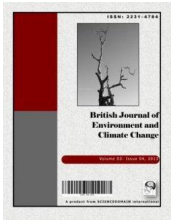

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An Exploration of Disaster Risk in Farmer's Community of Angaria Sub-sub-district in Bangladesh

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Aims: Analysis of risk, farmer's perceptions on risk and their adaptation practices through exploration of agriculture based farmer's community perceptions were lack on the perspective of Angaria sub-sub-district of Dumki sub-district of Patuakhali district in Bangladesh. That is why this study was conducted to gain understanding on agriculture farmers' risk profile, its impact and potential risk reduction strategy through community participation.
Study Design: A total of 23 Focus Group Discussion's (FGD) and 04 Key Informant Interviews (KII) were conducted. A well structured pretested questionnaire schedule was developed keeping in mind the objectives and variables under this study.
Place and Duration of Study: Angaria sub-sub-district of Dumki sub-district of Patuakhali district in Bangladesh, from January, 2015 to May, 2015.
Methodology: Primary data was collected through face to face FGD, KII methods and extensive field visit. Secondary data was collected from different secondary sources.
Results: The agriculture sector of the study area is potentially exposed by different primary and secondary risk factors such as cyclone, flood, drought, pest attack etc. which threats to agriculture production and pose the farmers to make their livelihood diversified. But due to the changing trend in risk profiles; increasing its persistence time and frequency and intensity, farmers' adaptation capacities and sustainability are more exposed to vulnerability and adaptive capacity of the farmers are decreasing in the study area. They are transforming from on-farm agriculture practices to nonfarm alternative livelihood options –not as innovative adaptive resilient options.
Conclusion: Recurring disasters phenomena threatened and undermined farmers capacity to adaptations, resulted more dependence on alternative nonfarm livelihood options than appropriate

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on farm adaptive options. Future extensive field based research in these regards will fulfill the required information to get the most efficient small farmers friendly risk management plan which will be beneficiary to the country by establishing climate smart disaster risk management in agriculture sector.

Keywords: Adaptation; agriculture; capacity; risk and vulnerability.

1. INTRODUCTION

The United Nations defines a disaster as a serious disruption of the functioning of a community or a society. Disasters involve widespread human, material, economic or environmental impacts, which exceed the ability of the affected community or society to cope using its own resources [1]. Disaster means natural, environmental and human induced hazards which require a significant coordinated response by the Government and other entities to help the community recover with external assistance as it is not able to do so with its own resources and capabilities [2].

Hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro-meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability [1]. Hazard means an abnormal event which has the potential to cause colossal loss to human life and livelihood and which can be either natural, human induced, biological or technological in nature [2].

According to UNISDR, risk is the combination of the probability of a hazardous event and its consequences which result from interaction (s) between natural or man-made hazard(s), vulnerability, exposure and capacity [1]. Risk assessment is an approach to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability. ISO 31000 defines risk assessment as a process made up of processes such as risk identification, risk analysis, and risk evaluation.

Risk identification is the process that is used to find, recognize, and describe the risks that could affect the achievement of objectives [1]. In risk assessment, the focus is on individuals and social groups and understanding the probabilistic of the triggering event [3]. This study on farmers' hazards, vulnerability, capacity and risk analysis by understanding, planning for and adapting to a changing climate from which an individual agriculture farmer can take advantage of opportunities to reduce risks associated with climate-induced stresses [4].

According to the IPCC, definition of vulnerability of climate change is, “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes [5]. Vulnerability is “a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity”. According to the Disaster Management Act vulnerability means measurement of elements at risk that are exposed to specific hazards both natural and human induced, and that have a low level of resilience to cope with the impacts or characteristics of that hazard [2]. Vulnerability is the degree to which a population, individual or organization is unable to anticipate, cope with, resist and recover from the impacts of disasters [6]. Children, pregnant women, elderly people, malnourished people, and people who are ill or immune compromised, are particularly vulnerable when a disaster strikes, and take a relatively high share of the disease burden associated with emergencies. Poverty – and its common consequences such as malnutrition, homelessness, poor housing and destitution – is a major contributor to vulnerability. Vulnerability is a set of prevailing or consequential conditions, which adversely affect people’s ability to prevent, mitigate, prepare for and respond to hazardous events. These long-term factors affect a household or community’s ability to absorb losses after disaster and to recover from the damage. Vulnerabilities precede disasters; contribute to their severity, impede disaster response, and may continue to exist long after a disaster has stuck [7].

