

Multiple Income-Generating Activities: A Way to Resilience for the Waterlog Community in Bangladesh

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Abstract: - Bangladesh's deltaic geography makes it highly subject to natural disasters, with the southwest region being especially vulnerable to cyclones, storm surges, waterlogging during the monsoon, and soil salinity during the dry season. Despite being primarily an agricultural country, frequent natural disasters have severely impacted crop production and biodiversity, making it difficult for small coastal farmers to earn a livelihood. This study sought to identify the various income-generating activities and effective strategies that could help the waterlogged community become more resilient to the challenges posed by climate change. A mixed method, including a household survey, field visit, in-depth interview, and key informant interview, was used to collect data based on the purposive sampling technique. The collected quantitative and qualitative data were analyzed using percentage measures and narrative processes, respectively, and interpreted in the socio-cultural context to give a specific form and basis to the study. The study revealed that marginal farmers in Malopara village are particularly vulnerable to biodiversity losses that threaten their lives and livelihoods. To address these challenges, the study also found multiple income-generating activities as a way of community-based adaptation. This approach would help reduce food insecurity and provide alternative sources of income for small farmers, who are most affected by the changing climate.

Key-Words: - Climate change, Waterlogging, Coastal farmers, Livelihood, Income generating activities, Resilience, Community-based adaption

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1 Introduction

Rural livelihoods are complex and dynamic, influenced by daily survival uncertainty. It involves individuals, households, or groups meeting consumption and economic necessities, coping with uncertainties, and responding to new opportunities.

Bangladesh, being highly susceptible to climate change, is recognized as one of the world's most climate-vulnerable nations. Its rural population, in particular, faces significant challenges due to the effects of climate change, such as floods and waterlogging, [1], [2]. Addressing the multifaceted

challenges faced by rural communities in Bangladesh is crucial for promoting sustainable livelihoods and resilience in the face of climate change impacts. The waterlogging community in Bangladesh, in particular the southwestern part, is affected by seasonal flooding and waterlogging, [3], [4], which often result in damage to crops, [5], loss of livestock, [6], and limited access to clean water and sanitation facilities, [7]. The prolonged waterlogging has resulted in the roots of trees rotting, fruit trees dying off, and vegetation dying off, [8]. Agriculture has been severely affected by this, and even homestead vegetation has been considerably reduced, [9], also making it hard to rear cattle, [10]. The calamity has had a cascading effect, destroying the ecosystem, [11], contaminating water resources, and damaging fragile human livelihoods, [12]. Thus, the symbiotic link between human culture and natural systems is being brought to our attention by climate change.

Moreover, Bangladesh is highly exposed to flooding, including riverine, flash, and coastal floods. Intensified severe rainfall, tropical cyclones, and related storm surges are anticipated to increase coastal, river, and flash floods, endangering people's lives as well as infrastructure and the economy, [13]. Temperature rises throughout the growing season, salt intrusion, increasing drought frequency, floods, and waterlogging might diminish yields in food production and agriculture, [13]. These challenges have negative impacts on the livelihoods and well-being of the waterlogging community, making them more vulnerable to poverty and other risks. Small-scale farmers suffer the most from the agricultural damage brought on by their vulnerability to natural disasters since they are completely dependent on farming for their lives and livelihoods. Further, dependence on rapidly reducing and depleting natural resources leads to environmental degradation.

The waterlogging problem in Bangladesh is one of the most significant challenges faced by the country's rural communities, [14]. In their study, [15], noted that substantial socio-economic and cultural problems result from the loss of coastal resources. The deterioration of society, discrimination, unemployment, and irreparable property destruction are some of these problems. Efforts to mitigate the impacts of waterlogging and restore the affected ecosystem are essential to safeguarding the long-term sustainability and resilience of both the environment and the livelihoods of the affected communities. The waterlogged community in Bangladesh has limited

access to resources and opportunities to earn an income. Due to the seasonal nature of agriculture and frequent flooding, many households struggle to meet their basic needs throughout the year. In addition, the lack of alternative livelihood options further exacerbates their vulnerability. In this context, this study aims to explore the potential of multiple income-generating activities that have emerged as a potential strategy to build the resilience of the waterlogging community in Bangladesh.

