Assessing the Resilience of Coastal Fishing Communities of Bangladesh to Climatic Hazards and Disasters

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Island fishing communities are vulnerable to climatic hazards. (Photo: A. Barman, 2021).

This study has measured the resilience of three coastal marine fishing communities of Rangabali Island in Bangladesh and assessed the factors responsible for increasing or decreasing the resilience. The findings have revealed that variations in the resilience scores are strongly affected (p-value < 0.001) by social, physical, and institutional attributes. More precisely, cooperation, trust, and equity among fishers, good leadership, physical assets ownership, proper early warning system, livelihood training programs, and strong government intervention have significant impacts in increasing the resilience of the fishing communities. This study suggests some measures to be taken to further strengthen the resilience of fishing communities, including strengthening social cohesion, introducing new aquaculture practices, incorporating value-added products, enhancing ice facilities, engaging women in income-generating activities, and improving emergency food, water, and medication facilities during disaster. In addition, both government and non-government organizations should work together to enhance the resilience of the fishing communities.

Introduction

Climate change-induced physical events such as cyclones, storms, droughts, floods, tidal water surges, erosion, and salinity intrusion, which are responsible for the loss and damage of life, health, property, infrastructure, livelihood, and other environmental resources, are called climate hazards (Field et al., 2012). Climate change in coastal areas might slow down economic growth by increasing inequalities and poverty incidents. It can lead to surface-water scarcity and cause heat stress, food insecurity, and other health problems, which can lead to displacement of people and involuntary migration, among other hardships. The predicted climate change is adding an extra risk factor to human settlement in coastal areas. Coastal communities are fragile and sensitive to these adverse conditions and ,most of the time, they fail to cope with extreme climatic events.

Bangladesh is one of the top ten most vulnerable countries affected by

severe weather events (1999-2018) (Eckstein et al., 2020). Low lying flat topography, anomalies in climatic features, along with high population density and socio-economic conditions, have made this country highly susceptible to many hazards, including cyclones, storm surges, floods, droughts, salinity intrusion, and earthquakes (Kreft et al., 2014). Bangladesh was ranked fifth in terms of the death toll, losses, and number of extreme events in the ten years between 1993–2012 (Kreft et al., 2014). Fishers occupy a large part of the rural population, and their contribution to the fisheries sector is indisputable. But they are being increasingly exposed to various climatic hazards, making them incapable of coping to extreme situations, especially in the coastal regions where most of the districts are highly or very highly exposed to climate variability and change (Islam et al., 2019).

Walker (2010) defined resilience as "*the capacity to absorb disturbance and reorganize while undergoing change to retain essentially still the same function, structure, identity, and feedbacks*." However, for social resilience, the definition of Timmerman (1981) is most relevant, as it defines resilience as "*the ability of human communities to withstand external shocks or perturbations to their infrastructures, such as environmental variability or social, economic or political upheaval and to recover from such perturbations*." It can be measured by a change of institutional, economic, and demographic structure, property rights, and access to resources (Adger, 2000). For climate change resilience, it is important that it can withstand shocks and rebuild subsequently (Folke et al., 2010) as it will demand susceptible reorganization of social, economic, and ecological systems to continue essential functions, identity, and structure as well as maintain adaptive capacity, learning, and transformation. Measuring resilience to attain sustainability of the fishing community is crucial, as these communalities have not received sufficient attention. There are a few studies available on exploring resilience in Bangladesh (Hossain et al., 2013; Islam et al., 2016; Mozumder et al., 2018). However, no published study has focused on measuring resilience of the fishing communities in Bangladesh. Measuring resilience is crucial for understanding the factors responsible for the increase or decrease of resilience and will help in creating robust plans and policies to increase resilience and decrease impact and vulnerability. In this context,

this study aims to measure the resilience of communities and identify the factors responsible for the increase or decrease of resilience using insights from three marine fishing communities of Rangabali Upazila (sub-district), an island in Patuakhali district on the central coast of Bangladesh.

