ASSESSING THE IMPACT OF CLIMATE CHANGE ON SMALL-SCALE FISHERIES LIVELIHOOD VULNERABILITY INDEX

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ABSTRACT

Small scale fishing (SSF) communities of the inland open water area are one of the most vulnerable communities. Actually, fishery activities provide significant support regarding food nutrition and security as well as alleviating poverty and maintaining sustainable livelihoods of the people. However, their contributions are undervalued in the global and national scale by scholars. This study assessed the impact of climate change on SSFs from the vulnerability perspective, using two livelihood vulnerability indices. Firstly, using the Livelihood Vulnerability Index (LVI), and second, using IPCC Vulnerability Framework Approach (LVI-IPCC framework). The main objectives of this study were to assess the vulnerability status of SSFs communities due to the impact of climate change. To achieve the objective, data on SSF communities in three sub-districts were randomly selected. They were fishers from Chatmohor, Gurudaspur and Tarash. A total of 352 SSF households were interviewed. Overall, the results of LVI and LVI-IPCC did not change the ranking of vulnerability status as both cases the households of Tarash were found to be most vulnerable than that of Chatmohor and Gurudaspur. Moreover, this study also found that SSFs were surrounded by various problems including insufficiency in food, lack of access to cash, chronic diseases, unsafe drinking water, unemployment, lack of physical assets, lack of availability of early warning systems (EWS), and low involvement in social networking. Finally, to improve the quality of the SSF livelihoods, some changes in food policy, health facilities, informal credits access, trainings, establishing efficient EWS should be provided by the policy makers.

Keywords: Climate Change, Inland Open Water, Livelihood, Small Scale Fisheries, Vulnerability.

INTRODUCTION

Climate change affects fisheries sector mutely and severely across the world (Fienkbeiner et al., 2018) especially towards inland open water small scale fisheries (SSFs) which are experiencing other non-climatic threats such as over fishing, loss of habitat, pollution and disturbance (Eriksson et al., 2018; Pomeroy, 2016). Moreover, SSF communities in developing countries, where 90% fishery-dependent people are living (Food and Agriculture Organization (FAO, 2016), are facing complex and localized impacts due to their limited mobility, widespread poverty, remoteness, and high dependence on fishing as well as on subsistence farming (Hanich

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et al., 2018). However, the contribution of SSFs is often unrecorded and underrated especially in the developing world like Bangladesh. Besides, in terms of policy implications SSFs are often seen overlooked (Tilley et al., 2018; Lynch et al., 2017; Pomeroy, 2016). So, this is an acid test for the future survival of SSFs livelihood which can be minimized by making a study on their livelihood. On the other hand, as the livelihood systems of fishing community is affected by climatic changes in different ways, and for this reason it in-depth studies on vulnerability and adaptation are required (Rahman et al., 2018).

National scale studies are not capable to provide of the household or community scale (Hahn et al, 2009), and at the local scale. Vulnerability assessments of agricultural livelihood systems dominate (Sissoko et al., 2011). The degree of these shocks is not equal within and among SSF communities. For that reason, more work is to analysis the degree of vulnerability within their groups such as in terms of location. age, and wealth. The SSFs of inland open water area of Bangladesh are exaggerated much than the other livelihoods of the country. The fishing communities needs greater resilience to deal with environmental and socio-economic shocks (i.e., fluctuating catches, disease and death in their families, natural disasters and hunger) which are the impacts of climate change (Rahman et al., 2018). This study has developed a livelihood vulnerability index of SSFs community, to address the SSFs' vulnerability status and the degree of vulnerability to climate change.

For the households and communities' changes in food availability and affordability consider as an additional health burden due to climatic disturbances. Due to climate change events, decreased catches in this phase leads high risk of malnutrition and under- nutrition for communities those who are highly dependent to get protein from fish (Ogutu-Ohwayo et al., 1997), combined with changes in diet (reduction of protein from a fisheries source), are some of the possible effects which are the scenarios of Asian and sub-Saharan African countries where people dependent more on fish to fulfill their nutritional requirement of animal protein (FAO, 2012). During the period of natural resource scarcity there is reduction in fishery-dependent incomes which has a direct effect on the reduction of the ability to get store-bought food (Callaway et al., 1999). Similarly, during the extreme events or flooding the infrastructure is damages which can reduce the local markets access, the availability of food products reduced as well as their prices will increase (Badjeck, 2008). However, this adverse impact can be mitigated by different adaptive actions. For instance, during the adverse phase of climate change group activity, food aid, depending on indigenous fruit, casual labor etc. can be very useful. But as mentioned earlier, because of the very limited access and capacity over resources fishery-based livelihood could not able to avail these opportunities. They even suffer lack of skills to do other jobs rather than fishing.

