Jahangirnagar University Environmental Bulletin, Vol. 9, 35-47, 2024

Jahangirnagar University Environmental Bulletin

ISSN: 2304-3326

Contents Available at: https://www.juniv.edu/department/env

Indigenous Ecosystem based Adaptation Practices: Insights from Medir Haor Community in Brahmanbaria District, Bangladesh

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Abstract

Indigenous Adaptation Practices in the wetland basin have provided compelling evidence of effectively dealing with climate extremes. The residents of the Medir Haor community, located in the Nasirnagar upazila of the Brahmanbaria district, predominantly engaged in farming and fishing while implementing indigenous adaptation techniques. Research endeavours spanning from January 2017 to September 2022 was carried out in the Medir Haor villages, incorporating community consultations, Focus Group Discussions, and Key Informant Interviews. The DPSIR (Driver-Forces-Pressures-State-Impacts-Responses) framework has been instrumental in pinpointing strategies to enhance the ecosystem and foster Ecosystem-based Adaptation options. The community has outlined various measures such as safeguarding fisheries resources, broadening livelihood opportunities linked to fisheries, crop diversification, integration of winter crops in Haor's crop fields, enhancement of communication networks including road infrastructure, dissemination of extreme weather forecasts for community readiness, and enhancement of health services as part of their Ecosystem-based Adaptation strategies. Traditional practices like dry paddy sowing, second-time seedbed sowing, Bhura (a roundish water hyacinth floating bed), 'diga dhan' harvesting, cultivation of Dhaincha (*Sesbania bispinosa*), maintenance of grazing lands (Bathan), removal of mud from deep pools (Peri-tana), adherence to traditional fishing restrictions (Mana), and exploration of potential uses of Changari and Airbandh have been identified by the community. The research has highlighted the valuable contribution of indigenous knowledge to Ecosystem-based Adaptation.

Keywords: *Adaptation to Climate Change, Indigenous practice, Ecosystem-based Adaptation, (Haor) Wetland Basin, DPSIR.*

Introduction

Bangladesh stands out as one of the nations most susceptible to the impacts of climate change. In response to this challenge, local communities have implemented various adaptation strategies, encompassing deliberate and spontaneous measures. Notably, Bangladesh has taken a lead role in pioneering multiple initiatives related to climate change adaptation. Over the period from 2005 to 2021, the country has formulated a significant number of policies, including NAPA, BCCSAP, NDC, Bangladesh Delta Plan, Mujib Climate Prosperity Plan, and NAP. Ecosystem-based Adaptation (EbA) leverages biodiversity and ecosystem services to bolster the resilience of human populations against climate change impacts. In rural

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communities where agriculture, fisheries, and livestock rearing are central to livelihoods, adaptation measures tend to be predominantly Ecosystem-based. Locally-led Adaptation (LLA) underscores the importance of tapping into local wisdom and expertise to address climate-related risks, ensuring that frontline actors have fair access to resources and decision-making power. This approach places a strong emphasis on community involvement. The wealth of traditional coping mechanisms developed by communities over generations is a valuable repository of knowledge and skills for dealing with climate extremes. These age-old practices, rooted in local customs and environmental understanding, offer insights into how communities interact with their surroundings amidst changing climatic conditions. There is a growing acknowledgement of their crucial role as assets for adaptation efforts, recognising the significance of local and traditional knowledge.

Previous research endeavours have focused on the documentation of traditional knowledge, albeit with limited exploration into the efficacy of conventional practices in mitigating climate vulnerabilities. Kumar (2015) elucidates various indigenous mitigation and adaptation skills historically employed in North-western India. The phenomenon of climate change stands out as a paramount challenge to sustainable development in the mountainous regions of Northern Vietnam. Indigenous knowledge is pivotal in refining cultivation techniques amidst extreme climatic conditions. Ataur Rahman and Rahman (2015) delved into investigating Natural and traditional defence mechanisms to mitigate climate risks in coastal areas of Bangladesh, proposing the integration of traditional coping strategies and wisdom with contemporary approaches. Lathsakid (2018) sheds light on indigenous knowledge that underpins sustainable agricultural production across communities for successive generations. UNEP (2018) has compiled a compendium of indigenous communities' knowledge pertinent to climate actions. Ghosh (2021) scrutinised the impact of indigenous knowledge on bolstering community resilience within the Indian state of Meghalaya, which borders the Haor basin of Bangladesh. The significance of indigenous knowledge in enhancing water sector adaptation to climate change was explored by Zvobgo et al. (2022). The incorporation of indigenous knowledge and local knowledge in adaptation planning has yielded substantial evidence of risk mitigation in contrast to strategies devoid of indigenous and local knowledge. Numerous African nations have integrated indigenous and local knowledge into their adaptation planning within the intended nationally determined contributions (iNDCs) framework.

