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Research article

RESILIENCE TO NATURAL DISASTERS: A CASE STUDY ON SOUTHWESTERN REGION OF COASTAL BANGLADESH

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Abstract: Bangladesh is one the disaster-prone countries in the world and has been suffering from different negative impacts. However, over the years, the coastal communities have developed their resilience capacity. This research assessed the local peoples' resilience against natural disasters at Kazirchar village in Muladi Upazila of Barishal district of the coastal region. In this study, an extensive literature review on disaster resilience, well-structured questionnaire survey, and focus group discussions were conducted to collect primary data. Most of the indicators show low values for socioeconomic resilience. The index value of literacy rate (1.12), primary health care facility (1.25), food consumption (1.30) and income (1.30) showed low disaster resilience. The result from the survey area implies a low level of institutional resilience (1.75). The reason behind low institutional resilience was weak disaster management activities. The index value of training (1.42), school/college (1.92), public awareness programme (2.14), and coordination (1) showed medium to very low of disaster resilience index. Results also showed that the villagers have low physical resilience. From the survey, electricity supply (1.08), dependency on rainfall (1.08), cyclone and flood warning system (2.10), water bodies (1.56) and housing pattern (2.94) were the physical indicators of this village and showed medium to low disaster resilience index. The overall disaster resilience score ranges from 1 to 2.94. Depending on the score, disaster resilience level was divided into five categories from high (3>2.5), medium (2.5>2), low (2>1.5) to very low (1.5>1.0). Based on the resilience index, the overall disaster resilience of Kazirchar village was low because of its low socio- economic (1.67), institutional (1.75) and physical (1.68) resilience values. The findings of this study will help to take necessary actions for building a more disaster resilient coastal Bangladesh.

Keywords: Natural disasters, Resilience, Coastal areas, Bangladesh.

1. Introduction

Bangladesh is considered one of the most climate-vulnerable and disaster-prone countries in the world (Ahmed et al., 2016; Rakib et al., 2019). Particularly, the coastal plains of Bangladesh are extremely prone to natural disasters. The country faces natural disaster at least once a year. The frequency, unpredictability, uncertainties of livelihoods, location and pattern of settlements associated with climatic events often make people more vulnerable. Such vulnerabilities have negative impacts on socio-economic and ecological aspects of coastal life (Uddin and Haque, 2012). Historically, between 1877 and 2009, a total of 159 cyclones including 48 severe cyclonic storms, 43 cyclonic storms, and 68 tropical depressions hit people in the coastal areas of Bangladesh (Rakib et al., 2019; Sultana and Mallick, 2015). Other hydro-meteorological coastal disasters, including storm surges, waterlogging, and salinity intrusion in the soil are also increased in this region. Climate change could be added to the number, intensity, and extent of disasters with more extreme weather events that may result in change in coastal people's lifestyle and routine work with the increasing chance of being vulnerable due to other social and situational factors (UNISDR, 2008; Rakib et al., 2019). In the coastal areas, on an average, poor households experience 7% of the asset losses, however, 42% of the welfare losses due to natural disasters (Verschuur et al., 2020). Three main coastal regions of Bangladesh (Chittagong coast, Khulna Coast, Barishal Coast) are commonly affected by cyclones. Throughout the century around half a million deaths cause because of at least 44 severe cyclonic storms that made landfall on Bangladesh coast. Among all these, the Killer November Cyclone of 1970 alone caused 300,000 deaths and affected 4.7 million officially. The Great Backerganj cyclone of 1876 killed approximately 200,000 people while the cyclone crossed the coast of Backerganj (present Barishal) near Meghna estuary. The 1991 cyclone in Bangladesh is considered as the worst killer Cyclone in human history that killed 138,882 people and injured another 139,054 (Hossain and Mullick, 2020; Mallick and Rahman, 2013). Cyclone *Sidr* was an extreme weather event with immense repercussions on humans and coastal plains in Bangladesh, taking 3,406 lives, and damaged crops and infrastructure significantly across 30 districts, 200 upazilas and 1,950 unions (Uddin and Haque, 2012). On 27-29 May of 2009, a severe cyclone *Aila* attacked offshore 15 districts of the southwestern part of Bangladesh with wind speeds up to 120 km/hour and about 150 persons killed and cultivated land and crops lost. The aftermath impact of natural disaster lasts long (Rahman, 2019). Two consecutive cyclones, "Sidr" and "Aila," brought noteworthy changes in the living pattern of affected areas. People are struggling to go back to their previous quality of life prior to *Sidr* and *Aila*. Dams were damaged and sea saline water came to the agricultural lands easily. Salinity in the water has increased which has affected the production of crops and agricultural lands are not suitable for growing crops anymore (Kabir et al., 2016). However, local affected people have been increasing their resilience capacity against natural disasters. In this study, we assess the resilience of affected local communities against different natural disasters.

Concept of Resilience

Nowadays the term 'Resilience' is widely used by natural disaster researchers, policy makers, government and non-governmental organizations which can be identified as abilities as well as capacities, along with skills and knowledge to deal with adversities. Resilience is comprised of capacities to absorb stress or destructive forces through resistance or adaptation; capacities to operate or maintain certain basic functions during disastrous events; and capacities to recover from destructions or 'build back better' after any disaster (Chowdhooree, 2019). In other words, resilience can be defined as '*The ability of groups or communities to cope with, [and adapt to], external stresses and disturbances as a result of social, political, and*

environmental change' (Adger, 2000). In simple words, resilience is defined as the ability of households or communities to effectively cope with and adapt to the riverbank erosions and other climatic hazards in such a way that helps to minimalize the loss of life and economic assets (Alam et al., 2018).

