DeepScience
Multidisciplinary Research: Innovations in Science, Arts and Commerce
Published in October 2025 by Deep Science Publishing (USA | UK | India | Turkey)
ISBN: 978-93-7185-157-2 | E-ISBN: 978-93-7185-737-6 | DOI: https://doi.org/10.70593/978-93-7185-737-6

Assessment of Ecosystem Services of Urpad Beel and Its Impact on People's Dependency

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Abstract

The study investigates the ecosystem services provided by Urpad Beel, a wetland of significant ecological importance. The study aimed to identify, assess, and analyze the diverse ecosystem services offered by Urpad Beel, as well as their contributions to the well-being and livelihoods of local communities. Through a comprehensive literature review, field surveys, and stakeholder consultations, this research examines the ecological, economic, and socio-cultural dimensions of the wetland's ecosystem services. The research employs a multi-disciplinary approach, integrating ecological assessments, economic valuation techniques, and qualitative analyses to understand the significance and benefits derived from Urpad Beel. The ecosystem services are classified, quantified, and ranked based on their perceived importance and utilization by local communities. Additionally, the study investigates the temporal dynamics of the wetland's ecosystem services, exploring how they have changed over time and the factors contributing to these changes. Furthermore, this study explores the implications of ecosystem service degradation or loss on the well-being of local communities and highlights the interdependencies between natural and human factors in shaping the wetland ecosystem. The findings of this research will provide valuable insights for policymakers, conservationists, and stakeholders involved in the sustainable management and conservation of Urpad Beel. Overall, this work contributes to the understanding of the ecosystem services provided by Urpad Beel and emphasizes their critical role in supporting the socio-economic well-being and cultural heritage of the local communities. The results will guide the formulation of effective policies and management strategies aimed at the conservation and sustainable use of Urpad Beel's ecosystem services for the benefit of both present and future generations.

Keywords: *Ecosystem services; Urpad Beel; conservation; people's dependence; sustainability*

1. Introduction

Wetlands are among the most biologically diverse and productive ecosystems on Earth, providing essential ecological functions and supporting human well-being. They serve as critical habitats for a variety of plant and animal species, many of which are unique to these ecosystems (Cherry, 2011; Davidson, 2014). According to the Ramsar Convention, wetlands are defined as areas where water is the primary factor controlling the environment and the associated plant and animal life. These ecosystems may be permanently or seasonally waterlogged, natural or artificial, and include both inland and coastal zones. The saturation of land with water in wetlands creates a mosaic of habitats that supports high biodiversity,

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maintains ecological balance, and provides essential ecosystem services. Globally, wetlands cover approximately 6% of the Earth's surface, and in India, they constitute an estimated 4.6% of the country's total land area, encompassing a wide range of types and ecological characteristics (ISFR, 2019; Bhattacharjee et al., 2020). In Assam, a north-eastern state of India, wetlands are critical for local livelihoods, culture, and biodiversity conservation, including species such as the endangered one-horned rhinoceros (Assam State Wetland Authority, 2019). The state has 708 identified wetlands, covering an area of 3,585 km², reflecting the ecological and socio-economic significance of these ecosystems. Wetlands provide numerous benefits, including water purification, flood control, nutrient cycling, carbon sequestration, and habitat for flora and fauna. These services are not only essential for ecosystem functioning but also underpin the livelihoods and cultural practices of local communities that directly depend on wetland resources for subsistence and income.

Ecosystem services from wetlands can be broadly categorized into four types: provisioning, regulating, supporting, and cultural services (MEA, 2005). Provisioning services include tangible goods such as fish, shellfish, water, fodder, fuelwood, timber, and medicinal plants. Regulating services encompass flood mitigation, water purification, nutrient retention, and climate regulation. Supporting services are ecological processes, including habitat provision, nutrient cycling, soil formation, and carbon sequestration, which maintain ecosystem health. Cultural services comprise non-material benefits such as recreation, tourism, aesthetic value, spiritual enrichment, and educational opportunities. These services collectively sustain both ecological integrity and human well-being.

Despite their importance, wetlands worldwide are facing severe degradation due to land-use changes, pollution, over-exploitation of resources, and climate change, leading to alterations in hydrology, biodiversity, and biogeochemical cycles. Such changes directly affect the availability and quality of ecosystem services, with significant consequences for the livelihoods, cultural practices, and resilience of communities that rely on them. For example, modifications in wetland hydrology can disrupt water supply for agriculture and domestic use, while declines in biodiversity can undermine traditional knowledge and resource-based livelihoods.

