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Role of Wetland and Its Importance as Bio-Hub of Ecosystem

[1]Dr. Dinky Mishra, [2]Dr. Biswajit Sarmah
[1]Assistant Professor, Department of Geography, Nagaon University, Nagaon
[2]Assistant Professor, Department of Zoology, Biswanath College, Biswanath

Abstract - The North Eastern region of India experiences substantial rainfall throughout the year, with significant peaks during the monsoon season. This heavy rainfall leads to increased flow in the mountainous streams and the prominent rivers, Brahmaputra and Barak, making these areas susceptible to severe flooding and sediment build-up. The region's unique hydro-geomorphological conditions have given rise to numerous natural lakes, wetlands, waterlogged zones, and swamps. Within this area, Assam, Arunachal Pradesh, Manipur, Sikkim, and Tripura contain extensive wetland regions, with Assam holding the largest portion. Reports indicate that Assam is home to 3,513 wetlands spanning approximately 101,231 hectares. Manipur ranks second in the region with 26,600 hectares of wetland. Locally referred to as "Beel," many of Assam's wetlands (or lakes) are interspersed along the course of the Brahmaputra River. Numerous tributaries from the surrounding hills converge into this river. The dynamic nature of these rivers, along with their hydrological traits and sedimentation patterns within the valley, influence the state's wetlands significantly. Currently, several wetlands in this region face serious threats due to inadequate land management practices in their catchment areas, resource over-exploitation, agricultural expansion, and other developmental pressures. Observations indicate a reduction in wetland size alongside pollution and a decline in diverse flora and fauna as well as other biological resources for various reasons. The hydrological and ecological importance of these wetlands and lakes remains largely unrecognized. Some floodplain wetlands function similarly to lakes during wetter months of the year. Furthermore, these wetlands play a crucial role in replenishing groundwater aquifers. This paper aims to evaluate Assam's wetland resources while emphasizing potential development opportunities for sustainable management across multiple uses such as job creation, recreational activities, and aquaculture.

Keywords - North Eastern region of India, Monsoon rainfall, Mountainous streams, Brahmaputra River, Barak River.

I. Introduction

Wetlands rank among the Earth's most productive ecosystems, offering numerous ecological services and hosting a wide variety of plants and animals. In Assam, a north eastern state of India, wetlands possess considerable ecological, economic, and cultural significance. Assam, noted for its abundant rainfall and numerous river systems, features a range of wetlands such as floodplain lakes (locally termed beels), marshes, swamps, and riverine habitats. These wetlands are crucial for sustaining regional biodiversity, regulating water cycles, and supporting local livelihoods through activities like fishing, farming, and tourism. The wetlands in Assam provide essential habitats for a variety of fish, birds, and other wildlife species. They serve as spawning areas for fish

and promote a vibrant variety of water plants. The wetlands in the area are vital for migratory birds, underscoring their importance from a conservation standpoint Assessment, M. E. (2005). Wetlands aid in groundwater replenishment, flood control, and water filtration, thereby preserving the overall well-being of the ecosystem. Wetlands serve as a fundamental source of economic support for local communities in Assam. Fishing serves as a main source of income, as numerous communities depend on the abundant variety of fish for their everyday sustenance. Besides fishing, wetlands also facilitate agriculture, especially the growth of paddy, which thrives in wetland environments.

The collection of water plants and the raising of animals in and near wetlands also support the livelihoods of the surrounding community. Ecotourism, focused on the distinct biodiversity of these wetlands, has also become an expanding sector, providing possible economic advantages while raising conservation awareness. Although vital, Assam's wetlands encounter numerous management issues. Human activities like encroachment, unregulated fishing, and agricultural growth are causing habitat deterioration Scanes, C. G. (2018). Agricultural runoff, industrial wastes, and urban sewage are harming water quality. Moreover, climate change presents a major risk, changing water patterns and affecting the fragile equilibrium of these ecosystems. The deficiency of thorough wetland management policies and inadequate enforcement of current regulations further worsen these problems. The successful management of Assam's wetlands requires a comprehensive strategy that combines sustainable livelihood methods with conservation initiatives.

