Assessing Factors Affecting Drought, Earthquake, and Flood Risk Perception: Empirical Evidence From Bangladesh

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Abstract

Understanding household disaster risk perception is crucial to formulate and apply disaster risk reduction strategies. Using survey data from 300 households from three highly disaster-prone areas of the lower Teesta River basin in Bangladesh, this study explores households' risk perception of drought, earthquake, and flood at the local-level. The ordered probit regression model was applied to identify the factors influencing household disaster risk perception. Most of the respondents perceived the likelihood of occurring drought, earthquake, and flood hazards on large-scale in the selected areas which cause negative impacts on their quality of life and financial losses. They lacked knowledge on mitigation actions which makes them unable to control the devastating impacts of disasters. Econometric results show that households' age, gender, education, and income-generating sources had significantly influenced the respondent's drought, earthquake, and flood risk perception ($p < 0.01$). Female participants perceived more risks, less knowledge on mitigations actions, and are less capable of controlling the hazards than their counterparts making them vulnerable group to the impacts of hazards. Urgent action is required to improve their socioeconomic conditions, to reduce the knowledge gap between male and female, as well as to improve the household's understanding of mitigation and preparedness for mitigating disaster risk.

1. Introduction

Risk perception (RP) is an essential constituent for formulating and implementing disaster risk reduction (DRR) approaches and plans (Peacock et al., 2005; Sattar and Cheung, 2019). Under the connotation of community participation in DRR strategies, the household's RP has gained much attention in recent studies (Birkholz et al., 2014; Rana and Routray, 2016; Sattar and Cheung, 2019). Bangladesh is an extreme disaster-prone country ranked 5th position in terms of the occurrence of disasters in the world (Dastagir, 2015). Floods, droughts, and earthquakes are the most challenging disasters among the frequently occurring various natural hazards in the country (Barua et al., 2016; Islam et al., 2017; Rahman, 2019; Zhang et al., 2019). Every year millions of people lose their livelihoods, lands, and societal status due to these frequently occurring disasters (Habiba et al., 2012; Alam et al., 2018).

The Lower Teesta Basin (LTB) of northern Bangladesh has been facing the difficulties of floods and droughts on a different scale every year. Although earthquake is not a frequently occurring event in northern Bangladesh, this region is seismically active due to the Dauki fault and Shillong plateau in its north causing infrastructure disruption, environmental disruption, and so on when it occurs (Paul and Bhuiyan, 2010; Haque, 2015; Islam et al., 2016). These disasters cause huge losses of crops resulted in regional and seasonal food insecurity, livelihood loss, migration-related crises, psychological problem, and environmental degradation (Paul, 1997; Paul, 1998; Azad et al., 2013; Islam et al., 2014; Barua et al., 2016; Rahman, 2017; Mardy et al., 2018; Haque et al., 2019). However, the degree of disaster risk and loss differ from individual to individual based on the perception of the respective disaster (Fernandez et al., 2018). Consequently, clear perception and understanding of any disaster by the household might contribute to reducing the potential losses through forwarding planning of how and which initiatives are needed to lessen the disaster impacts. Reliable local level data is the primary prerequisite of getting the clear insight about the contemporary level of the RP of the residents at local areas which is very essential to act

accordingly to reduce the bad effects of extreme events arising from the lack of proper knowledge on hazards preparedness and mitigation at local areas. So, it is crucial to assess RP at local-scale, instead of constructing a generalize idea by considering a large area.