Barua & Rahman (2018a) investigated the role of indigenous knowledge in managing coastal resources in response to Climate Change. They also scrutinised the traditional ecological knowledge in the coastal islands of Bangladesh (Barua & Rahman, 2018b). The exploration of EbA in Bangladesh was initially conducted by the Bangladesh Climate Change and Environment Outlook in 2012. The Hakaluki Haor area and the coast of Shyamnagar were specifically examined to identify potential opportunities. In a study by Ahmed (2013), the focus was on the possibilities of ecosystem-based adaptation in the coastal zone of Bangladesh. The research advocated for the cost-effective stabilisation of coastal lands by planting suitable mangrove species as a long-term measure for biodiversity conservation in Bangladesh, aligning with EbA principles. Haq et al. (2013) emphasised that the EbA approach could significantly enhance the effectiveness of current adaptation practices.

Rahman et al. (2014) conducted a Vulnerability and Impact Assessment on Climate Change and EbA in the drought-prone regions of Bangladesh using the DPSIR Framework. The study highlighted nature-based solutions through EbA as a potentially cost-effective strategy to address drought challenges and safeguard the environment. Recommendations such as re-excavating traditional ponds and implementing integrated fish farming were suggested as EbA interventions to enhance capacity and sustain ecosystem services. Raid et al. (2017) investigated the effectiveness of EbA in supporting community adaptive capacity and resilience at Chanda Beel wetland and Balukhali Village in the Chittagong Hill Tracts of Bangladesh. Findings indicated that utilising diverse natural resources at these sites expanded livelihood options for the community, particularly benefiting poorer households.

In a study by Saroar et al. (2018), the Opportunities and Challenges of EbA were examined. The research highlighted the interconnectedness of EbA with cropping practices, soil and nutrient management, water management, erosion control, and food and livelihood security. Integrated institutional approaches were proposed to enhance the potential of EbA, emphasising the importance of aligning EbA strategies with scientific knowledge to bolster community resilience and ecosystem health.

Recent national policies have acknowledged the critical role of community-based and locally-driven adaptations. While interventions led by international and national non-governmental organisations (NGOs) have demonstrated effectiveness and local acceptance, significant gaps persist in the nationwide implementation of locally-led adaptations due to various constraints. Achieving Bangladesh's ambitious national targets will necessitate improved coordination among government entities and NGOs to leverage mutual benefits (ICCCAD, 2023).

The objective of this study was to investigate traditional coping strategies that could enhance Locally-led Adaptation initiatives in the wetland regions of Bangladesh.

Study Area

The investigation was conducted in Medir Haor, situated in the Brahmanbaria district under Nasirnagar Upazila, a relatively small Haor compared to the northern Hoars. Covering an area of approximately 17.38 square kilometres, Medir Haor supports a population of around 25,000 individuals who rely on its resources. Linked to the river Meghna, the Haor's indigenous strategies for dealing with severe climatic occurrences were identified through observations and consultations with the local community. From January 2020 to December 2022, Nasirnagar, Monoharpur, Goalnagar, and Kistopur villages were regularly visited to investigate indigenous community practices.