This study focuses on Urpad Beel, a lesser-known wetland in Assam, North-East India, to assess its ecosystem services and examine their contribution to local livelihoods. It aims to identify and rank the wetland’s provisioning, regulating, supporting, and cultural services, while also evaluating the impacts of ecosystem service changes on community dependency. The research highlights both the ecological and socio-economic dimensions of wetland

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management, explores challenges such as siltation, invasive species, and flooding, and identifies opportunities for conservation, sustainable use, and livelihood enhancement. By emphasizing the interconnections between ecosystem services and human well-being, this study provides critical insights for policymakers, conservationists, and local stakeholders to ensure the long-term sustainability and resilience of Urpad Beel and its surrounding communities.

2. Materials and methods

Study site*:** The study site for this research is Urpad Beel, a wetland located in the Goalpara district of Assam, India. Urpad Beel is situated at approximately 26.1750° N latitude and 90.5708° E longitude, with a total area of approximately 649.38 ha. It is about 12 km from Goalpara town, the district headquarters and is approximately 150kmfrom the state capital i.e. Guwahati. ***Methodology*: A** case study approach was adopted, and data were collected using both qualitative and quantitative methods. The data for this research was collected using a combination of field surveys, household survey, and literature review. ***Field surveys: Field surveys were conducted to collect primary data on the physical and biological characteristics of Urpad Beel. The survey included mapping the wetland, identifying the different wetland zones, and wetland vegetation based on peoples' perception. ***Household survey*:** An initial rapid assessment was conducted in five villages surrounding Urpad Beel, namely Chamaguri, Genderapara, Paharkata, TNT, and Sutradharpara, to determine the level of household dependency on wetland resources. To gather more detailed information on the impact of wetland degradation on these households, a semi-structured questionnaire was developed based on previous works in the same field. The questionnaire focused on the ecosystem services provided by the wetland, the level of household dependency on these services, the drivers of change, and the impacts on the ecosystem services. ***Data Collection*:** Data was collected through face-to-face interviews with the head of the household or the primary decision-maker in the household. The interviews were conducted in the local language and were administered by trained enumerators. ***Data Analysis****:* The data collected through the household survey was analyzed using descriptive statistics and cross-tabulations. The findings were presented using graphs and tables, which helped to summarize and visualize the data. Ethical considerations: Ethical considerations were taken into account during the research process, including obtaining consent from stakeholders before conducting interviews and ensuring confidentiality of the collected data.

3. Results

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***Socio-economic assessment*:** Based on the comprehensive personal interviews conducted in five distinct regions of the study site, a meticulously designed questionnaire was employed to assess the socio-economic characteristics of the area under investigation. The respondents exhibited a predominance of males, accounting for 52.5% of the sample. Among the participants, three distinct age groups were identified, namely 25–45 (40%), 46–65 (32.5%), and 66–85 (27.5%). In terms of marital status, the majority of respondents, namely 67.5%, were married, while the remaining portion was unmarried. An examination of educational attainment among the villagers revealed a noticeable dearth of individuals with higher education credentials. Only a meagre proportion, approximately 5% each, identified as graduates or post-graduates. The literacy rate within the community can be characterized as low, as the majority of respondents, totalling 55%, had not progressed beyond the matriculate level. Among the various educational levels, the highest percentage, amounting to 17.5%, represented individuals who had completed their higher secondary education. The primary occupation of the local populace was primarily cantered around agriculture, with 52.5% of respondents identifying themselves as farmers or fishermen. Government employees constituted a mere 7.5% of the sample, while students comprised an equivalent proportion. Wage earners accounted for 12.5% of respondents, and businessmen constituted 20% of the study population.

These findings underscore the socio-economic profile of the study site, highlighting the gender disparity, age distribution, marital status, educational background, and predominant occupations within the community. The overrepresentation of males in the sample indicates the need for targeted strategies to ensure the inclusion and participation of women in future research and development initiatives. Moreover, the limited presence of individuals with higher education underscores the importance of promoting educational opportunities and increasing literacy rates in the study area. Efforts to diversify occupational opportunities beyond agriculture may be warranted to address potential vulnerabilities associated with the dependence on a single sector. By elucidating these socio-economic dimensions, this research contributes valuable insights into the unique characteristics of the study site, providing a foundation for evidence-based policymaking and targeted interventions aimed at improving the well-being and livelihoods of the local population. Further exploration is encouraged to gain a more comprehensive understanding of the factors influencing socio-economic dynamics in the region.