By diversifying their income sources, the waterlog community can reduce their dependence on agriculture and create new opportunities for income generation. This approach has been successful in other countries, [16], where multiple income-generating activities have been used to reduce poverty, increase household income, and improve livelihoods, [17]. Likewise, promoting income-generating activities can also contribute to gender empowerment by providing opportunities for women to participate in income-generating activities and increasing their decision-making power within households, [18]. Besides, it is believed that gender equality is one of the critical pillars of socioeconomic development. In addition, income-generating activities can promote sustainable development by reducing dependence on traditional agricultural practices and promoting more diversified livelihood options, [19]. Achieving sustainable livelihoods is the foundation of sustainable development. The findings of this study can inform policymakers and help them develop interventions aimed at upholding sustainable livelihoods and reducing poverty in the waterlogged community.

The researchers felt the inadequacy of livelihood adaptation strategic studies as there are many published articles available on different domains of knowledge, based on waterlogging and agriculture, and the application of indigenous knowledge on household-level disaster management. However, none of them have considered multiple income-generating activities as a driver to release from poverty and build resilience. Indicators of improvement in a waterlogged community in Bangladesh's Satkhira District included employment, a variety of sources of income, the restoration of household assets, an increase in total asset value, a reduction in the burden of debt, an increase in monthly income, as well as improvements to the infrastructure of the community, [20]. However, the ability of people and communities to cope with the negative impacts of hazards is referred to as resilience, [21]. In other

words, resilience is called a socio-ecological system, [22]. This study's findings would play a role in the well-being of the waterlogged community in the face of misery caused by waterlogging and adaptation strategies on the verge of climate change. An effective strategy to put resilience into practice on the ground would be to employ the idea of well-being. The concept of well-being is provided by establishing a portfolio of livelihood possibilities, using social memory, and increasing capacity for self-organization, which might be viewed as resilience building. Therefore, a resilience study is complemented by a well-being analysis, which sheds light on local livelihood realities.

2 Materials and Methods

2.1 Research Design

The study utilizes a mixed-method research approach, combining quantitative and qualitative methods to gain a comprehensive understanding of the study area. This approach allowed for a nuanced exploration of the experiences and perspectives of the local population during the flood period through qualitative data, [20], in Malopara village, while also incorporating quantitative data for analysis and comparison. This mixed-method research design strengthens the validity and reliability of the study's findings and ensures a more accurate representation of the complexities of the waterlogging issue and its resilience in the local community.

2.2 Study Area Selection

The researchers purposively selected Malopara village in Kumira Union, Tala Upazila, Satkhira District, Khulna, as the study area. The village was chosen due to its long history of waterlogging and vulnerability to various environmental challenges, [23], which significantly impact the livelihoods of the local population. This selection ensured that the research focused on a context relevant to the research objective.

2.3 Sampling Method

A purposive sampling technique was employed to select the participants for the study. The sample size consisted of 184 individuals, representing 16.7% of the total population of Malopara village. The researchers aimed to ensure a representative sample that captured the diversity of the community.

2.4 Data Collection Methods

To gather primary data, the researchers employed various methods during the study period in January 2017. These methods included

2.4.1 Household Surveys

Structured questionnaires were administered to a representative sample of households in Malopara village, collecting quantitative data from small-scale farmers who depend on agriculture for their livelihoods and have to cope with limited access to basic amenities like electricity, water, and sanitation on livelihood practices, access to amenities, and experiences during the flood period.

2.4.2 Field Visit

Researchers conducted field visits to observe the environmental conditions and gather contextual information about the village.

