wetlands.As the case study of Kabartal wetland demonstrates, more than half of the population wants the wetland to be drained and the land to be converted for agricultural use (Ambastha *et al*., 2007). Similarly, a case study of the Maguri-Motapung wetlands in Assam reveals that the overexploitation of ecosystem services, including fish, tourism, and other wetland products, as well as siltation, are the primary causes leading to the degradation of this wetland (Bhatta *et al*., 2016).Studies on the East Coast mangrove wetlands of India, such as those in Pichavaram, Krishna, Mahanadi, Bhitarkanika, and the Sunderbans, identify them as the most vulnerable ecosystems in the world. Shrimp farming, agriculture, and timber production have resulted in the loss of mangrove forest cover, leading to increased coastal storm frequency (Ghosh *et al*., 2015). Urban development and encroachment are significant factors contributing to the widespread loss of wetlands, as the case study on the Basai and Sultanpur wetlands reveals. Governmental and public apathy have further contributed to the decline of the Basai wetlands in Gurgaon (Solanki and Joshi, 2017). Case studies on the Chilika, Koleru, and Vembanad wetlands elucidate the preva-

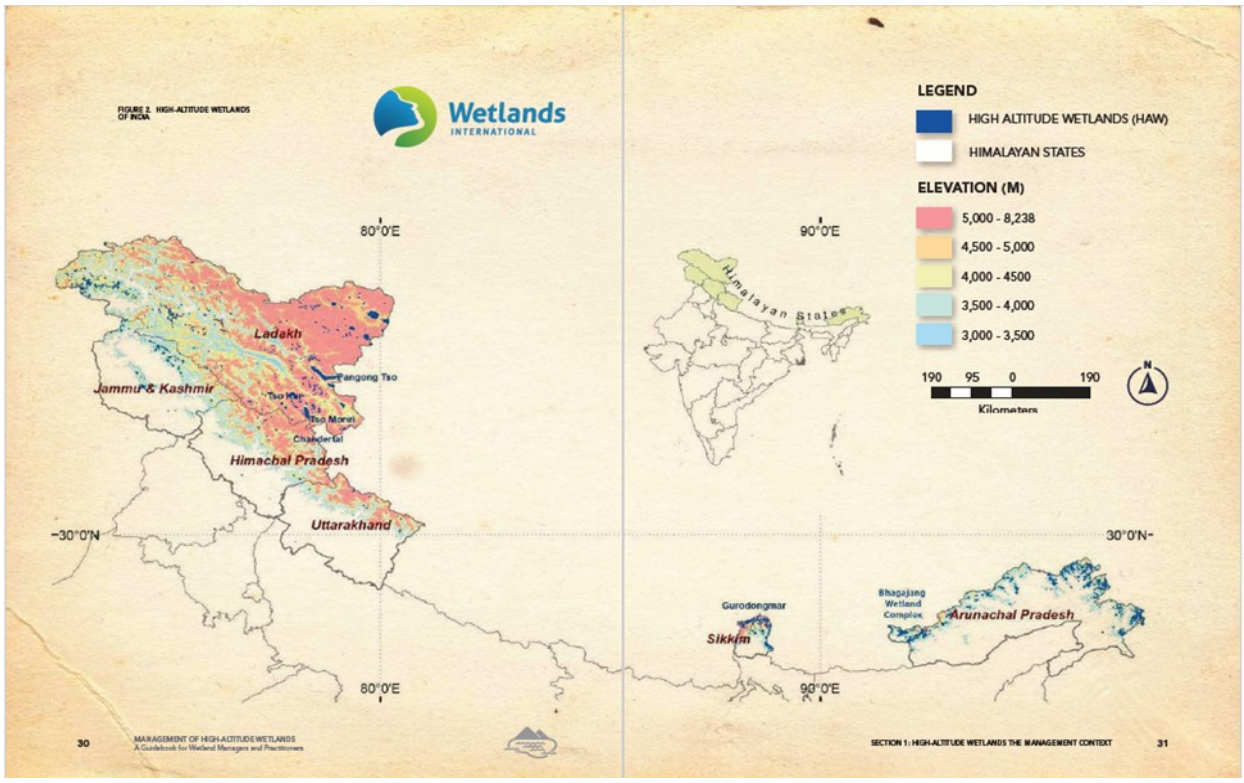

Fig. 1. *High-Altitude Wetlands (HAWs) of India; (Source: MoEFCC, UNDP and Wetlands International 'Management of Wetlands' 2021)*;https://indianwetlands.in/wp-content/uploads/library/1635226884.pdf)

