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MORALITY BEFORE KNOWLEDGE

Navigating economic fragility and climate risk: Transformative pathways to eco-welfare in vulnerable coastal ecosystems

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ABSTRACT

Background: In Hatiya Upazila, Noakhali District, Bangladesh, a coastal area vulnerable to one to three yearly disasters as well as risks like tidal waves, floods, and river erosion, this study examines climate risk and community-driven resilience. **Method:** This study was conducted in four villages in Hatiya Upazila, namely Nalchira, Chariswar, Jahajmara, and Nijhum Dwip, which were selected due to their geographical vulnerability and socio-economic diversity. Data were collected through triangulation of primary sources, including 12 interviews with key informants, 12 thematic case studies, and 12 focus group discussions, as well as secondary government statistics. Analysis was conducted using iterative thematic coding and subjective interpretation to synthesize field observations and individual narratives into insights on local resilience. **Finding:** The results show extreme economic fragility, with 80% of households using ways to cope, like cutting back on meals and buying food on loan, to deal with malnutrition. The majority of the population, who make between BDT 4,000 and 4,500 a month, rely on daily employment, fishing (21%), and agriculture (20%), all of which are hampered by severe weather. Raised plinths, income diversification (e.g., livestock rearing, handicrafts), and water management are examples of adaptable behaviors; but susceptibility is made worse, especially for women, by a lack of availability of alert systems, health services, and education. **Conclusion:** Recommendations include strengthening early warning systems, promoting sustainable livelihoods, and improving infrastructure like storm shelters and sanitation. Leveraging Hatiya's productive fisheries and fields can enhance resilience and serve as a model for other climate-sensitive regions. **Novelty/Originality of this article:** This study highlights the critical role of local governance, informal leadership, and social networks in shaping resilience. It suggests that adaptation is most effective when integrating indigenous knowledge with structured community coordination, offering a more dynamic perspective on long-term climate survival.

KEYWORDS: Hatiya island; livelihood; disaster; coastal; community resilience.

1. Introduction

Coastal regions across the world are increasingly recognized as frontline spaces of climate vulnerability where environmental hazards intersect with entrenched poverty,

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weak infrastructure and limited institutional reach. Bangladesh, situated at the confluence of major river systems and the Bay of Bengal, exemplifies this reality. Its coastal belt is regularly exposed to cyclones, storm surges, flooding, salinity intrusion and riverbank erosion, all of which have intensified under changing climatic conditions. These hazards disproportionately affect marginalized populations whose livelihoods depend heavily on climate-sensitive sectors such as agriculture, fishing and daily wage labor. Hatiya Upazila of Noakhali District represents one of the most disaster-prone coastal environments in Bangladesh. Located within the Meghna estuary, Hatiya experiences one to three climate-induced disasters annually, resulting in recurrent displacement, livelihood loss, and food insecurity. Despite persistent exposure to risk, external support mechanisms remain insufficient, compelling local communities to rely heavily on indigenous knowledge, informal social networks and community-driven coping strategies to survive. These grassroots responses are not merely reactive but reflect a complex process of adaptation shaped by historical experience, social norms and environmental learning.

While national and regional studies on climate change adaptation in Bangladesh are extensive, there is a relative lack of micro-level, community-based empirical research that documents how households and social groups negotiate vulnerability on a daily basis. Existing studies often emphasize infrastructure, technology or policy frameworks, overlooking the lived experiences, agency and adaptive capacities of communities themselves. Moreover, gendered dimensions of adaptation, household-level decision-making, and the socio-economic trade-offs embedded in coping strategies remain underexplored in highly vulnerable island settings such as Hatiya.

This study addresses these gaps by examining community-driven adaptability and social resilience to environmental threats in Hatiya Upazila. By employing qualitative methods—key informant interviews, focus group discussions, and case studies—the research captures nuanced insights into how households and communities perceive risks, mobilize resources, and sustain livelihoods amid recurring disasters. Guided by this approach, the study explores the community-driven adaptation strategies employed by residents of Hatiya Island to cope with recurrent environmental hazards, examines how these strategies contribute to social resilience, livelihood security, and household survival, and analyzes the structural, gendered, and institutional constraints that limit the effectiveness of local adaptation efforts. By documenting local adaptation practices and linking them to broader debates on resilience and sustainability, this research contributes context-specific evidence that can inform policy, development programming and climate adaptation planning in Bangladesh and other climate-sensitive coastal regions. The research additionally frames resilience as a dynamic process where adaptive capacity is co-constructed by both environmental exposure and community agency. By integrating socio-economic analysis with ecological understanding, the study bridges gaps between descriptive disaster assessments and strategic climate adaptation planning. It also highlights the critical role of intra-community knowledge sharing and local leadership in shaping equitable resilience outcomes, particularly for marginalized groups such as women and landless households.