Ecosystem Services: Uses and Ranking

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A total of 13 key ecosystem services were identified through household survey (Table 1), FGDs and key informants interviews for the Urpad Beel. Among them, 8 were provisioning, 6 regulating, 2 supporting and 5 were cultural services.

Table 1. Ecosystem services identified from the study area

Ecosystem service categories	Ecosystem services recorded
Provisioning (8)	Fish, livestock grazing, Irrigation, Macrophytes, Edible plants Water for drinking, NTFPS, Fodder
Regulating(6)	Water regulation, Flood control, Nutrient Cycling Siltation Regulation, Pollination, Air purification
Supporting (2)	Habitat for fauna and flora, Nursery for fishes
Cultural (5)	Tourism, Recreational value, Bird watching, Educaional & research, Spritual value

Through the survey conducted with local communities, the top ranked service was *habitat for biodiversity* followed by *fishing, tourism, livestock grazing, water, grass collection*. Eight out of 13 were provisioning services, while two were supporting services and five was a cultural service. These services were ranked based on their use at their household and/or ability to sell them in the market for economic returns. The top 8 services with details on their use by local people are given in **Table 2.**

Table 2. Ranking of the ecosystem services based on peoples' perception.

Ecosystem Servives	Ranking	Uses
Habitat for biodiversity	1	Supporting biodiversity of global significance.
Fishing	2	Food/Selling in market.
Tourism	3	Employment generation/Source of income.
Livestock Grazing	4	Use by local people to food their animals.
Water	5	Drinking / Irrigation
Grass collection	6	For decoration of stores,houses.
Edible plants	7	Collection for personal use in daily diet and to sell in the local market.

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Nursery for fishing	8	Breeding of indigenous/local fishes.

People's Dependency on Ecosystem Services

The investigation yielded a comprehensive understanding of livelihood strategies, uncovering a total of six distinct approaches pursued by the local population. It was observed that approximately 57% of the respondents engaged in the intertwined activities of fishing and agriculture, while the remaining individuals were involved in diverse occupations such as teaching, business, and labour. Notably, a significant proportion of approximately 25% of households primarily relied on fishing as their occupation.

Further analysis revealed that a subset of nine respondents exhibited complete dependency on fishing for their sustenance. The Focus Group Discussions (FGDs) shed light on the economic aspect of these livelihood strategies, with participants reporting an average daily earning of Rs. 600.Agriculture, encompassing horticultural practices, emerged as the second most prominent livelihood strategy within the study site. This finding highlights the significance of cultivating crops and fostering sustainable agricultural practices to ensure the overall well-being of the local community. In addition to fishing and agriculture, other viable livelihood strategies identified in the area, as illustrated in Figure 2, encompassed tourism, business ventures such as boat services and small-scale hotels, labor-intensive occupations, and teaching positions within government institutions. The data indicated that tourism employment, involving activities like guiding for bird watching and providing boat services, has been gaining traction as a promising alternative livelihood option, particularly among the younger generation. This emerging trend underscores the potential of tourism to generate income and foster economic growth while simultaneously preserving the ecological integrity of the region. Among the six identified livelihood strategies, four demonstrated a direct reliance on ecosystem services. Fishing, agriculture, livestock grazing, and tourism, including business enterprises such as hotels, guides, and boat services, were found to be entirely dependent on the invaluable services provided by the Beel. The symbiotic relationship between these livelihood strategies and the ecosystem exemplifies the interdependence of human activities and the natural environment. Understanding the intricate dynamics and interconnections among these livelihood strategies is crucial for formulating effective policies and interventions that promote sustainable development in the area. Moreover, recognizing the diverse range of occupations pursued by the local population highlights the importance of fostering a multifaceted and inclusive approach to economic growth.

