



Original Research

Assessing Local Livelihood and Underlying Factors for Sustainable Management of Mangrove Forest: Empirical Evidence from Satkhira District of Bangladesh

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Abstract

The mangrove forest is a unique ecosystem that supports the local livelihoods of economically disadvantaged people who reside in nearby areas. The purpose of this study was to assess the state of local livelihoods and the contributing factors in Shyamnagar upazila (sub-district) under Satkhira district due to the complex interplay between the detrimental effects of climate change and vulnerable rural livelihood. To fulfil the research purpose, we assessed local livelihood conditions and the contributory factors by introducing mixed-methods research. Primary data were collected from 70 residents following a simple random sampling method by using a structured questionnaire survey. Besides, we also introduced a focus group discussion as a qualitative approach for narrative interpretation of the findings and data triangulation. The results clarified that the major proportion of the residents (56%) were involved in non-wood forest products (NWFPs) accumulation, indicating poor socio-economic conditions and a high dependency on the Mangrove Forest. Local households were vulnerable to natural disasters due to the low living standards of the majority of respondents (52.86%). The factors of training exposure, adaptive strategies and access to finance were most crucial for the livelihood conditions of local inhabitants. The policy implications of our study suggest paying attention to community-centred training and equal access to livelihood assets based on local demands. Priority should be given to creating gender-inclusive income-generating opportunities and enhancing the capacity of economically disadvantaged individuals to increase their adoption of climate-responsive livelihood approaches in the mangrove ecosystems of Bangladesh.

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Statement of Sustainability: The naturally occurring mangrove forest (commonly known as the Sundarbans) is a unique ecosystem and offers a variety of functions to support the local livelihood. In order to investigate local livelihood situations and to determine the underlying elements for sustainable forest management, this study follows a mixed-methods research approach. The specific findings of this study will act as concrete evidence for the government and policy-makers to formulate appropriate strategies to support the livelihood of climate-affected people and check the gradual deterioration of forest coverage as an environmental safeguard in the coastal region of Bangladesh. This will contribute to achieve SDG-1 (No poverty), SDG-13 (Climate action) and SDG-15 (Life on land).

1. Introduction

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) designated the Sundarbans, a naturally occurring mangrove forest, as a World Heritage Site in 1997 (Banerjee, 2014). Throughout the world, mangrove forests are only found in tropical and subtropical regions. It is situated in the southern region of Bangladesh and spans 10,000 km², with 245 taxa and 334 species of trees, shrubs, bryophytes, and pteridophytes (Siddiqui and Islam, 2020). A variety of functions are offered by man-



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grove ecosystems, such as supplying (food, timber, and fodder), monitoring (wave energy reduction, storm surge impact mitigation, windbreaks, and protection of inland crops from saline air), sustaining (animal habitat), and cultural (including ecotourism). These advantages work together to improve the standard of living in communities that depend on mangroves (Rahman et al., 2024). Furthermore, climate change has become the primary environmental issue from the standpoint of development, especially for the most vulnerable populations in developing nations (Lopoukhine et al., 2012). Bangladesh is already suffering greatly from the effects of climate change, since the country's agricultural output and economic growth are being seriously affected by longer flood seasons and more frequent cyclones, droughts, and earthquakes (Derbile et al., 2022).

The Intergovernmental Panel on Climate Change (IPCC) estimates that Bangladesh will lose 30% of its food production and 17% of its landmass by 2050. In addition to increasing poverty, this will increase susceptibility to sea level rise and global warming (Planetizen, 2008; Islam et al., 2022). It is anticipated that by 2080, sea levels will have risen 40 cm and temperatures will have increased by roughly 1.0 to 1.5 °C, causing heavy damage to biodiversity (Streatfield, 2008; Chowdhury et al., 2014). An important ecological benefit that mangrove forests provide is mitigating climate change by storing atmospheric carbon in soil and plant biomass (Warren-Rhodes et al., 2011). Despite these enormous advantages, mangrove forests are being destroyed and degraded at an alarming rate globally, primarily as a result of human activities (Donato et al., 2011). For instance, over-exploitation of resources, oil spills, and uncontrolled shrimp farming development have all contributed to the loss of 35% of mangroves during the past century, with an annual loss rate of 1% to 2% (Islam et al., 2022). Like other tropical mangrove ecosystems, the Sundarbans are deteriorating as a result of extreme cyclones (such as Aila, Amphan and Sidr) and natural calamities like sea level rise (Khan et al., 2021; Duke et al., 2017). Approximately 60% of the Sundarbans, the world's largest contiguous mangrove forest, is located in Bangladesh (Giri et al., 2015). This mangrove habitat comprises 44% of Bangladesh's total forest cover and 4.2% of its total land area (Ortolano et al., 2017). The mangrove forest significantly supports the lives of a large number of low- and middle-income people, and provides a unique example of the difficulties associated with the broader context of mangrove dependency (Abdullah et al., 2016).