The changing climate is raising the rate and severity of catastrophes worldwide, putting areas of vulnerability at serious danger. Many communities rely on indigenous adaptation strategies—local scholarly methods created across generations—to endure (Bansal & Ahmad, 2023). Whenever an organization is able to operate and uphold its social order in the face of unfavorable occurrences, it is said to be robust. Resiliency includes the ability to adapt to harsh circumstances, bounce out of setbacks, and maintain means of subsistence. Catastrophe adaptability has been the subject of many investigations, but few of them concentrate on finding regionally successful approaches which might be applied in additional areas at risk. To improve regional resilience and promote information sharing among comparable vulnerable areas, it is imperative to record this kind of technique (Güngör & Elburz, 2024). Furthermore, vulnerability is shaped not only by physical exposure but by socio-cultural hierarchies that influence access to resources, decision-making, and knowledge dissemination. Recognizing these social dimensions of resilience

allows for more targeted interventions that strengthen both community cohesion and adaptive capacity. Indigenous knowledge systems, when coupled with formalized early warning and disaster management mechanisms, create hybrid solutions that enhance both short-term coping and long-term sustainability.

About 452,463 persons live on Hatiya Island in the Bay of Bengal, which is classified as a dangerous location. It loses about 1 km of soil every year due to tidal surges, cyclones, floods, waterlogging, and river erosion due to its shallow geography, lack of dyke safeguards, and closeness to the coast (Kabir et al., 2020). The island's fragility is highlighted by past tragedies like the 1991 storm that killed almost 3,000 people and Cyclone Aila in 2009 that claimed 129 people. Such dangers are increased by a lack of storm refuges, a lack of knowledge about surveillance systems, and insufficient media equipment (Miyaji et al., 2020). Notwithstanding these obstacles, locals use a variety of cultural ways to adapt to save their societies, houses, and means of subsistence (Rahman et al., 2024). The study highlights micro-scale differences in exposure across unions, noting that proximity to riverbanks and embankments creates varying degrees of risk. These localized insights underscore the necessity of site-specific adaptation strategies rather than uniform regional policies. Additionally, the interplay between community trust, local leadership, and resource allocation strongly influences the effectiveness and uptake of adaptation strategies.

The concept of resilience has gained prominence in climate change and disaster studies as a framework for understanding how systems absorb shocks, adapt to change and reorganize while maintaining core functions. In social-ecological systems, resilience extends beyond physical infrastructure to include social capital, institutional capacity, livelihood flexibility and cultural knowledge. Communities with strong social networks, diversified livelihoods and locally grounded knowledge systems are often better positioned to withstand and recover from environmental stressors. In coastal Bangladesh, resilience is shaped by a combination of structural vulnerability and adaptive ingenuity. Frequent exposure to cyclones, floods and erosion has historically forced coastal populations to develop localized coping mechanisms such as raised homesteads, crop diversification, seasonal migration and reliance on informal credit systems.

These practices align with the principles of Community-Based Adaptation (CBA) which emphasize participatory decision-making, local ownership and the integration of indigenous knowledge into climate responses. Social capital theory further illuminates how trust, reciprocity, and social networks function as critical resources during crises. In hazard-prone contexts, kinship ties, neighborly support and community organizations often substitute for weak formal institutions. However, social capital is not evenly distributed; gender norms, class relations and land ownership patterns can exclude certain groups—particularly women, the landless and the ultra-poor—from accessing support. Evidence from comparative coastal studies indicates that integrating livelihood diversification with social capital interventions improves adaptive capacity. Households that simultaneously cultivate multiple income streams and participate in community networks are more resilient to both environmental shocks and economic instability. Moreover, the literature underscores that gender-sensitive adaptation measures, such as supporting female entrepreneurship and equitable access to early warning systems, are crucial to enhancing overall community resilience. These findings contextualize Hatiya's strategies within broader regional and global discourses.

Gender dimensions of resilience have received growing attention in recent literature. Women in coastal Bangladesh often bear disproportionate burdens during disasters due to limited mobility, restricted access to information, and caregiving responsibilities. At the same time, women play crucial roles in sustaining household food security, managing savings and engaging in home-based income-generating activities. Recognizing women as active agents of adaptation rather than passive victims is essential for inclusive resilience-building. Despite these insights, significant research gaps remain. Many studies focus on short-term coping rather than long-term transformative adaptation. Micro-level analyses of island communities like Hatiya are scarce, particularly those that integrate livelihood dynamics, gender relations and indigenous practices within a single analytical framework.

This study responds to these gaps by providing an in-depth, union-level examination of resilience practices in one of Bangladesh's most climate-vulnerable settings.