The term resilience is used in different research papers to define various kinds of resilience. In the case of disaster resilience, there is no solid definition which describes disaster resilience though disaster resilience means the capacity of hazard-affected bodies to resist loss during disaster and to regenerate and recognize after disaster in a specific area in a given period (Habiba et al., 2011; Zhou et al., 2010). Community resilience attributes function interactively rather than independently (Uddin et al., 2020). Several studies found that disaster preparedness and resilience of the coastal people are average or below average (Rahman and Li, 2018). Char-the island- dwellers have a poor level of resilience due to access to food, income and health facilities, agricultural and non-agricultural assets, and adoption of technology which made them unable to withstand against any adverse effect of natural disasters (Sarker et al., 2020a). Moreover, resilience capacity among the disaster affected communities in the vulnerable char areas fails to manage the harmful and adverse impact of natural disasters on the social system (Sarker et al., 2020b). Resilience attributes that were deeply embedded in community characteristics assisted in ameliorating immediate impacts as well as in building future adaptive capacities (Ahmed et al., 2016). A welfare-orientated perspective like 'leaving no-one behind' helps to identify adaptation options that enhance resilience (Verschuur, 2020). Besides, women engagement at the local operational level of disaster management, capacity building program through activating local government, NGOs intervention and public-private partnership, disaster policies, infrastructural developments and coastal plantation might be a possible solution to enhance the resilience of the char dwellers across Bangladesh (Sarker et al., 2020a; Islam et al., 2017; Uddin and Haque, 2012). Therefore, context-specific disaster management policies and effective monitoring systems should be developed to improve resilience.

Disaster resilience

The word resilience comes from the Latin word 'resilio' which means "to spring back" (Klein et al., 2003). Resilience was first used to social systems research (Adger, 1997) and linked human–environment systems (Holling, 1973;Carpenter et al., 2001). According to the fourth assessment report of IPCC, "*Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change*". Disaster resilience refers to a hazard-affected area's ability to withstand loss during a disaster and to regenerate and adapt after a disaster in a particular time frame (Zhou et al., 2010). Disaster resilience research necessitates the integration of socioeconomic and physical data from multiple sites within a certain geographic area (Shahid and Behrawan, 2008). Furthermore, social, institutional, cultural, religious, economic, environmental, hydrologic, topographical, educational, and political aspects all have a role in the development of a useful disasters' resilience index (Viljoen et al., 2001).

Past research on disaster resilience in Bangladesh

As a disaster-prone country, there were some studies conducted in disaster resilience in Bangladesh (Table 1). Buildings, cities, women, community-based resilience, policies needed to foster disaster resilience were the different dimensions of resilience covered in previous

studies. The keywords of the published articles mainly clustered in three groups (Figure 1) whereas the researchers changed their focus on resilience research in Bangladesh over the time (Figure 2). For instance, in recent times, community resilience, adaptative disaster management, livelihood are the major areas of investigation.

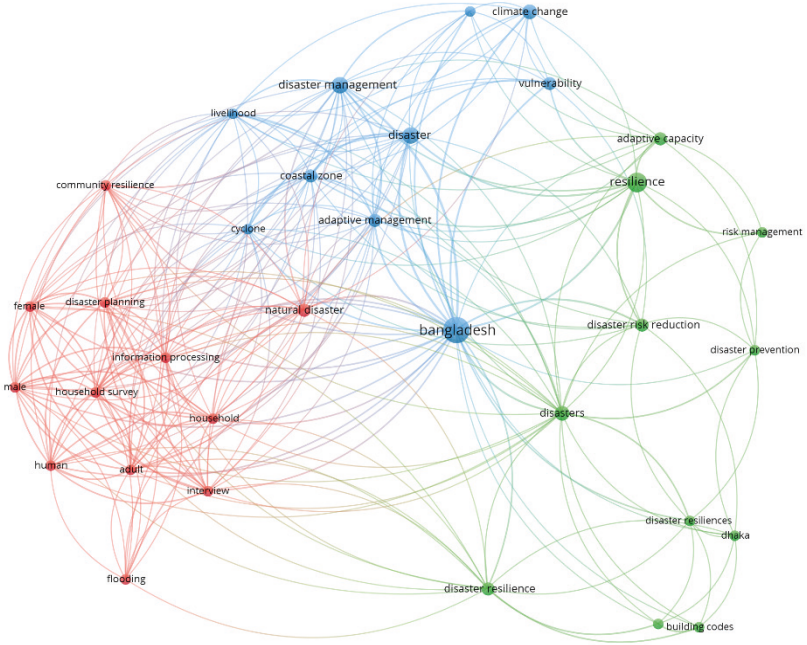

Figure 1: Cluster of co-occurrences of keywords related to disaster resilience research in Bangladesh