The Brahmaputra and Barak basins contain more than 5,000 large wetlands and approximately 6,000 medium and small wetlands (locally termed beel/haor), spanning an area of 7.64 hectares, representing roughly 10% of Assam's overall geographical area. The needs of riverine species for food, shelter, and breeding grounds are primarily met by the nearby floodplain lakes (beels), which are regarded as the "fish granaries" of Assam. In addition to this, the beels also retain excess floodwater. They serve as the natural reservoir for waste substances and, most crucially, for flood control. Wetlands in Assam are generally divided into (a) oxbow lakes (open beel); (b) tectonic lakes (closed beel); (c) seasonal inundated zones; (d) artificial tanks (like the historical tanks of upper Assam). Beels are shallow bodies of water with a significant organic load and are predominantly infested with weeds, especially water hyacinth. The volume and depth of water in the beels show significant variation. During the height of summer, certain beels are completely dry. Numerous studies carried out in the wetlands of Assam have repeatedly highlighted the various threats they encounter. Several authors have expressed their worries about the declining state of Assam's wetlands.

This research offers a comprehensive and inclusive perspective on Assam's wetlands, highlighting their significance, the challenges they face, and potential solutions that will serve as a foundation for future research. Assam, located in Northeast India, is noted for its heavy rainfall and vast river networks, which foster a variety of rich and diverse wetland environments. These beels are forms of floodplain, lake, are essential for the region's ecological stability and socio-economic health. The wetlands of Assam, spanning more than 100,000 hectares, are crucial to the state's ecosystem but are threatened by human actions and natural events. These wetlands comprise oxbow lakes,

tectonic lakes, temporary waterlogged regions, and artificial tanks, with beels (shallow lakes) being a significant characteristic. Conservation initiatives are in progress, featuring legal safeguards, the National Wetlands Conservation Programme, and the Ramsar Convention, yet community engagement is vital for their sustained protection.

Table1: District wise distribution of wetlands in Assam (Source: ASTEC)

District	Number	Area (ha)	District	Number	Area (ha)
Barpeta	97	3301.0	Karbi Anglong	77	897.00
Bongaigaon	100	3158.50	Karimganj	70	5719.50
Cachar	340	7188.00	Kokrajhar	85	1578.40
Darrang	103	3515.00	Lakhimpur	151	3033.50
Dhemaji	139	3960.00	Morigaon	183	11658.00
Dhubri	233	6459.00	Nagaon	379	11295.50
Dibrugarh	86	2752.00	N.C Hills	10	2552.50
Goalpara	165	3832.50	Nalbari	68	1988.00
Golapara	330	5467.50	Sibsagar	109	2135.50
Hailakandi	47	840.00	Sonitpur	206	3651.00
Jorhat	109	2108.50	Tinsukia	74	2732.50
Kamrup	352	11407.00	Total	3513	101231.60

Table 2: Size and area of wetlands of Assam (Source: ASTEC)

Area Class (ha)	Total no.	Total Water spread Area (ha)	Total Vegetation Area (ha)	Total wetland Area (ha)
1.0-100.0	3341	52878.1	1920.5	55821.5
100.1-200.0	100	12921.5	947.5	13869.0
200.1-300.0	36	7979.5	537.0	8527.0
300.1-400.0	14	4505.0	328.0	4823.0
400.1-500.0	4	1815.0	0.0	1815.0
500.1-600.0	6	2625.0	602.5	3227.5
>600.1	12	13068.0	70.0	13148.0
Total	3513	96818.10	4405.5	101231.6

Types of wetlands

The wetlands of Assam consist of different kinds, each contributing significantly to the ecosystem.

The wetlands of Assam are varied, comprising oxbow lakes (beels) (created by river meanderings), tectonic lakes (resulting from geological processes), seasonal inundated regions, and ancient tanks.

Beels (Floodplain Lakes): Shallow aquatic systems, typically characterized by a high organic load and weed growth (mainly water hyacinth), essential for regulating hydrological cycles and supporting biodiversity.