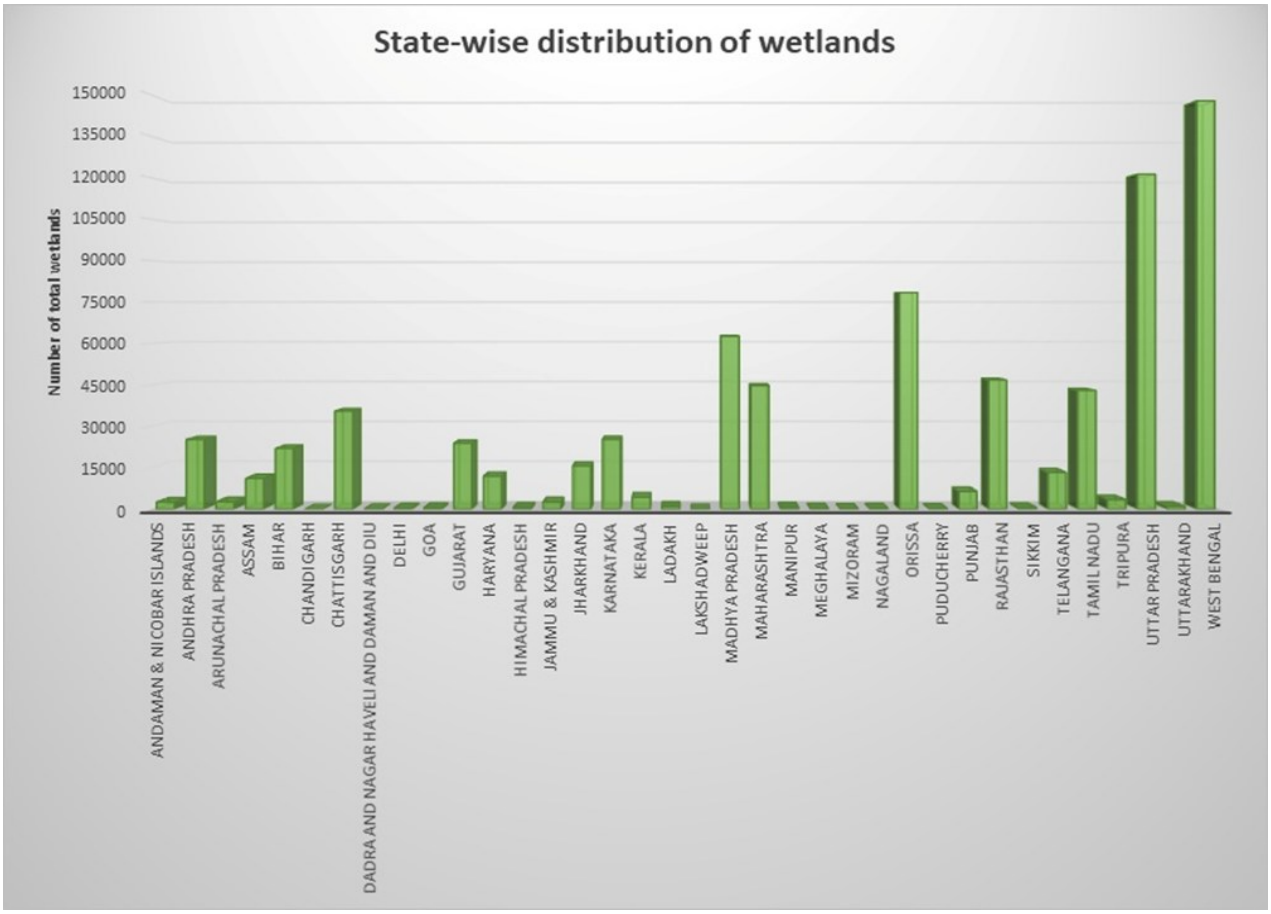

Fig. 2. *State-wise distribution of wetlands in India; Source: Wetlands of India Portal, MoEFCC, Government of India 2025 https://indianwetlands.in/*