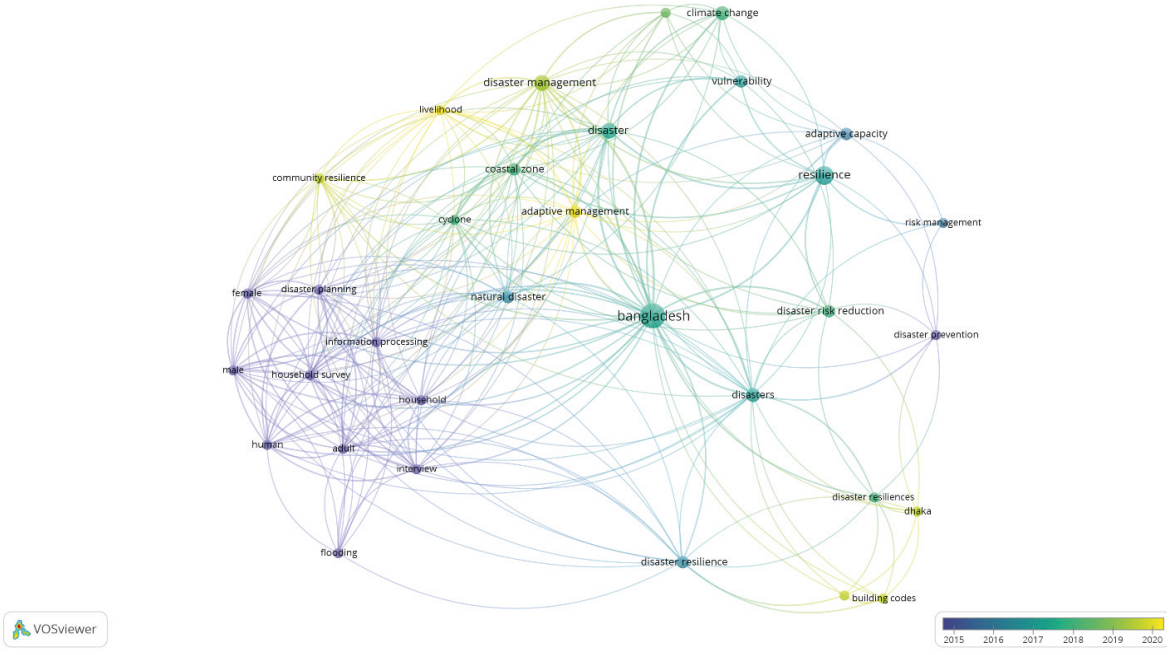

Figure 2: Network of co-occurrences of keywords related to disaster resilience research in Bangladesh over the years

Table 1: Summary of past research on disaster resilience in Bangladesh

Sector	Method used	Major findings	Recommendations	Source
Building	Documented and analysed the views of relevant stakeholders through qualitative approach	1) Lack of compliance 2) Unawareness about Bangladesh National Building Code 3) Reluctant to follow regulations and codes 4) No incentives for following codes 5) Limitations of enforcement	1) Capacity building 2) Incorporation of knowledge on regulations and codes for disaster resilience 3) Capacity building of built environment professionals 4) Awareness raising through training, media, and public events	Ahmed and Kabir, 2021
	Log-frame approach	1) Reason behind of compliance lacking: a) Socio – economic b) Political c) Cultural conditions 2) Evidence-based knowledge is a critical component	1) Raising awareness among communities on effectiveness and barriers to enforcing building codes	Ahmed et al., 2018
Resilience policies	1) Novel welfare loss modelling framework 2) High-resolution spatial analysis 3) Comparison of various adaptation options	1) Poor households experience, on average, 7% asset losses, but 42% welfare losses 2) Combining dike heightening, post-disaster support and stronger housing can reduce welfare losses up to 70%, and foster sustainable development by benefitting the poor, increasing resilience, and demonstrating robustness under socio-economic and climatic uncertainties.	1) Welfare-orientated perspective 2) Leave no-one behind	Verschuur et al., 2020
	Systematic review of policies and strategies and institutional settings	1) National and local level institutions are already grappling 2) Limited institutional capacity in mainstreaming climate smart risk reduction strategies		Hussain and Huq, 2013

Community	Participatory research methods: household survey, focus group discussions, key informant interviews, and case studies	1) Traditional-informal and quasi-formal institutions play vital role for rapid recovery 2) Resilience attributes ameliorating immediate impacts and building future adaptive capacities 3) Community resilience attributes and their functionality depends on their economic base, occupations, and their respective contexts of vulnerability. 4) Community resilience attributes function interactively rather than independently.	Community attributes require a clear understanding of network functioning, and the processes that drive institutional structures, relations, and outcomes.	Uddin et al., 2020
	Economic model of production, and in-depth interviews	1) Local communities are almost entirely reliant on self-generated social capital 2) Resourcing is necessary to better plan, response, and recovery	1) Emphasis on disaster prevention activities 2)Further need of integrated response	Islam et al., 2017
	Focus group discussions, and household surveys	1) Engagement with hazard-resilient and vulnerability-reducing livelihood activities 2) achieved resilience characteristics, better managing their available resources. 3) DRR based on Sustainable Livelihood approach has positive results		Ahmed et al., 2016
	"Dominant-less dominant" research methodological framework: i) household survey, ii) semi-structured questionnaire survey, iii) oral history interviews, and iv) key informant interviews	1) wetland communities are highly vulnerable to flash flood 2) Vulnerability occurs due to asymmetrical social power structure 3) reactive recovery measures result in maladaptation and passive towards risk mitigation 4) transformative patterns showed modified or changed behavior of community to achieve sustainability	1) Designing development interventions to enhance adaptive capacity 2) Emphasis on diverse range of skills and educational development	Choudhury and Haque, 2016