2.4.3 In-depth Interviews

Five respondents were purposively selected for in-depth interviews to gain detailed insights into their experiences, coping strategies, and perceptions related to the research.

2.4.4 Key Informant Interviews

Three key informants with expertise and familiarity with the local context were purposively selected for interviews. Their insights provided additional depth to the research findings.

2.5 Data Analysis

The collected data, both quantitative and qualitative, were analyzed and interpreted using appropriate methods. For quantitative data, simple statistical measures like percentages were calculated to analyze the household survey results. Qualitative data from interviews and field observations were analyzed descriptively, aiming to provide a detailed account and description of the results. The analysis focused on presenting the findings in a narrative format, capturing the richness and complexity of the participants' experiences, perspectives, and responses.

2.6 Ethical Considerations

The researchers ensured ethical considerations throughout the study by obtaining informed consent from participants, ensuring confidentiality and privacy, and following ethical guidelines for research involving human subjects. The researchers made an utmost effort to make proper analysis and interpretation of survey data, field observation, and

interviews for better conclusions in an objective manner.

3 Results

This section begins by providing an overview of the household conditions of the study participants, followed by an analysis of their socioeconomic vulnerability and livelihood strategies. The study then discusses the training and livelihood support provided to vulnerable communities and the benefits of water- and saline-tolerant trees and fruit trees. Additionally, the study explores sustainable agriculture practices in coastal areas and the engagement of women in income-generating activities.

3.1 Household Condition

Table 1. Household Condition

Household Condition of the families Suffered from waterlogging	Percentage (%)
Compelled to live in prolonged waterlogging for 6-9 Months	76%
Person with disability	3.7%
The family suffered from the elderly person	12.3%
Having children under 5 years	8%
	100

Source: Field Survey, 2017

Based on the survey data, it was discovered that 76 percent of the households surveyed experienced long-term waterlogging, which forced them to reside in waterlogged conditions for a duration of 6 to 9 months during the year 2017. Considerably above 3% of waterlogged households had disabled family members, which triggered more uncertainty about income issues because the families were not ensured with safe water supply, sanitation, shelter, food security, and employment opportunities as there were people with disabilities. The percentage of waterlogged families comprising elderly people was slightly above 12%, which indicates that those families were also vulnerable because they had unproductive manpower and had entered disengagement. 8% of the extremely poor waterlogged households had children less than 5 years old, and they needed to get support for the better future of their children (Table 1).

Prolonged waterlogging has a significant impact on the socio-economic condition of households. Long-term waterlogging causes health risks, loss of livelihoods, and displacement, impacting vulnerable groups such as children, older

people, and persons with disabilities. The households face food insecurity, inadequate shelter, and a lack of safe water and sanitation facilities, which worsen their already fragile socio-economic conditions. Economic pressures forced these people to live in cheap but dangerous areas (Field Visit, 2017).

3.2 Socio-Economic Vulnerability and Livelihood Strategies in Waterlogged Areas

Through a field survey, potential climate-resilient alternative livelihood activities are identified as a means to withstand the negative effects of climate change. The impact of waterlogging on communities is determined by the location of nearby rivers and the presence and effective use of canals, which serve as channels for water discharge within the area. The loss of biodiversity and the resulting decline in well-being are manifestations of these pains. According to this study, Tala Upazila experiences the most severe and persistent waterlogging issues. The powerful Kobadak River, known for its tidal waves in the 1970s and 1980s, has gradually weakened due to the accumulation of sediment in its riverbed and the significant flood that occurred in 2001-02, [24].

The people who live nearby are suffering greatly as a result of this river's utter death. As a result, when the area is submerged, biodiversity losses are worse. As a result, it can be anticipated that the socio-economic vulnerability in this region is a critical concern. Aman's season of production has shrunk; possible yields and returns from Boro have become reduced, with tenants particularly affected. However, the cropping and harvesting seasons of this area are shown in Table 2.