Anderson and Woodrow categorize vulnerabilities into three areas [8]:

- *Physical / Material Vulnerability:* For example, poor people who have few physical and material resources usually suffer more from disasters than rich people. People who are poor often live on marginal lands; they don't have any savings or insurance; they are in poor health. These factors make them more vulnerable to disasters and mean that they have harder time surviving and recovering from a calamity than people who are better off economically.
- *Social / Organizational Vulnerability:* People who have been marginalized in social, economic or political terms are vulnerable to suffering from disasters whereas groups, which are well organized and have high commitment to their members, suffer less during disasters. Weakness in social and organizational areas like deep divisions may also cause disasters. Conflict over resources due to poverty can also lead to violence.
- *Attitudinal / Motivational Vulnerability:* People who have low confidence in their ability to affect change or who have "lost heart" and feel defeated by events they cannot control, are harder hit by disasters than those who have a sense of their ability to bring the changes they desire.

Coping capacity is the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters. The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during crises or adverse conditions. Coping capacities contribute to the reduction of disaster risks [1].

Adaptive capacity, the capacity of a system to adapt in order to be less vulnerable, is a dynamic notion. In fact, it has two dimensions: adaptive capacity to shocks (coping ability) and adaptive capacity to change. The first dimension is related to the coping ability (absorption of the shock), the second dimension is related to time (adaptability, management capacity). Adaptations are manifestations of adaptive capacity [9].

This research is based on the agriculture based community. The reason for implementing community-based approaches is that communities are knowledgeable about the hazards occurring in their environment and are able to anticipate them in some cases. They may not be scientific however; the richness of experience and indigenous knowledge is a resource to be recognized [10]. In risk assessment, the focus is on individuals and social groups and understanding the probability of the triggering event [11].

Cyclone, flood, drought, tornados, nor'wester, coastal erosion and so on occur in the country round the year [12] in Bangladesh and cause big damages and losses for farmers and agriculture sector. Though, as the largest non government enterprise, agriculture; crops, livestock, fisheries, forestry sectors contribute about 21% of the GDP, sustain the livelihood of about 52% of the labor force [13]. Agricultural activities are by nature prone to risks and uncertainties of various nature- biophysical, abiotic, climatic, environmental, biotic (pests, diseases) and economic. Many of these risks have a climatic component and most of them will be affected by climate change, either in intensity, scope or frequency [14]. Risk-sensitive agriculture is a prerequisite for food security and sustainable development [15]. Despite one of the poorest and most climatically vulnerable countries in the world, Bangladesh has achieved important gains in reducing poverty and increasing agricultural productivity. At present roughly 25% of the population is considered food insecure [16]. As the dominant economic activity in Bangladesh, role of agriculture is vital in enhancing productivity, profitability and employment in the rural areas for improving the livelihood security status of the poor [12]. That is why; analyzing the existing different risk factors' impact on agriculture is a need in assessing the farmer's community's risk and vulnerability.

The study focuses on exploring the agriculture farmer's risk profile through community participation. The main objectives of the research were -to identify the major types of hazard related risks faced by farmers, to what extent natural hazard affects the agricultural sector and to find out the potential risk reduction strategies in agricultural sector.

2. METHODOLOGY

2.1 Area, Location, Demography and Socio-economic Condition

The study was conducted at Angaria union (sub-sub-district) of Dumki upazila (sub-district) under Patuakhali district in Bangladesh, established in 1983. Total area is 7.5 sqkm; located in between

22°23´ and 22°30´ north latitudes and in between 90°17´ and 90°27´ east longitudes; bounded on the north and west by Payra river, south by Angaria; on the east by Muradia sub-sub-district of Dumki sub-district. Total numbers of villages are 7; total population is 20,152; female-10135, male-10017; density is 477/sq km; households are 3,755 and average household size is 5.1. Literacy rate is 79%. Number of cyclone shelter is 02; sanitary latrine is 3755; community clinic is 02 and has one family planning office. Total agricultural land is 3500 acre for one crop/year and 2400 acre for two crops/year. Annual average temperature is 22.7°C. Main river is Payra. The economy of Anagaria sub-sub-district is predominantly agriculture. Farmers produce varieties of crops, namely local and HYV rice, jute, mug-bean, khesari (pulses), mustard, vegetables etc. Various fruits like banana, jackfruits, guava, coconut etc are grown. Besides crops, livestock forestry and fishery are the main source of household income. Without agricultural activities people are also related with various off farm activities for their livelihood (Source: Sub-sub district office).