Method

The Drivers-Pressures-State-Impacts-Responses (DPSIR) framework was employed to evaluate the ecosystem and sustainable management strategies in the face of climate vulnerability. The DPSIR framework serves as an analytical tool for monitoring changes, identifying driving factors, assessing impacts, and evaluating responses within an ecosystem. In this context, drivers are the fundamental factors instigating various pressures in the ecosystem, while pressures are the direct causes of changes. The state refers to the overall conditions of the ecosystem, encompassing physical, chemical, and biological aspects. Impacts signify the consequences of alterations in coastal wetland conditions on ecosystem functionality, and responses denote societal efforts to address resulting challenges. The DPSIR framework comprises four key stages: interpretation of drivers and pressures, description of state changes, analysis of impacts, and evaluation of human responses. Initially introduced by the European Environmental Agency, the DPSIR framework has been widely adopted by the United Nations and the US Environmental Protection Agency (EPA) through initiatives like Sustainable Puerto Rico (Kristensen, 2004). This framework facilitates the integration of social, economic, and environmental factors to address various issues (Omann et al., 2009). Its versatility is evident in applications related to environmental resource management, such as agriculture (Omann et al., 2009) and water resources (Laura et al., 2009). Recently, DPSIR has been predominantly utilised to bridge ecological and socioeconomic aspects for informed decision-making on environmental concerns (Yee and Bradley, 2015; Gari et al., 2015). For instance, Ahmed et al. (2020) applied the DPSIR framework to assess ecosystem services in the Mekong Delta in response to mining challenges.

The EbA options are identified by the community based on the response identified in the framework. Rahman et al. (2016) utilised the DPSIR Framework to propose EbA in a River Bank erosion-prone area of Bangladesh. EbA has been conceptualised in the DPSIR framework by UNEP, UNDP, and IUCN (UNEP 2012). EbA entails the conservation, sustainable management, and restoration of ecosystems that facilitate human adaptation to climate change impacts. EbA is a nature-based approach that leverages biodiversity and ecosystem services to mitigate vulnerability and enhance resilience to climate change.

The data presented in this paper is derived from nine community consultations, six Focus Group discussions (two involving Fishers, two involving farmers, one involving women, and one involving development actors), and twelve key informant interviews.

Results and Discussion

Historic Climatic Extreme events in Medir Haor have increased erratic rainfall since the flooding in 2004. Early and late flooding were major concerns before that. High-yielding rice cultivation began in 1963 and expanded in 1974; previously, only local boru varieties were grown. Two canals, Abbair Khal and Nilokhiar Nala, were excavated under the government scheme for rice cultivation. Table 1 details extreme events and community coping mechanisms. Until the 1980s, Medir Haor's livelihoods relied on natural resources. Urbanisation began in 1982, with Nasirnagar as the administrative town centre.

Table 1: Extreme climatic events and community copping followed in the Medir Haor

Year	Extreme event	Community Coping mechanism
1998	Flood	Take sheltered in school, No cultivation
2004	Flood	Harvested green paddy, cultivated in water hyacinth made small floating bed
2006	Late monsoon	Dry sowing of paddy
2012	Late monsoon	Dry sowing of paddy
2018	Late monsoon	Sowing of germinated seeds
2021	Thunderstorm	Seed bed sowing in second time

Community Responses to the Climate Extremes

Dry sowing of paddy: The conventional method involves transplanting or broadcasting germinated paddy seeds in fields, but during periods of insufficient rainfall, farmers opt to scatter non-germinated rice seeds in the paddies. This type of sowing typically requires 1.5 times more seeds than regular germinated sowing and is referred to as Doilla Bain due to its application on dry ploughed soil. Upon the first rainfall, the seeds sprout, with farmers observing fewer weed growth in such dry sowing practices.

Seedbed sowing for second time: Establishing a seedbed for a second time is a strategy employed to address prolonged inundation in the initial stages of paddy cultivation. Research indicates this practice is prevalent in the western Medir Haor region near the Meghna River.

Bhura, a roundish water hyacinth floating bed: The Haor basin is susceptible to waves, locally called 'Afal'. While efforts to introduce long rectangular floating beds in the Hoar area have not yielded the expected results, the indigenous practice in Haor involves using Bhura, a roundish water hyacinth bed measuring 1 to 1.5 meters in radius. This traditional floating bed, known for cultivating water guard since the 1970s, differs from the rectangular beds promoted by development initiatives.

Early harvesting for diga dhan: In cases of low paddy yield, the Haor community selectively harvests only the top portion of the paddy sheaf, allowing for a second growth cycle termed Diga Dhan, which can yield up to 35% of the initial harvest. The second harvest typically takes 2.5 to 3 weeks to mature.