Three broad areas are covered by the impacts of climate change: direct effects on humans, their enterprises, and assets; effects on natural systems; and effects on humans via natural systems. The negative impacts occur in many places and affect most people. This apparent asymmetry of impact is hypothesized to have three causes: the rapidity of climate change relative to adaptive processes in social and ecological systems; the exposure of societies to climates not experienced during the period over which complex, agriculturally dependent human societies developed; and the approach toward limits in the Earth system. Covariates of climate change especially rising atmospheric carbon dioxide and ongoing land transformation are an inextricable part of the projected loss of services in the coming century and the projected shortfall between supply and demand is strongly demand-driven (Scholes, 2016). Fishing

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communities of inland water area is particularly interesting cases for the study of vulnerability to climate change. This study tries to find the impact of climate change on small scale fishing communities' livelihood assets (Salamzadeh, 2020). The aim of this study was to assess the impact of climate change on SSFs communities from the vulnerability perspective. So, this will lead to vulnerable to food security for the fishing communities. Besides, a study from (Sadekin et al., 2018a) found that there are low levels of social networking and poor water management behavior among the SSF community.

LITERATURE REVIEW

Impact of Climate Change on SSF Livelihood

Common environments of poverty characteristic of SSF communities are trying to increase the attention of governments and other agents towards this issue by developing different programs which includes various specific objectives related to the upraising of the standard of living of these communities (Pomeroy, 2016). It is predicted that climate change has an impact of wide range on both inland fishing livelihoods (Sadekin et al., 2018b). The climate change can significantly influence the inland fisheries concerning the water resources, biodiversity, productivity and sustainability (Salagrama, 2012; Thinkprogress, 2013). Equally, there is no other alteration for SSFs, by the adverse impact of climate change. Nevertheless, a lot of research and policy analysis have been developed from different perspectives on SSFs for the last fifty years *(i.e.,* disciplinary studies, multidisciplinary, holistic studies etc.) (Pomeroy, 2016). However, Pomeroy (2016) also found that on SSFs only a small amount of economic and social research has been done whereas the most research primarily has been focused on fisheries biology and stock assessment and technology development. In the 2000s the climate change projections came at forefront (Pomeroy, 2016) strongly suggested that the effects on coasts, lakes and rivers, and on the fisheries, they support, will bring new challenges for these systems and the people who depend on them (Hall, 2011 as cited in Pomeroy, 2016). Although impact and vulnerability-based research approaches are common in the Bangladesh-focused climate change literature, relatively little formal attention has been paid to bridging gaps between science and policy and science and society especially towards SSF communities (Rahman et al., 2018).

Bangladesh fisheries contribution to Agricultural GDP is 23.12% (second largest subsector in agriculture after forestry) and 11% of the total population's livelihood (DoF, 2017). Additionally, in Bangladesh after ready-made garments (RMG) sector the second largest export sector is fisheries (Export Promotion Bureau, Bangladesh, 2017). However, fisheries sector and fishing livelihood in Bangladesh are adversely affected by the climate change. As a result, fishing communities have less access limit of food and money. For the SSF communities this situation becomes worst as they have no other alter choices available for their survival (Baki et al., 2015). Additionally, this incidence is more severe in the developing world because more than 50 percent of their annual income comes from the fishing activities for most of the SSF households (Sadekin et al., 2018c & d). So, it is needed to make the SSF communities out of poverty which should be addressed properly in case of Bangladesh. The results indicated that there was a significantly positive correlation between all four dimensions of economic, legal, ethical and discretionary social responsibility and development of SMEs. Moreover, facilitating legislation and giving more authority to SME owners/managers for developing their enterprises are highly advised (Doshmanli et al., 2018). Startups, as an integral part of any entrepreneurship

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ecosystem, play a critical role in the success of emerging markets. Without these entities, less niche market opportunities are prone to be explored and exploited. In recent years, startup boom is happening in most of the emerging economies, and the startup ecosystem is shaped to some extent in different countries at this level of development (Salamzadeh, 2018).