Oxbow Lakes (open beels) and Tectonic Lakes (close beels): Created from alterations in river channels or tectonic movements, they sustain diverse aquatic ecosystems and act as fishing areas.
Swamps and Marshes: Defined by thick plant life and shallow waters, serving as natural filters and offering homes for a variety of plants and animals.

Artificial Tanks: Predominantly located in upper Assam, utilized for multiple functions such as water retention, aquaculture, and agricultural activities.

II. Importance of wetlands

Wetlands are currently regarded as the final remnants of fresh water sources on the planet, aside from the continuous rivers. Wetlands are increasingly recognized globally for their ecological, economic, and recreational roles; however, their importance remains underappreciated, and they continue to face constant threats from escalating human activities.

• Wetlands help in reducing flood intensity by storing surface water.
• Coastal wetlands absorb energy of the waves and thereby reduce erosion.
• Wetlands provide habitats for diverse life forms.
• Wetlands trap pollutants and can remove toxic residues.
• Wetlands provide fish, flood, fuel and fiber.
Wetlands purify water, trap sediments, absorb pollutants, and act as natural buffers during floods and storms.

However, wetlands are the most threatened ecosystem, vanishing three times faster than forests. The Global Wetland Outlook 2025 warns of a potential $39 trillion loss in ecosystem services if urgent conservation measures are not adopted.

The North East region of India experiences significant rainfall throughout the year, with the monsoon season contributing the most. The heavy influx of water into its mountainous streams and the mighty Brahmaputra and Barak Rivers makes this area susceptible to severe flooding and sedimentation Jain, S. K., Agarwal, P. K., & Singh, V. P. (2007). The region's unique hydro-geomorphological features have led to the creation of numerous natural lakes, wetlands, waterlogged areas, and swamps. Among these states, Assam is the largest wetland area, followed by Arunachal Pradesh, Manipur, Sikkim, and Tripura. In Assam alone, there are approximately 3,513 wetlands spanning an area of about 101,231 hectares. Manipur ranks second in the region with wetlands covering around 26,000 hectares. Locally referred to as "Beel," Assam's wetlands are nourished by the flowing Brahmaputra River.

Threats to wetlands
Despite their importance, Assam's wetlands face several threats:

Encroachment: Uncontrolled expansion of human settlements and agricultural activities leads to shrinkage and degradation of wetlands. Unsustainable use, encroachment, siltation, and erosion pose significant challenges to wetland health and Urban encroachment and infrastructure development.

Pollution: Discharge of domestic and industrial effluents, agricultural runoff containing pesticides and fertilizers, and unscientific waste disposal severely impact water quality and aquatic ecosystems.

Over-exploitation: Unsustainable fishing practices and extraction of resources disrupt the ecological balance and deplete biodiversity. Agricultural expansion and water diversion Siltation and Climate Change: Increased siltation due to deforestation and changing hydrological patterns due to climate change pose significant threats to the long-term health of wetlands.

A variety of factors, both natural and man-made, create tremendous pressure and threats to the wetlands Rozema, J.et.al (1991). The human factors are, however, found to be more serious to cause degradation and loss of the wetlands world over. Therefore, a great need to make people and policy-makers aware of the role played by the wetlands as habitats for life forms and regulators of local ecosystems.

Wetlands are used by people in many different ways as they offer a range of benefits, however, to exploit different resources from the same source tends to overuse of the wetland resources make the ecosystem increasingly weak Kingsford, Richard T et.al (2016). Human activities, particularly farming and grazing around the wetlands create situations quite detrimental to the sustainability of the wetland ecosystems.

These not only contribute to gradual shrinkage of the wetlands through accelerated situation, but also may sometime lead to wet land eutrophication, a process by which certain pollutants are washed into water bodies and overload them with organic and mineral nutrients. Among these nutrients, phosphorus and nitrogen are particularly important as they control the growth of aquatic plants. Eutrophication can be accelerated by human activities like fertilization of soil for farming and discharge of domestic sewage and industrial effluents.