Due to frequent cyclones, tidal surges, floods, and riverbank erosion, Bangladesh has some of the most fragile coastal communities exposed to the serious dangers presented by global warming (Alam et al., 2024). In addition to infrastructure, socialization, local capability, and the incorporation of indigenous knowledge into adaptation plans are all necessary for boosting resilience (Tanner et al., 2015). Raising homesteads, storing dry food, and strengthening buildings employing regional supplies are examples of particular ways to cope that were used for centuries in seaside Bangladesh (Islam, 2015). Results comparable from South Asia and Fiji highlight the value of indigenous knowledge and women's roles in boosting durability, as well as highlighting the necessity of incorporating it into contemporary systems (Singh & Tabe, 2022; Selje et al., 2024). Because of their plight, inadequate infrastructure, and reliance on low-yield agriculture and fishing, beach towns like Hatiya are particularly vulnerable to catastrophes and have little ability to adjust (Islam et al., 2020). As a result, Community-Based Adaptation (CBA) has become a crucial strategy that empowers neighborhoods via grassroots, democratic procedures and projects like coastline forestry, that have effectively integrated economic growth with conservation efforts (Rawlani & Sovacool, 2011).

More comprehensive data shows that CBA can lower risks by enhancing buildings, ecosystem health, and nutrition and expanding conventional methods (Niu et al., 2023; Tota et al., 2025). Furthermore, livelihoods resiliency is becoming more widely recognized as crucial for transformational change, in which groups move away from immediate buffering to tactics that are long-term, including expansion, relocation, and job changes (Alam et al., 2024; Quandt, 2018). Additionally, research indicates that integrating indigenous knowledge with strategic planning improves paths to long-term adjustment in the countryside (Tohidimoghadam et al., 2023). Although the research study emphasizes the importance of livelihood diversity, CBA, and traditional wisdom in boosting environmental adaptation, there are still a number of limitations. There is little small-scale data from extremely vulnerable places such as Hatiya Upazila, and the majority of studies concentrate on larger regional or national dimensions. There is still much to learn about the socioeconomic vulnerability of coastal families, especially how poverty, food insecurity, and adaptive responses interact.

Furthermore, despite their crucial importance, particular gender adaptation methods and household-level resilience practices are not well documented. Additionally, the current study focuses more on immediate ways to cope than on shifts towards revolutionary economic adaptability. The investigation's uniqueness is its union-specific, inclusive, livelihood-driven situation examination of Hatiya, which uses qualitative triangulation (KII, FGD, case studies) to show the way grassroots tactics and traditional methods promote durability and provide practical policy advice for climate-affected areas. The study aims to identify and accelerate the adaptation techniques of Hatiya Island residents that can be scaled and transferred to similar communities, as well as to examine local opportunities that can direct the development and execution of flexible approaches in the years to come. This investigation addresses several topics, including the adaptation strategies employed by Hatiya Island residents to cope with risks and disasters and the ways in which these adaptation techniques benefit the community in terms of resilience and livelihood security.

2. Methods

2.1 Study area and site selection

The study was conducted in four Hatiya Upazila unions—Nalchira, Chariswar, Jahajmara, and Nijhum Dwip—in Bangladesh's Noakhali district. Due to their geographic proximity to the sea, these unions, which are located in the coastline zone, are thought to be more susceptible to climate dangers relative to other areas. The selection of these unions was guided by both geographic vulnerability and socio-economic diversity, allowing for an

in-depth understanding of how adaptive strategies vary within a single island context. Additionally, spatial mapping of hazard-prone zones was integrated to correlate community responses with risk exposure, providing a granular perspective on localized resilience.

2.2 Data sources and collection strategy

Primary sources of data were collected through focus group discussions (FGDs), research projects, and home surveys to obtain initial information directly from people in the area. The primary data collection emphasized participatory approaches to empower local respondents, ensuring that their perspectives on adaptation and resilience were central to the analysis. Special attention was paid to including marginalized voices, such as women, elderly, and landless households, to capture diverse adaptation experiences.

Secondary sources consisted of supplementary data, including statistical data, analyses, and official files, which were gathered from relevant government departments and agencies at the upazila and union divisions. Secondary sources were triangulated with primary data to validate reported patterns of livelihood disruption, migration, and resource allocation. This integration enhanced the reliability of findings and allowed for cross-checking local experiences against district-level statistics on disasters and socio-economic indicators.

2.3 Key informant interviews (KII)

Key informant interviews (KII) were conducted through 12 investigations with respectable and informed individuals, including seniors and community figures. The participants shared information on previous catastrophes, observable climate shifts, and survival strategies that have been used repeatedly. Participants were selected purposively based on their knowledge, experience, and involvement in community activities to ensure relevant insights. Key informants provided insights into informal governance structures, highlighting how community leadership and collective decision-making influence access to resources and implementation of adaptive measures. This also revealed mechanisms through which social norms either facilitated or constrained resilience.