This study on impact of climate change on fisheries and fishery based livelihoods of inland water area would provide a pathway towards better livelihood and fishing status of fisheries sector. It is not only important for the local population but has significant impact on the ecosystem services, supplied for the whole inland area. The findings of this study will contribute to the existing knowledge of these issues in other localities of the world which have similar socio-economic status, environmental situation, and livelihood conditions. This study will contribute to assess the livelihood of inland fishing based communities due to the climatic impact from the local aspect. This study will use *"Livelihood Vulnerability Index (LVI)"* method and *"Climate Vulnerability Index (CVI)"* method to assess the impact of climatic vulnerability of small scale fishing communities of inland water area. Empirically these two approaches are been used for different livelihood communities. However, in this study these two methods will be used particularly for small scale fishing communities and will be adjusted according to the local context (Salamzadeh & Kirby, 2017).

Approaches for Assessing Climatic Vulnerability

The idea of *"vulnerability"* was first founded in the early study of Hewitt (1983), and it was originally made on natural hazards. Since vulnerability become the main focus in many branches including disaster management, climate change, poverty analysis, livelihood analysis etc. (Füssel, 2010). Now-a-days *"Vulnerability"* is considered as a vital concept in the research of global change as well as in the research related with climatic change (IPCC, 2001). IPCC defined vulnerability as; *"Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity"* (IPCC, 2007). According to this definition of IPCC, it is clear that each of these three components of vulnerability (e.g., exposure to change, sensitivity to change, and adaptation to change) has different impact on vulnerability. For example, there exists a positive association between exposure and vulnerability; as well as between sensitivity and vulnerability. On the other hand, adaptive capacity decreases the degree of vulnerability which means adaptive capacity negatively impact vulnerability (IPCC, 2007).

The concept of livelihood and sustainable livelihood has received much attention over the years. According to Chambers & Conway (1992), the sustainable livelihoods approach (SLA), is a method which is used to project different development programs at the community level by looking at the household's assets pentagon. The term 'livelihood' consists of five major capital assets (e.g., natural capital, physical capital, human capital, financial capital, and social capital). These assets are commonly cited as capital asset pentagon. Additionally, the community's livelihood is the activities of capital asset pentagon that determine the living environments of individuals and households. However, when a livelihood is capable of coping with as well as improving from various stress and different shocks and continuing or refining their resilience without decline its natural resource base is considered as sustainable livelihood. For the broader view of vulnerability analysis some researchers advocate to use indicator based approach (IBA). As an argument they state that due to the availability of data, appropriate policies and their implications are generally done at the national scale level. Moreover, in a study Allison et al.

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(2009) argued that IBA can be also used to detect particular vulnerability regions (e.g., Low, Medium, and High). After spotting the regions this will helpful to the policy makers to make a national level assessments because this valuation provide them a wider picture of the vulnerability pattern of a country.

In IBA firstly indicators are set for the measurement of the components of vulnerability (e.g., exposure to change, sensitivity to change and adaptive capacity to change). After then IBA is calculated by combined according to several indicators of each component (Allison et al., 2009). The livelihood Vulnerability Index (LVI) is a combination of multiple indicators. The indicators are as follows: to assess exposure the indicators are natural disasters and climate change. The second one is the household's both the social characteristics and the economic characteristics that are affecting their adaptive capacity. Finally, the impact of climate change limited the sensitivity to the quality of household's current health, food, and water resource (Hahn et al., 2009). However, Hahn et al., (2009) identified seven major components of LVI which are also supported by different scholars (Alam et al., 2017; Pandey & Jha, 2012; Shah et al., 2013). These includes socio demographic profile of a community, a community's livelihood strategies, social networks, people's accessibility to health facility, access to food, access to water resources and finally the natural disaster's impact and several climatic variabilities. Each component is consisting of several sub components or indicators.