Understanding the dynamics of socio-ecological systems in relation to mangroves is receiving attention, with a particular emphasis on livelihood dependency processes, climate change susceptibility, and resilience of local households, as studied by Mukhopadhyay et al. (2018). The findings indicated that the quantity of carbon stored in the mangroves as biomass reflects these changes, and a decline is predicted over the course of this century. It is evident from the literature that Hossain et al. (2015) investigated the issues that coastal wetlands encounter due to changing climate conditions. Rahman et al. (2025) carried out another empirical investigation on the deterioration of mangrove forests utilizing the DPSIR framework. The results showed that decreased freshwater availability, rising local demand, tourism, and climate change were the main causes of mangrove deterioration. Researchers have also looked at how oil spills affect mangroves (Islam et al., 2018) and how human activities affect the cultural and provisioning services that mangroves offer (Ahmed et al., 2021). Nevertheless, there are very few studies that provide empirical evidence on the extent and circumstances of the reliance of local households on mangrove ecosystems. Thus, the primary goal of this research is to explore the livelihood conditions of local disadvantaged people and the associated factors for sustainable management of the mangrove forest.

2. Methodology

2.1. Study Location

Satkhira district, which is located in the south-western coastal zone under Khulna division, was the research target of this study (Figure 1). Geographically, it is located between 21°36' and 22°24' north latitude and between 89°00' and 89°19' east longitude. The Bay of Bengal borders Satkhira district to the south, Jessore district to the north, Khulna district to the east, and India to the west (Banglapedia, 2025). The study region has unique ecological attributes and is within the vicinity of the Sundarbans. A sub-district of Satkhira district called Shyamnagar was chosen due to the high dependency of the local people as a means of livelihood and its close proximity to the mangrove forest (Aziz and Paul, 2015). Among the total area, about 1,632 km of the Satkhira district is covered by forest area (Forest Department, 2010). A village named Atulia under Shyamnagar (sub-district) was the specific study location.

The target region has a subtropical climate and is located between 0.8 and 4 meters above mean sea level. According to Kamruzzaman et al. (2019), these areas have had similar seasonal fluctuations in terms of average rainfall (1700 mm), maximum temperature (35.5 °C), minimum temperature (12.5 °C), and humidity (70-80%). As a coastal region, the study area is also prone to natural calamities like flash floods, tidal surges, salinity intrusion, tropical cyclones and other natural and man-made disasters, which create complex dynamics between vulnerable rural communities and changes in climate that affect local livelihoods (Shameem et al., 2014).



Figure 1. Geographic location of the study area.

2.2. Survey Design and Data Management

The primary goal was to find out how the locals in the study area maintain their subsistence. The locals are involved in the collection of different non-timber forest products that vary with seasonal variability (Zohora, 2011). About 250 households depend directly or indirectly on the mangrove ecosystem as a means of livelihood (LGRD, 2022), and the sample size was determined by using the following formula (Yamane, 1967):

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where, n = sample size, N = population size, and e = level of precision which was set at 10%

To meet the research purpose, primary data were obtained from 70 local respondents following a simple random sampling technique by using a structured questionnaire survey during the period from May to June 2026. The questionnaire was pre-tested prior to the final poll to prevent response bias. The male or female heads of each household were considered for investigation. The semi-structured questionnaire contained both open- and closed-form questions covering socio-demographic attributes and means of livelihood in the locality. The socio-demographic attributes such as age, gender, educational qualification, family size, land ownership, annual family income, involvement in community-based organizations, access to information sources, training exposure, adaptive livelihood strategies and access to finance were selected from the detailed literature review and consultation with academic experts. Furthermore, in June 2026, we held a focus group discussion (FGD) with ten local residents to gain a comprehensive understanding of household vulnerability and climate-responsive livelihood choices.