Cultivating Dhaincha, Sesbania bispinosa to protect wave action: To mitigate land erosion caused by strong waves in the Hoar region, the Haor community plants Dhaincha around village mounds, resembling islands during the rainy season. When submerged, Dhaincha, a water-tolerant plant with puffy stems, serves as a natural barrier against high waves due to its height and ability to thrive in water. Khola: The initial regular flash flood in the Medir Haor occurs soon after the harvesting period. The community lacks extensive yard space in each household; however, the harvesting season is brief; therefore, common harvest processing sites exist in the Haor. These sites are typically situated near the village mound and are well-connected to waterways. Such a harvest site is referred to as Khola. A few of these Kholas are located on raised platforms.

Bathan, the grazing land: The relatively elevated areas of the shallow Hoar were utilised as grazing lands, known as bathan. Bathan land is unsuitable for cultivation as it is undulating and predominantly sandy. Cultivation and alterations in the landscape were not permitted in the bathan area. The path connecting villages to the bathan is called go-pat, which translates to "path for the cows".

Peri-tana, taking out the mud from the deep pools: In the Hoar region, numerous deep pools with an average radius of 5 meters are scattered throughout. These pools are perennial, retaining water throughout the year. Typically, no irrigation is permitted from these pools, locally known as Koa. In years with high siltation due to flash floods, the community removes the mud using bamboo containers, a practice known as Peri-tana, meaning "removal of mud".

Otherwise, this process is carried out every 3 to 4 years based on the sediment accumulated at the bottom.

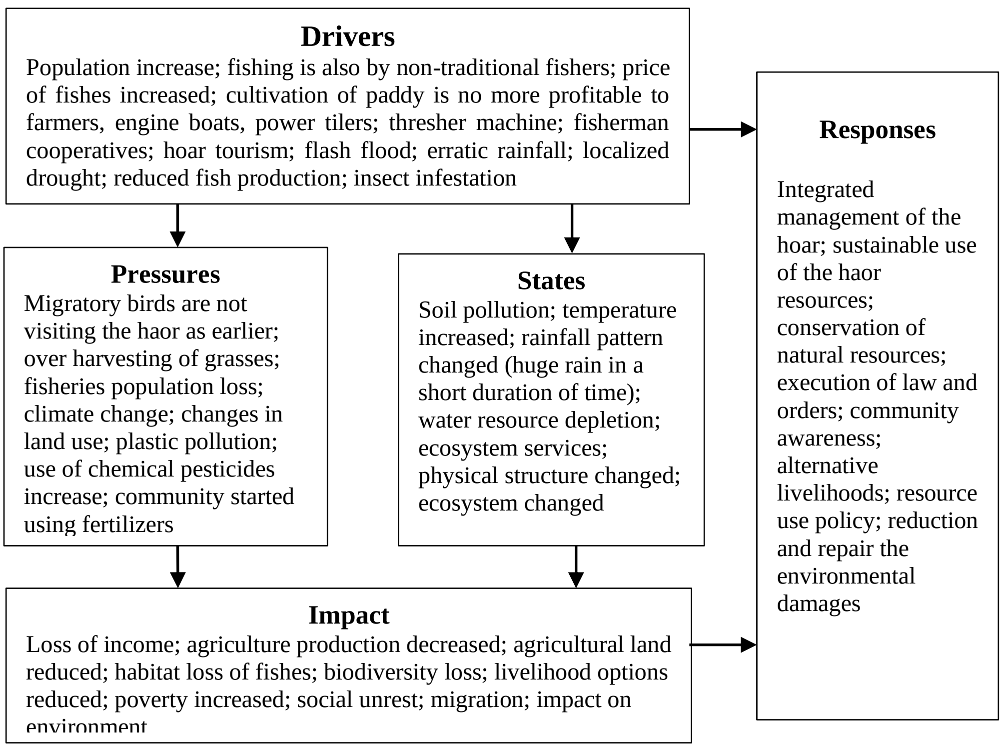
Mana, traditional fishing is forbidden. Conservation of fish and fisheries is a customary practice in the Haor region. In the Medir Haor, approximately 12 Manas have been identified. Mana, signifying "forbidden", designates an area where fishing is prohibited, marked by a Bamboo structure adorned with leaves and branches. While the area lacks a distinct boundary, fishermen acknowledge and respect the central region as the core area and the surrounding area as a buffer zone where fishing is prohibited.