LVI method is very flexible in terms of adding or removing indicators and can also applicable for any community. LVI method has applied two approaches. One approach is to calculate the LVI as a composite index of the seven crucial components whereas the other approach advocates to present the seven components into IPCC prescribed three major contributing factors (e.g., exposure to change, sensitivity to change, and adaptive capacity to change) of vulnerability. The second approach is also known as LVI-IPCC framework method which can be derived from the seven major components of LVI. In this study both approaches are prescribed. However, comparative to SLA, LVI method has more preference and usefulness for several reasons. Major among them are, the LVI provides different institutions with an applied tool at the community level to better understand demographic, social, and health factors which are contributing in climate change. For instance, Hahn et al. 2009 proposed that by characterizing the quality of health and water resource, LVI method is very useful to quantify the strength of current livelihood of any community. Additionally, LVI approach also emphases to the alteration capacity of communities' livelihood strategies regarding to those exposures that are related with climatic events (Alam et al., 2017).

METHODOLOGY

Calculating LVI: Composite Index Approach

In this section the mathematical calculation for LVI is described. LVI calculation is needed three steps. The steps are explained as follows:

Step 1

In step 1 the values for each of the major components are calculated. Since all major components and sub components are contributing equally to the overall index, a balanced weighted approach will be used to find the values of the components and their respective sub components. However, it is observed from the previous studies that the sub components are

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measured in different scales. For this reason, the values of the sub components are needed to be standardized by the following calculation:

$$\text{Index } X_a = \frac{Xv - Xmin}{Xmax - Xmin} \qquad \ldots\ldots(1)$$

In equation 1, Xa denotes the original sub-component for area a. The Xv indicates the observed value as well as the Xmin symbolize minimum values and Xmax symbolize maximum values for each of the sub-component.

Step 2

After then the values of each main component, the sub-components will be averaged after their standardization for calculating. The following equation will be used for averaging the sub-components.

$$P_a = \frac{\sum_{i=0}^{m} Index\ Xa_i}{n} \qquad \ldots\ldots(2)$$

In equation 2, for an area a, each Pa is any one of the main components, of which Index Xai is representing the sub-components, indexed by i, which makeup each main component. Finally, n indicates the number of sub-components consists in each main component

Step 3

After otaining the values for each of the seven main components, the next step is to calculate the value of LVI. In the following equation 3 and equation 4 are used to get the averaged value of LVI. This is the simple average formula to calculate the LVI. Equation 3 is extended in equation 4 in the followings.

$$LVI_a = \frac{\sum_{z=1}^{7} H_{P_z} P_{az}}{HP_z} \qquad \ldots\ldots (3)$$

This is the simple average formula to calculate the LVI. Equation 3 is extended in equation 4 in the followings.

$$LVI_a = \frac{H_{SDP}SDP_a + H_{LS}LS_a + H_{SN}SN_a + H_H H_a + H_F F_a + H_W W_a + H_{NDC}NDC_a}{H_{SDP} + H_{LS} + H_{SN} + H_H + H_F + H_W + H_{NDC}} \qquad \ldots\ldots (4)$$

In the above equation, LVIa is for an area *"a"* which is the Livelihood Vulnerability Index, which can be calculated by computing the weighted average of the seven main components. WMz equals the weight of each of the main components. These are determined by the number of sub-components that make up each main component. Weights are being included because of all sub-components have equal contribution to the overall LVI. Furthermore, the value of LVI of a area lies between 0 (least vulnerable) to 0.5 (most vulnerable)

Calculating the LVI-IPCC: IPCC Framework Approach

The major components of the LVI methods can be decomposed to the component of vulnerability (IPCC, 2001), the next is to be needed to calculate the index of three dimensions of

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vulnerability which this study can call step 4 (e.g., exposure, sensitivity and adaptive capacity). Following next three equations (equation 5, equation 6, and equation 7) are shown the mathematical calculations.

$$Expo = \frac{H_{expo}NDCV}{H_{exp}} \quad \ldots\ldots(5)$$

Exposure's index (Expo) includes natural disasters and climate variability (NDCV). In equation 5, Hexpo represents the corresponding weights for the components of exposure.

$$Sens = \frac{H_{sens1}H + H_{sens2}F + H_{sens3}W}{H_{sens1} + H_{sens2} + H_{sens3}} \quad \ldots\ldots(6)$$

In equation 6, the index for sensitivity (Sens) is calculated. Where, Hsens1, Hsens2 and Hsens3 were the weights of the main components of health, food and water, respectively.