Livelihood	Resilience Index Measurement and Analysis (RIMA) model	1) Char dwellers have a poor level of resilience 2) Char dwellers residing near to the mainland area relatively more resilient than the distant char areas.	1) Access to food, income and health facilities, agricultural and non-agricultural assets, and adoption of technology which need to be improved for their survival. 2) Capacity building program through activating local administration, NGOs intervention and public-private partnership	Sarker et al., 2020
	1) Sustainability Livelihood Approach (SLA) Model 2) Survey	1) Disaster preparedness and resilience are average or below average 2) Institutional framework and policies, plans, programs are comprehensive and capable of achieving targeted goals and objectives. 3) Lack of proper integration and coordination 4) Scarcity of resources, 5) Lack of transparency and accountability		Rahman and Li, 2018
Administrative	Qualitative and quantitative approaches	1) Most of the char dwellers are not aware of their rights 2) Char dwellers suffers from basic public services 3) Poor administrative system to respond to adverse effects of natural disasters 4) Poor administrative resilience	1) Context-specific disaster management policies and effective monitoring systems should be developed 2) Improvement of administrative response in the geographically isolated areas	Sarker et al., 2020
Governance	qualitative method i.e., Case Study approach & Participatory Rural Appraisal toolbox	1) Good governance, financial and technical capacity and autonomy and cross-scale institutional linkages are necessary for successful local-level disaster management	1) Policy and research attention require a closer examination 2) Dynamics of local-level institutions 3) Integration of 'governance' and 'resilience' research streams	Choudhury et al., 2019
Coastal resilience	Qualitative case study	1) Livelihoods, location, and pattern of settlements are important for indicating vulnerability 2) Better preparedness and improved early warning systems can save lives	1) Cyclone preparedness still needs improvement 2) Strengthening of people's adaptive capacity	Uddin and Haque, 2012
		1) Limiting factors: a) bio-physical b) socio –economic c) technological d) institutional		Saroar, 2018

Urban environment	Urban Disaster Resilience Index (UDRI) model	1) Utility services and environmental conditions are each playing a role in determining the resilience 2) Urban Disaster Resilience Index is lower than physical and social resilience and higher than whereas natural and institutional resilience 3) Improving infrastructure alone cannot ensure disaster resilience	1) Holistic and continuous approach is required	Kabir et al., 2018
Women/Gender	In-depth interviews	1) Two million people were affected in the floodplains and low-lying areas in Sirajgang in 2012 2) Seven hundred and fifty families were made homeless 3) Unemployment	1) Women engagement in local operational level	Islam et al., 2017
Health security	Informal interviews, field diaries, and observation	Understanding health security reduce the effects of disasters	Improve of health security for poorer households in general and women	Ray-Bennett et al., 2016
	Household surveys, interviews, and focus group discussions	Coping strategies and agentive capabilities vary from one micro-context to the next.	Need a dynamic and integrative resilience approach	Ray-Bennett et al., 2010

Methodology

Sampling procedure

Purposefully, the study region was chosen in Barishal district, which is one of the most vulnerable districts to natural disasters. One Union Parishad named Kazirchar Union Parishad, and the Kazirchar village were purposefully chosen. We chose 50 households systematically from the village's approximately 300 households. Households were sampled from two different locations based on their proximity to the river and char areas. In this study, 30 of

the 50 households were from the Char area, and the remaining 20 were from the riverside (Figure 3).

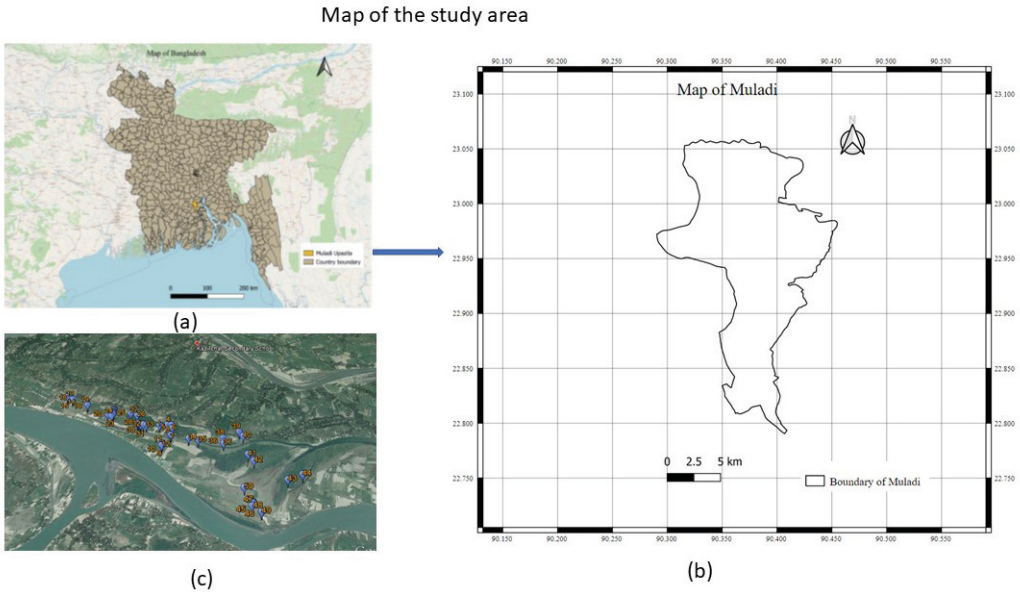

Figure 3: Geo-location of surveyed households in Kazirchar village, Muladi Upazila, Barishal

Collection of primary data

For the purpose of collecting data from each household, a well-structured semi-questionnaire was prepared. A pilot survey was conducted with 10 households in the study area to test the survey design and procedure. After testing this survey, we modified some questions and improved our surveying technique. We also made a number of changes to the interview schedule, including revisions to the wording of some questions, adjusting the survey's time, identifying unclear or ambiguous questions, and evaluating the appropriateness of response options. The final questionnaire had three sections such as respondents' socio-economic resilience, institutional resilience, and physical resilience. Monthly average income, respondents' educational status, household type, job status, disaster perception, disaster adaption measures, shelter, and portable water protection, livelihood, agriculture, and other topics were gathered through interviews with respondents using this questionnaire. Key informants, such as school teachers, and religious and political leaders, double-checked the socioeconomic data provided by the respondents of surveyed households.