Table 2. Three main cropping and harvesting seasons of the coastal belt of Bangladesh

Cropping Season	Main agriculture-based livelihood/ Farming
Rabi (October-March)	Winter vegetables and fruits, fish/shrimp
Kharif 1 (March-July)	Summer vegetables and fruits, pulses, fish/shrimp
Kharif 2 (July-October)	Rice, summer vegetables and fruits, fish/shrimp

Source: Field Survey, 2017

The most vulnerable households in the studied area have very limited sources of income-generating activities, and a majority of them are described as dependent on day labor, which is only possible for 4-6 months of the year. They also do not have access to land or a special skill set for

alternative income generation (In-depth Interview, 2017).

The field visits findings indicate that the socio-economic situation of the residents in the villages of Kumira Union, located in Tala Upazila, is comparatively more favorable when compared to other waterlogged areas such as Monirampur and Kesabpur, where the duration of waterlogging lasts for eight to ten months. The utilization of saline water in shrimp fields eliminates the possibility of cultivating rice on the nearby land. Additionally, waterlogging restricts the opportunities for traditional agricultural-based household economies, such as raising livestock and cultivating vegetables, fruits, and timber trees. As a response to this hydro-meteorological hazard, people in the area adopt alternative income-generating activities to cope with the situation (Field Visit, 2017).

The data collected from the field survey reveals that the resilient people of this region have adjusted to the altered environmental conditions and integrated those changes into their ways of earning a living, effectively dealing with the challenges posed by waterlogging. The study found that, within the total number of respondents of 184, 62 reared cows, 40 made nets, 22 started mat businesses, 14 cultured fish, 10 reared goats, 8 were repairing and making boats, 6 ran tailoring, 6 reared ducks and hens, 2 cultivated Beatle Leaf, 2 started cloth business, and 2 started grocery business. A total of 10 beneficiaries were doing multiple income-generating activities (IGAs) with the utilization of different NGOs and government support (Field Survey, 2017).

Shrimp cultivation dominated the majority of the land in the waterlogged area. In this regard, the author reveals that, while water logging reduces the number of native fish species in this community, it has little to no influence on significant commercial fish farming. Also, the market is accessible, and these cultivators needed to be linked with the international market for resilience (Field Visit, 2017).

3.3 Training and Livelihood Support for Vulnerable Communities

Underserved and vulnerable communities in the areas could not start any entrepreneurship due to a lack of proper knowledge, training, and capital formation. The respondents of the research are the beneficiaries of different national and international NGOs who received cash grants for livelihood and homestead gardening support. Among them, almost three-fifths (58.08%) of the sample respondents informed that they have benefited from livelihood

training, while over two-fifths 41.92% said they attended training to generate livelihood, which has slightly released their misery compared to depending on monsoon agriculture production (Field Survey, 2017).

After Cyclone SIDR and AILA, some donors and NGOs carried out recovery projects, most of which are almost phased out as of 2017. However, the poverty situation has deteriorated due to the long-term impact of salinity and shrimp cultivation and global warming. Some Micro Finance Institutes (MFIs) such as BRAC, SAPLAFHUL, and CARITAS were operating microfinance programs, while very few organizations (i.e. CODEC, Solidarities International, Muslim Aid, Islamic Relief) were providing integrated support on climate change, disaster risk reduction, and livelihoods for limited households and communities in adjacent areas. As of 2013, government departments or international agencies have not initiated projects related to climate change adaptation, [25].

3.4 Benefits of Water- and Saline-Tolerant Trees and Fruit Trees

Unused and under-utilized land in the homesteads and surrounding areas of the coastal region holds the potential for the cultivation of water- and saline-tolerant trees, as well as fruit trees, offering various benefits to the local farmers. By planting saline-tolerant varieties such as Tamarind, Coconut palm, Keora, and Gewa, etc, farmers can make productive use of land that would otherwise remain unutilized, thereby augmenting their incomes. Additionally, fruit trees have the advantage of providing additional household income within a relatively short period of time. Moreover, the cultivation of fruit trees can yield large quantities of fruits, which can be consumed or sold, thereby generating income for poverty-stricken families (Field Visit, 2017).