This is also crucial to understand the factors that influence household RP for adopting options by policymakers and planners for sustainable disaster management, especially for sustainable agricultural crop management (Islam et al., 2020). Several studies have found that socioeconomic characteristics such as gender, education, age, family size, and monthly income are significantly correlated with various risks perception variables such as controllability, knowledge of mitigation options, and perceived likelihood of disaster. These characteristics influence people to take appropriate measures for reducing disaster losses (Abid et al., 2015; Daramola et al., 2016; Qasim et al., 2016; Mills et al., 2016; Shah et al., 2017; Ahmad and Afzal, 2020). There is, however, a lack of studies on households' RP in many Southeast Asian nations, including Bangladesh. Even after the great flood in northern Bangladesh in August 2017, there found no notable research on flood RP (Islam and Haque, 2018). Previous studies on RP conducted in north-western Bangladesh considering in single risk perspective of drought (Habiba et al., 2012, Salam et al., 2021), Earthquake (Islam et al., 2016), Riverbank erosion (Alam et al., 2017), and flood risk (Rahman, 2017). However, the integrated RP studies of drought, earthquake, and flood are still unexplored in Bangladesh. Previous studies have mainly focused on reasons, outcomes, and measures for lessening the risks of these disasters in northern Bangladesh (Habiba et al., 2012; Azad et al., 2013; Habiba et al., 2014; Islam et al., 2014; Barua et al., 2016; Islam et al., 2016; Ferdous and Mallick, 2019; Rahman, 2019; Haque et al., 2019). To the best of the authors' knowledge, no prior published studies have been explored the local level RP at the household level and the factors influencing their simultaneous RP of drought, flood, and earthquake in Bangladesh. In northern Bangladesh, disaster risk management strategies had prepared at different administrative scales (Islam and Haque, 2018), without a deeper insight into the level of households RP and what provisions they had implemented to avoid disaster risks (Habiba et al., 2012). For motivating local households to take disaster preparedness actions, it is very essential to recognize which factors stimulate them taking cautionary actions. This study fills the void in the gaps in RP research. Thus, the goals of this study are: (i) to understand the local level of RP of drought, earthquake, and flood among the local households at three disaster-affected areas of the LTB of northern Bangladesh; and (ii) to detect the socio-economic and observed factors affecting households' RP. The findings of this study will help the policymakers and practitioners to take precise DRR strategies.

2. Theoretical Framework

RP is defined as commons views, attitudes, decisions, and emotional states on the possibility and significance of the events, or technologies (Fernandez et al., 2018). In other words, psychological, spiritual, cultural, social, indigenous knowledge of the individual which collectively regards as experiences of certain risk factors can clearly define any hazardous satiation and its fate known as RP. In a short term, the progression of collection, selection, and interpretation of the impacts of certain unpredictable events denote RP (Wachinger, 2013; Castro et al., 2017). Most scholars do believe that commons RP can influence their preparedness for, response to, and recovery from natural disasters (Grothmann and Reusswig, 2008; Ho et

al., 2008; Salam et al., 2021). RP plays a vital role in managing any hazardous and disastrous event. Knowledge of RP may give a significant understanding of common people's readiness to implement cautionary measures and may assist government and non-governmental organizations (NGOs) DRR strategies (Pidgeon, 1998, Rana and Routray, 2016). Researcher scholars reached a consensus that RP is measured in higher by scholars than the two vital features of risk: possibility and magnitude of effect (Ren, 2001).

Now a day, the impacts of several disasters increased nearly exponentially throughout the world. Nature and extent of disaster impacts vary from place to place, season to season, and community to community. The mitigation actions, as well as adaptive strategies, are also depending on the respective communities' and places' socio-economic and geographic characteristics, respectively. The lower Teesta basin (LTB) of northern Bangladesh is susceptible to drought, earthquake, and flood due to its geographic location, physical characteristics, and socio-economic characteristics of the people of that area (Haque, 2015; Islam et al., 2016; Mardy et al., 2018; Haque et al., 2019). Prolonged shortage of groundwater along with surface water for a considerable period due to rainfall deficiency, extensive withdrawal of groundwater, and deforestation causing extensive structural, environmental, agricultural, and socio-economic disruption of a certain community regarding as drought (Islam et al., 2017; Mardey et al., 2018; Ahmed et al., 2019). Earthquake is the most unpredictable and overwhelming geo-tectonic hazard in the earth history defined as the sudden vibrating of the surface of the earth due to the intension of severe energy discharge mainly caused by movement of plates and seismic activities (Paul and Bhuiyan, 2010; Choudhury et al., 2020). On 28 April 2021, a strong earthquake measuring 6.0 magnitude on the Richter scale had been felt in almost all regions of Bangladesh and the epicenter of that ground shaking is situated 43 km west far-flung Assam Tezpur (The Daily Star, 2021). Due to its unpredictability a small-scale earthquake able to cause severe structural, hydrogeological, and environmental damages which then disrupts the normal economic and social life status of the affected community. A flood is a hydro-meteorological event defined as the outflows of water of the bank of the river which then flows onto dry land and persists for a long time on that land. Several natural, as well as anthropogenic factors, act as triggering elements for occurring floods such as heavy rainfall, deforestation, unplanned structural establishment by grabbing river, and unplanned river dredging (Tingsanchali, 2012; Azad et al., 2013). Therefore, the planners and policymakers must know the RP about a certain disaster to formulate appropriate rules, laws, and regulations for sustainable risk management in a certain community.