Data analysis

The Weighted Mean Index (WMI) approach was used to create the disaster resilience index (DRI). Initially, a rating scale was created, and weight was allocated subjectively depending on how respondents perceived the vulnerability of each characteristic as they were compared one by one. Each dimension (socio-economic, institutional, and physical) corresponds to several variables that were used to generate their respective scores (Shaw, 2009). There were eleven variables in the socio-economic dimension of the DRI, for example, literacy rate, natural disaster knowledge, primary health care facility, food consumption, occupation, income, savings, asset sales, participation in NGOs, and loan. These characteristics were chosen to better explain each family's vulnerability in terms of physical, socioeconomic, and institutional dimensions of resilience. The numbers 1, 2, 3, and 4 were assigned to rating scales, equivalent to extremely low, low, high, and very high, respectively. As a result, WMI was

computed by multiplying the sum of respondents' weights by the index of each variable (obtained by dividing the sum of rating scales under each variable by the number of elements) and then dividing the total by the number of variables in each dimension. After averaging the resilience levels of each dimension, overall DRI values were determined. SPSS 17.0 was used to compile and analyze the acquired field data.

Results and discussion

Socio-economic resilience

In this study, education and knowledge about natural disaster health, food consumption, income, use of savings are considered for the socio-economic dimension. Most of the indicators show low values for socioeconomic resilience. The index value of literacy rate (1.12), primary health care facility (1.25), food consumption (1.30) and income (1.30) showed low disaster resilience (Figure 4).

Stakeholders are influenced by their socio-economic characteristics and natural resource management activities. Hossain et al. (2009) depicted that socio- economic factors are interrelated and influenced by one another. The educational status of a person affects his occupation, income, skill, and adaptation to modern technology (Hossain et al., 2009). Education is an important issue for understanding and coping with any adverse situation. For example, in the study area literacy rates are below 50% and these households have poor knowledge of disaster and low predictable capacity against disaster. In the survey area, agriculture is the main income-generating source for people, but people have been practicing the use of different short-duration crops to adapt to the impacts of disasters. They engage themselves in nonagricultural farming involving rearing live stocks, dairy farms, cattle fattening, fish culture and other income-generating activities such as business, day labour, services, and construction. Moreover, they use food grain reserves during the disaster period and reduce their daily consumption.

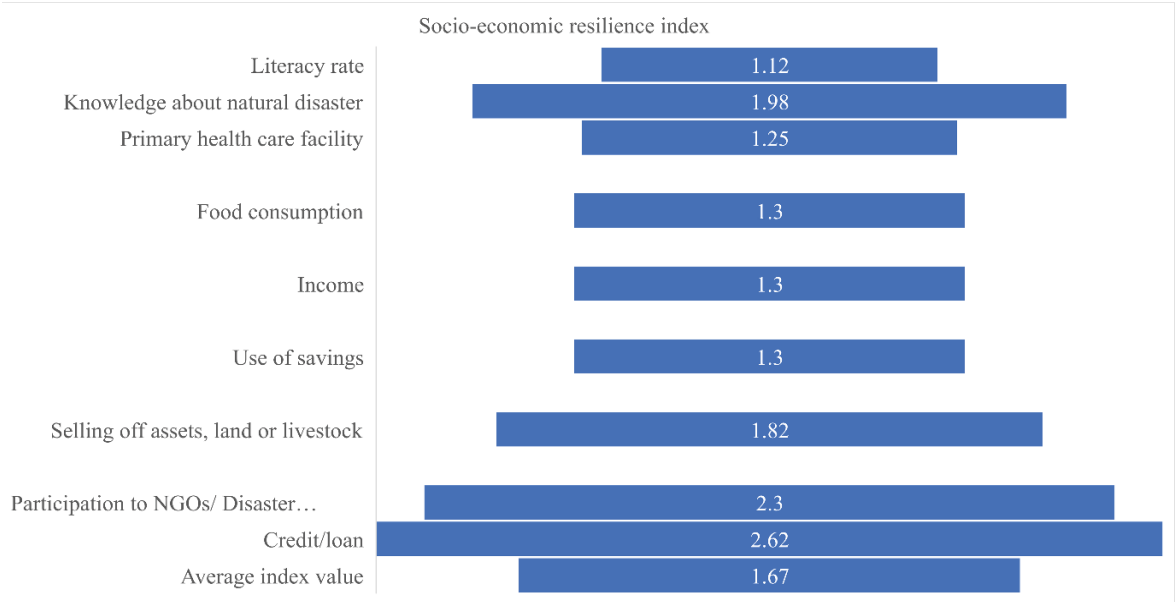

Figure 4: Socio-economic resilience to disaster resilience of local communities in Kazirchar, Bangladesh