2.3. Measurement of the Focus Variable

This study's main goal was to evaluate local livelihood conditions in a region frequently affected by natural disasters. The livelihood status was determined based on ten substantial statements covering the components of livelihood assets (e.g. human capital, social capital, natural capital, physical capital and financial capital). A 3-point rating scale such as 'improved', 'unchanged' and 'declined' was employed to assess each dimension of livelihood, and a specific score was assigned as +1, 0 and -1 respectively (Rana et al., 2022). Afterwards, the livelihood conditions of each respondent were calculated by accumulating the total score of ten statements. Therefore, the livelihood status score could vary from -10 to +10.

2.4. Data Processing and Analytical Procedure

The gathered data were appropriately edited, coded, assembled, and examined in accordance with the study's goals. SPSS (Statistical Package for Social Sciences) version 22 was used for data processing and analysis. The results were interpreted using descriptive



and inferential statistical techniques, including mean, standard deviation, multiple regression, charts, and graphs (Fraenkel et al., 2012). Moreover, the qualitative data were acquired to conduct a narrative analysis for data triangulation and to support the findings from quantitative analysis (Creswell and Plano Clark, 2017).

3. Results and Discussion

3.1. Socio-economic Attributes

It is anticipated that various socioeconomic characteristics may affect local residents' quality of life. Table 1 displays the characteristics of the socio-demographic attributes. The respondents' ages ranged from 25 to 62, with an average age of 43, and the average educational qualification was 4.64 years of schooling. The results also aligned with Mallick et al. (2021), who found that, on average, the majority of the mangrove inhabitants had a primary level of education. According to BBS (2022), the average family size was 4.51, and the mean land ownership value was 0.42 ha, which was less than the 0.54 ha national average. Additionally, the average household income was BDT 75,892.36 per year, which was less than the BDT 139,260 national average (BBS, 2022).

Table 1. Salient characteristics.

Variable groups	Measuring technique	Mean	SD	Min.	Max.
Age	Years	43.00	9.18	25.00	62.00
Gender	Male/female	0.86	0.34	0.00	1.00
Educational qualification	Years of schooling	4.64	2.75	0.00	10
Family size	Number of family members	4.51	2.34	3	8
Land ownership	Hectare	0.42	0.29	0.08	1.25
Annual family income	BDT	75,892.36	52,620.14	48,600	140,000
Involvement in community-based organizations	Scale score	2.06	0.299	1.00	3.00
Access to information sources	Scale score	8.16	1.036	4.00	9.00
Training exposure	Days	1.76	1.09	0	7
Adaptive livelihood strategies	Scale score	4.37	2.59	0	8.00
Access to finance	'000' BDT	15.34	11.84	0	50

Note: SD = Standard Deviation

The local people were involved in different community organizations, for example farmers' clubs, village development groups and microfinance organizations. In the case of access to information sources at the local level (e.g. Union Parishad, Upazila Parishad and Local Agriculture Office), the average value was 8.16 with a possible score range of 0 to 16. This indicates limited access to information sources at the village level due to a low literacy rate and poor communication facilities. The local people received training from government and non-government organizations focusing on climate-resilient livelihood practices and the mean duration of training exposure was 1.76 days. Training exposure improved their knowledge and skills on capacity-building and resource utilization efficiency (Seyedeh et al., 2018). The results showed that the locals adopted a variety of farming and non-farming practices to minimize the negative consequences of climate change. The adaptive approaches included the cultivation of salinity-tolerant crop varieties, the construction of water reservoirs for rainwater harvesting, the raising of livestock and the planting of fodder crops. In the study area, the credit availability from GOs and NGOs was limited due to geographic location and poor socio-economic conditions, with an average of BDT 15.34 thousand, which limits the potential of local residents to undertake income-generating activities.

3.2. Means of Livelihood of the Local Inhabitants

The local inhabitants were affected by poverty, hunger and lack of employment opportunities due to the frequent occurrence of natural disasters. The distribution of respondents based on their nature of occupation is shown in Figure 2. The findings revealed that a major proportion (56%) of local inhabitants depended on non-wood forest products (NWFPs) to maintain their livelihood. Fish, crabs, prawns, honey, beeswax, fuelwood, and leaves of *Nypa fruticans*, commonly known as golpata, are among the NWFPs. The local inhabitants opined that honey and beeswax collection and fishing activities in the nearby rivers and canals acted as the major income sources.