lence of several factors that impact these wetlands such as pollution from aquaculture, agriculture, and industrial effluents, increased siltation, decreasing water quality, increasing waterweeds, decrease in the flow of fresh water and contamination of the fish population (Narayanan and Venot, 2009). Due to heavy industrialization and urbanization from 1988 to 2016, the coastal wetlands of the southeastern coast have decreased by 8% (Jacintha *et al*., 2019). Studies by Tamuli *et al*. (2021) on the East Kolkata wetlands of West Bengal, Sarkar and Dana (2022) on the Silsako wetland in Guwahati, and Rahman *et al*. (2025) on coastal wetlands further highlight how rapid industrialization and urbanization have resulted in the degradation of coastal wetlands.

Both HAWs and LAWs face distinct sets of threats and challenges due to their geographical locations and characteristics. Managing them requires continuous research inputs and an integrated approach. The Government of India's NPCA guidelines, 2019 and 2024, through their Integrated management plan (IMP), recommended site-specific management of wetlands, balancing conservation with sustainable use. In 2017, the MoEFCC also notified the Wetlands Conservation and Management Rules, focusing on the integrated management of wetlands while promoting their wise use (Wetlands of India Portal, 2025). However, at a recent regional workshop on 'Conservation and wise use of Wetlands for Eastern States' held on March 2024 under the 'Sahbhagita Mission', site managers of the states of Odisha, Bihar, Chhatisgarh, Jharkhand, Madhya Pradesh, West Bengal, Chandigarh, Andaman and Nicobar, Dadra and Nagar Haveli-Daman and Diu and Lakshadweep deliberated upon the challenges faced in the implementation of the Wetlands Conservation and Management Rules 2017 and integrated management planning (Report of Regional Workshop on Conservation and Wise Use of Wetlands under Sahbhagita Mission for Eastern Region States 2024).

Bihar identified encroachment, limited jurisdictional power, and limited economic resources as its primary challenges. Chhattisgarh, on the other hand, mentioned sewage pollution, overfishing, the spread of invasive species, and a lack of coordination among related departments as its primary management challenges. Lakshadweep cited a lack of skilled workforce, sewage treatment plants (STPs), and inadequate primary infrastructure as its main concerns in dealing with the increasing impacts of climate change. The state of Madhya Pradesh's challenges included encroaching, invasive species, and mapping of the boundaries of the wetlands. Jharkhand mentioned an additional threat of water hyacinth spread. Odisha identified siltation of the river mouths, encroachments, human resource shortages, and inadequate sewage management as its key concerns and suggested improved communication between site managers and the state wetland authority (Report of the Regional Workshop on Conservation and Wise Use of Wetlands under the Sahbhagita Mission for Eastern Region States, 2024). Conservationists contend that the new Wetland Rules 2017 have weakened the earlier regulations.A few selected wetlands are protected under several management plans, while most others continue to be neglected (Bassi *et al*., 2014). Stakeholder conflicts and policy gaps continue. The policies recognize the significance of adopting site-specific management strategies, but these have yet to be developed. The lack of data on the rate of vertical accretion, a strategy adopted by coastal wetlands to cope with sea level rise, is not taken into consideration under management notifications on coastal wetlands, such as classifying a particular area as a No Development Zone (NDZ). This makes management efforts one-sided, as they are based solely on human population density and not on these other site-specific processes (Ragavan *et al*., 2021; Vincent and Owens, 2021; Imdad *et al*., 2023; Prasanya *et al*., 2024).

RESULTS AND DISCUSSION

Is Social resilience the way forward?