Institutional resilience

The Government of Bangladesh approved the CDMP under Ministry of Food and Disaster Management to increase resilience at all levels and reduce damage and losses from natural disasters (Habiba et al., 2011). The result from the survey area implies a low level of institutional resilience (1.75). The reason behind low institutional resilience was non-existence of disaster management activities. The index value of training (1.42), school/collage (1.92), public awareness programme (2.14), and coordination (1) showed medium to very low of disaster resilience index (Figure 5). For disaster management Bangladesh has established an institutional mechanism that apparently recognizes the role of different stakeholders (Khan and Rahman, 2007). In the Disaster Management Bureau (DMB), have created which has coordinated all activities related to disaster management from the national to grassroots level. Marchildon et al. (2008) claimed that institutions have been critical to local, regional, national, and international efforts in reshaping agriculture in drought-prone environments. In the study area, governments and other NGOs are found operating in the field. Among these agencies, Department of Agricultural Extension (DAE), Department of Livestock, Department of Fisheries, Department of Health, Department of Water and Sanitation, Local Government and Engineering Department (LGED) and other NGOs like ASA, BRAC are working at field level to increase the institutional resilience to natural disasters.

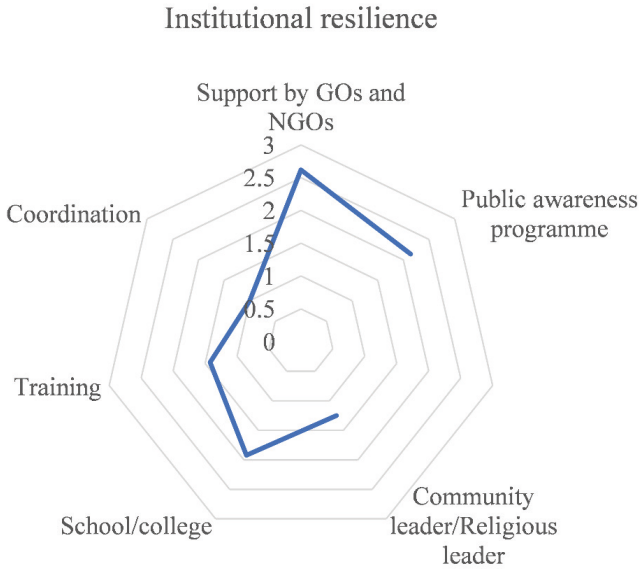

Figure 5: Institutional resilience to disaster resilience of local communities in Kazirchar, Bangladesh

Physical resilience

Study showed that the villagers have low physical resilience. From the survey, electricity supply (1.08), dependency on rainfall (1.08), cyclone and flood warning system (2.10), water bodies (1.56), and housing pattern (2.94) were the physical indicators of this village showed medium to low disaster resilience index (Figure 6). Households in this area extensively use irrigation water for daily agricultural purposes. The utilization and contribution of ground water in Bangladesh has increased from 41% in 1987-1988 to 75% in 2001-2002, and surface water has declined accordingly (Shahid and Hazarika, 2011). During the dry period, ponds dry up and moisture of the soil is quickly evaporated away (Saadat et al., 2009). As result, households extremely depend on ground water for irrigation purposes. As a remote area, the supply of electricity goes down for a long time and farmers cannot get irrigation water.

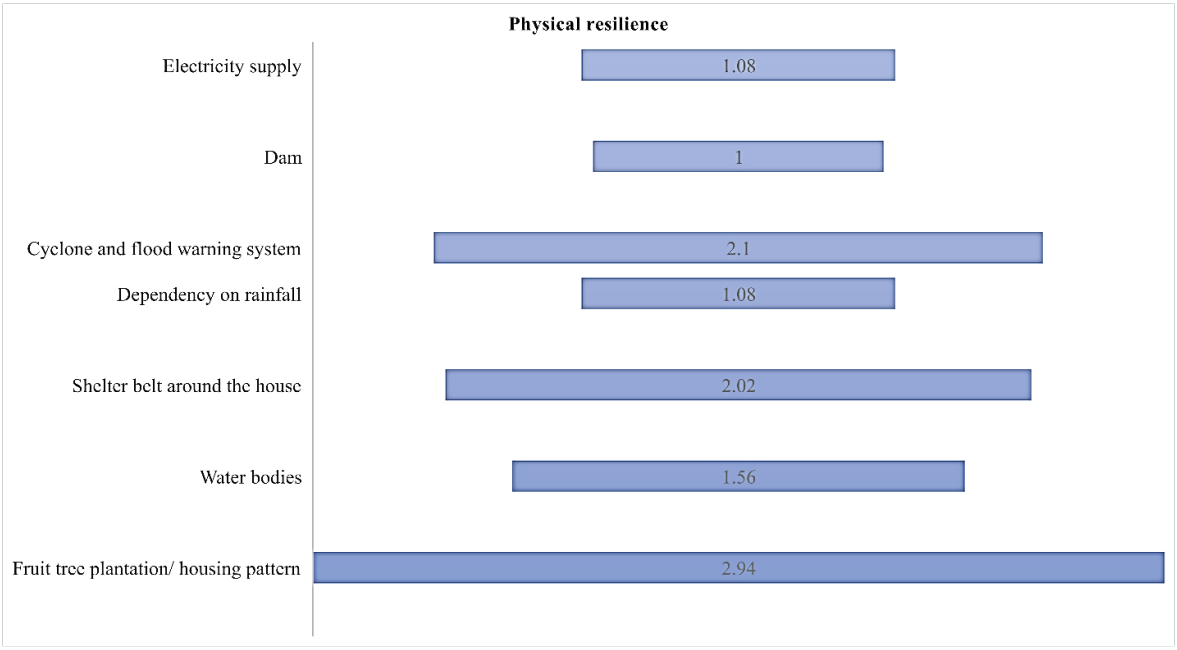

Figure 6: Physical resilience to disaster resilience of local communities in Kazirchar, Bangladesh