Furthermore, *Nypa fruticans* acts as a rich source of sugar and medicine, while the collected leaves were commonly utilized as building materials for rural households in the coastal regions (Hossain and Islam, 2015). A significant portion (25%) of local people who had no cultivable land worked as agricultural laborers on a daily wage basis at neighboring farms. Agricultural farming is troublesome and affected by high soil salinity and frequent natural disasters (e.g. cyclones, flash floods and soil erosion). Despite facing the constraints of low crop productivity, some local people (12%) were also involved in the cultivation of salinity-tolerant rice varieties and seasonal vegetables in floating beds. Due to the high financial return and rising rate of soil salinity, the locals were encouraged to transform their arable land into shrimp farming. Besides, some local inhabitants (7%) were also involved in other occupations based on seasonality, such as boat making and rowing, auto vehicle driving and petty business. Mallick et al. (2021) evaluated the reliance of livelihoods on mangrove ecosystems. The findings revealed that among the directly dependent



households, the majority of the inhabitants (29%) were involved in catching fish, followed by crab (26%) and honey (9.15%) collection. In the case of indirectly dependent households, the major occupations were day labor (21.35%), followed by farming (17.45%) and business activity (13.55%).

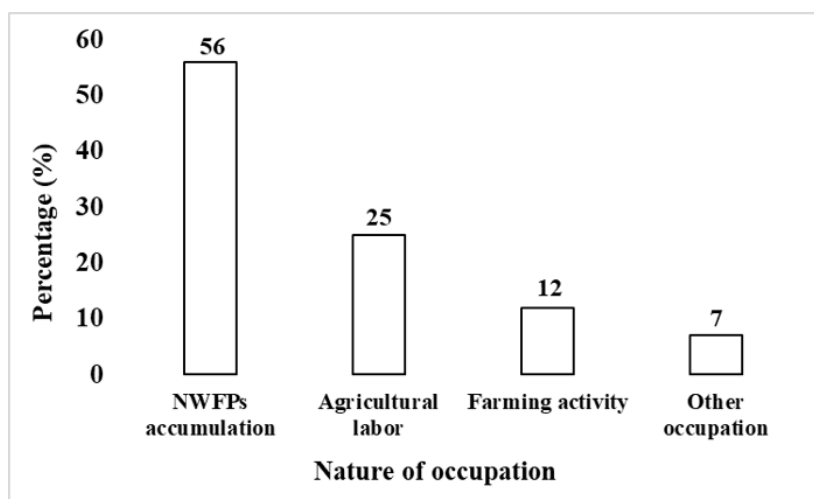


Figure 2. Distribution of the respondents based on their occupation.

3.3. Current Livelihood Conditions of Local People

The livelihood conditions score was determined to gain an in-depth understanding of the current living standard of local people. The livelihood status score of the respondents ranged from 2 to 7 with a mean of 3.76 and SD 1.34. Based on the score, the respondents were distributed into three categories (Table 2).

Table 2. Distribution of the respondents based on their livelihood conditions.

Categories	Respondents		Mean	SD
	Frequency (n)	Percentage (%)		
Low living conditions (1-3)	37	52.86	3.76	1.34
Moderate living conditions (4-6)	29	41.43		
High living conditions (>6)	4	5.71		

Note: SD = Standard Deviation.

The results revealed that the majority of the respondents (52.86%) belonged to low living conditions, while 41.43% of them had moderate living status and only 5.71% had high living standards. The limited income-earning activities, high dependency on the mangrove forest and frequent occurrence of natural calamities resulted in low living standards in the locality. An empirical study on the change in livelihood status of common interest group farmers was conducted by Rana et al. (2018). The findings reported that 71.82% of farmers had a high status of livelihood change and 28.18% of farmers belonged to a moderate status of livelihood change due to the interventions of the National Agricultural Technology Program (NATP).

3.4. Factors Affecting the Livelihoods of Local Inhabitants

The purpose of this section is to examine the relationships that exist between local residents' livelihoods and socio-demographic characteristics. The Pearson's product-moment coefficient of correlation (r) was introduced in order to identify the underlying factors. The correlation analysis findings are displayed in Table 3. Firstly, among the socio-demographic attributes, land ownership had a significant positive relationship with the livelihoods of local inhabitants. The findings showed that local residents who owned agricultural land had easier access to resources that might be used for production (e.g. crop seed, finance and farm machinery) than individuals without farmland. Local people having farmland can increase land utilization efficiency by enhancing agricultural productivity, bringing positive impacts on their livelihood conditions. Islam et al. (2023) conducted an empirical investigation and concluded that households participating in agroforestry practices surrounding mangrove forests had a significant positive association with farmland ownership. Rana et al. (2018) observed similar findings about the livelihood status of a group of common interest farmers in Bangladesh.