The study was conducted at three fishing communities named Bhuiya Hawla, Sener Hawla, and Shamudafath (Figure 1). Patuakhali is considered as one of the highly vulnerable districts to climate variability and change in terms of both aquaculture and fisheries perspective (Islam et al., 2016; 2019). Severe climatic hazards and disasters i.e., cyclone, storm surge, tidal flooding, riverbank erosion, waterlogging and salinity intrusion commonly invade the Rangabali Island as it is located inside the Bay of Bengal (Rahman et al., 2017). Among these, cyclone and storm surge are considered the most devastating disasters affecting the district (Kulatunga et al., 2013). About 70 percent of the agricultural livelihoods in that area are affected by climate change (Rahman et al., 2017). Most of the houses of this island are poorly built, made of tin or wood which get severely damaged during these disasters. Due to the substandard communication system with mainly unpaved road, it takes about four hours to reach the nearby town. Most of the people in the community do not have access to grid electricity facility, so, they use solar panels for partial electricity supply. For livelihoods, people in the community mostly depend on offshore fishing and limited deep-sea fishing. Agricultural practices, cattle raising, net making and boat making provide supplementary income. Some of the people also collect crabs and sell them to the nearby fish market. People in the community live in an unhygienic condition with poor sanitation and insufficient pure drinking water facility (Paul & Routray, 2011). Development process of Rangabali Upazila is quite slow due to geographical location and undeveloped socio-economic conditions. The morphology of Rangabali is changing very rapidly due to climate change.

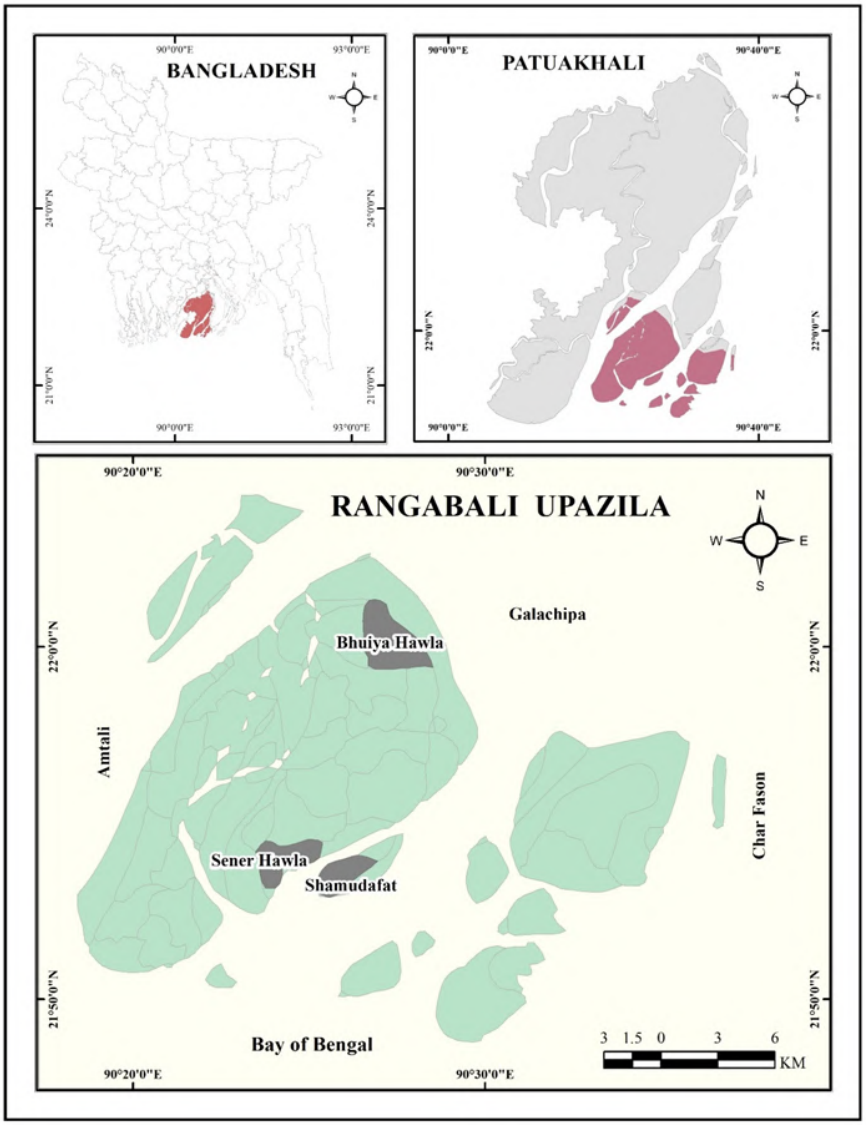

Figure 1. The geographical location of the selected community in Rangabali Upazila in the central coastal zone of Bangladesh

To assess resilience in three communities, the head of the fishers' households was selected randomly and interviewed in the local language in February 2019. 60 respondents (20 respondents from each community) were interviewed using a structured questionnaire and scored by the surveyor. Besides, three focus group discussions (FGDs) and twelve key informant interviews (KIIs) were conducted to collect additional information and triangulation. Multidimensional scaling was applied to assess resilience in each of the attributes in a field on the scale from good (resilient), medium, and bad (vulnerable) (Stanford et al., 2017). The quantitative data were analyzed by SPSS 20 software. Analysis of variance (ANOVA) *F*-tests were performed to examine the variation among mean resilience scores of three communities under different fields of interest and determine the factors/fields that significantly affect the variation of resilience scores among the communities. The FGDs and KII data were analyzed by content analysis using manual coding after transcription.