To ensure favorable plant growth, it is crucial to maintain an optimum balance of water, air, and salt in the root zone. This balance can be achieved by implementing effective drainage systems. Conventional drainage solutions, such as surface, subsurface, or vertical drainage, have been made to address issues of waterlogging and salinity. These drainage systems facilitate the removal of excess water and salts from the root zone, creating a suitable environment for plant growth. However, it is important to note that these conventional drainage methods come with certain drawbacks. They often involve high construction and maintenance costs, which can be a barrier for

resource-constrained farmers. Additionally, the disposal of drainage effluent during and after the restoration process can pose environmental concerns (Key Informant Interview, 2017).

3.5 Sustainable Agriculture Practices in Coastal Areas

Waterlogging inhibits the growth of all types of trees, with the exception of a few salinity-tolerant species. Farmers are forced to sell their harvest at low prices and buy rice at a relatively higher price, as they have access to food grains at a fair price. Waterlogging, therefore, has a significant effect on the quality of life for those living in the investigated areas. However, local people implemented the sag bag technique to grow and cultivate eco-friendly vegetables, as the technique uses fresh water to reduce the salinity of groundwater. It can meet the demand for family nutrition and is also economically attractive as it necessitates only an initial investment for vegetation planting. Once established, the system has the potential to generate economic returns. They mainly produce basil, balsam, bottle guard, pumpkin, sponge guard, bindweed, radish, tomato, spinach, kohlrabi, and beans. These vegetables are eco-friendly on the dyke. Using marginal land, homesteading, and vertical gardening brings hope. A remarkable number of households sold vegetables alongside their consumption, which amounts to between BDT 500 and BDT 800 on average weekly (In-depth Interview, 2017).

3.6 Women Engagement

In addition to agriculture, women are engaged in a variety of activities such as livestock rearing, poultry farming, fish farming in Gher, and handicrafts. This diversification of income streams has helped to reduce their dependency on a single source of income and has enabled them to cope with various economic shocks. Furthermore, the engagement of women in income-generating activities has had a positive impact on their social status and decision-making power within the household. This has led to improved nutrition and healthcare for themselves and their families. It is crucial to incorporate women in climate change management and to create a strategy that takes gender into account. It has been observed that women play a major role, especially during and after a disaster (Field Visit, 2017).

4 Discussion

The study highlights the challenges faced by waterlogged communities and explores the potential of multiple income-generating activities to improve their resilience. Exploring diverse livelihoods might assist those who use resources in participating in wetland resource restoration without facing livelihood deprivation, [26]. Because, wetland communities are highly vulnerable to livelihood, [27], [28]. The study identifies household conditions, socio-economic vulnerability, and limited livelihood strategies as key factors contributing to the vulnerability of these communities. To address these challenges, the study recommends training and livelihood support for vulnerable communities, particularly women, sustainable agricultural practices, as well as the use of water- and saline-tolerant trees and fruit trees to generate income.

By promoting multiple income-generating activities, the study recommends a holistic approach to resilience-building that addresses the economic, social, and environmental dimensions of vulnerability. The emphasis on initiatives aimed at enhancing resilience at the household and community levels brings attention to livelihood concerns, [29]. A community that is disaster-resilient is the safest one that is feasible and where people have the required knowledge to grow and construct in a natural-hazard environment, [30]. The insights obtained from this study can contribute to the formulation of policies and programs aimed at enhancing the livelihoods and well-being of waterlogged communities in Bangladesh and other low-lying areas vulnerable to flooding and waterlogging. Policies and programs should focus on extending households' adaptation capacity to promote equitable and sustainable livelihoods, [31].