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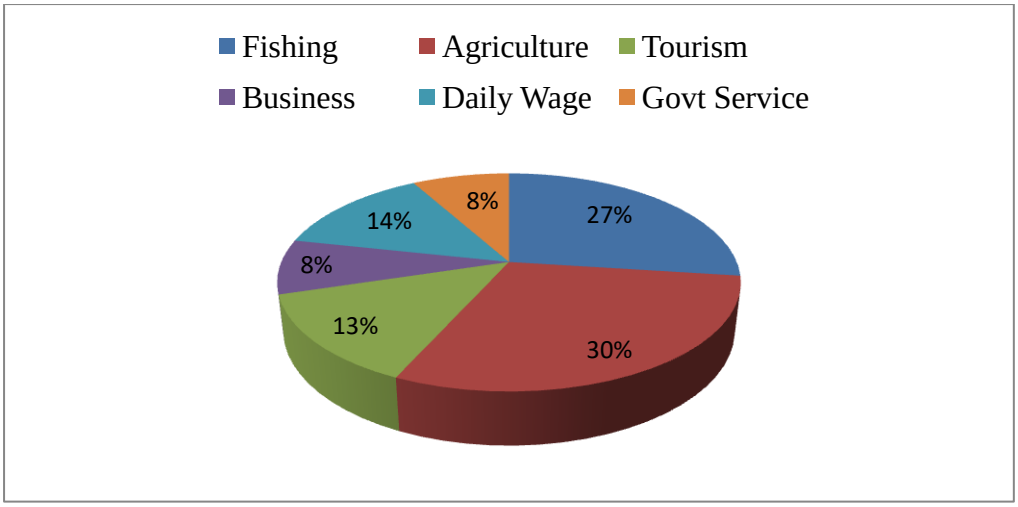

Figure 1. Livelihood strategies of the locals in Urpad Beel

Drivers of ecosystem services change

Urpad Beel is a wetland ecosystem where the community members are dependent on ecosystem services for their livelihood. To identify the drivers of ecosystem services change in Urpad Beel, a survey was conducted with personal interviews, and a focused group discussion with the community members. Based on their perceptions, various drivers of ecosystem change were identified and prioritized according to the perceived impact on the ecosystem (Figure 2). The highly prioritized drivers of ecosystem change in Urpad Beel include siltation, over-exploitation of resources, deforestation, and invasive alien species. These drivers have a significant impact on the ecosystem and are causing negative effects on people's livelihood. For example, siltation can reduce the water storage capacity of the wetland, leading to floods during the monsoon season. Over-exploitation of resources such as fish and timber can reduce the biodiversity of the ecosystem, leading to a decline in ecosystem services that are important for people's livelihoods. The drivers that have intermediate effect on the ecosystem change in Urpad Beel include climate change, erosion and landslide, use of chemical fertilizers, use of advanced fishing equipment, flood, sewage, and other pollution. These drivers can have negative impacts on the ecosystem, but their effects are not as significant as the highly prioritized drivers. The drivers that are least prioritized by the community members of Urpad Beel include encroachment, imbalance in water regulation, chemical poisoning, and river cutting. These drivers are not perceived as having a significant impact on the ecosystem, and their effects are not as severe as the highly prioritized drivers.

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It is important to note that some drivers, such as burning of forest ground, are not considered by the community members as drivers of ecosystem change. This may be because the effects of these drivers are not immediately visible, or because the community members are not aware of their impact on the ecosystem. Overall, the drivers of ecosystem services change in Urpad Beel are complex and multifaceted, and addressing them requires a holistic approach that considers the ecological, social, and economic dimensions of the ecosystem.