$$AdCp = \frac{H_{adcp1}SD + H_{adcp2}LS + H_{adcp3}SN}{H_{adcp1} + H_{adcp2} + H_{adcp3}} \quad \ldots\ldots(7)$$

Finally, in equation 7, the index for adaptive capacity (AdCp) is calculated. Where, Hadcp1, Hadcp2 and Hadcp3 represent the weight of the socio-demographic profile of the selected community, their livelihood strategies and community's social networks, respectively. It is mentioned that the value of each dimension will be between 1 the maximum value and 0 minimum value. Once exposure, sensitivity, and adaptive capacity were calculated, the three contributing factors were combined using the following equation:

LVI –IPCCa = (Expo – AdCp) * Sen ....(8)

By using the equation 8, the three contributing factors exposure, sensitivity, and adaptive capacity were calculated by combining where, LVI–IPCCa is the IPCC vulnerability framework used by the LVI for area a, Expo is the calculated exposure score for area a (equivalent to the Natural Disaster and Climate Variability major component), AdCp is the calculated adaptive capacity score for area a (weighted average of the Socio-Demographic, Livelihood Strategies, and Social Networks major components), and Sens is the calculated sensitivity score for area a (weighted average of the Heath, Food, and Water major components).

The adaptive capacity sub-components and LVI-IPCC must be in the inverse of each other because the things like the percentage of female headed households in an area for the LVI is an indicator of vulnerability. So, a high value of this indicator represents higher degree of vulnerability, but this sub-component is contributing to adaptive capacity in the LVI-IPCC framework. For this reason, it should use the percentage of male headed household. Therefore, for LVI-IPCC approach all the same sub-component indicators were used in normal way except taking the inverse of all the adaptive capacity indicators before they were averaged into their respective major components to fit the LVI-IPCC framework. To standardize these indicators same index formula is used, so they could be integrated into their respective major component. Moreover, the scaled the LVI–IPCC from -1 (least vulnerable) to 1 (most vulnerable). After calculating the index value of exposure, index value of sensitivity and index value adaptive capacity this study can assess the degree of severity of these three indexes of different small-scale fishing communities of Chalan Beel area of Bangladesh, which is the final objective of this study.

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Study Area and Sampling

For this study, three upazilas (sub districts) were randomly chosen. They are Chatmohor, Gurudaspur and Taras upazilas from Pabna, Natore and Sirajgonj districts respectively. After that the survey was done in different SSF communities of Chaikhola union, Khubjipur Union and Saguna union of Chatmohor, Gurudaspur and Tarash upazilas respectively. The reasons behind the selection of these areas are for the availability of a reasonable number of respondents and availability of easy communication to each of the area. Using the Nations (2005) survey formula, total 352 small scale fishing households were randomly selected of which 115 SSF households were from Chatmohor, 121 households from Gurudaspur and 116 from Tarash Upazila.

Data Collection

This study developed a structured survey questionnaire to collect data using face-to-face interviews between December 2017 and February 2018. The unit of analysis was the SSF households and for data collection the household head (either male or female) was the survey participant. Furthermore, nine sections made the surveys which including demographic information of household, household's occupation and water management practices, household's social networks, identified community problems valuation by the households, access to health services and valuation, food safety, water strain, natural tragedies, and climate variability. Additionally, on average 30 minutes each interview will be lasted. Surveys were carried out in Bengali the mother language of the household heads. Generally, interview was taken by the household's head, but in their absence, interview was taken by the spouse. However, husband was listed as household's head by the female respondents (wife) but when they further questioned; they answered that more than 1 month per year he lived away from the house. In these cases, it was coded that household's head was the female respondent (wife).

RESULTS

The Livelihood Vulnerability Index

LVI major components index values and overall LVI value for Chatmohor, Gurudaspur, and Tarash Upazila. Found that Tarash had a greater LVI than Chatmohor and Gurudaspur (0.359 versus 0.354 and 0.326, respectively), indicating relatively greater vulnerability to the impact of climate change. The index values of all seven main components of LVI along with the overall LVI value for three upazilas. The dependency ratio index is higher for Gurudaspur (0.330) than that of other two upazilas such as Chatmohor (0.265) and Tarash (0.265). On the other hand, Tarash on the socio demographic profile index showed greater vulnerability (0.322) than Chatmohor (0.308) and Gurudaspur (0.295). Similarly, Tarash also showed higher vulnerability in terms of Health index (0.284 versus 0.228 and 0.278).