Changari: Due to the fish drying lands in the Haor basin being submerged regularly, a practice known as Changari is implemented, involving the construction of bamboo platforms for sun-drying fish. These platforms are usually built close to the village mound, varying in sizes from 400 to 1000 square meters.

Airbandh: The village mound is susceptible to wave activity and erosion. To safeguard the village mound, the community uses bamboo rails and various grasses and straw within the bamboo enclosure.

Changes recurring in the Medir Haor and their causes and impacts

The Drivers-Pressures-State-Impacts-Responses (DPSIR) framework for the Medir Haor has been detailed by the Hoar community as follows:



Indigenous Ecosystem based Adaptation Practices:

Ecosystem-based Adaptation (EbA) options in the Medir Haor

No adaptation initiatives have been put into effect in the Medir Hoar. The following EbAs have been suggested by the local community for implementation in the Medir Haor, utilising a locally-driven strategy:

Preservation of fishery resources and expansion of fishery-related livelihoods: Safeguarding fisheries to enhance production and encourage sustainable harvesting. Diversification of fishery-related businesses. In the Medir haor, fish drying is a prevalent practice, which includes sun-drying of fish and producing "Shidol" from farmed fish. The community believes that broadening the fish market through the introduction of external knowledge and practices will augment the community's income.

Crop diversification and the introduction of winter crops in the Haor's crop fields: Paddy cultivation in the Medir Haor is primarily dominated by BRRI Dhan 28, with a limited number of indigenous varieties. During the winter season, several areas suitable for vegetable cultivation remain unused. To address this, the dissemination of technology and farming techniques is essential.

Enhancement of the communication network, including road infrastructure: In the rainy season, the village mounds are dispersed like isolated islands. Boats are the only mode of transportation during this period. However, the existing boats, comprising both engine-powered and traditional boats, cannot withstand the high Afal.

Provision of critical weather information for community readiness: The Medir hoar experiences severe flash flooding due to its location at the lower end of the haor basin. The lead time for flash floods from the Tanguar Haor is three days. Nevertheless, other hazards have intensified. They can effectively plan adaptation measures by equipping the community with climate change projections and accurate weather forecasts well in advance. The hazard calendar specified by the Medir Haor community is outlined in Table 2.

Enhancement of healthcare services: The primary concern highlighted by the community in the hoar basin pertains to health services. Access to treatment and medications poses significant challenges in terms of medical services. The community has proposed the establishment of floating hospitals and water ambulances.

Hazard calendar

In Medir Haor, early floods are a prevalent hazard. A riverine flood is witnessed in the area. The emergence of localised drought is increasingly observed in contemporary times. Drought affects only a limited expanse within the crop field. The significant occurrence of dense fog is a recent phenomenon dating back to 1984.

Table 2: Hazards of the Medir Haor

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Dry	Drought		Early Flood, Insect infestation	Flood, Northwester	Flood	Flood	Standing water	Standing water, Thunderstorm	Standing water, Drought	Dry weather, Fog	Dry weather, Fog

Newly formed of livelihoods options

The Medir Haor has seen a surge in revenue from the marketing of snails and cow dung as sources of cooking fuel following the outbreak of the Covid-19 pandemic.

The accumulation of snails for duck farming purposes has witnessed a significant increase, corresponding to the rise in duck rearing activities within the community. Despite being prohibited by legislation, over 200 individuals engage in daily snail collection at the Medir Haor, with an average yield of approximately 4 kg per person. The collection process primarily involves manual selection, supplemented by the use of nets.

Conversely, the procurement of cow dung serves as a fundamental component for the production of cooking fuel intended for household consumption. Harvested from pasture grounds, cow dung is gathered to facilitate fuel production, with collectors averaging 22 kg per day. The Medir Haor accommodates a cohort of more than 400 cow dung collectors dedicated to sourcing dung for this purpose.