2. Data And Methods

2.1 Study area description

The LTB is the home of around 30 million people. About 71% area of the Teesta Basin has covered the LTB positioned in the northwest part of Bangladesh. The present research has been selected the Upazilas (i.e., sub-district) Kaunia, Lalmonirhat Sadar, and Char Rajibpur, respectively, from the districts Rangpur, Lalmonirhat, and Kurigram by taking consideration of the severity of drought, earthquake, and flood (Fig. 1). In Bangladesh, mouza has been recognized as the lowermost administrative unit made of one or more

than one village (BBS, 2014). For this reason, mouza has been taken in consideration with a view to collecting comparatively precise data. Data were collected from Haibat Khan (Kaunia), Madhuram (Lalmonirhat Sadar), and Swikar Pur (Char Rajibpur) mouza of Tepamadhupur, Rajpur, and Mohanganj unions, respectively.

An overview of the study areas is presented in Table S1 (please see the supplementary file). Table S1 shows the climatic condition of the three Upazilas. These areas are located in the northern part of Bangladesh, adjacent to the largest Teesta and Brahmaputra rivers. Heavy monsoon rain and water from upstream sources have triggered rivers to raise its water levels. The rivers become dry for removing water from its upstream in certain periods of the year, and this region is situated in the seismically active zone. For these reasons, these areas are highly vulnerable to flooding, drought, and earthquake hazards. Several natural hazards have severely damaged the population leading to death tolls and property losses. Most of the people in this region depend on agriculture as their main source of income. The local people have comparatively given priority to the indigenous knowledge they holding instead of scientific approaches for building different types of disaster RP. All These reasons together have driven to choose these specific areas for this study.

2.2 Ethical consideration

Informed permission was taken before the questionnaire investigation. The field assistants were trained beforehand and consent were taken from the survey respondents. They were informed that the information will be used for research purposes. The authors took help for correctly reviewing and approving the content of the questionnaire and the procedure of the survey from a committee of Department of Disaster Management of Begum Rokeya University, Rangpur, Bangladesh that has been working for evaluating proposal and considering the ethical issues.

2.3 Design of the questionnaire, collecting and coding the data

Data has been collected by making some field visits with the intension of collecting the required information needed to complete the proposed study from the selected study areas. The total number of populations of Haibat Khan, Madhuram, and Swikar Pur, respectively, are 2995, 2704, and 1098 (BBS, 2014; BBS, 2015). The present study has been utilized the method for calculating the total number of sample size for each area that had proposed by Cochran (1977). After applying the Cochran's formula, the total number of calculated sample size found for this study ($p < 0.05$ and error value at $< \pm 10\%$) were 98, 98, and 92, respectively, for Haibat Khan, Madhuram, and Swikar Pur mouza. This study has increased the number of sample size up to 100 for each mouza of Haibat Khan, Madhuram, and Swikar Pur. Thus, the total number of sample size taken for this study is 300. Before finalizing the structured questionnaire, in early August 2019, a pre-testing questionnaire survey was conducted for assessing the rationality along with the topicality of the questions. By considering all the feedbacks collected from the participants of the pre-testing survey, the questionnaire was finalized (see the supplementary file). There are two parts in the questionnaire: i) demographic information, and ii) risk perception items. The questionnaire consisted of 16

questions, where 9 questions were for the basic demographic profile and disaster experience of the respondent and the remaining 7 questions were under risk perception items using a Likert scale 1–5.

The household head (both male and female) was selected as the respondent for the interview. Random selection method was applied for selecting the respondents. Before commencing the interview, the purpose of the survey was informed to the participants. If any participant hesitated to talk, then the surveyors has stepped forward to another one. From the time between August to September, 2019, in-person interviews were conducted.

In case of the absence of the household head, an adult member of that household was interviewed. When both household head and adult members were absent, data collectors were moved to the next-door household. The collected data were then coded and analyzed utilizing the software Statistical Package for the Social Sciences (SPSS v23).