2.2 Research Methods and Data Collection

This study was conducted from January 2015 to May 2015. The methods of data collection included completion of the Focus Group Discussion (FGD) -semi-structured farmer's interviews (questionnaire survey) with the community members, direct field observation and Key Informant Interviews (KII). A total of 23 FGD sessions (total 138 respondents) was conducted. Additional information as secondary data was pertaining to the study was attained by accessing the relevant information from media such as journal articles, research thesis, recorded data, data from different local government administrative offices-Union and Upazila office. A total of 04 key informant interviews were done with sub-sub-district chairman, school teachers and agriculture extension officer of Dumki Upazila and assistant agriculture officer of Angaria Union. During data collection the following questions were focused to get the information—i) Existing hazards for agricultural sector, vulnerability and capacity of this

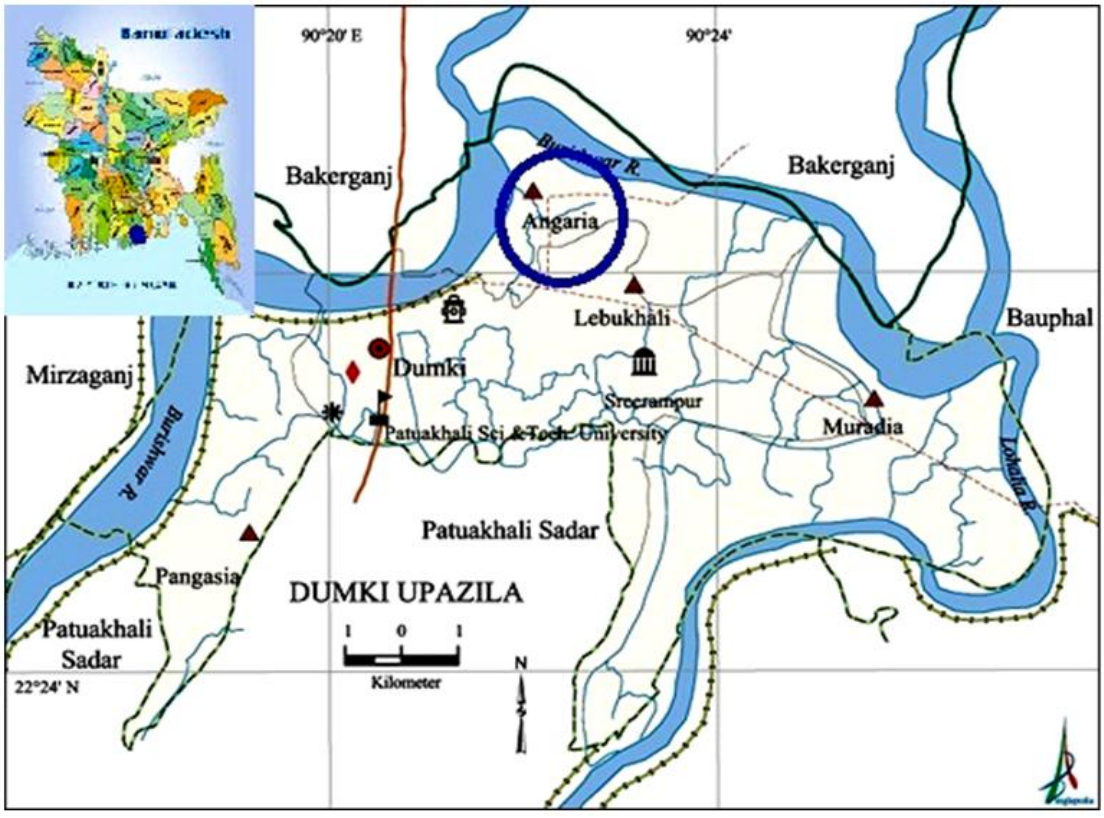


Fig. 1. Map of Angaria sub-sub-district, Dumki, Patuakhali in Bangladesh (Blue color circled)
(Source: Banglapedia)

community in the study area ii) Risk factors related to the agriculture and the impact of all risk factors on local community based agriculture production and iii) Existing best adopted adaptation strategies.

2.3 Data Analysis Method, Statistical Tools and Techniques

After the completion of data collection, tabulation work including editing, coding and tabulation manually. Data computation and analysis was done using Microsoft Office Excel program. The United Nations Development Programme [17] defines risk by the equation: Risk = Hazard X Vulnerability. [R= (HXV)] ([18]; other scientists and organizations [19,20,21] add manageability or capacity to the equation and propose: Risk = (Hazard X Vulnerability) /Manageability or Capacity [R = (HxV)/C]. Therefore risk assessment and computation was done following the equation (Here, R= Risk; H= hazard; V= Vulnerability and C= capacity). Correlation (CORREL) between different dependent and independent variables was determined and ANOVA was performed to determine the significance or insignificance at *p= .05*. Different secondary data were analyzed and integrated with primary data.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic Condition