The anthropogenic eutrophication commonly leads to excessive growth of algae, serious depletion of dissolved oxygen and in extreme cases, to an inability to support fish life (Goudie, 2001). When the process is well advanced, water bodies such as lakes and streams can appear to be ecologically dead. A natural area will receive protection only if the value a society assigns to its natural functions is higher than the value the society assigns to exploiting its natural resources (Sjögersten, Sofie, et al). Conservation of natural element does not imply use by human society whatsoever, it rather implies a kind of management to allow a certain system to recover its loss. The aim of conservation is to manage or regulate use so that it does not exceed the capacity of the system to regenerate itself.
The Ramsar convention held in Ramsar city of Iran in 1971 is considered to be a landmark for wetland conservation. Among the countries of the world, Netherlands set one of the best examples of both systematic degradation and conservation of wetlands.

Covering 16 percent of the globally important wetlands, more than half of the land of Netherlands is reclaimed wetlands.

Covering around 3 percent of the country's land surface, wetlands of India are under tremendous threats and pressures. Little efforts are made to conserve important wetlands like Chilika, Sambar, Ular, Loktak, Deepor Beel etc. Covering all the states and eco-regions of the country, the National Biodiversity Strategy and Action Plan 2001, carefully address the issues of wetland conservation and suggest strategies towards sustainable use and conservation of wetland resources.

The case of Loktak Lake in Manipur is an example of threatened wetlands. Covering about 980 sq. km, Loktak Lake is the largest natural wetland in north-east India. The characteristic feature of the lake is the floating islands called phumdis. The Keibul Lamjao National Park, known for the most endangered brow antlered deer (Cervus eldi eldi), is over such a phumdis. But due to severe deforestation in the hills, high rate of land degradation and resultant siltation has reached such an extent that the very existence of the wetland as a rich habitat of aquatic fauna including waterfowls has been badly threatened.

Conservation efforts

Recognizing the crucial role of wetlands, several initiatives are underway for their **conservation:**

Government Policies and Regulations: The Guwahati Water Bodies (Preservation and Conservation) Act (2008) and the Wetlands Conservation and Management Rules (2017) provide a legal framework for protecting wetlands.

Restoration and Rejuvenation Projects: The Assam government, in collaboration with institutions like the Asian Development Bank (ADB) and the Assam Science Technology and Environment Council (ASTEC), has undertaken projects to revitalize wetlands through dredging, desiltation, and other measures aimed at restoring their ecological functions.

Community Involvement: Encouraging local communities to participate in conservation efforts and promoting sustainable livelihood options to reduce dependence on wetland resources are essential for long-term protection.

Awareness and Capacity Building: Organizations like the Nature Environment and Wildlife Society of India (NEWS) are actively involved in raising awareness about wetland conservation among students and local communities, fostering a sense of responsibility and promoting sustainable practices.

The preservation and sustainable management of Assam's wetlands are crucial for ensuring the well-being of its people and the health of its environment Ghosh, Swagat, et al. (2024). A collaborative approach involving government agencies, local communities, and conservation organizations is essential to protect these valuable ecosystems for future generations.

Covering 6% of the earth's surface, wetlands constitute an important component of the earth's natural system, including a wide range of water bodies, such as lake, marsh, swamp, pond, bog and fen. While many wetlands occur on or near the coast, there are also many inland wetlands which are better called freshwater wetlands.
For conservation of such kind of wetlands, there is no other option at this moment but to encourage the local people to join hands with the concerned authorities for their protection. Shine, C., & De Klemm, C. (1999). Fortunately, some NGOs and committed Individuals have come forward to work for the cause of wetland conservation.

The 15th meeting of the Conference of the Contracting Parties to the Ramsar Convention on Wetlands (COP15) took place in Victoria Falls, Zimbabwe, from July 23rd to 31st, 2025. A key outcome was the adoption of India's resolution on "Promoting Sustainable Lifestyles for the Wise Use of Wetlands," emphasizing community-driven conservation and individual behavioural changes. The conference saw participation from governments, civil society, and international organizations, reaffirming global commitments to wetland conservation.