Environmental sociologists, such as Catton and Dunlap (1978), have long argued for a paradigm shift from an anthropocentric Human Exemptionalism paradigm (HEP) to a New Ecological Paradigm (NEP). The HEP considers human beings distinct from nature or the environment, suggesting that society can exempt itself from biophysical factors and therefore address all environmental issues it confronts through human creativity and scientific inventiveness. The NEP, on the other hand, considers society and ecology as deeply interconnected. The solution to address environmental issues, therefore, has to be a mutually adaptive one. Recent work in this field has been conducted by scholars such as Marcinokeva *et al*. (2024), Dorward *et al*. (2024), and Jayasinghe and Smiley (2025). The environmental sociologists demanded this shift because instances from all over the globe demonstrated that environmental issues do not exist in isolation. They are interwoven and deeply entrenched in the socio-cultural, economic, political, and religious fabric of any society. Any approach that considers nature or the environment as distinct from human beings cannot fully comprehend the relationship and therefore, cannot yield the desired results.

Furthering this point of view are other scholars, such as Michael Bell, who argue that society-environmental interactions can be viewed as having three dimensions: material, ideal, and practical. The material, represents how production, consumption, technology, population, and development shape our socio-environmental conditions, the ideal elucidates how our culture, ideas, moral

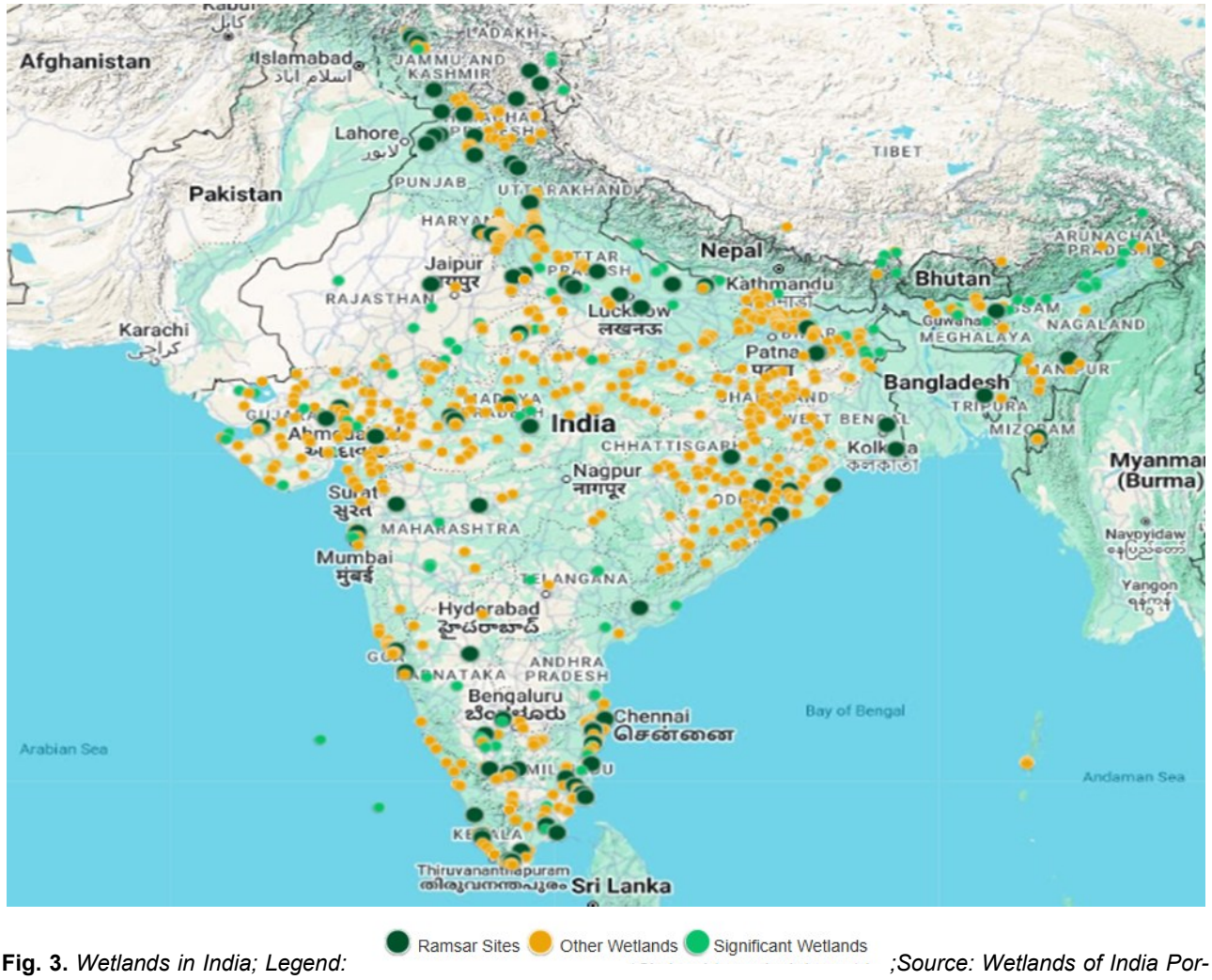

Fig. 3. *Wetlands in India; Legend: ;Source: Wetlands of India Portal, MoEFCC, Government of India, 2025; https://indianwetlands.in/*

values, and social experiences shape the ways in which we relate to our environment and the practical demonstrates responses to the ensuing ecological dialogue between the material and the ideal (Chung-En and Bell, 2017). This comparative study on India's HAWs and LAWs, while highlighting the complex interplay between the material, the ideal, and the practical, also suggests the need to move from a HEP to a NEP. It illustrates how societal-environmental interactions can take on multiple forms. On the one hand, we have an increasing population, a state-run development agenda, ecosystem services that provide sustenance to a massive population dependent on it, a spiritual dimension indicating how communities relate to these wetlands, national and international efforts at managing the same, communities' responses to these efforts, ongoing social conflicts between different stakeholders and on the other we have the natural changes and processes that impact these wetlands.