According to the research analysis, of the 138 respondents of the study area, 55% were male and 45% were female. Here, 41% respondents were between 18-35 years old; 40% were 35-50 years and only 19% respondents were above 50-years. Analysis revealed that 23% of males and 35% of females have primary; 20% of males and 13% of females have secondary and 7% male and 2% female have higher secondary education. In the study area 43% of the respondents' farm size was within 1-50; 38% was between 50 and100 and 19% was above 100 decimal. Here, 35% of the respondents have farming experience of at least 15 years, 46% up to 30 years and 19% above 30 years. Analyses indicated that more experienced and poor farmers showed more knowledge to deal with the disaster risk. As most of the farmers are poor, they are very much vulnerable to various disaster risks and their capacity was insufficient to cope with these disasters. In the Dumki upazila, 21% of its populations are living below the food poverty line [22]. Researchers reported that the ability of farming households to cope with disasters is also significantly impacted by family members' experiences and their economic context at the village level [23]. Research of other scientists [24] revealed that Bangladesh is a land scarce country where per capita cultivated land is only 12.5 decimals.

3.2 Livelihood Activities and Local Hazards Calendar

Table 1 showed the livelihood activities and local hazards calendar formulated by the respondent farmers. The Color Codes of each calendar are used for understanding the risk or probability of occurrence of particular hazards at different agriculture production of the year. Analysis revealed that pest and diseases harassed, all the year round but during rainy and pre winter season (from May to November) the infestation reached high due to higher moisture and damaged a lion part of crop, vegetable and livestock production. Tidal flood and flood remains low and medium in January to April and October to December; reaches high in May to September and caused high damage of agriculture field, outbreaks of water borne diseases; loss of livestock production etc.

This time especially cultivation of Aman paddy became uncertain due to inundation and water logging. Cyclone and storm surge remain high in April to November and caused high damages and losses of human, wealth, infrastructures, communication, health and sanitation etc. Drought remained high to medium in January to April and November to December and made difficult to cultivate Aus paddy and winter agriculture practices. Nor'wester caused high damages of plant, houses, standing crops and emergency communication in April to June. Hail storm damaged the watermelon and other winter crops in April to July. Due to thunderstorm caused loss of human and animal and high rising trees in April to September.

From the previous research it was found that the farmers who are living on agriculture and fish production suffer a lot during the dry season due to drought. These farmers also suffer during the wet season as flood, cyclone, inundation, flash flood is observed which destroyed livestock, cattle, paddy, trees and crops, and flood water swept away their crops [25]. Pests are any organism or microorganism- weeds, insects, and pathogens that harm or kill crops and reduce the value of crops before and after harvest. Most analyses concur that in a changing climate, pests may become even more active than they are

currently, thus posing the threat of greater economic losses to farmers [26]. In this situation researchers [27] suggested that adoptions of management practices are the most appropriate strategies to reduce these risks for growing crops. Other researchers [28] also suggested a combination of pest and insects control techniques in a particular cropping system includes cultural practices, crop rotation, use of resistant varieties and chemical treatment only when there is a real need.