5 Conclusion

The study findings indicate that the water-logged community in Bangladesh can achieve resilience through multiple income-generating activities. By adopting entrepreneurial and adaptive livelihood strategies, they can find sustainable paths for income generation and improve their standard of living. However, this requires the development of absorptive, adaptive, and transformative knowledge, skills, and capacities to reduce their exposure to climate hazards. While the study provides valuable insights into the resilience of the water-logged community, it is limited by its scope,

and the lack of in-depth analysis of specific factors that influence resilience such as socio-economic dynamics, cultural factors, governance structures, and access to resources could have enhanced the understanding of resilience in the water-logged community.

The study does not explore the influence of external factors on the resilience of the water-logged community. Factors such as policy frameworks, international aid, and global economic trends could play a significant role in shaping resilience outcomes, and their omission limits the study's scope. The study focuses specifically on the water-logged community in Bangladesh, and its findings may not be directly applicable to other communities or regions facing different environmental challenges. The unique context of the community studied limits the generalizability of the findings to broader populations. To address these limitations and enhance future research on resilience in water-logged communities, engaging in participatory research methodologies can be suggested, which would foster a deeper understanding of the community's needs and aspirations.

However, in the past, it has been highlighted that the adaptation measures taken by community members were temporary and insufficient to improve livelihoods in the face of recurrent waterlogging, [32]. Additionally, households or communities with limited adaptive capacity are not necessarily the most vulnerable, as their lower sensitivity and/or exposure levels may contribute to this. Agricultural and fishing communities, for instance, exhibit varying levels of sensitivity and adaptive capacity, resulting in differing degrees of vulnerability.

It is therefore important to strengthen institutional capacities for climate change adaptation and resilience and invest in climate-resilient livelihoods and adaptation decision-making processes. Government and NGOs must also collaborate to develop and monitor household livelihood portfolios and enforce risk management strategies to secure and strengthen livelihood planning. The participation of women, men, and youth in livelihood portfolios can build absorptive and adaptive resilience capacities, including liquid assets that can be easily converted to cash if needed. Moreover, a greater comprehension of the relationships between social, economic, and environmental factors is necessary to resolve the connected problems of waterlogged areas and to achieve the sustainable development goals of the United Nations. Finally, creating opportunities for

livelihood transformation based on successful evidence is crucial to achieving long-term resilience.

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References:

- [1] Huq, N., Hugé, J., Boon, E., & Gain, A. K. (2015). Climate Change Impacts in Agricultural Communities in Rural Areas of Coastal Bangladesh: A Tale of Many Stories. *Sustainability*, 7 (7), 8437-8460, doi: 10.3390/su7078437.
- [2] Khan, Md. A. (2022). Livelihood, WASH related hardships and needs assessment of climate migrants: Evidence from urban slums in Bangladesh. *Heliyon*, 8(5), e09355, DOI: 10.1016/j.heliyon.2022.e09355.
- [3] Awal, M. A. (2014). Water logging in southwestern coastal region of Bangladesh: Local adaptation and policy options. *Science Postprint*, 1 (1), 1-13, DOI: 10.14340/spp.2014.12A0001.
- [4] Payton, R. W., Barr, J. J. F., Martin, A., Sillitoe, P., Deckers, J. F., Gowing, J. W., Hatibu, N., Naseem, S. B., Tenywa, M., & Zuberi, M. I. (2003). Contrasting approaches to integrating indigenous knowledge about soils and scientific soil survey in East Africa and Bangladesh. *Geoderma*, 111(3), p.355–386, DOI: 10.1016/S0016-7061(02)00272-0.
- [5] Rahman, M. M., Chakraborty, T. K., Al Mamun, A., & Kiaya, V. (2023). Land-and Water-Based Adaptive Farming Practices to Cope with Waterlogging in Variably Elevated Homesteads. *Sustainability*, 15 (3), 2087, DOI: 10.3390/su15032087.
- [6] Hasan, I. (2017). Coastal Livelihood Vulnerability to Climate Change: A Case Study of Char Montaz in Patuakhali District of Bangladesh. *American Journal of Modern Energy*, 3, p.58–64, DOI: 10.11648/j.ajme.20170304.11.
- [7] Haque, A., Rahman, M. H., & Rahman, D. (2019). An Evaluation of Sea Level Rise Vulnerability and Resilience Strategy to Climate Change in the Coastline of