Resilience assessment of island fishing communities

The mean resilience score of Bhuiya Hawla fishing community is 72.65, where human capital has highly influenced (total score 18.05) the resilience score. In human capital, among the attributes, the wife's contribution to the household's income has the highest mean score (3) (Table 1). Besides, economic and physical capital have notably impacted the overall mean resilience score of the Bhuiya Hawla fishing community. However, the significance of each field depends on the number of attributes considered in that field; a higher number of attributes might have a higher impact on that particular field. Though in this study, the number of attributes in human and physical fields are the same (total 7), the human field has a higher impact (18.05) than the physical field (13.05) (Table 1). Conversely, the economic field has a higher impact (13.15) than the physical field (13.05) despite having less attributes (6) than the physical field (7) (Table 1). Therefore, determining the significance of the fields in resilience score in one fishing community is somehow tricky and cannot be concluded considering the

mean score of each field. However, in the institutional field, the highest mean score in livelihood program (3) denotes that the fishers of this community attend various livelihood programs arranged by the government and non-government organizations.

Table 1. Resilience scores of three fishing communities along with the mean scores of 31 attributes under six capital fields (data source: questionnaire survey).

Fields	Attributes	Communities		
		Bhuiya Hawla	**Sener Hawla**	**Shamudafath**
Natural	Loss and damage	1.30	1.50	1.15
	Coastal resources (revenue)	2.85	3.00	3.00
	Coastal stocks	2.90	2.20	2.40
	Total	**7.05**	6.70	6.55
Social	Community cooperation	2.25	2.25	2.55
	Community leadership	2.90	2.60	3.00
	Degree of trust/ honesty	2.90	2.80	2.90
	Equal right to speak	2.90	2.50	2.95
	Total	10.95	10.15	**11.40**
Economic	Ability to save	2.60	2.50	2.80
	Access to credit	1.70	1.85	2.30
	Collateral credit	2.45	1.80	2.05
	Ability to repay	1.85	1.95	1.95
	Current savings	1.85	1.95	1.95
	Supplementary income	2.70	2.90	2.85
	Total	13.15	12.95	**13.90**
Human	Awareness of market	2.85	2.65	3.00
	Productive activities	2.85	3.00	3.00
	Occupational multiplicity	2.70	3.00	2.75
	Contribution (Wife)	3.00	2.90	2.45
	Family thriftiness	2.70	2.55	2.50
	Sufficient food	2.05	1.95	1.85
	Hygienic food	1.90	1.65	1.85
	Total	**18.05**	**17.70**	**17.40**
Physical	Boat ownership	2.25	1.70	2.70
	Adequate gears	2.25	2.00	2.10
	Physical asset ownership	1.85	2.00	1.90
	Ice availability	1.80	1.10	1.90
	Processing value	1.35	1.00	2.00
	Livelihood condition	1.35	1.05	1.30
	Market place	2.20	2.00	2.00
	Total	13.05	10.85	**13.90**
Institutional	Functionality of Government office	2.55	2.55	2.65
	Early warning	2.85	2.60	2.85
	Emergency response in disaster	2.00	1.95	1.90
	Livelihood program	3.00	2.05	3.00
	Total	**10.40**	9.15	**10.40**
	Resilience Score:	72.65	67.50	**73.55**

The total resilience score of the Sener Hawla Fishing community is 67.50, and similar to the Bhuiya Hawla fishing community, the human field has the highest impact (17.70) on the overall resilience score. In the human field, two attributes (i.e., productive activities and occupational multiplicity) have the highest mean score (3) (Table 1), which means that the fishers of this community have more access to other income-generating activities along with fishing and are more engaged in productive activities. Interestingly, the economic field of this fishing community contributes more (12.95) to the resilience score than the physical field (10.85). However, the physical field has a higher number of attributes than the economic field (Table 1).

The resilience score of Shamudafath fishing community is 73.55 and has been particularly impacted by the human field (17.40). Interestingly, economic and physical fields have the same mean score (13.90) despite having different attribute numbers in each field (6 and 7 respectively) (Table 1). Fishers of this community have knowledge of the market and are highly engaged in income-generating activities. Besides, the fishing people of this area generate more revenue from fishing now than they did ten years before. They are also more involved in livelihood programs arranged by the government and NGOs.