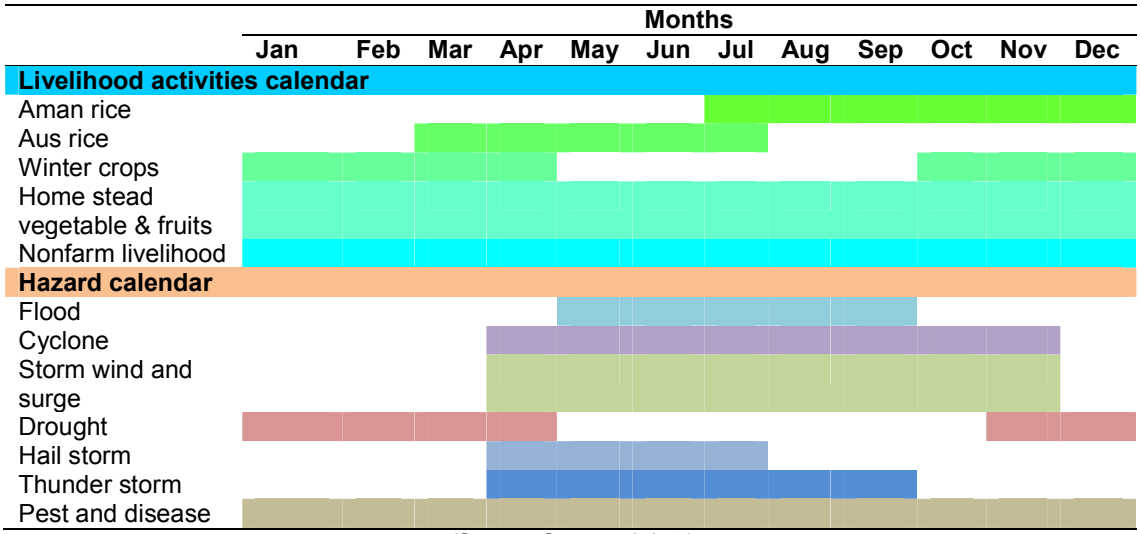
3.3 Livelihood Diversifications

People of Angaria union lead their livelihood mainly by agricultural activities (82%). Nonfarm activities and employment opportunities are limited in the study area, only 8% are connected with tailoring, fishing; 6% are engaged with rickshaw-van pulling, day laborer and 4% lead their life through teaching, retail shopping, rickshaw workshops, motorbike-taxi driving etc. But they are not permanent on their current livelihood activities. Occasionally it changes with the changed situation. Approximately 77% households have rear indigenous poultry and livestock on their homestead area. Traditionally farmers' family members take care the feeding of the animals and other activities following traditional practices. About 18% of the Farmers practice fishing in open water body's whole year as their extra source of income and family need. Farmers are increasingly changing their livelihoods as alternative options -not as appropriate innovative options and which results no sustainable change in agriculture but almost compensation based adaptation practices [29]. Other scientists [30] suggested on risk mitigation techniques in agriculture and suggested that the most commonly applied risk management strategy is diversification and risk-averse farmers particularly diversify their crop and livestock as nonfarm livelihood activities. By doing so, loss in one sector is relatively covered by productivity of the other sectors. From the previous research [31], it was found that farmers generally have livestock and poultry in their house for cash income and usually they sell these in order to meet household financial needs during disaster and when they have no income.

3.4 Exploring the Hazard, Vulnerability, Capacity and Risk Faced by Farmers Community

Field studies and investigations among the local farmers community allowed the identification of the types of potential hazards present in the studied region. Results were analyzed and the potential natural and human induced hazards were identified according to their intensity and frequency. Study (Fig. 2) showed that the first prior hazard is pest and disease which scores 8.83; subsequently drought scores7.08, cyclones cores 6.57, hail storm scores 6.57; storm surge scores 5.86; storm wind scores 5.59; flood scores5.32; thunderstorm scores 4.77 and salinization scores 4.50.

Table 1. Livelihood activities and local hazards calendar



(Source: Surveyed data)

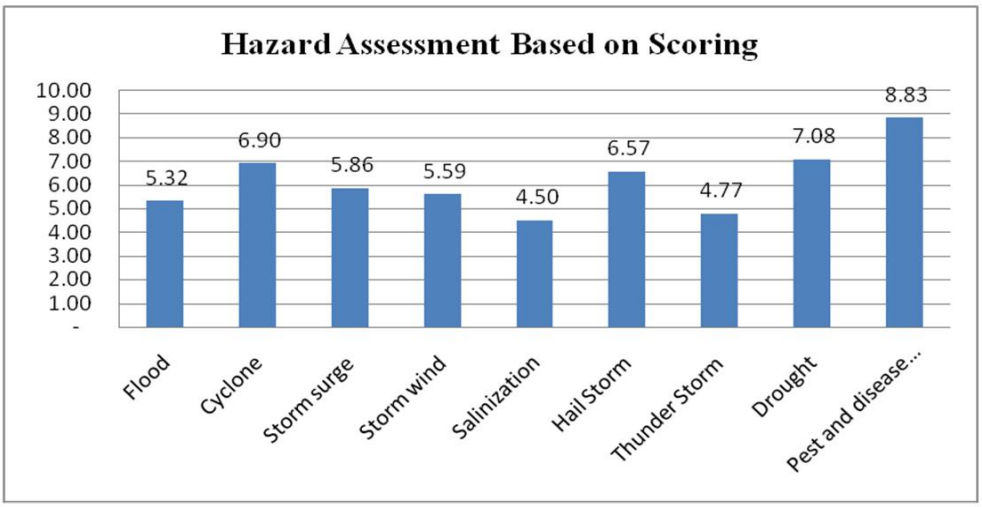


Fig. 2. Hazard assessment based on farmers' perception score
(Source: Surveyed data)

Due to these hazards every year farmers are recurrently and intensely faced big losses of crop production and economic damages in the study area. Farmers who earn their livelihood by agriculture and fishing activities suffer a lot during dry season due to drought and in wet season because of flood, cyclone, inundation, flash flood [25]. These disasters destroy farmers' agriculture related livelihood and other sources of income. Researchers [32] commented that excessive rain fall may cause damage to younger plants and yield declines due to water flood, water logging and increased pest infestations. Drought and inundation can also hinder field operations. Adoptions of management practices are the most appropriate strategies to reduce these risks for growing crops were suggested by researchers [26].