2.4 Case study analysis and focus group discussions (FGD)

Case studies involved 12 instances carried out with people who had firsthand knowledge of difficulties brought on by global warming. Their accounts emphasised the challenges encountered throughout dangerous situations and the tactics used to adjust and maintain livelihood in challenging circumstances. Data from case studies were coded thematically using a systematic coding framework to identify recurring patterns and insights. Case studies further explored intra-household dynamics, particularly gendered labor divisions and decision-making processes, demonstrating how household strategies evolve under chronic environmental stress. These qualitative narratives provided evidence for the intersection of social vulnerability and adaptive agency.

Focus group discussions (FGDs) were conducted with men and women through 12 group discussions, with 9 male and female members in each group. Opinions on dangers and weaknesses, potential sources of income, and local ways to adapt were discussed. Because the sessions were semi-structured, there was room for free discussion outside of the pre-planned set of topics. To enhance validity, triangulation was applied by cross-checking information from KIIs, case studies, and FGDs. FGDs allowed for collective reflection on past disaster events and generated insights into social cohesion, mutual aid networks, and community-led solutions. This participatory method also highlighted tensions, trade-offs, and negotiation processes inherent in adaptive practices, such as the prioritization of livelihood versus health or education needs.

2.5 Data processing, research limitations, and scope

Data analysis was primarily conducted through subjective exegesis, as the research itself was subjective in nature. In order to represent the actual situation of climate change impacts and community adaptation techniques, results were synthesised using information obtained from field trips, individual accounts, and group debates. Data coding and thematic analysis followed an iterative process to ensure systematic categorization and reliability of findings. Thematic analysis not only identified common adaptation strategies but also illuminated underlying social patterns, such as gendered access to information, disparities in resource allocation, and the role of social capital in mediating vulnerability. Comparative thematic coding with literature from other coastal regions highlighted unique context-specific adaptations in contrast to globally recognized resilience practices.

The research faced a number of limitations. Initially, the integration of quantitative validation, which could have strengthened the evaluation, was constrained by the use of exclusively descriptive techniques. Conducting the investigation was also logistically challenging due to the isolated location of the research area and limited communication facilities. Additionally, the purposive sampling approach may limit generalizability, although it ensured in-depth insights from knowledgeable participants. Despite these limitations, the study provides critical micro-level insights that are often absent from national or regional assessments. Recognizing these constraints, the research emphasizes qualitative depth and local specificity, prioritizing actionable knowledge for practitioners and policymakers.

3. Results and Discussion

3.1 Socio-economic context of Hatiya Island

Hatiya Island, which is situated in the Bay of Bengal's Noakhali region, is known for its unstable socioeconomic status, which is made worse by the island's vulnerable location. The island, which is located inside the biggest river estuary on the globe, experiences one to three moderate to severe tropical cyclones per year, along with hurricanes that can travel up to 70 kilometres inside and cause extensive damage. The incidence and severity of cyclones and floods are expected to increase due to warming temperatures. A great deal of people in Hatiya are extremely poor and have little opportunity for assets or reliable sources of employment.

The majority of families are without homes and live on khas (government-owned) land with permission from landlords or the municipality; rent fees are frequently required (Rahman et al., 2025). Poor schooling limits knowledge of catastrophe preparation and adaptation techniques, which exacerbates susceptibility. In areas susceptible to flooding, homes are usually made of inexpensive supplies that are quickly destroyed by storms and floods, resulting in frequent destruction of possessions and means of subsistence. A downward spiral of fragility is created when destitution, erratic earnings, and insufficient facilities combine to ruin houses and resources of revenue at the same time, leaving families with little money for rebuilding.

The dependence on indigenous knowledge and community-led adaptation to endure recurring risks is highlighted by this financial instability (Ho et al., 2022). The socio-economic fragility also intersects with social stratification, as landless households and women-headed families experience compounded vulnerability. These households often have reduced access to relief programs and formal credit systems, which underscores the importance of integrating equity considerations into climate adaptation planning.

3.2 Major hazards and their impacts

Cyclones, tidal surges, river erosion, flooding, salt invasion, and floods are just a few of the impacts of climate change that Hatiya Island faces. These risks significantly affect

unionists like Burirchar and Chariswar, where drainage is a major issue, and Nalchira, Jahajmara, and Chariswar, where river erosion is common throughout the rainy period. Community susceptibility is increased by the frequent regularity of these occurrences as well as the island's treacherous coastline location along the Meghna River.

Inadequate understanding of systems for early alert and catastrophe preparations intensifies the effects, leading to substantial losses of life, property, and means of subsistence. The area's widespread misery makes populations more vulnerable since they lack the means to adequately prevent or recover from these frequent calamities (Chowdhury et al., 2025). Mapping the frequency and intensity of hazards revealed spatial clustering of vulnerability, with certain unions experiencing overlapping risks of erosion, flooding, and storm surges simultaneously. This layered hazard exposure accentuates the need for differentiated local adaptation strategies rather than uniform interventions.