2.4 Econometric analysis

Previous studies on factors influencing households' disaster RP employed the probit model, binary logit model, multinomial logit model, and ordered probit model (Gbetibouo, 2009; Mabe and Donkoh, 2014; Fadina and Barjolle, 2018; Fernandez et al., 2018; Ullah et al., 2018). Some scholars have argued for using the ordered probit model due to its robustness, simple statistical calculation, and reliable outcomes (Alauddin and Tisdell, 2006; McKelvey and Zavoina, 2007; Ho et al., 2008; Farnandez et al., 2018). This study also used an ordered probit model to explore the factors affecting drought, earthquake, and flood risk perceptions of the households in the study areas. The model can be stated as follows Duncan et al. (1998):

$$y^* = \beta'x + \epsilon \quad (1)$$

Where, in this study, y^* denotes dependent variable (i.e., perceived likelihood, dread or fear, threat to life, anticipation of financial loss, effect on the quality of life, knowledge of mitigation actions and controllability); β' denotes the vector of estimated parameters and x is the vector of explanatory variables (i.e., age, gender, education, monthly income, family size, income-generating source, housing type, and experience of disasters); ϵ denotes error term. This model explored the factors affecting drought, earthquake, and flood RP in the study areas. In recent decades, the ordered probit model has been extensively used by several scholars from different parts of the world for exploring the factors influencing the RP of fire, cyclone, and earthquake hazards (Alauddin and Tisdell, 2006; McKelvey and Zavoina, 2007; Ho et al., 2008; Farnandez et al., 2018).

According to the pre-survey outcomes, 7 dependent variables such as perceived likelihood (PL), threat to life (TL), effect on the quality of life (EQL), anticipation of financial loss (AFL), Dread/fear (DR/FR), knowledge of migration actions (KMA) and controllability (CR), were measured using a 5-point Likert scale (see the supplementary file). The ordered probit model is appropriate for this analysis/ or/Since the dependent variables are ordered categorical variables, therefore, ordered probit regression model is suitable for the analysis. Relatively few studies have employed ordered probit regression model to analyze factors affecting household risk perception (Farnandez et al., 2018; Islam et al., 2020). The descriptions of the

explanatory variables are presented in Table S2. Table S3 shows the description of the dependent variables used in the model.

3. Results

3.1. Demographic information

The Table S2 of supplementary document shows the mean, standard deviation, and description of the explanatory variables. The mean age of the respondents is 39.96 (SD 13.60). The majority has no education (45%) and lived in a Teen-made house with the mean family size is 5.37 (SD 2.17). Most (58%) of them had a monthly household income of BDT 5100 to 10,000 from agriculture or farming (47%), as it is their main income-generating source. The majority of the respondents (91%) had experienced drought disasters followed by floods (90%) and earthquakes (78%) disaster (Table S2).

3.2 Perception of drought, earthquake, and flood

The respondent's perception of drought, earthquake, and flood is graphically represented by Fig. 2 and is numerically presented by Table S4. Surprisingly, most of the respondents believe drought, earthquake, and flood will likely happen in the upcoming years (Fig. 2a). About 42.9% of the respondents perceived flood, 52.1% drought, and 33.3% earthquake will occur largely in the upcoming years in the study areas (Table S4). Very few respondents perceived that drought (5.0%), earthquake (33%), and flood (1.7%) will occur on small scale and a group of people was neutral to speak out about the future likelihood of drought (3.3%), earthquake (6.9%) and flood (9.6%) (Fig. 2a).

Figure 2b illustrates the perception among the respondents about the threat created by drought, flood, and earthquake in the study areas. Very few respondents were neutral on the topic. Few respondents perceived these disasters as a less threat to their life. Approximately, 58.4% of the respondents perceived flood, and 47.2% of respondents perceived drought as a very serious threat to their life (Table S4). Almost 46.5% of the respondents perceived that earthquake poses a little serious threat to their everyday life (Table S4).

Figure 2c describes the perception of the respondents about the impacts of the selected disasters on their quality of life. Nearly three fourth number of the respondents perceived that these disasters have both serious and very serious effects on their quality of life. About 38.2% of respondents thought that the earthquake had a little impact on their quality of life (Table S4). Very few didn't give any perceptions and the rest of the people thought that these disasters are not serious at all for altering the quality of their life (Fig. 2c).