In addition, in case of food Chatmohor is relatively more vulnerable than other two upazilas (0.502 versus 0.354 and 0.387). Similarly, in terms water Tarash is relatively more vulnerable than other two upazilas (0.182 versus 0.107 and 0.111). Additionally, in terms of socio demographic status Tarash is also more vulnerable than other two upazilas (0.322 versus 0.295 and 0.308). Finally, for natural disaster and climate variability component Tarash is more vulnerable (0.612 versus 0.556 and 0.464) than other two upazilas. In a spider diagram, the results of the main component calculations are presented collectively (Figure 1 & Figure 2). At

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the center of the web, the scale of the diagram ranges from 0 (less vulnerable), increasing to 0.7 (more vulnerable) at the outside edge in 0.1unit increments.

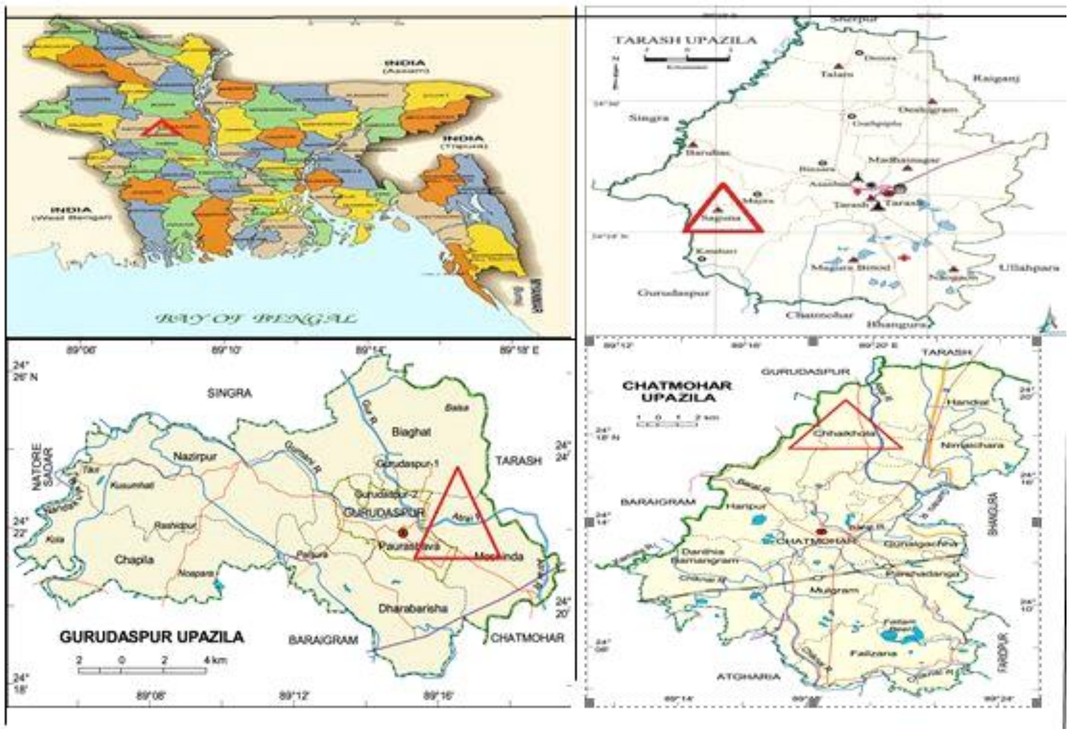
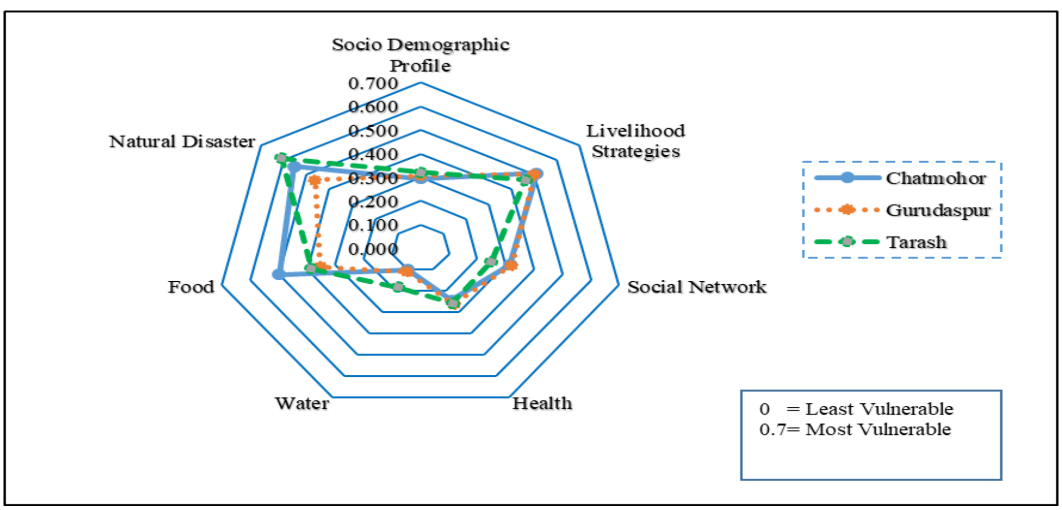