3.3 Food security and livelihood

For Hatiya families, food security—which is characterised as having consistent possession of enough food that is secure and nourishing—is a major problem. Getting three meals a day is a challenge for numerous households. People have developed experience-based native ways to cope as a result of prolonged contact with catastrophes. Using less-liked foods, borrowing from family, buying food on credit, and varying the quantity of meals are typical tactics (Table 1).

Table 1. Hatiya Island inhabitants' ways to cope

Coping strategies	Proportion who DO (%)	Proportion who DO NOT (%)
1. Rely on less preferred and less expensive foods?	60	40
2. Borrow food, or rely on help from a friend or relative?	70	30
3. Purchase food on credit?	80	20
4. Consume seed stock reserved for next season?	40	60
5. Send household members to eat elsewhere?	40	60
6. Limit portion size at meal times?	80	20
7. Restrict consumption by adults so that small children can eat?	60	40
8. Give working members of the household more food than the non-working members?	70	30
9. Reduce the number of meals eaten in a day?	60	40
10. Skip entire days without eating?	20	80

Farmhouse farming and angling are significant supplemental foods during summertime, when seasonal food shortages are more noticeable (Doustmohammadian et al., 2025). Analytical insight indicates that while these coping strategies alleviate immediate hunger, they often undermine nutritional adequacy and long-term agricultural resilience. The reliance on credit or asset liquidation highlights systemic vulnerabilities in financial inclusion for disaster-affected households.

3.3.1 Household economy

The majority of families in Hatiya lack reserves or assets that are useful, and the country's economy is marked by poor and erratic earnings. Everyday labor (dominant), fishing (21%), agriculture and raising animals (20%), and small enterprises (10%) are the main sources of income. Revenue unpredictability is due to these professions' cyclical

character, which is impacted by supply and surroundings. Hurricanes and floods are examples of catastrophes that interfere with farming and fishing, resulting in job losses and revenue losses. Families vary their means of revenue in order to cope, increasingly engaging in smaller enterprises, crafts, and chicken farming.

Financial organizations, non-governmental organizations, and local financiers (Mahajans) frequently offer loans, but payback frequently necessitates the sale of valuables like jewellery or cattle, thereby reducing family stability (Shehrin et al., 2023). The economic analysis demonstrates how short-term survival strategies, such as taking loans or selling assets, may inadvertently perpetuate cycles of vulnerability. This underlines the importance of introducing climate-informed microfinance and financial literacy programs to enhance household economic resilience.

3.3.2 Disaster impact on livelihood

Economic activities are often disrupted by cyclones, tidal surges, waterlogging, and erosion of rivers. Families frequently deal with compelled relocation, short-term unemployment, and changes in their line of work. In order to support families amid emergencies, women and children are becoming more involved in ways to earn money. Despite recurrent challenges, local communities employ adaptive strategies to cope with these disruptions (Rahman et al., 2022). A comparative lens reveals that households engaged in multiple income streams recovered faster from disasters than those relying on a single livelihood, highlighting the protective effect of income diversification on resilience.



Fig. 1. Cultivating flood-resilient crops in Jahajmara Union

3.3.3 Gender roles

Women in Hatiya face limited access to land, healthcare, education, and employment. Social and religious constraints restrict their participation in income-generating activities, although recent shifts have enabled some women to engage in family-level enterprises, handicrafts, and livestock production (Rola-Rubzen et al., 2024). Gendered analysis indicates that women's adaptive strategies, including handicrafts and home-based enterprises, contribute significantly to household survival but remain undervalued in formal policy frameworks. Strengthening women's access to information and decision-making platforms could amplify resilience outcomes.

Table 2. Gender division of income sources

Women	Men	Both
Livestock Production	Livestock product sale	Homestead gardening
Poultry Rearing	Crop production	Daily labor
Tailoring	Fishing	Small business
	Van/Rickshaw pulling	
	Selling of products	

3.3.4 Possibilities and priorities for income-generating activities

Community members identified various potential livelihood options, including livestock rearing, net making, small businesses, poultry and duck rearing, tailoring, bamboo crafts, handicrafts, retail shops, crop production, and fishing. The identified opportunities for local income generation include a diverse range of sectors, namely: livestock rearing, net making, small business, poultry rearing, duck rearing, van/rickshaw pulling, tailoring, bamboo crafts, handicrafts, grocery shop, vegetable shop, tea stall, fried rice business, egg business, varki, pan shop, cloth shop, medicine shop, wood business, cycle business, crop production, fishing, and fish culture. These activities reflect the multifaceted economic landscape of Hatia Island, offering various pathways for community-based livelihood development. Furthermore the options reflect local resource availability and adaptive capacity (Fig. 3) (Parvin et al., 2023).