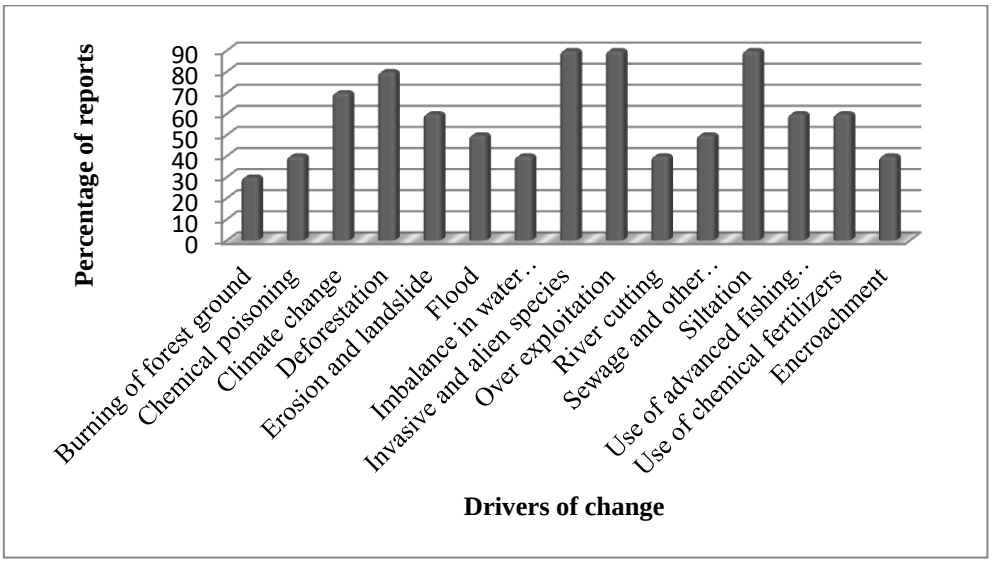

Figure 2. Drivers of change of ecosystem services

Impacts on Ecosystem Services and People's Dependency

The study revealed that both direct and indirect drivers of change exerted significant influences on ecosystem services and the local population's reliance on the surrounding ecosystems. The effects of these drivers were multifaceted, with implications for various aspects of people's lives. Notably, approximately 98% of respondents in the household survey reported a substantial decline in fish stocks, accompanied by a noticeable decrease in available fodder. Given the direct connection between ecosystem services and individuals' livelihood strategies, alterations in these services had profound effects on people's dependency, particularly in fishing and agriculture activities.

Although only 40% of participants reported water pollution resulting from chemical and fertilizer usage in agricultural fields and sewage, this issue emerged as a concerning factor. Over-exploitation emerged as a major cause contributing to the decline in bird migration by 30% and the reduced movement of elephants. Additionally, the invasion of non-native species negatively impacted siltation and led to a decrease in oxygen levels within the water.

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Another significant driver of change identified in the study was flooding, which had detrimental effects on people's livelihoods. Flooding resulted in a reduced availability of fodder and hindered collection efforts. Interestingly, the rise in tourism, despite being associated with a decline in migratory bird populations, renowned for their presence in the area, provided economic growth opportunities for the local population. Furthermore, climate change-induced transformations had both direct and indirect impacts on the lives of the individuals residing in the area.

In conclusion, this research highlights the intricate interplay between direct and indirect drivers of change and their effects on ecosystem services and the well-being of local communities. The decline in fish stocks and fodder availability, coupled with the negative consequences of pollution, over-exploitation, invasive species, flooding, and climate change, underscore the urgent need for conservation efforts and sustainable management practices. By comprehending these complex dynamics, policymakers and stakeholders can formulate strategies to mitigate the negative impacts and foster resilient ecosystems and communities in the area.

4. Discussions

The present study from Urpad Beel utilizes the Millennium Ecosystem Assessment (MEA) framework to identify and prioritize 13 distinct ecosystem services, aligning with global standards for assessing ecosystem services (MEA, 2005). This approach builds upon previous research emphasizing the recognition and valuation of wetland ecosystem services as essential for effective conservation and sustainable management (Costanza et al., 1997; Sharma et al., 2016; Ahmed et al., 2018; Borgohain et al., 2018; Ghermandi et al., 2019; Dey et al., 2020; Kalita et al., 2020). In Assam, prior studies by Saikia et al. (2015), Bhatta et al. (2016), Hazarika and Goswami (2019), and Dey et al. (2020) focused on identifying ecosystem services and documenting traditional uses of wetland resources. These studies provided important groundwork but did not comprehensively integrate community perceptions and local conservation practices, which the present study addresses.

To achieve a detailed understanding of ecosystem services, this study employed household surveys and focused group discussions. Drawing on global frameworks (MEA, 2005) and national-level research (Barbier et al., 2008), it captures a nuanced perspective of Assam's wetland landscapes, considering both ecological and socio-cultural dimensions. Integration of insights from local studies (Ahmed et al., 2018; Dey et al., 2020) highlights the ongoing challenges and opportunities for wetland conservation within the region, particularly in balancing human use and ecosystem integrity. The community-based approach adopted here

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underscores the crucial role of local knowledge and participation in promoting sustainable wetland management practices.