Potentials of the traditional practices towards LLA

Towards the adaptation to climate change in the Haor areas, the traditional practices of the community exhibit significant potential. The mana represents a conservation initiative towards fisheries. Due to the high harvesting of the fish Punti (Swamp barb), Puntius chola in the early monsoon, the market price for it decreases. The Punti fish is predominantly used in making Shidol, however, sun-drying poses a challenge in the Haor region due to the limited availability of drying land. The construction of Changari in inundated areas serves this purpose, typically lasting for a year and made of bamboo. Strengthening the quality of Changari through the use of treated bamboo can extend its durability. The protection of fish breeding sites and the enhancement of fisheries breeding sites are crucial, with Peri-tana playing a vital role. In the Medir Hoar, approximately 35 deep perennial water bodies known as Kuya are identified as significant fish breeding sites. Despite the practice of using Kanta, which involves placing branches of trees such as Hijol and Sheora, not only to increase fish yield but also to create habitats for various aquatic species including small fish, mollusks, and turtles.

Indigenous Ecosystem based Adaptation Practices:

Table 3: Scope of using indigenous practices on EbA and LLA

Ecosystem based adaptation (EbA)	Indigenous practices that can contribute
Protection of fisheries resources and diversification of fisheries-based livelihoods	Peri-tana; Mana; Changari
Crop diversification and introduction of winter crops in the crop fields of Haor	Dry sowing of paddy; Seedbed sowing for second time; Bhura; Early harvesting for diga dhan; Khola
Strengthen the communication system including the road networks	Cultivating Dhaincha to protect wave action; Airband; Hijol plantation
Make available the extreme weather information for community preparedness	Bathan; Airbandh; Dry sowing of paddy; Bhura
Improve the health supports	Medicinal plants gardening

There exists the potential for cultivating winter vegetables in the Haor region. It has been observed that, taking into account the trend of rising temperatures and forecasts of climate change, the local community could opt for a specific cropping pattern. It has been approximated that by promoting the cultivation of winter crops in the Medir Haor, an additional area encompassing approximately 15% of the Haor region could be utilised for agricultural purposes. An evaluation of the Balir-bondh crop fields suggests that expanding the cultivated land in this manner would not lead to significant alterations in land use or wildlife habitats. Enhancing the community's knowledge and skills in climate-smart agriculture may be necessary. The traditional practice of Bhura, although in decline, could serve as a valuable groundwork for initiating winter crop cultivation early in the season.

The primary use of the Dhaincha plant was as a floating device for fishing nets. The introduction of alternatives such as plastic floats has posed a challenge to the market for Dhaincha and its cultivation. Dhaincha, being biodegradable and eco-friendly, stands in contrast to the detrimental impacts of pollution on the ecosystem. Additionally, Dhaincha serves as a viable fuel source. However, the collection of cow dung for fuel production disrupts the natural manuring process. In the Airband area, the utilisation of Chailla grass, Hemarthria protensa, has diminished due to its scarcity. Preserving and fostering the growth of Chailla grass would not only benefit the environment by providing habitats for numerous bird species, but also contribute to ecological equilibrium and help reduce erosion risks.

The local community holds certain beliefs regarding weather predictions. Traditional proverbs like Khonar bachon (Verse of the philosopher Khana) and folk poetry offer insights into short-term weather forecasts, typically not exceeding a year. However, these sources are not commonly used for long-term climate change projections. The widespread use of mobile phones could serve as a platform for disseminating early warning predictions.

The community has recognised the importance of enhancing healthcare services as an EbA strategy for the Haor region. While there is limited historical evidence supporting the effectiveness of traditional medicine in addressing severe health crises, the use of medicinal plants is a common practice among the community. In remote rural areas, the cultivation of medicinal herbs is not widespread despite the common use of these plants for medicinal purposes.

Discussion

The investigation revealed that conventional practices can potentially influence EbA and LLA outcomes. Rahman et al. (2014) have recognised the re-excavation of traditional ponds and integrated fish farming as EbA measures to enhance capacity and sustain the Barind ecosystem. Similarly, the Haor basin community has identified sustainable fisheries as EbA opportunities, encompassing various practices to uphold ecosystem stability, while the LLA approach can empower the community to endure livelihoods in a climate-sensitive ecosystem. The Department of Environment (2015) highlighted that climate variations impact traditional crop patterns and cycles. Moreover, Rahman et al. (2016) observed that factors such as river bank erosion, population growth, intensified use of agrochemicals, land siltation, inadequate irrigation technology, temperature fluctuations, delayed monsoon onset, excessive rainfall, land-use modifications, and flow adjustments are the primary drivers in riverine ecosystems; a similar scenario was identified in the Madir Haor. Despite being distinct areas, the COVID-19 pandemic also poses risks to natural resources. Large-scale snail collection could disrupt species population demographics, affecting the hoar ecosystem. Initial observations of the Medir Haor ecosystem suggest that the sail may not serve as the keystone species, but rather the Ghechu and Aponogeton spp. Harvesting cow dung from fields could disrupt the natural fertilisation process.