In this context, the natural is not really separate from the social. Conventional conservation strategies need a serious rethink. Most of our management policies are based upon this narrow conservation ethic, which segregates the environment from society. Conservation has failed to contain ecological degradation, as it has either failed to connect with human populations, which are an integral part of the ecosystem, or neglected the adaptive potentials of both the natural and social systems. Forty per cent of the mangrove areas are listed as protected, yet they continue to degrade. Restoration efforts have not been effective either, as they have mostly emphasized monoculture plantations while ignoring the unique ecological conditions of habitats (Kathiresan, 2018). What compounds the problem is India's environmental bureaucracy, which is plagued by conflicting interests between state and central authorities, the politicization of bureaucratic structures, and a shortage of local officers (Singh, 2007). Given the complexities of interactions between the environment and communities, where there is no finality in terms of solutions, the study emphasizes the importance of adopting a social resilience perspective to comprehend these dynamics.

An Integrated Management Plan (IMP) for wetlands

should focus on conservation, in line with the social resilience perspective that emphasizes the adaptive potential of species in conjunction with their environment. It should recognize that most natural wetlands also have an inherent capacity to adjust to environmental changes. For instance, mangroves resort to processes such as vertical adjustment and horizontal movements to adjust to sea level rise (Schuerch *et al*, 2018). Relocation and rehabilitation of communities that depend on it should be done accordingly. Similarly, different species employ various strategies to adapt to such changes. Conservation efforts should now focus on understanding the physiological, ecological, and genetic processes underlying the unique adaptive capabilities of different species. The current study suggests that there is a lack of site-specific research on the adaptive potential of species inhabiting these areas, rendering conservation efforts ineffective. Conservation approach that prioritizes conservation of wetlands alone, without understanding- a) the natural processes impacting them b) how the wetlands cope with those changes, and c) how best the priorities of the affected species and the local communities can be matched up to these changes, is inadequate. Contemporary conservation approaches must collaborate with economic actors to maximize biodiversity without compromising development goals. They must strike a balance between economic and conservation activities, simultaneously blending development goals with a concern for nature (Kareiva 2011; Srivathsa *et al*., 2023; Prasanya *et al*., 2024; Kundu *et al*., 2024; Nyumah and Brambilla, 2025).