Residents of Chamaguri village demonstrate a strong commitment to conserving Urpad Beel, actively resisting encroachment and maintaining vigilance throughout the year. This reflects findings from Dey et al. (2020) in Goalpara district, which emphasize the importance of community engagement in wetland conservation (Day et al., 2020; Nayak and Bhusan, 2022). In recent years, Chamaguri has emerged as a popular destination for tourists. Activities such as boating and observation from watchtowers demonstrate the wetland's cultural ecosystem service of recreation (MEA, 2005). Globally, studies on ecotourism in wetlands, such as in the Amazon Basin or African savannas, highlight both the economic and cultural benefits of tourism while also pointing out potential ecological impacts (Balmford et al., 2002). Similarly, tourism at Deepor Beel in Assam has contributed to cultural and economic benefits while also raising concerns about environmental disturbance (Ahmed et al., 2018).

The fishermen community of Budhipara practices rituals such as Ganga Puja, reflecting the cultural ecosystem service of spiritual enrichment and reinforcing cultural identity (Chan et al., 2012; Verschuuren et al., 2010). Such rituals exemplify the deep connections between local communities and natural landscapes, showing how cultural practices can foster environmental stewardship. At the same time, tourism activities have disturbed habitats of both indigenous and migratory birds, resulting in reduced arrival rates of migratory species. This illustrates a trade-off between cultural services and biodiversity conservation, emphasizing the need to carefully manage human activities in ecologically sensitive areas (Buckley, 2004). Understanding these interactions between cultural and ecological services is essential for holistic wetland management strategies that promote both human well-being and ecological sustainability.

Flooding presents a major challenge in the Urpad Beel ecosystem, leading to siltation, river cutting, and the invasion of alien plant species. In response, the government has constructed a road around the lake to mitigate erosion. However, this development has disrupted an elephant corridor and resulted in a reduction of the lake's overall area. Flooding alters hydrological patterns, affects water quality, and modifies habitat structure (Talbot et al., 2018). Globally, studies on floodplain wetlands, including the Amazon Basin and the Mississippi Delta, highlight the ecological significance of natural flooding cycles for nutrient cycling and biodiversity, while human interventions can disrupt these critical processes (Junk et al., 1989). Infrastructure development in wetlands can fragment habitats, alter hydrology, and disturb wildlife movement (Ramsar Convention Secretariat, 2010; Mitsch and Gosselink,

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2015). The reduction in Urpad Beel's area underscores global concerns regarding wetland loss, which threatens biodiversity, water purification, and flood regulation services crucial for human well-being (Davidson et al., 2012; Zedler and Kercher, 2005).

The study also highlights the direct link between ecosystem services and local livelihoods, showing that changes in wetland functions significantly impact fishing and agriculture, consistent with Mitra et al. (2019). For instance, the extinction of the Saal fish due to floods and changes in water quality demonstrates the wetland's role in supporting aquatic biodiversity and sustaining local livelihoods. Despite these challenges, the formation of a conservation committee by local residents reflects proactive community efforts to protect Urpad Beel. Such community-led initiatives, combined with continuous research and adaptive management strategies, are essential to ensure the long-term sustainability of the wetland and the ecosystem services it provides.

Overall, the study of Urpad Beel demonstrates how ecological, cultural, and socio-economic aspects of wetlands are deeply interconnected. By highlighting community participation, cultural values, livelihood dependence, and ecological challenges, this research provides insights necessary for integrated wetland management. It reinforces the idea that preserving wetland ecosystems requires a balance between human use and ecological protection, where local communities play a central role in sustaining these invaluable natural resources.

Conclusion: Based on the findings of the study on Urpad Beel's ecosystem services and its impact on local dependency, several recommendations emerge. Conservation efforts should prioritize establishing protected areas, enforcing strict regulations, and promoting habitat restoration. An integrated management approach involving local communities, government, NGOs, and stakeholders is crucial for sustainable resource use and biodiversity conservation. Providing sustainable livelihoods through eco-tourism and agriculture can reduce dependency on wetland resources. Education and awareness initiatives should highlight Urpad Beel's ecological and cultural significance. Long-term monitoring and research are essential for adaptive management, while policy integration should value ecosystem services in land use and development decisions. Collaboration with stakeholders and international partners enhances conservation effectiveness and knowledge exchange, ensuring the resilience and sustainability of Urpad Beel's ecosystem services.

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