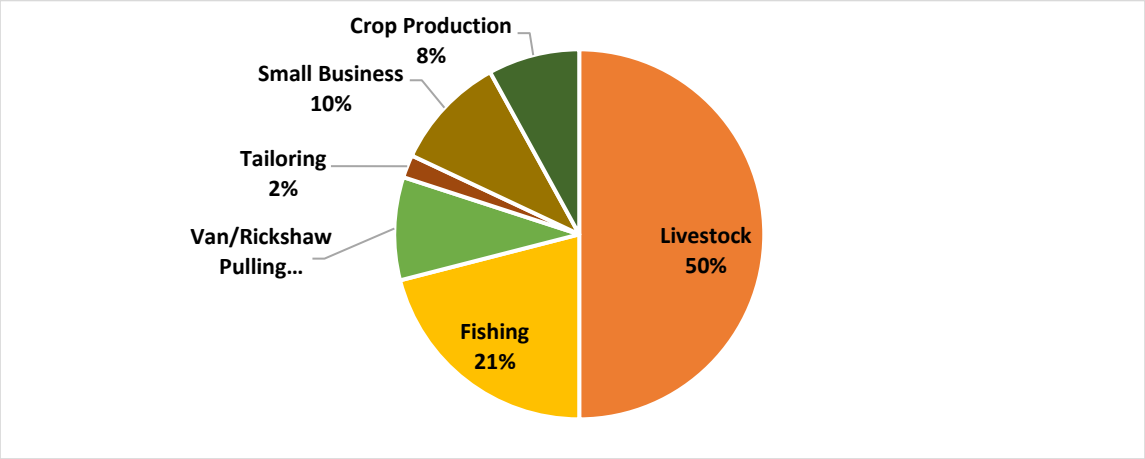


Fig. 2. IGA priorities by community

3.4 Household skills and socio-economic conditions

Skills in Hatiya are primarily acquired through intergenerational knowledge transfer, shaped by the local environment. For instance, riverside communities excel in fishing and net-making. FGDs revealed that households earn approximately BDT 4,000–4,500 monthly from various IGAs, though income varies across poor, middle, and better-off households (Islam et al., 2024). The qualitative data highlights the role of tacit knowledge in sustaining livelihoods, illustrating that skill-based adaptation is as critical as infrastructure-based interventions. Training programs that combine indigenous and modern techniques could enhance adaptive capacity.



Fig. 3. Fishermen repairing a net at riverside

Training from NGOs has enhanced the efficiency of these activities, increasing incomes and encouraging neighbors to adopt similar practices. Scaling is nevertheless limited by the absence of expert instruction. The availability of funds gets worse when households rely on loans from microfinance organisations, NGOs, or loan sharks throughout winter months or calamities. These loans are frequently returned by liquidating property. Fiscal difficulties are made worse by a lack of schooling, limited availability of care (there is just a single inadequately furnished clinic), and lack of interaction with the continent, especially for women who are more vulnerable to health problems. The prevalence of superstition and early marriage contributes to societal advancement (Chowdhury, 2025).



Fig. 4. A person carrying a net for fishing

3.5 Shelter, water, and sanitation

Whether they have official tenancy papers or not, a sizable chunk of the population resides on Khash property. The plinth leveling, building reinforcing, and relocation during high-risk times are alternatives for homes beyond bottoms that are vulnerable to floods and storms. Interim constructions enable adaptability in the face of rainfall or erosion of rivers (Alam, 2019). Analytical insight, shelter adaptation reflects an iterative process where households continuously modify structures based on past disaster experiences, demonstrating adaptive learning. Policy support could formalize these practices through technical guidance and safe-building incentives.

In Hatiya, getting to sanitary facilities and pure water is restricted. Rainwater, river, or pond water is used for cookery, among other reasons, but wells with tubes are the main supply of drinking water. Tube well water gets rare during floods or dry seasons (March–April), forcing homes to save water from far-off places, which is sometimes an issue for women and children. When flooding, pollution is avoided by elevated tube well tops. Women's confidentiality and security are especially impacted by the ongoing sanitary problems, since so many communities lacked bathrooms and resorted to naked urination. Although they are growing, volunteer-organized and outside-funded toilet installation initiatives are still minimal (Khanam et al., 2024). Inclusion of water management strategies as an adaptive measure demonstrates households' proactive approach to safeguarding health. Policy emphasis on gender-sensitive water and sanitation solutions can reduce disease exposure and social vulnerability.

3.6 Health and disease outbreaks

Because of the inadequate medical system, recurrent diseases are an urgent issue. Dependence on local physicians is necessary due to the lone hospital's insufficient amenities and the non-operational neighborhood clinics. Accessibility to health services is hampered

by inadequate transport networks, which particularly impacts women. Costs restrict therapy possibilities with rising health consciousness, as certain families turn to religious ways to cope (Sharma et al., 2025). The study highlights health vulnerabilities as both a driver and consequence of climate-induced stress, showing the need for integrated health and climate adaptation interventions, including mobile clinics and community health training.