A small number of respondents anticipated a little serious financial loss due to the disasters. About two-thirds of the respondents anticipated serious and very serious financial loss due to the disasters (Fig. 2d). About 52.8% of the respondents said flood and 41.8% said drought was liable to very serious financial loss and earthquake (37.2%) posed a little serious financial problem in the study areas (Table S4).

It is evident that most of the participants are afraid and very afraid of disasters (Fig. 2e). About 52.6% of people are very afraid of flood and 53.1% for drought and approximately 54.4% of people are afraid of the earthquake (Table S4). A few respondents who can face disaster or have some resources are not afraid of any disaster at all. Very few respondents were neutral about their fear of disasters (Fig. 2e).

Figure 2f shows that about one third of the participants have unclear mitigation knowledge of the disasters. Very few respondents pose very clear mitigation actions against the selected disasters. Surprisingly, many respondents (66%) pose unclear mitigation measures related to the earthquake. Nearly, 35.3% and 44.2% of the respondents have unclear knowledge of mitigation strategies against flood and drought disasters, respectively (Table S4).

Many of the respondents assume that they have little control over the negative impacts of droughts, earthquakes, and floods (Fig. 2g). One-third of the respondents believe that they cannot control the disastrous impacts of drought, flood, and earthquake at all. The rest of the respondents were neutral for giving any perception and nearly 31.0% of the respondents were neutral about the controllability of the impacts of the earthquake (Table S4).

3.3 Factors affecting drought risk perception

The values of the coefficient estimated by ordered probit models for drought hazards are shown in Table 1. The model offers a good fit where all the explanatory variables show the expected sign. The result indicates that respondents' age is significantly correlated with their anticipation of financial loss (0.03, $P < 0.01$), dread/fear (0.020, $P < 0.05$), knowledge of mitigation actions (0.016, $p < 0.05$), and controllability (0.015, $p < 0.1$). Gender and education of the respondents' have found a significant positive relationship with the perceived likelihood (2.326 and 0.717, $p < 0.1$), threat to life (1.648 and 0.539, $p < 0.01$), and negative relationship with the knowledge of mitigation actions (-2.191 and - 0.413, $p < 0.1$) and controllability (-1.273 and - 0.572, $p < 0.1$) respectively. Effects on quality of life (-0.194, $p < 0.01$), fear (-0.065, $p < 0.05$) and controllability (0.069, $p < 0.1$) significantly influenced by the respondents' family size. Perceptions of the effects on quality of life (0.119, $p < 0.05$), knowledge of mitigation actions (-0.219, $p < 0.01$), and controllability (0.218, $p < 0.01$) significantly influenced by the respondent's monthly income. People's income-generating sources (except fear and controllability) and housing type significantly correlated with the perception of the respondents related to drought events. Surprisingly, experiences of past drought hazards didn't significantly influence the respondent's perception of that hazard (Table 1).

Table 1
Factors influencing drought risk perception of the respondents

Explanatory variables	PL	TL	EQL	AFL	DR/FR	KMA	CR
Age	0.010 (0.010)	0.009 (0.009)	0.005 (0.009)	0.030*** (0.009)	0.020** (0.008)	0.016** (0.008)	0.015* (0.008)
Gender	2.326*** (0.280)	1.648*** (0.225)	1.454*** (0.209)	2.501*** (0.250)	1.485*** (0.198)	-2.191*** (0.220)	-1.273*** (0.180)
Education	0.717*** (0.116)	0.539*** (0.094)	0.671*** (0.093)	0.187** (0.086)	0.166** (0.079)	-0.413*** (0.081)	-0.572*** (0.084)
Family size	-0.037 (0.046)	-0.064 (0.040)	-0.194*** (0.040)	0.003 (0.042)	-0.065** (0.036)	0.000 (0.038)	0.069* (0.037)
Monthly income	-0.02 (0.061)	-0.031 (0.052)	0.119** (0.052)	0.079 (0.052)	0.013(0.048)	-0.219*** (0.051)	-0.218*** (0.050)
Income source	0.146*** (0.049)	0.108** (0.042)	0.136*** (0.041)	0.249*** (0.042)	0.048 (0.037)	-0.071** (0.038)	-0.027 (0.038)
Housing type	-0.464*** (0.105)	-0.195** (0.091)	-0.497*** (0.092)	-0.420*** (0.092)	-0.142* (0.083)	-0.269*** (0.089)	0.147* (0.086)
Exp. of Drought	-0.232 (0.301)	-0.295 (0.266)	-0.185 (0.259)	-0.026 (0.272)	-0.281 (0.242)	0.041 (0.240)	0.153 (0.241)
Number of samples	300	300	300	300	300	300	300
<i>Note.</i> N = 300. Standard errors are in parentheses. (***, **, and * indicates variable significant at 1%, 5% and 10%, respectively).							