Ramsar COP15: India's Leadership in Global Wetland Conservation
Ramsar COP15 marked a pivotal moment in global wetland conservation, concluding with the adoption of 13 resolutions and 5th Strategic Plan for 2025-2034.
Wetlands are among the most valuable ecosystems on Earth, yet they face an alarming crisis. The recent Ramsar COP15 conference in Zimbabwe brought this issue to global attention.

In the Ramsar Convention COP15, 13 resolutions and 5th strategic plan were adopted which aimed at protecting wetlands. This conference, themed "Protecting Wetlands for Our Common Future," saw India emerge as a leader in wetland conservation.

Insights from COP15
Ramsar COP15 adopted 13 resolutions, presenting a global resolve to protect and restore wetlands. Some of the important resolutions include those on wetland restoration, protection of migratory birds through flyway conservation and the Global Water bird Estimates Partnership among others.

Parties also adopted the 5th Strategic Plan (2025-2034) with four goals and 18 targets. These goals are:
Goal 1: Address and reverse wetland loss and degradation.
Goal 2: Achieve the wise use of Wetlands through policy planning and inclusive participation.
Goal 3: Conserve and Manage Wetlands of International Importance effectively.
Goal 4: Enhance implementation of the Convention through scientific cooperation, capacity building, and raising money.
The small 4.1% budget increase to CHF 15.5 million for 2025-27 highlights the challenges of financing conservation efforts. However, it is a modest but important step towards reinforcing its operational capacity. Building on this foundation of inclusive participation and community involvement established at COP15, one country took a particularly innovative approach to wetland conservation.

India's Historic Resolution at Ramsar COP15

India's resolution on "Promoting Sustainable Lifestyles for the Wise Use of Wetlands" was successfully adopted on receiving support from all 172 countries at Ramsar COP15. This resolution aligns with the ethos of India's Mission LiFE (Lifestyle for Environment) initiative, which was introduced by the Indian Prime Minister at COP26 in Glasgow in 2021. Mission LiFE promotes a lifestyle that is synchronous with nature and does not harm it.

The resolution draws focus towards community-driven conservation. It shows how individual and community choices can impact wetland protection Zhang, W, et.al. (2023). By promoting a "pro-planet lifestyle" that fits different national situations, India has made behavioural change an important part of environmental policy.

The support for India's resolution shows that wetland conservation needs a "whole of society" approach. This means moving beyond government-only conservation models to include grassroots participation and local ownership.

Understanding the Wise Use Principle

The concept of "wise use" forms the foundation of the Ramsar Convention and has changed since the treaty began in 1971. Originally focused on sustainable use, the principle now means "maintaining the ecological health of wetlands through ecosystem-based approaches within sustainable development."

This change reflects a better understanding of ecology. We now recognize wetlands as complex, connected systems that provide many services beyond just being homes for animals. The wise use principle applies to all wetlands in a country, not just designated Ramsar Sites.

India's utilization of wise use principles through national programs shows how to apply this concept. The country's National Plan for Conservation of Aquatic Ecosystems (NPCA) and Integrated Management Plans (IMPs) provide frameworks for wetland management.

The Ramsar Convention on Wetlands (1971) is the only global environmental treaty dedicated to wetlands. Initially focused on migratory waterfowl habitats, it now covers all wetland types, recognizing their role in biodiversity, climate regulation, and human well-being.

India's Ramsar Sites

India became a signatory to the Ramsar Convention on February 1, 1982. India currently has 91 Ramsar sites covering a total surface area of 1,359,951 hectares, making it one of the countries with the highest number of Ramsar sites globally.
These sites represent diverse wetland ecosystems across the country, from the high-altitude lakes of Ladakh to the coastal mangroves of the Sundarban.

Legal Framework for Wetland Protection

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified Wetlands (Conservation and Management Rules, 2017) under the provisions of the

Environment (Protection) Act, 1986 as the regulatory framework for conservation and management of wetlands in India.

The 2017 Rules have strengthened the institutional framework through State/UT Wetland Authorities and a National Wetland Committee. They have enhanced the focus of management of wetlands from a central authority (as per 2010 Rules) to state bodies.