What makes livelihood resilience different?

The comparison among the livelihood resilience status of the three fishing communities and the total score of six different fields are presented in Table 2. The highest score in each field shows the significance of the field in strengthening the resilience of the fishing communities. The higher the score, the higher resilience, and vice versa. The resilience of Shamudafath fishing community (73.55) is higher than Bhuiya Hawla (72.65) and Sener Hawla (67.50) fishing communities (p-value < 0.012) as the mean score of three important capital fields (social, economic, and physical) are higher in Shamudafath fishing community (Table 2). However, in natural and human fields, Bhuiya Hawla fishing community have the highest scores (7.05 and 18.05 respectively), which means the natural and human capital

of Bhuiya Hawla fishing community are better than Sener Hawla (6.70 and 17.70 respectively) and Shamudafath fishing community (6.55 and 17.40 respectively) (Table 4). However, in social (11.40), economic (13.90), and physical (13.90) fields, the Shamudafath fishing community has a higher score than Bhuiya Hawla and Sener Hawla fishing community (Table 2).

Interestingly, the total score of institutional field (10.40) is the same for both Bhuiya Hawla and Shamudafath fishing communities. However, while comparing the resilience score of the fishing communities, the attributes of social, physical, and institutional fields are found to be highly significant for the variation of resilience scores of different fishing communities (p-value < 0.001) (Table 2). The attributes in these three fields are good leadership, cooperation, trust, equity among the community in social field; ownership of physical assets e.g., fishing boats and gears, livelihood condition, marketplace, ice availability and processing value in the physical field; and efficient early disaster warning and response system, long or short-term livelihood training program and government intervention in institutional field. At the same time, other attributes among natural, economic, and human fields are not statistically significant for the variation of resilience scores among the three fishing communities (Table 2).

Table 2. Mean resilience score, standard errors (SE), 95 % confidence interval for the mean score, and p-value of ANOVA F-test for three fishing communities of Patuakhali by different fields.

Field	Community	Total Score	SE	95% CI	*p*-value
	Bhuiya Hawla	**7.05**	0.135	(6.77, 7.33)	
Natural	Sener Hawla	6.70	0.147	(6.39, 7.01)	0.065
	Shamudafath	6.55	0.170	(6,19, 6.91)	
	Bhuiya Hawla	10.95	0.185	(10.56, 11.34)	
Social	Sener Hawla	10.15	0.284	(9.56, 10.74)	<0.001
	Shamudafath	**11.40**	0.134	(11.12, 11.68)	
	Bhuiya Hawla	13.15	0.716	(11.65, 14.65)	
Economic	Sener Hawla	12.95	0.344	(12.23, 13.67)	0.405
	Shamudafath	**13.90**	0.435	(12.99, 14.81)	
	Bhuiya Hawla	**18.05**	0.573	(16.85, 19.25)	
Human	Sener Hawla	17.70	0.300	(17.07, 18.33)	0.554
	Shamudafath	17.40	0.336	(16.69, 18.10)	
	Bhuiya Hawla	13.05	0.583	(11.83, 14.27)	
Physical	Sener Hawla	10.85	0.182	(10.47, 11.23)	<0.001
	Shamudafath	**13.90**	0.410	(13.04, 14.76)	
	Bhuiya Hawla	**10.40**	0.169	(10.05,10.75)	
Institutional	Sener Hawla	9.15	0.182	(8.77, 9.53)	<0.001
	Shamudafath	**10.40**	0.184	(10.02, 10.78)	
Overall	Bhuiya Hawla	72.65	2.007	(68.45, 76.85)	
	Sener Hawla	67.50	0.958	(65.49, 69.51)	0.012
	Shamudafath	**73.55**	1.323	(70.78, 76.32)	

The most significant fields ($p < 0.001$) influencing the variation of the resilient scores are social, physical, and institutional fields. This means that the attributes residing in these three fields (i.e., good leadership, cooperation, trust, equity among the community, ownership of fishing boats and gears, community's livelihood condition, market place, ice availability, processing value, efficient early disaster warning and response system, short-term livelihood training programs and government interventions) are the key in changing the resilience of a community. Cooperation, trust, equity, and strong leadership can bring social harmony (Sharma, 2015), which can significantly increase a community's relative resilience (Sharifuzzaman et al., 2018). A community network can allow individuals to draw on the social resources in their community (Green & Haines, 2015); in order to facilitate a sustainable development process, it is necessary to resolve collective problems (Mayunga, 2007). More than eighty percent (85 percent) of the respondents agreed that they have a supportive leader who works for the development of the community. Communities with a common goal and intention to work together have the ability to strengthen their resilience (Davidson, 2006).