3.7 Community perceptions of disasters

Alert networks are essential for disaster preparedness, but their distribution is insufficient, especially for women who frequently have no knowledge of data because of gender conventions or the dearth of male relatives. Elevating homesteads, stockpiling dry food, and safeguarding possessions and cattle are examples of fundamental emergencies that are becoming more widely known, according to FGDs. Although some locals are aware of storm warnings, more widespread distribution is required to lessen risk (Sufri et al., 2020). The qualitative evidence underscores the gap between awareness and actionable knowledge. Strengthening early warning systems with inclusive communication channels can enhance timely community responses.

3.8 Community-led adaptation actions

Individuals of society use a variety of adaptation tactics across sectors (Table 4), such as moving for work, diversifying ways to earn earnings, limiting food, liquidating assets, switching jobs, altering housing, establishing forests, and managing water. These methods show indigenous expertise and ingenuity in handling frequent calamities (Suhaeb et al., 2024). Analytical observation, these grassroots strategies reveal adaptive capacity embedded within local culture. Recognizing these as legitimate resilience mechanisms can inform community-centered adaptation policies and development programs.

Table 3. Hatiya Island's neighborhood-driven adaptive initiatives

Sectors	Adaptation Techniques	Description of Adaptation technique
Food security and Livelihood	Migration from one area to another areas/countries for livelihood purposes	Migrating for livelihood opportunities, mainly to affordable countries (e.g., Middle east countries etc.)
	Increasing involvement in a diversified income sources	Earning money by wage labor, small business, and livestock farming), they prioritize on daily income business.
	Taking low amount of meals	They do not take 3 times of meal and also amount is also decreased.
	Selling assets and taking loans	Selling livestock, trees, jewelries and taking loans from Mahajan/rich relatives (especially among poor households)
	Changing occupation	People beside river, the occupation also based on river. But due to climate change fish is not available, so people change their business strategy
	Gender dimensions	Women are also taking jobs or doing business
	Receiving support from relatives and social networks	Any kind of support from relatives and social networks to cope with devastation.
Shelter	Raising the plinth	To lessen the severe effects of flooding and floods, residents in arid locations frequently elevate their farmhouse and foundation significantly above the ground.
	Tree plantation	Planting trees around the house to reduce the intensity of storm surge attacks

	Modification of houses	Houses are being tighten and modified receiving the early warning.
	Changing house locations	Relocating from the coast of offshore islands to inner parts of the islands or to the adjacent mainland
Health	Adopting household level coping strategies	Different household-level strategies aimed at preventing disease.
Water and Sanitation	Water management	People are habituated to move a long distance to get water and they collect for more days at a time.

3.9 Case study: Sarjan Begum's resilience

Sarjan Begum, a 48-year-old Chariswar Union citizen, is a prime example of the difficulties and tenacity of the Hatiya community. She has moved three places because of hurricanes and erosion in the river, and she had three kids and a crippled spouse. Her relatives originally resided in Nalchira Union, but erosion caused them to lose their property. As a result, they were forced to relocate outside the embankment in Chariswar, where a tornado in 2012 damaged their house. She worked for a tenant and earned a meager salary in order to obtain acreage below the retaining wall. A lack of funds is reflected in her daughter's early marriage and her children's rudimentary school.



Fig. 5. One female is involved in handicraft business.

Sarjan produces handicrafts to augment her paycheck, yet her struggles are exacerbated by periodic lack of food and her dependency on far-off wells with tubes for freshwater. She repairs her lightweight home after taking cover in sanctuaries throughout storms. Sarjan's adaptive strategies—relocation, handicrafts, and water stockpiling—show perseverance in the face of minimal outside help and credit denials, but she voices anxiety regarding what lies ahead owing to persistent issues and decreasing wellness. Sarjan Begum's story highlights how individual resilience is intertwined with systemic gaps, particularly gendered vulnerabilities and limited institutional support. Scaling such micro-level adaptive strategies through community networks and policy interventions can enhance broader social resilience.

3.10 Discussion

The results demonstrate how ecological dangers and poverty interact to influence Hatiya's adaptive tactics. Raised plinths, lightweight materials, and a variety of livelihoods—all examples of traditional knowledge—reflect society's resistance while also highlighting constraints brought on by hunger, insufficient facilities, and gender inequality. Methods for ensuring nutrition are successful in the moment, but they put a sustainable future in danger by depleting resources like seed supplies. In addition to highlighting

poverty, the growing participation of women and children in revenue generation suggests a change in sex roles. The instance of Sarjan Begum highlights the necessity of better assistance structures, such as improved alert distribution, more cyclone shelters, and easily available medical care, by demonstrating that complex problems limit resilient individuals. The results shown are consistent with international research on grassroots mitigation, indicating that Hatiya's tactics might be applied in various susceptible areas with comparable social-environmental circumstances. Comparative analysis with other South Asian coastal regions indicates that Hatiya's adaptive strategies, particularly livelihood diversification and social network reliance, align with best practices in community-based resilience but require complementary policy support to be sustainable. Gender integration and local knowledge incorporation are crucial for replicable success.