Table 3. An overview of correlation analysis (n=70).

Primary focus	Farmers' socio-demographic features	Correlation coefficient (r)
Livelihood conditions of local people	Age	0.046
	Gender	0.114
	Educational qualification	0.167
	Family size	-0.148
	Land ownership	0.241*
	Annual family income	0.219
	Involvement in community-based organizations	0.087
	Access to information sources	0.116
	Training exposure	0.314**
	Adaptive strategies	0.323**
	Access to finance	0.254*

Notes: *Significant at 0.05 level of probability (2-tailed); **Significant at 0.01 level of probability (2-tailed).

Secondly, training exposure had a positive association with the livelihoods of local people. The local residents received training from GOs and NGOs on climate-resilient livelihood strategies. Training experience greatly enhances a person's technical proficiency and practical understanding of climate-resilient activities. Those who have received sufficient training exposure may make effective use of the resources and preserve mangrove habitats, which improves living conditions in comparison to those who have not. Kabir et al. (2018) revealed that participatory forest management practices and hands-on training were effective for capacity development and brought positive impacts on the local livelihoods of Madhupur forest in Bangladesh. Furthermore, the local residents followed several adaptive strategies to cope with the vulnerability caused by natural disasters, which seemed to have positive impacts on local livelihoods. Among the adaptive strategies, the local people also incorporated non-cropping economic activities, for example indigenous chicken or goat rearing, small-scale dairy farming and home-based businesses involving tailoring, sewing and handicrafts, which acted as additional income sources and brought significant impacts on local livelihoods. Soriano et al. (2017) also revealed significant positive associations between income-generating adaptive strategies and livelihood conditions of forest households in the Bolivian Amazon. Additionally, the results align with the research on livelihood dependence on mangrove ecosystems by Mallick et al. (2021).

Finally, access to finance was reported to have a positive impact on livelihood conditions. Credit availability from formal institutions is a crucial factor in undertaking income-earning activities, especially in resource-limited conditions. Local people with access to institutional credit can undertake diverse economic activities as income-generating sources to improve the living standard of family members. According to Islam et al. (2020), the availability of financial capital had a positive correlation with the livelihoods of *Nypa fruticans* leaf collectors.

A stepwise multiple regression analysis was performed in order to gain a thorough knowledge of the individual contributions of the explanatory factors to the variations in the livelihood conditions of local people. Table 4 displays the results of the stepwise multiple regression.

Table 4. Results of multiple regression analysis (n = 70).

Model	Contributory variables	Multiple R	Multiple R ²	Change in R ²	Variation explained (%)	Significance level
Constant +X ₁₀	Adaptive strategies	0.323	0.104	0.104	10.4	0.01
Constant+X ₁₀ +X ₉	Training exposure	0.419	0.175	0.071	7.1	0.01
Constant+X ₁₀ +X ₉ +X ₁₁	Access to finance	0.476	0.226	0.051	5.1	0.05

According to Table 4, the model is composed of three determining variables: adaptive strategies, training exposure and access to finance. These three contributory variables ($R^2=0.226$) can explain 22.6% of the variation in the livelihood conditions of local people. The first of these contributing variables, farmers' adaptive strategies ($R^2=0.104$), contributed the most to the explanation of the focus variable (10.4%). Training exposure ($R^2=0.071$) was the second contributing factor, accounting for 7.1% of the variability, while access to finance ($R^2=0.051$) was responsible for 5.1% of the variation in the focal variable. The results of the stepwise multiple regression analysis made it clear that various adaptive strategies acted as a notable contributory factor in local livelihoods in the climate-vulnerable areas of the mangrove forest. Training experiences increased technical know-how and the level of understanding of the effectiveness of climate-resilient strategies for sustainable livelihoods in the locality. Finally, access to finance was crucial to enhance the capability of economically disadvantaged people to follow the climate-responsive practices at the household level. So, farmers having financial access were capable of utilizing their technical knowledge and practical skills together to implement the livelihood strategies at the household level. Additionally, these results are aligned with the empirical study on the *Nypa fruticans* leaf collection as a livelihood strategy in the Sundarbans (Islam et al., 2020) and on native date palm (*Phoenix sylvestris*) based agroforestry practice for livelihood improvement and biodiversity conservation (Rana et al., 2023).