On the other hand, ownership of fishing boats and gear can enhance the resilience of the fishing communities by 20-40 percent (Sharifuzzaman et al.,

2018). In the present study, though 8.3 percent of fishers have no physical asset, most of them (88.3 percent) own limited fishing gear; this lack of fishing gear can force the fishermen to adopt more climate sensitive strategies as they have limited household options (Islam et al., 2014). About 90 percent of the fishers sell their catch in the nearby fish market due to the lack of ice facility, and 83.3 percent do not have the most current knowledge of fish price, which prevents them from getting a fair price. Providing sufficient ice facility and proper market knowledge could mean not only that they can sell the fish in the market of a nearby town but that they also receive a fair price. In case of severe hazard risks, i.e., cyclones or floods, the early warning system can greatly increase resilience by decreasing impacts. Communities can get the chance to prepare for the pre-disaster, during disaster and post-disaster situations (Fakhruddin et al., 2015). Besides, short-term livelihood programs are beneficial to the community in building resilience. In coastal regions, non-government organizations (NGOs) play a significant role in attaining resilience in climate change (Hasan et al., 2018).

This study has identified that the impact of natural, economic, and human fields in building resilience is not significant as the community's geographical, livelihood, and economic conditions are indistinguishable. However, 68.3 percent of people became affected by the severe climatic hazards and lost their belongings despite all their effort in building resilience. Disasters like cyclone, storm surge, flood, and riverbank erosion destroy coastal communities' major assets such as houses, lanyards, and cattle (Khan et al., 2015) and make them vulnerable (Alam & Collins, 2010). Sufficient credit access can increase a community's resilience, but earnings in the fisheries sector are highly uncertain and seasonal as fishers who do not own boat or fishing gear eventually cannot catch nor can they earn more (Allison et al., 2007). Borrowing money from family, relative, bank, or *mahajan* (moneylender who impose higher interest rate) can help cope in post-disaster conditions though sometimes a lack of collateral hinders this process. The involvement of local NGOs in attaining coastal resilience can be a better way to reduce stress against coastal disasters by providing loans (Hasan et al., 2018). At the same time, taking a large loan is a difficult task for the fishing community as they

need to pay it back on time, otherwise they have to sell their assets. In addition, geographical isolation can restrict both the capacity to access market and the opportunity to adopt alternative livelihood (Allison et al., 2007). Nonetheless, proper management is crucial for the sustainable utilization of the resources, where stakeholders should be directly involved in the management process (Pomeroy, 1995). Societal rules, norms and formal institutions like groups, organizations, and government bodies can enhance adaptive capacity, which is crucial for building resilience (Speranza et al., 2014).

Conclusion and way forward

Climatic hazards, such as cyclones, floods, erosions, tidal water surges and salinity intrusions, seriously affect the socio-economic conditions of the fishing community in the coastal area of Bangladesh, and undermine their resilience. Community cooperation, trust, equity, good leadership, physical asset ownership and accessibility, suitable disaster warning and response system, livelihood programs, and government interventions can significantly influence a community's resilience. More specifically, in the context of Rangabali Island, the following initiatives can be taken to make the community more resilient to climatic impacts and decrease its level of vulnerability. First, strengthening social cohesion in taking new initiatives (e.g., crab culture, cage culture) will increase the community's resilience. Second, fishers' association and cooperative marketing can facilitate the process of adopting new initiatives, getting a fair fish price by increasing market knowledge, and improving loan facilities for poor fishers. Third, since there are existing fish drying practices of Shamudafath fishing community, incorporating practices of value-added product (e.g., preserving fish or shellfish by drying, smoking, or salting) can help increase their income and increase their resilience. Fourth, providing an adequate icing facility can help with preserving as well as selling fish far from the village or nearby town and can increase the value of fish, thus increasing resilience. Fifth, the active participation of women in fishing, drying, harvesting, and other income-generating activities can make them stronger and more financially independent to fight against hazards Sixth, in

extreme climatic hazards, an adequate emergency shelter, food, water, and medication facility must be ensured (both by government and NGOs). Finally, the meaningful coordination and management of different national and international NGOs and government projects can ensure equal distribution of relief or compensation schemes among all fishers during hazards or fishing ban periods.

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