The findings from Hatiya Upazila demonstrate that resilience is not a fixed condition but a continuous process shaped by environmental exposure, socio-economic constraints and collective action. Community-driven adaptation strategies—such as livelihood diversification, raised housing plinths, seasonal migration and reliance on social networks—reflect both necessity and innovation. These practices enable households to manage immediate risks, yet they also reveal the limits of coping in the absence of structural support. Food security strategies observed in Hatiya illustrate this tension clearly. While reducing meal frequency, purchasing food on credit and borrowing from relatives help households survive periods of scarcity, these measures often undermine long-term nutritional outcomes and economic stability. The consumption of seed stock, for instance, protects households in the short term but jeopardizes future agricultural productivity, trapping families in cycles of vulnerability. Livelihood diversification emerges as a central pillar of resilience. Engagement in fishing, agriculture, livestock rearing, handicrafts and petty trade allows households to spread risk across multiple income sources. However, these opportunities are constrained by limited access to capital, markets and training. Microfinance loans, while widely used, frequently exacerbate indebtedness when disasters disrupt income flows. This highlights the need for financial instruments that are explicitly designed for climate-risk contexts, such as flexible repayment schedules and microinsurance.

Gendered patterns of adaptation reveal both progress and persistent inequality. Increased participation of women in income-generating activities indicates shifting social norms and economic necessity. Yet women continue to face barriers in accessing early warning information, healthcare, and education. The case of Sarjan Begum underscores how resilience at the individual level is often achieved at great personal cost, particularly for women managing caregiving responsibilities under conditions of chronic stress. From a policy perspective, the findings suggest that community resilience cannot be strengthened through infrastructure alone. While cyclone shelters, embankments and water facilities are essential, they must be complemented by investments in education, health services and livelihood development. Integrating local knowledge into formal disaster management systems can enhance effectiveness and community trust. Comparatively, the adaptation practices observed in Hatiya resonate with experiences from other climate-vulnerable coastal regions in South Asia and the Global South, where community-based strategies form the backbone of survival. This underscores the potential for cross-regional learning while cautioning against one-size-fits-all solutions. Contextual specificity, cultural sensitivity and participatory approaches remain critical.

4. Conclusions

Bangladesh is one of the nations with the greatest climate risk in the world, and Hatiya Upazila in Noakhali District is a prime example of this vulnerability because of its coastline position and low income. Tidal surges, river erosion, flooding, saltwater invasion, and one to three medium to serious storms occur in the area each year, severely disrupting lives. The majority of families lack funds, are without land, and make between BDT 4,000 and BDT 4,500 per month from daily labor (dominant), fishing (21%), agriculture/livestock (20%),

and small businesses (10%). This makes recuperation after a challenge. Although a lack of food, which affects around 80% of families, is solved by tactics like decreasing eating timing, lending, and buying food on finances, migration and loans from microfinance organizations or family members are frequent ways to cope. There is clear communal resiliency regardless of those weaknesses. Flexible tactics, such as elevating farm plinths, modifying structures, diversifying ways to earn earnings, involving women and children in earning money, and relying on traditional abilities such as creating nets, crafting, and raising cattle, were emphasized in twelve focus group discussions and twelve case analyses. Fishing and cottage farming can alleviate periodic food scarcity. The potential for sustainable livelihood development is offered by Hatiya's lakes, fishermen, and good farms. Prospective resiliency may be improved by bolstering early warning systems, healthcare access, and financial stability whilst utilizing local expertise and biodiversity. Policymakers are encouraged to integrate community-driven adaptation into national climate strategies, while practitioners should support neighborhood-driven initiatives through targeted funding and capacity-building programs. Researchers are recommended to further explore union-specific adaptive strategies to inform scalable interventions. All things considered, the interaction of fragility, financial status, and grassroots adaptation highlights the chances and hazards associated with promoting climate-resilient livelihoods in Hatiya Upazila. The study concludes that resilience is an ongoing process shaped by social, economic, and environmental factors. Long-term adaptation requires integrating local knowledge with formal policy, enhancing gender equity, improving infrastructure, and supporting sustainable livelihoods. Contextual specificity and participatory approaches are critical for effective replication.

Author Contribution

The authors jointly contributed to all components of this study, including conceptualization, methodology, data collection, formal analysis, drafting of the original manuscript, review and editing, visualization, and project administration.

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Data Availability Statement

The data presented in this study are not publicly available due to privacy and ethical restrictions. The interview data contain confidential information provided by expert participants.

Conflicts of Interest

The authors declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the authors used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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