India's Conservation Model

India's approach to wetland conservation has gained international attention, particularly through its remarkable achievement of restoring 68,827 small wetlands in just one year through the Amrit Sarovar Mission and Mission Sahbhagita. This was achieved through a combination of community participation, technology use, and policy coordination.

The Amrit Sarovar Mission represents India's commitment to small-scale wetland restoration. Most of these revived wetlands are less than 1 hectare in area, demonstrating that significant conservation impact can be achieved through numerous small-scale interventions. Haryana's model, showcased at Ramsar COP15 in Zimbabwe, drew international attention for its speed and reliability.

Community-Driven Initiatives: The 'Mission Sahbhagita' and 'Save Wetlands' campaigns show India's commitment to conservation. These programs have engaged over 2 million citizens as volunteers, leading to mapping more than 170,000 wetlands and marking boundaries of nearly 120,000 wetlands across the country in three years.

Technology Use

India's use of technology in wetland conservation includes

GIS-Based Mapping and Remote Sensing for wetland classification and monitoring National Wetlands Portal serving as a digital platform for data collection and progress tracking.

Citizen engagement applications allowing community reporting and complaint handling.

Together, these innovations create a model of conservation that other countries can replicate, particularly in the Global South.

Path Forward

The outcomes of Ramsar COP15, particularly India's leadership through its Mission LiFE resolution and restoration model, provide a blueprint for wetland conservation. The focus on governance, traditional knowledge integration, and community-driven approaches offers solutions that can be copied worldwide.

As the COP15 President said in her closing remarks, the success of these commitments depends on putting them into national policies and strategies, strengthening international cooperation, and establishing financial mechanisms to close resource gaps.

Conservation and Management of Wetlands

Wetlands play a crucial role in ecological conservation; however, they are highly vulnerable to human-induced disturbances. Pollutants from nearby industrial activities

can infiltrate these ecosystems over time, leading to bioaccumulation issues within their components.

Activities such as livestock grazing and agriculture along wetland banks further contribute to their degradation by causing siltation and murkiness in the water Munubi, A. (2009). This reduces sunlight penetration for micro-flora growth and subsequently lowers overall biological productivity within these ecosystems. Intensive fishing practices also harm micro-flora populations, resulting in reduced yields in subsequent years—prompting increased fishing efforts that threaten wetland sustainability.

The degradation of the Brahmaputra valley's wetland system began over a century ago with rampant proliferation of water hyacinth Sarkar, Smritikana, et al. (2021). This invasive species blocks sunlight from reaching essential micro-flora and accelerates eutrophication by slowing water flow and accumulating debris on the bottom. Following this initial phase came a further exacerbation due to earthen bunds constructed along much of the river's length after an earthquake in 1950; these structures significantly hindered seasonal flushing caused by monsoon floods. A third wave of encroachment on wetlands occurred in lower Assam where agricultural development has transformed these areas into rice-vegetable cultivation zones devoid of wildlife. Consequently, fish production has also declined Mamunul Hoque, et al. (2012).

Despite having abundant waterways like the Brahmaputra and its many tributaries alongside numerous wetlands, Assam faces a yearly fish import deficit total of 52,000 tonnes; approximately 20% (or 14 thousand tonnes) is consumed domestically while local production reaches only about 155 thousand tonnes annually—with imports accounting for roughly 6.68% (sources: Directorate of Fisheries, Government of Assam). The potential fish yield from developed state wetlands is estimated at between 400-500 kg per hectare per year—indicating considerable opportunities for job creation if appropriate management strategies are implemented.

Recommendations for Sustainable Wetland Development

- To ensure sustainable use and development of these vital ecosystems:
- Protect land surrounding water bodies/wetlands by limiting construction.
- Implement measures that promote equitable access to resources while ensuring responsible usage.
- Focus on conserving aquatic flora and fauna within wetland environments.
- Raise awareness regarding hydrological importance related to aquifer recharge and water conservation.