Literature review confirmed that risk is the combination of the probability of a hazardous event and its consequences which result from interaction(s) between natural or man-made hazard(s), vulnerability, exposure and capacity [1]. Hence it is important to consider the farmers' contexts in which vulnerability increased and their underlying risk factors to increased vulnerability. Regarding the vulnerability analysis, Fig. 3 showed that among all hazards, hail storm vulnerability is the highest (score 7.5); then cyclone, pest and disease obtaining the same score 7.2; after that storm wind, flood, storm surge, drought, salinization and thunderstorm (5.5) accordingly. Climate change may be connected to an increase in the number of natural disasters worldwide and the primary message for disaster management should be on the reduction of vulnerability to such extreme natural processes. Consequently, an enhancement of capacity-building and resilience is essential [33]. The risk of crop losses from pest and disease and natural hazards like drought, cyclone, flood, excessive rain fall are the important vulnerability for agricultural producers [34,35]. Capacity to cope is increasingly seen as a key component of a household's or community's level of vulnerability [36]. Thus, capacities of the farmers were analyzed and the result revealed that (Fig. 3) the highest coping capacity score is obtained by pest and disease epidemic which is 6.9; then cyclone scoring 5.8; storm surge 5.3; flood 5.2; drought 5.0; then storm wind, hail storm, thunder storm and salinization (4.0) accordingly. Scientists [8] stressed the need to identify the capacities that already exist in societies when designing disaster-related development interventions. Risk has been calculated after the calculation of hazard (H) and vulnerability (V) scores and exploring the capacity (c) to cope with disaster. Fig. 3 showed that highest capacity score is 15.3 which is obtained by hail storm; then pest and disease epidemic 9.6; then cyclone -9.4; drought -9.1; flood -7.5; then storm surge, thunder storm and salinization consequently. Lower levels of adaptive capacity in developing countries are very often associated with poverty [37,38]. Thus, vulnerability is context-specific, and the factors that make the farmers vulnerable to the effects of climate change depend on the nature of the system and the type of effect [39].

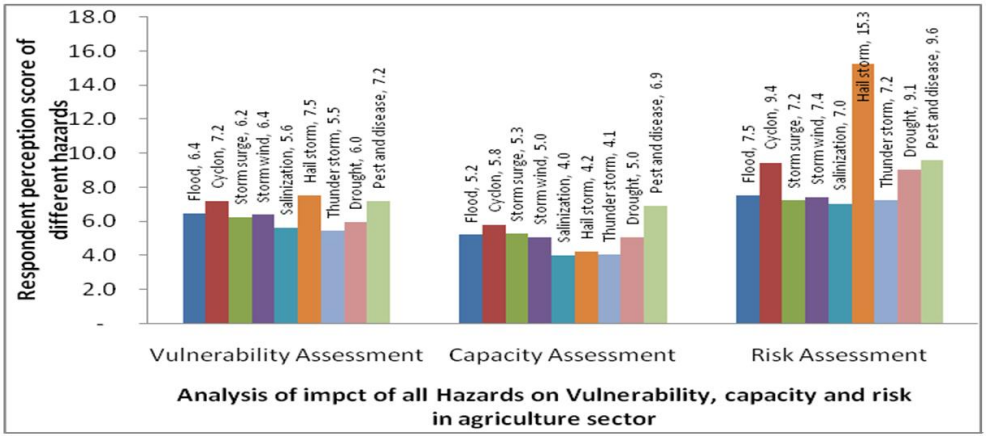


Fig. 3. Vulnerability, capacity and risk faced by farmer's community
(Source: Surveyed data)

3.5 Elements at Risk Due to Vulnerability

There are two major research traditions in vulnerability: the analysis of vulnerability as the lack of entitlements and the analysis of vulnerability to natural hazards. The basis of the second tradition is the physical elements of exposure, probability and impacts of hazards [40]. Discussion with respondents and physical visit revealed the elements at risk were identified considering the potential existing hazards phenomena. Following area and elements in the Table 2 are susceptible to being affected by pest and disease epidemic, cyclone, seasonal drought, hail storm, storm wind, thunderstorm, flood and salinization etc.

3.6 Correlation and Regression Analysis of Different Risk Factors and Their Analysis

Table 3 shows the relationship between risk and vulnerability to all hazards in the study area. Result revealed that all existing hazards in the locality have moderate positive correlation considering the risk and vulnerability. This indicates that all the year round due to different types of hazards phenomenon when vulnerability increases, risk of farmers in agriculture sector increases and threatens the overall situation recurrently and frequently.

At the same time, analysis of the correlation between risk and capacity (Table 3) revealed strong negative significant correlation for thunderstorm and moderate negative significant correlation for flood, cyclone, storm surge, storm wind, thunder storm, hail storm, drought and pest and diseases epidemics phenomenon. This means that all the year round due to different types of hazards phenomenon, farmers face vulnerability and results fragile socioeconomic conditions that threatened farmer's livelihood. Consequently capacity to face the disaster in agriculture sector decreased and different secondary risks increased in agriculture sector. That's why communities are increasingly depending on the non-agricultural livelihood activities.