FIGURE 1
MAP OF BANGLADESH, MAP OF TARASH UPAZILA, GURUDASPUR UPAZILA AND MAP OF CHATMOHOR UPAZILA OF BANGLADESH



Source: Field survey (2017/18)

FIGURE 2
SPIDER DIAGRAM OF THE MAJOR COMPONENTS OF THE LVI

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LVI-IPCC Framework

For adaptive capacity, the contributing factors are socio demographic profile, livelihood strategies and social networking. It has showed the contributing factors of Tarash results are the most adaptive capacity score (0.751) comparative to other two upazilas by using the LVI-IPCC. On the other hand, for climatic sensitivity health, water and food are three major components of LVI that are considered as the contributing factors, although in terms for sensitivity of Tarash, it has the highest adaptive capacity score which is 0.272. Finally, for the climatic exposure, natural disaster and climate variability are considered as the contributing factor. Tarash is also considered as the most exposed upazila in terms of climate change. It scores 0.612 which is quite higher than other two upazilas which are for 0.556 and 0.464 for Chatmohor and Gurudaspur respectively.

Moreover, for exposure, sensitivity and adaptive capacity are contributing factors to the vulnerability triangle that plots the scores are shown in Figure 3. Furthermore, in Figure 3, 0 indicating low contributing factor whereas, 1 indicating a high contributing factor. It is shown from the figure that households from Tarash are more visible (0.612) to climate change and also have the high sensitivity (0.272) to climate change comparing to other two upazilas. The estimated results of the LVI-IPCC are slightly shown the change in the ranking of vulnerability as households of Tarash are found to be most vulnerable (-0.038 as comparative to households of Chatmohor and Gurudaspur with index scores of -0.046 and -0.050 respectively).

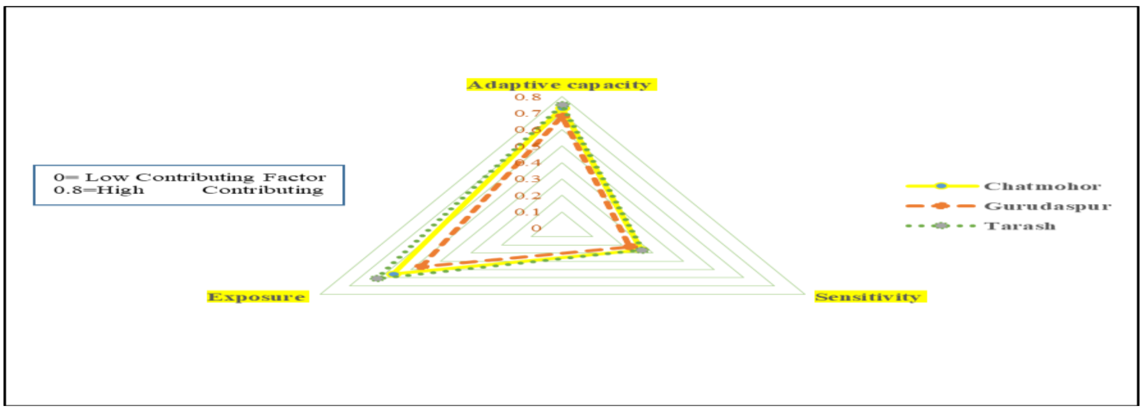

FIGURE 3
VULNERABILITY TRIANGLE DIAGRAM OF THE CONTRIBUTING FACTORS OF THE LVI–IPCC FRAMEWORK FOR CHATMOHOR UPAZILA, GURUDASPUR UPAZILA AND TARASH UPAZILA OF BANGLADESH