- Bangladesh. *International Journal of Environmental Sciences & Natural Resources*, 18 (2), p.56-70, DOI: 10.19080/IJESNR.2019.18.555983.
- [8] Gazi, H., & Moniruzzaman, S. M. (2022). Impact of water logging on agriculture and food security: A case study in Satkhira, Bangladesh. *International Journal of Surface and Groundwater Management*, 1 (1), p.29-32.
- [9] Shepherd, K. D., & Soule, M. J. (1998). Soil fertility management in west Kenya: Dynamic simulation of productivity, profitability and sustainability at different resource endowment levels. *Agriculture, Ecosystems & Environment*, 71 (1), p.131–145, doi: 10.1016/S0167-8809(98)00136-4.
- [10] Swapan, M. S. H., & Gavin, M. (2011). A desert in the delta: Participatory assessment of changing livelihoods induced by commercial shrimp farming in Southwest Bangladesh. *Ocean & Coastal Management*, 54(1), p.45–54, doi: 10.1016/j.ocecoaman.2010.10.011.
- [11] Islam, M. R., & Shamsuddoha, M. (2017). Socioeconomic consequences of climate induced human displacement and migration in Bangladesh. *International Sociology*, 32 (3), p.277–298, doi: 10.1177/0268580917693173.
- [12] Tse-Ring, K., Sharma, E., Chettri, N., & Shrestha, A. B. (2010). Climate change vulnerability of mountain ecosystems in the Eastern Himalayas. International centre for integrated mountain development (ICIMOD).
- [13] World Bank Group, (2021). Climate Risk Country Profile: Bangladesh. https://climateknowledgeportal.worldbank.org/sites/default/files/country-profiles/15502-WB_Bangladesh%20Country%20Profile-WEB.pdf.
- [14] Anik, S. I., & Khan, M. A. S. A. (2012). Climate change adaptation through local knowledge in the north eastern region of Bangladesh. *Mitigation and Adaptation Strategies for Global Change*, 17 (8), p.879–896, doi: 10.1007/s11027-011-9350-6.
- [15] Rahman, M. A., & Rahman, S. (2015). Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh. *Weather and Climate Extremes*, 7, p.84-95, doi: 10.1016/j.wace.2014.12.004.
- [16] Zezza, A., Carletto, G., Davis, B., Stamoulis, K., & Winters, P. (2009). Rural Income Generating Activities: Whatever Happened to the Institutional Vacuum? Evidence from Ghana, Guatemala, Nicaragua and Vietnam. *World Development*, 37(7), p.1297–1306, doi: 10.1016/j.worlddev.2008.11.004.
- [17] Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quiñones, E. J., Zezza, A., Stamoulis, K., Azzarri, C., & DiGiuseppe, S. (2010). A Cross-Country Comparison of Rural Income Generating Activities. *World Development*, 38(1), p.48–63, DOI: 10.1016/j.worlddev.2009.01.003.
- [18] Montanari, B., & Bergh, S. I. (2019). A Gendered Analysis of the Income Generating Activities under the Green Morocco Plan: Who Profits? *Human Ecology*, 47(3), p.409–417, doi: 10.1007/s10745-019-00086-8.
- [19] Wang, J., Jiang, H., & He, Y. (2023). Determinants of Smallholder Farmers' Income-Generating Activities in Rubber Monoculture Dominated Region Based on Sustainable Livelihood Framework. *Land*, 12 (2), 281, doi: 10.3390/land12020281.
- [20] Gros, C., Bailey, M., Schwager, S., Hassan, A., Zingg, R., Uddin, M. M., Shahjahan, M., Islam, H., Lux, S., Jaime, C., & Coughlan de Perez, E. (2019). Household-level effects of providing forecast-based cash in anticipation of extreme weather events: Quasi-experimental evidence from humanitarian interventions in the 2017 floods in Bangladesh. *International Journal of Disaster Risk Reduction*, 41, 101275, DOI: 10.1016/J.IJDRR.2019.101275.
- [21] Ray-Bennett, N. S., Masys, A., Shiroshita, H., & Jackson, P. (2015). Reactive to Proactive to Reflective Disaster Responses. In *Hazards, Risks, and Disasters in Society* (pp. 99–117). Elsevier, doi: 10.1016/B978-0-12-396451-9.00007-X.
- [22] Djalante, R., & Thomalla, F. (2010). Community Resilience To Natural Hazards And Climate Change Impacts: A Review Of Definitions And Operational Frameworks. *Asian Journal of Environment and Disaster Management (AJEDM) - Focusing on Pro-Active Risk Reduction in Asia*, 03, DOI: 10.3850/S1793924011000952.
- [23] Alam, Md. S., Sasaki, N., & Datta, A. (2017). Waterlogging, crop damage and adaptation interventions in the coastal