3.7 Analysis of Combination Effect of All Hazards

Tables 2 and 3, Figs. 4, 5 and 6 represents the impact of all hazards on farmers' vulnerability, capacity and risks faced. These studies revealed that both regression analyses showed a significant relationship (at 5% level of probability) among (vulnerability, risk) and (capacity, risk) variables. They have the moderate positive (r=0.6) and negative (r=0.5) relationships respectively. That means due to all hazards effect, if vulnerability increases, the risk increases; on the other hand if capacity decreases, risk increases. So, it is possible to reduce the risk through minimizing the vulnerability and uplifting the capacity of the farmers. Previous research pointed out the significance of vulnerability assessment since it proves that although the hazard has decreased the vulnerability has risen due to higher physical exposure and lower adaptive capabilities [41]. Researcher commented that [40] key parameters affecting vulnerability are the stress to which a system is exposed, its sensitivity and its adaptive capacity.

Table 2. Analysis of elements at risk

Area	Elements at risk	Hazards								
		Pest and disease	Cyclone	Seasonal drought	Hail storm	Storm wind	Thunder storm	Flood	Storm surge	Salinization
Population	20,152 inhabitants		√		√	√	√	√	√	√
Households	3,755 households		√		√	√	√	√	√	√
Infrastructures	School-15		√		√	√	√	√	√	
	Madrasa -5		√		√	√	√	√	√	
	Mosque- 43		√		√	√	√	√	√	
	Pagoda-3		√		√	√	√	√	√	
	Hat and bazaar-4		√		√	√	√	√	√	
Sources of income	Agriculture 30.10%,	√	√	√	√	√	√	√	√	√
	Fishing 26.45%,			√				√	√	√
	Non-agricultural labor 3.3%,	√	√		√	√	√	√	√	
	Business 15.62%,	√	√	√	√	√	√	√	√	
	Construction 8.20%,	√	√	√	√	√	√	√	√	√
	Rickshaw pulling - auto bike or motorcycle driving 16.03%	√	√	√	√	√	√	√	√	
	Religious service 0.30%	√	√	√	√	√	√	√	√	
Communication	Pucca road and mud road		√		√	√	√	√	√	
Critical facilities	Rural electrification area		√	√	√	√	√	√	√	
	Tube well		√	√	√	√	√	√	√	√
	Pond and cannels		√	√				√	√	√
	Sanitation		√			√	√	√	√	

(Source: Surveyed data)

Table 3. Correlation and regression analysis of different parameters (*P*= .05)

Hazard	Risk x Vulnerability			Risk x Capacity		
	Correlation	r^2 value	*P*-value	Correlation	r^2 value	*P*-value
Flood	0.4	0.13	.51	(0.7)	0.09	.00*
Cyclone	0.7	0.46	.46	(0.7)	0.00	.00*
Storm surge	0.6	0.37	.37	(0.4)	0.00	.00*
Storm wind	0.7	0.51	.17	(0.4)	0.00	.05*
Salinization	0.4	0.12	.34	(0.6)	0.10	.07
Hail storm	0.7	0.52	.49	(0.7)	0.00	.00*
Thunder storm	0.6	0.35	.58	(0.8)	0.00	.00*
Drought	0.7	0.45	.29	(0.5)	0.00	.01*
Pest and disease	0.4	0.14	.14	(0.7)	0.08	.08*
All hazards	**0.6**	**0.39**	**.00***	**(0.5)**	**0.22**	**.00***

**Significant. (Source: Surveyed data)*

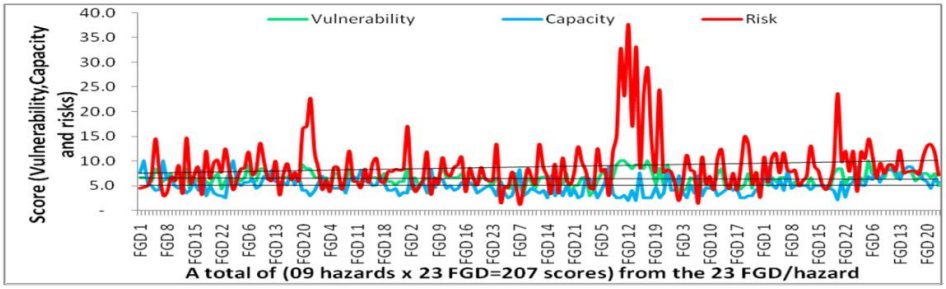


Fig. 4. All hazards' impact on vulnerability & risk and capacity & risk
(Source: Surveyed data)