DISCUSSION

The overall objective of this study was to assess the impact of climate change on the SSF communities. This study found that the SSFs of this area had very limited income-generating activities (heavily rely on the income from fishing activities) with big family members (average number of family members is more than four). Moreover, they are surrounded with both the climatic as well as non-climatic problems. For instance, the household heads are not very educated (only 47% of household heads attended school and the average schooling years is 7.2

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years); the dependency ratio of each household is moderately high (average dependency ratio 0.57), they have less access to health facilities, and most households have water problems. Furthermore, on average, they struggle for food for approximately 3 months in a year. On the other hand, these households face the adverse effects of climate change and extreme climate events such as floods, storms, rock rain, and cyclones which became a part of their lives. Most households lose their physical assets during extreme climatic events.

Besides that, from this study it was also found that the SSFs typically have a higher incidence of water, health and sanitation problems. Traditional beliefs and poor education create social barriers which affect both household vulnerability and the adaptive capacity of a particular community (Jones & Boyd, 2011). Moreover, in Bangladesh, public spending on sanitation, access to clean and freely-available drinking water and public health are the lowest in the world. This study supports the previous studies which found that high index values for food, water and health components act as primary drivers for vulnerability (Alam et al., 2017). Moreover, working outside of the community for part-time IGAs and high dependency ratios are very common among poor communities (Hahn et al., 2009; Pandey & Jha, 2012). The households live in their houses on average since the last 40 years, which indicate that they have very limited opportunities to shift to another place. Furthermore, they have less access to financial capital assets which they believe is the most important asset among the capital asset pentagon. Additionally, from the oral interview, it was found that most of the SSF households do not have their own physical asset such as land, fishing gears, boats, fishing nets and others.

Finally, natural disasters are very frequent in the study areas in the form of floods, rock rain, storms and cyclone. Most of the households have lost their physical assets due to extreme climatic events and the family members are injured during the natural disaster period. Furthermore, very few households were warned prior the natural disaster which led the households in a devastating state during extreme climatic events. For these reasons, early warning system (EWS) and seasonal weather forecasting may help communities to prepare for extreme weather events (Hahn et al., 2009). In this study, it was found that due to the lack of these factors, the SSFs of Chalan Beel area face a severe climatic vulnerable situation. Besides that, the high dependency on fishing activities for livelihood made SSFs more vulnerable due to climate change (Allison et al., 2009).

CONCLUSION

This study found Tarash Upazila mosre vulnerable in terms of both livelihood vulnerability index (LVI) method and LVI-IPCC method Tarash upazila than other two upazilas. The spider diagram (See Figure 2) and the vulnerability triangle diagram (See Figure 3) show more vivid picture of the subcomponents of LVI and Climatic vulnerability of the three upazilas. In recent years, a growing body of literature points to the impact of gender on vulnerability. There is a scope for future researchers on these issues. It is hard to make the SSFs out of poverty without synchronizing all the stake holders. For this reason, it is necessary to coordinate the communication and cooperation among policy makers, local government, resource users and enforcement authority. Besides, resources and capacity for management, including data collection, policy sharing and information transparency, should be integrated.

Nevertheless, the LVI and LVI-IPCC framework approaches can be replicated in many sectors as well as in geographical areas, however, it is noted that vulnerability assessment is a complex procedure and needs a wide range of socio-political factors to be considered. It is often

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found that there is some level of subjectivity in choosing indicators by which the factors would be measured and the local environment plays a significant role in framing and designing the indicators. For this reason, extensive review of the literature from the local perspective, local knowledge, consultation of subject experts (i.e., environment scientist, fisheries experts etc.) and engagement of local stakeholders, would expect more good results in future.

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