region of Bangladesh: A perception analysis of local people. *Environmental Development*, 23, p.22–32, doi: 10.1016/j.envdev.2017.02.009.

- [24] Al Masud, M. M., Moni, N. N., & Azad, A. K. (2014). Impacts of water logging on biodiversity—study on south-western region of Bangladesh. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSRJESTFT)*, 8 (9), p.20-27.
- [25] IRB, (2013). Enhancing Climate Change Adaptation and Disaster Resilience in Bangladesh project (Project proposal). Islamic Relief Bangladesh, Dhaka 1212 Bangladesh.
- [26] Rahman, Md. M., & Begum, A. (2011). Implication of livelihood diversification on wetland resources conservation: A case from Bangladesh. *Journal of Wetlands Ecology*, 5, p.59–63, doi: 10.3126/jowe.v5i0.4905.
- [27] Choudhury, M.-U.-I., & Haque, C. E. (2016). “We are more scared of the power elites than the floods”: Adaptive capacity and resilience of wetland community to flash flood disasters in Bangladesh. *International Journal of Disaster Risk Reduction*, 19, p.145–158, DOI: 10.1016/j.ijdr.2016.08.004.
- [28] Kamal, A. S. M. M., Shamsudduha, M., Ahmed, B., Hassan, S. M. K., Islam, Md. S., Kelman, I., & Fordham, M. (2018). Resilience to flash floods in wetland communities of northeastern Bangladesh. *International Journal of Disaster Risk Reduction*, 31, p.478–488, DOI: 10.1016/j.ijdr.2018.06.011.
- [29] Marschke, M. J., & Berkes, F. (2006). Exploring Strategies that Build Livelihood Resilience: A Case from Cambodia. *Ecology and Society*, 11(1), art42, doi: 10.5751/ES-01730-110142.
- [30] Geis, D. E. (2000). By design: The disaster resistant and quality-of-life community. *Natural Hazards Review*, 1 (3), p.151-160.
- [31] Hoque, S. F., Quinn, C., & Sallu, S. (2018). Differential livelihood adaptation to social-ecological change in coastal Bangladesh. *Regional Environmental Change*, 18 (2), p.451–463, DOI: 10.1007/s10113-017-1213-6.
- [32] Islam, E., Khan, S. A., Khaleque, M. A., & Ahammed, S. S. (2020). Waterlogging in the Southwest Coastal Areas of Bangladesh:

Local Adaptation Techniques and Challenges. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, 68 (1), p.112-119.

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