Overall resilience

The overall disaster resilience score ranges from 1 to 2.94. Depending on the score, disaster resilience level was divided into five categories from high (3 > 2.5), medium (2.5 > 2), low (2 > 1.5) to very low (1.5 > 1.0). Based on the resilience index the overall disaster resilience of Kazirchar village is low because of its low socio- economic (1.67), institutional (1.75) and physical (1.68) resilience values. Previous study reveals that in *Mohanpur upazila* has the highest (3.61) overall resilience because of its high socio-economic (3.68), institutional (3.63) and physical (3.53) resilience values (Habiba et al., 2011). This result reflects that the village has a low preparedness against various disasters due to poor management system by government, less knowledge about disaster, less coordination and poor collaboration between GOs and NGOs regarding disaster risk.

Conclusion

Bangladesh is frequently recognized as most vulnerable country in the world. In Bangladesh, southwestern coastal districts, especially Barishal, has been experiencing the worst impacts of recurring natural disasters. Consequently, this study is intended to know the community resilience in response to various disasters in Kazirchar village of Muladi Upazila in Barishal, Bangladesh. Primary data were collected through a well-structured questionnaire survey, interviewing the key informants and focus group discussions. Assessing the indicators of socio-economic, institutional, and physical dimension, the overall disaster resilience of Kazirchar village was low because of its low socio- economic (1.67), institutional (1.75) and physical (1.68) resilience values. The study identified that lack of education and awareness, low income, poor existence of GOs and NGOs activities have made the village people vulnerable to disaster from the socioeconomic, institutional, and physical points of view. Although number of NGOs are working on disaster risk reduction and building resilience among the local communities in Kazirchar, but this is still far away from the expectation. It is expected

that this study will be act as a reliable source of information for the taking natural disaster management initiative in this area as micro-level and formulating relevant policies to address the coping strategies against adverse effects of natural disasters in southwestern coastal areas of Bangladesh in broader sense. Finally, we suggest that fostering the socio-economic status, sound institutional set-up and strong physical arrangement can make more natural disaster resilient the local communities of Kazirchar village.

References

Adger, W. N., 1997. Sustainability and Social Resilience in Coastal Resource Use. CSERGE Working paper.

Adger, W. N., 2000. Social and ecological resilience: are they related? Progress in Human Geography 24(3):347-364. DOI:10.1191/030913200701540465.

Ahmed, B., Kelman, I., Fehr, H. K., & Saha, M., 2016. Community resilience to cyclone disasters in coastal Bangladesh. Sustainability (Switzerland), 8(8) doi:10.3390/su8080805.

Alam, G. M. M., Alam, K., Mushtaq, S., Filho, W. L., 2018. How do climate change and associated hazards impact on the resilience of riparian rural communities in Bangladesh? Policy implications for livelihood development. Environmental Science and Policy 84 (2018) 7–18.

Choudhury, M. 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*, pp.145-158.

Carpenter, S., Walker, B., Anderies, J. M. and Abel, N., 2001. From metaphor to measurement: resilience of what to what? Ecosystems, 4(**8**): 765–781.

Chowdhooree, I., 2019. Indigenous knowledge for enhancing community resilience: An experience from the south-western coastal region of Bangladesh. International Journal of Disaster Risk Reduction 40 (2019) 101259.

Habiba, U., Shaw, R., Takeuchi, Y., 2011. Drought risk reduction through a Socio-economic, Institutional and Physical approach in the northwestern region of Bangladesh, Environmental Hazards, 10:2, 121-138. http://dx.doi.org/10.1080/17477891.2011.582311.

Hossain, I. and Mullick, A. R., 2020. Cyclone and Bangladesh: A Historical and Environmental Overview from 1582 to 2020. International Medical Journal (1994) 25(6):2595-2614.

Hossain, M. I., Siwar, C., Mokhter, M. B., Dey, M. M. and Jaafar, A. H. 2009. Socio-economic condition of fishermen in seasonal floodplain *Beels* in Rajshahi District, Bangladesh. *Research Journal of Social Sciences*, 4: 74–81.

Holling, C. S., 1973. Resilience and stability of ecological systems. Annual Review of Ecology and Systematics, 4: 1–23.

Intergovernmental Panel on Climate Change (IPCC), 2001.Working Group II Report, Climate Change 2001: impacts, adaptation, vulnerability, Intergovernmental Panel on Climate Change, Third Assessment Report.

Islam, M. R., Ingham, V., Hicks, J., & Manock, I., 2017. The changing role of women in resilience, recovery and economic development at the intersection of recurrent disaster: A case study from Sirajgang, Bangladesh. Journal of Asian and African Studies, 52(1), 50-67. doi:10.1177/0021909614560244.

Kabir, R., Hafiz, T. A. K., Ball, E., Caldwell, K., 2016. "Climate Change Impact: The Experience of the Coastal Areas of Bangladesh Affected by Cyclones Sidr and Aila", Journal

of Environmental and Public Health, vol. 2016, Article ID 9654753, 9 pages, https://doi.org/10.1155/2016/9654753.