Crop diversification is a common adaptation strategy in indigenous communities to mitigate harvest failure risks (Macchi, 2008). Some crop varieties are specifically suited to environments such as riversides, mountainous regions, or primary forests, thereby commanding higher market value. For instance, the wild chilli variety Naga Morich, initially found in the hillocks near the Haor basin in Sylhet and Sunamganj, is now being cultivated in farms and home gardens. The utilisation of chailla grass for erosion mitigation is prevalent in the Haor basin, yet due to chailla's current scarcity, villagers struggle to safeguard their properties from wave erosion. The Sustainable Environment Management Programme project initiated the combined use of geo-textile and chailla (IUCN Bangladesh, 2004). According to UNEP (2012), implementing EbA faces obstacles such as insufficient information, financial constraints, and institutional opposition. Employing the LLA approach for EbA could effectively address these hurdles. The lack of details in adaptation initiatives includes uncertainties in climate impact projections, ecological and societal vulnerabilities, and economic development. These uncertainties are compounded by the inadequate data from past and ongoing adaptation efforts. Developing climate risk assessments and vulnerability evaluations that integrate scientific and traditional knowledge of ecosystem services and adaptation capabilities offers potential remedies.

The significance of traditional ecological knowledge in adapting to climate change is undisputed, although a lack of awareness exists beyond science and specific local communities. The amplification of Traditional Ecological Knowledge holds great importance in managing resources and mitigating the impact of climate change. (Lemi, 2019). Among indigenous communities, there is a notable decline in traditional knowledge linked to wetlands. The decline and disappearance of wetlands, exacerbated by the impacts of climate change, present a peril to communities reliant on wetland-based resources (Adhikaria & Poudel, 2018). Rejuvenating eco-friendly traditional principles and developing effective environmental safeguarding strategies are imperative to enhance governance that fosters ecological and economic advantages for local communities and national welfare. (Barua & Rahman, 2018a). Barua & Rahman, 2018b observed a waning interest in these traditional customs in coastal island regions in recent times due to modern technology, which mirrors the situation in Medir Haor. Despite being aware of these customs, the community increasingly uses information technology for knowledge management.

Nonetheless, a prominent approach concerning climate change and biodiversity conservation has emerged in the past five years: Nature-based Solutions (NbS). NbS integrates various ecosystem-centric activities, including EbA. NbS entails utilising biodiversity and ecosystems to address numerous pressing issues, such as food insecurity, poverty, and climate change. An appealing aspect of NbS is that it benefits humans and enhances biodiversity. To summarise, NbS is a comprehensive concept, with EbA being a specific type of NbS that concentrates on climate change adaptation (Irfanullah, 2024).

Conclusion

The cost-effective nature of EbA solutions enables their integration to address water management issues in developing regions. The global scientific community has acknowledged the significance of incorporating nature-based solutions into long-term policy planning concerning climate change soil and water conservation, among other aspects (Khaniya, 2000). The LLA is strengthening local institutions to enhance their capacity to comprehend climate-related risks and uncertainties, devise solutions, and support and oversee adaptation efforts without reliance on donor funding tied to specific projects. Community traditions reflect the community's skills and contribute to its identity and sense of pride. The community's traditional coping strategies are deeply rooted in the local environment. The efficacy of conventional practices in dealing with extreme climate conditions has been demonstrated. Due to a generational knowledge transfer gap within communities, it is imperative to document indigenous practices to empower the community, as well as scientists, policymakers, and stakeholders, in achieving the objectives of the LLA. If necessary, a harmonious blend of modern technology can be integrated with traditional methods to enhance their effectiveness and relevance in the current climate change scenario.

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