3.5. Narrative Interpretation of the Focus Group Discussion (FGD)

In order to obtain a comprehensive understanding of local livelihoods and household vulnerabilities, we held a focus group discussion (FGD) with ten people in June 2026, including both male and female individuals. According to the participants, natural disasters occurred nearly annually, resulting in enormous and unavoidable losses to households and individuals. The villages were less accessible, and the residents lacked access to basic amenities, had limited economic prospects and had a weak social network, which made them particularly vulnerable. The participants stated that roads, schools, embankments, and clinics were damaged by regular cyclones and rising tidal surges. Due to poor infrastructure, the local families suffered from cyclonic storms, rising sea levels and creeping saline intrusion associated with climate change. It also resulted in the extinction of locally available fish species and a decrease in the availability of fresh drinking water. These risks caused dehydration, high blood pressure, newborn mortality, and other problems for aged individuals. A few people had the opportunity to receive training on climate-resilient livelihood strategies. Participatory training was reported to enhance their technical know-how and willingness to adopt climate-resilient practices. Several farming and non-farming strategies were identified from the focus group discussion based on the understanding of the respondents. One female participant said: “Besides regular household responsibilities, we used to cultivate seasonal vegetables (e.g. tomato, spinach, eggplant, gourd, green chili and country bean) on a small scale in the homestead or open space in the backyard, and to rear goats, indigenous chickens and ducks to provide safe and nutritious food for family members and a source of additional income. Due to the patriarchal society and traditional gender roles, we frequently faced several constraints, for example restricted social mobility and limited availability of useful resources and decision-making ability within the households.”

The poor and disadvantaged people, especially women, residing in the low-lying coastal region had limited access to land and other productive resources. The socio-psychological barriers and economic dependency limited their potential to participate in outdoor income-earning activities. Rana et al. (2025), who concentrated on farmers’ capacity-building in rural resource-poor areas, also discovered similar outcomes. Therefore, climate change had a disproportionate negative impact on the coastal population due to geographic location and poor socio-economic conditions. One male respondent stated: “On a small scale, we adopted salinity-tolerant rice cultivars, constructed water reservoirs to catch rainwater, installed deep tube wells for safe water, and planted fodder crops to raise livestock. Moreover, we were also involved in auto vehicle driving, small-scale business, and boat making and rowing for income generation, especially during the non-cropping seasons.”

Finally, through the discussion, the participants agreed that limited access to agricultural advisory services (e.g. technical information and input support), poor infrastructure and lack of economic ability limited their potential for wider adoption of climate-resilient livelihood practices.

4. Conclusion

This study investigated the livelihoods of the local population and the factors that contribute to the sustainable management of the mangrove forest in the coastal region. The results showed a high degree of reliance on the mangrove forest, with the majority of the local population (56%) relying on the accumulation of non-wood forest products (NWFPs) for their livelihood. This also indicates poor living conditions and a lack of income-earning opportunities for the majority of the respondents (52.86%), which leaves the households vulnerable to natural hazards. Several farming and non-farming adaptive strategies brought positive impacts on local livelihoods through income generation. Furthermore, the most important factors influencing the livelihood conditions were exposure to training, adaptive strategies, and financial accessibility. Based on the findings, the policy implications suggest paying attention to community-based training focusing on climate-responsive livelihood practices and equal access to assets and opportunities. Finally, to reduce the dependency on the mangrove forest, priority should be given to creating alternative income-generating sources for both men and women, and to the promotion of ecotourism to enhance economic growth in the locality. In the sampling frame, the major proportion of the household heads were male, which weakens the gender analysis of the study. Moreover, we did not take into account the cost-effectiveness of the livelihood strategies considering the poor socio-economic status of local people. Our next research agenda will focus on gender-disaggregated data and econometric analysis of the adaptive strategies in relation to the climate-vulnerable mangrove ecosystem.

Author Contributions

Md. Masud Rana: Conceptualization, Methodology, Formal Calculation, Software, Writing-reviewing & editing; Farzana Akter: Methodology, Investigation, Writing-reviewing & editing; Nirob Kumar Barmon: Resources, Investigation, and Data Curation.

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Declarations

Conflicts of Interest: The authors declare no conflict of interest.

Institutional/Ethical Approval: This study did not involve human or animal subjects and no institutional or ethical approval was required.

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