A social resilience perspective would go a long way in ensuring sustainability because it is a perspective that believes building the resilience of an ecosystem requires including marginalized groups that use it, promoting social justice, and ensuring accountability (Lebel *et al*., 2006). It should be understood that both natural and human resources are limited, and often difficult decisions must be made based on which should be prioritized more, given a specific set of circumstances. It also needs to be coupled with an assessment of the adaptive potential of both natural and human resources. For instance, Sinclair *et al.* (2021) in their study on the Ashtamudi Lake Ramsar site in Kerala demonstrated how valuations of ecosystem services could go a long way in guiding conservation and restoration efforts. In the Ashtamudi case, the local communities were willing to bear the minimal costs involved in the restoration of wetlands, indicating how the inclusion of local communities in the developmental projects ensured both social justice and accountability on the one hand, and adaptability on the other keeping in mind the natural changes happening to the wetland.This contributesto the building of social resilience.

Ghosh (2016) in his study on the East Kolkata wetlands, demonstrates the significance of the local knowledge of traditional fishermen in shaping the institutions related to resource management, modifying not only the ways in which resources are used but also transforming the landscape. In the East Kolkata Wetland case, the fishermen were at odds with the real estate developers. It was the struggle, narratives, and experiential knowledge transfers that occurred between various stakeholders that ultimately shaped this peri-urban wetland, which was designated as a Ramsar wetland site in 2002. Similar studies on the East Kolkata Wetland by Mukherjee and Chakraborty (2016) highlight how the East Kolkata wetland has been transformed into a space that not only recycles the city's waste but also provides several means of livelihood to the poor communities indicating that mutual adaptation to the changing socio-ecological context of both the natural and the social world, the foundation of social resilience,is the way to a sustainable future.Recent studies that emphasize resilience as key to economic development and conservation include those by Bhattacharya and Stern (2023), Baraj *et al*. (2024), and Rakkasagi and Goyal (2025). While Bhattacharya and Stern (2023) highlight the importance of resilience in sustainable development, Baraj et al. (2024) argue that resilience is a recurring theme in contemporary discussions on climate change and agriculture. They argue that resilience needs to be integrated with conservation to secure livelihoods that are impacted by climate change. Rakkasagi and Goyal (2025) advocate for conservation strategies that recognize the significance of the adaptive potential and resilience of wetlands, as such an approach would ensure a more robust and sustainable ecosystem.

Future perspectives

Traditional approaches to wetlands in the Indian context have been primarily focused on protection and conservation. Over time, policies have also evolved, and more recently, have adopted an integrated approach that considers the requirements of various stakeholders involved. However, the National Atlases often use different scales and resolutions, making them incomparable. Arriving at exact estimates regarding wetlands becomes an arduous task. More importantly, our policies have also been hierarchical, with a command-and-control approach, where the government enacts conservation and management strategies to be followed. A social resilience perspective would undoubtedly go a long way in broadening the approach to wetland conservation by adding new dimensions to it. However, future perspectives, in addition to having more site-specific resilience-based research, should also convey the idea that the protection or conservation of these wetlands is a primary duty and responsibility of every individual. Efforts at conservation can only be success-

ful if there is a commitment to the cause by all parties involved, including the individuals themselves.

Conclusion

In conclusion, this comparative study of India's HAWs and LAWs provides an overview of the specific threats that the wetlands face and the challenges in their management. Despite several attempts at conservation, protection, and restoration, India's natural wetlands continue to decline. This is because strategies have been lopsided, with inadequate research, emphasizing only the preservation of nature while ignoring the social aspects. Although the conservation guidelines mention wise use, there is no clarity on this concept, often leading to stakeholder conflicts. Given this context, the study advances the need for an integrated social resilience perspective because this recognizes a) that both the natural and the social world are deeply connected, b) that they have an adaptive potential, c) local ecological knowledge plays a significant role in influencing the institutions that manage natural resources which in turn can transform the landscape, d) and any attempt at conservation should be aware of social justice, equity and power issues to be effective. Integrated social resilience, supported by adequate research and greater citizen involvement, is the way forward to sustainability.

Conflict of interest

The authors declare that they have no conflict of interest.

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