III. Conclusion

This overview emphasizes the significance of wetlands in Assam regarding food security as they represent one of Earth's most critical ecosystems linking terrestrial land with aquatic environments. They serve as corridors facilitating life evolution from

water onto land while acting as 'kidneys' that regulate nutrient flow between soil and water systems through filtration processes—all while supporting a substantial portion of global biodiversity. Effective management practices can unlock multiple benefits such as reducing pollutants through natural biophysical processes occurring within wetlands; mitigating floods; protecting against storms; managing sediment deposition; recycling nutrients; removing pollutants; regulating groundwater levels; treating wastewater; preventing erosion; providing habitats for fish—and fostering diverse wildlife alongside extensive eco-tourism prospects—ultimately serving millions reliant on these ecosystems for livelihood support. Wetlands located within protected areas benefit from a certain level of safety due to the established rules and regulations governing these zones. In contrast, wetlands situated outside these protected boundaries lack stringent oversight, leading to their swift degradation and even total destruction. To ensure the preservation of these vulnerable wetlands, it is essential to motivate local communities to collaborate with relevant authorities for their safeguarding. Fortunately, several NGOs and dedicated individuals have stepped up to support wetland conservation efforts.

References

1. ARSAC (1997) Wetlands of Assam, Assam Remote Sensing Application Centre, Guwahati.
2. Hazarika, U.M, Patra, S.C & Seethapathi, P.V (2000) Action Research in Kaliabor Lift Irrigation Scheme: Objective, Methodology and Achievements, Proceedings of National Seminar on Resource Management for self-reliant agriculture economy of NE region-NERIWALAM, Tezpur, during 09-10th February, 2000.
3. Patra, S.C & Seethapathi, P.V (2001) Water Resource of Brahmaputra river Basin and planning for development of Multipurpose Project, Proceeding of International Seminar on Advances in Civil Engineering, IIT, Kharagpur, January,2001.
4. Goudie, A.S. and Middleton, N.J., 2001. Saharan dust storms: nature and consequences. Earth-science reviews, 56(1-4), pp.179-204.
5. Sjögersten, Sofie, et al. "Tropical wetlands: a missing link in the global carbon cycle?." Global biogeochemical cycles 28.12 (2014): 1371-1386.
6. Assessment, M. E. (2005). Ecosystems and human well-being: wetlands and water. World resources institute.
7. Rozema, J., & Leendertse, P. C. (1991). Natural and man-made environmental stresses in coastal wetlands.
8. Ghosh, Swagat, et al. "Fisheries and aquaculture in wetland ecosystems: A review of benefits, risks, and future prospects in India." Journal of Coastal Research 40.3 (2024): 598-612.
9. Kingsford, Richard T., Alberto Basset, and Leland Jackson. "Wetlands: conservation's poor cousins." Aquatic Conservation: Marine and Freshwater Ecosystems 26.5 (2016): 892-916
10. Munubi, A. (2009). The role of human activities in the degradation of'wetlands a case study of lumbuye wetland in Luuka county, Iganga District.
11. Sarkar, Smritikana, et al. "Status, ecological services and management of aquatic weeds of floodplain wetlands in India: An overview." Lakes & Reservoirs: Research & Management 26.1 (2021): 76-91.

12. Khan, Mamunul Hoque, et al. "Community conserved areas in Chittagong Hill Tracts of Bangladesh." Wildlife Trust of Bangladesh, Dhaka, Bangladesh (2012).
13. Zhang, W., ElDidi, H., Masuda, Y. J., Meinzen-Dick, R. S., Swallow, K. A., Ringler, C., ... & Aldous, A. (2023). Community-based conservation of freshwater resources: learning from a critical review of the literature and case studies. Society & Natural Resources, 36(6), 733-754.
14. Shine, C., & De Klemm, C. (1999). Wetlands, water, and the law: using law to advance wetland conservation and wise use (No. 38). IUCN.
15. Scanes, C. G. (2018). Human activity and habitat loss: destruction, fragmentation, and degradation. In Animals and human society (pp. 451-482). Academic Press.
16. Jain, S. K., Agarwal, P. K., & Singh, V. P. (2007). Brahmaputra and barak basin. In Hydrology and water resources of India (pp. 419-472). Dordrecht: Springer Netherlands..