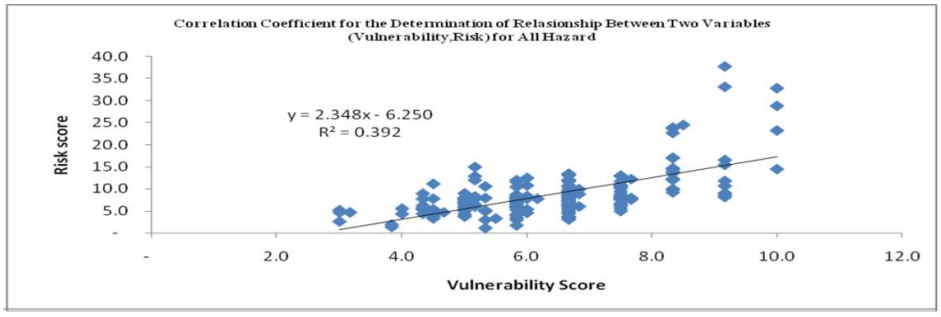


Fig. 5. All hazards impact on correlation between vulnerability and risk
(Source: Surveyed data)

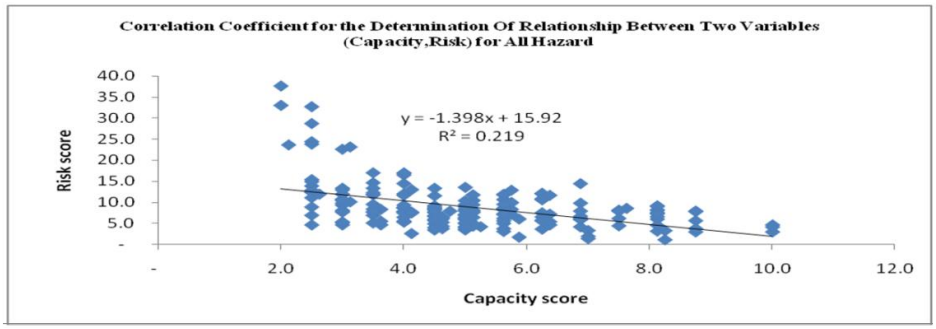


Fig. 6. All hazards impact on correlation between capacity and risk
(Source: Surveyed data)

3.8 Farmer's Coping Strategies and Adaptation Practices

Farmer's rate of adoption of coping strategies are influenced by variations in risk perception, which are also influenced by several factors like age, gender, livelihood, level of education and socio-economic conditions etc. Majority farmers of Angaria union follow T. Aman\pulse–Fallow–Fallow cropping pattern. Aus and Rabi crop - mainly grass pea, mungh bean and chili are widely grown by the farmers. Farmers also adopted different adaptation strategies like integrated farming system, use of resistant/tolerant variety, good agronomic practices, IPM, early or late variety selections etc. Farmers with their family members are engaged in homestead gardening, poultry and small livestock rearing, fishing, small business that helps in increasing their economic contribution. To overcome the loss farmers occasionally sell these sources of cash income in order to meet household financial needs and when they have no income. Farmers refurbish and increase house plinth using traditional techniques and materials; thus make it resilient to cyclone, storm wind and flooding or inundations. An immediate and direct way to help smallholder farmers ensure their farm-based livelihoods in the face of the increasing stresses posed by climate variability is to focus on helping them use farm management practices based on agro-biodiversity and ecosystem services that provide adaptation benefits [42]. Previous researchers also supported that the farmers adopted adaptation measures and recommended to adopt modern adaptation measures to reduce risk and suggested to emphasis on appropriate crop variety selection for early or late cultivation, good quality seed, timely planting or sowing, appropriate fertilizer management, weeding and integrated pest management [15]; establishment of 'Field school' as demonstration plot and center for crop seed or seedling; location specific packages of technologies moving towards "prescription farming" [43] could be helpful to promote the adaptation of good agronomic practices to increase the productivity, yield and profit.

4. CONCLUSION

The agriculture sector of the Angaria is potentially exposed by different primary and secondary risk factors phenomena, such as cyclone, flood, drought, pests attack etc which are revealed in the analysis. Recurring phenomenon of hazards and increasing threats to agriculture production provide the farmers to make their livelihood diversified. Present research revealed changing cropping pattern, adoption of good agronomic practices, selection of early or late crop variety, homestead gardening; rearing poultry, livestock and fishing; and nonfarm livelihood like small business were adopted by the farmers to cope with climate change and risk impact. Farmers are more aware about their risks and what they could do to reduce their exposure on the impacts of future disaster risks. Future extensive field based research in these regards will fulfill the required information to get the most efficient small farmers friendly risk management plan which will benefit the country to establish climate smart disaster risk management in agriculture sector.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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