Khan, M. R., and Rahman, M. A., 2007. Partnership approach to disaster management in Bangladesh: a critical policy assessment. Natural Hazards, 41:359–378.

Klein, R. J. T., Nicholls, R. J. and Thomalla, F. T., 2003. Resilience to natural hazards: how useful is this concept? Environmental Hazards, 5:35–45.

Mallick, F. H., and Rahman, M. A., 2013. Cyclone and Tornado Risk and Reduction Approaches in Bangladesh. Disaster Risk Reduction Approaches in Bangladesh (pp.91-102). DOI:10.1007/978-4-431-54252-0_5.

Marchildon, P. G., Kulshreshtha, S., Wheaton, E. and Sauchen, D., 2008. Drought and institutional adaptation in the Great Plains of Alberta and Saskatchewan, Natural Hazards, 45: 391–411.

Rahman, M. M., & Li, W., 2018. A sustainability livelihood approach (SLA) model for assessing disaster preparedness and resilience of the people: Case study of Cox's Bazar sadar upazila in Bangladesh doi:10.1007/978-3-319-70479-1_3

Rahman, S., 2019. 11 cyclones claimed nearly 4,000 lives since 2007. The Financial Express. Retrieved from https://thefinancialexpress.com.bd/national/11-cyclones-claimed-nearly-4000-lives-since-2007-1556971146.

Rakib, M. A., Sasaki, J., Pal, S., Newaz, M. A., Bodrud-Doza, M., Bhuiyan, M. A. H., 2019. An investigation of coastal vulnerability and internal consistency of local perceptions under climate change risk in the southwest part of Bangladesh. Journal of Environmental Management, 231: 419–428.

Ray-Bennett, N. S., Collins, A., Bhuiya, A., Edgeworth, R., Nahar, P., & Alamgir, F. (2010). Exploring the meaning of health security for disaster resilience through people's perspectives in Bangladesh. *Health & place*, *16*(3), 581–589. https://doi.org/10.1016/j.healthplace.2010.01.003

Ray-Bennett, N.S., Collins, A.E., Edgeworth, R., Bhuiya, A., Nahar, P. and Alamgir, F., 2016. Everyday health security practices as disaster resilience in rural Bangladesh. *Development in Practice*, *26*(2), pp.170-183.

Saadat, A. H. M., Alam, J. A. T. M., Alam, M., Shovon, J. and Uzzaman, R., 2009.Impacts of Climate Change on Livelihoods, Agriculture Aquaculture and Fisheries of Bangladesh. Department of Aquaculture, Bangladesh Agricultural University, Mymensingh.

Sarker, M. N. I., Wu, M., Alam, G. M., & Shouse, R. C. (2020a). Livelihood resilience of riverine island dwellers in the face of natural disasters: Empirical evidence from Bangladesh. Land use Policy, 95 doi:10.1016/j.landusepol.2020.104599.

Sarker, M. N. I., Wu, M., Alam, G. M. M., & Shouse, R. C. (2020b). Administrative resilience in the face of natural disasters: Empirical evidence from Bangladesh. Polish Journal of Environmental Studies, 29(2), 1825-1837. doi:10.15244/pjoes/109527.

Shahid, S. and Behrawan, H., 2008.Drought risk assessment in the western part of Bangladesh, natural hazards. Journal of the International Society for the Prevention and Mitigation of Natural Hazards, 46:391–413.

Shahid, S.; Hazarika, M.K. Groundwater Droughts in the Northwestern Districts of Bangladesh. Water Resour. Manag. 2011, 24, 1989–2006.

Shaw, R., 2009. Climate Disaster Resilience: Focus On Coastal Urban Cities in Asia.

Sultana, Z., and Mallick, B., 2015. Adaptation strategies after cyclone in southwest coastal Bangladesh – pro poor policy choices. Am. J. Rural Dev. 3 (2), 24–33.

Uddin, M. S., & Haque, C. E. (2012). Disaster risk and vulnerability in coastal plains of bangladesh: Observations on human responses and local resilience to the effects of cyclone sidr, bangladesh. Paper presented at the Proceedings of the 4th International Disaster and Risk Conference: Integrative Risk Management in a Changing World - Pathways to a Resilient Society, IDRC Davos 2012, 711-714.

Uddin, M. S., Haque, C. E., Walker, D., & Choudhury, M., (2020). Community resilience to cyclone and storm surge disasters: Evidence from coastal communities of Bangladesh. Journal of Environmental Management, 264 doi:10.1016/j.jenvman.2020.110457.

UNISDR [United Nations International Strategy for Disaster Reduction Secretariat], 2008. Briefing Note 01: Climate Change and Disaster Risk Reduction. International Environment, Geneva.

Verschuur, J., Koks, E. E., Haque, A., & Hall, J. W., 2020. Prioritising resilience policies to reduce welfare losses from natural disasters: A case study for coastal Bangladesh. Global Environmental Change, 65 doi:10.1016/j.gloenvcha.2020.102179.

Viljoen, M. F., Pelser, A. J. and Steyn,M. S., 2001. Towards the Development of Guidelines for the Evaluation of Social, Economic and Political Impacts of Droughts and Water Scarcity. Report to the Water Research Commission, Departments of Sociology, Agricultural Economics, Political Science and History, University of the Free State, Bloemfontein, Pretoria.

Zhou, H., Wang, J., Wan, J. and Jia, H., 2010. Resilience to natural hazards: a geographic perspective. Natural Hazards, 53. 21–41.