3.4 Factors influencing earthquake risk perception

The results of the ordered probit model for the determinants of earthquake hazards are shown in Table 2.

Table 2
Factors influencing earthquake risk perception of the respondents

Explanatory variables	PL	TL	EQL	AFL	DR/FR	KMA	CR
Age	-0.013* (0.007)	-0.015** (0.007)	-0.005 (0.007)	0.02*** (0.007)	0.010 (0.007)	0.004 (0.008)	0.021*** (0.007)
Gender	0.823*** (0.163)	0.489*** (0.162)	0.953*** (0.163)	0.613 (0.162)	0.807*** (0.170)	-0.932*** (0.182)	-0.634*** (0.164)
Education	0.115 (0.072)	0.069 (0.073)	0.056 (0.072)	0.047 (0.072)	-0.253*** (0.076)	-0.026 (0.076)	0.129* (0.074)
Family size	-0.076** (0.034)	-0.007 (0.034)	-0.026 (0.033)	-0.029 (0.033)	0.014 (0.035)	0.048 (0.035)	0.043 (0.034)
Monthly income	-0.011 (0.045)	-0.040 (0.046)	-0.008 (0.045)	-0.007 (0.045)	0.019 (0.047)	-0.134*** (0.049)	-0.003 (0.046)
Income source	0.104*** (0.036)	0.018 (0.036)	0.011 (0.036)	0.073** (0.036)	0.108*** (0.037)	-0.031 (0.039)	0.053 (0.036)
Housing type	-0.270*** (0.080)	0.175** (0.082)	-0.008 (0.080)	-0.050 (0.079)	-0.079 (0.083)	-0.319*** (0.086)	-0.004 (0.082)
Exp. of earthquake	-0.183 (0.151)	0.082 (0.153)	-0.051 (0.151)	-0.196 (0.150)	-0.137 (0.155)	-0.075 (0.163)	0.068 (0.154)
Number of samples	300	300	300	300	300	300	300
<i>Note.</i> N = 300. Standard errors are in parentheses. (***, **, and * indicates variable significant at 1%, 5% and 10%, respectively).							

All the explanatory variables except education and experience of earthquake significantly influenced the perceived likelihood of the respondents. Gender significantly and positively influenced the respondents' perception of perceived likelihood (0.823, $p < 0.01$), threat to life (0.489 $p < 0.01$), effects on quality of life (0.953, $p < 0.01$), dread (0.807, $p < 0.01$) and significant negative relationship with the knowledge of mitigation actions (-0.932, $p < 0.01$) and controllability (-0.634, $p < 0.01$). The anticipation of financial loss was significantly related to the respondent's age (0.02, $p < 0.01$) and income-generating sources (0.073, $p < 0.05$). Age and education are highly correlated with the controllability of earthquakes. Knowledge of mitigation actions is significantly influenced by respondents' monthly income and housing type. Education and income-generating source were significantly responsible for creating fear in the mind of the

respondents. Perception of the threat to life created by earthquake significantly influenced by the respondent's age (-0.015 , $p < 0.05$), and housing type (0.175 , $p < 0.05$). Experiences of past earthquake events didn't significantly influence the respondents on their perception of that hazard.

3.5 Factors influencing flood risk perception

The values of the coefficient estimated by the ordered probit model for flood hazards are shown in Table 3. Gender and income-generating sources shows significant positive correlation with perceived likelihood (0.415 , $p < 0.1$ and 0.170 , $p < 0.01$), threat to life (0.980 , $p < 0.01$, and 0.205 , $p < 0.01$), effects on quality of life (0.197 , $p < 0.01$ and 0.085 , $p < 0.05$), anticipation on financial loss (0.803 , $p < 0.01$ and 0.202 , $p < 0.01$), dread (0.459 , $p < 0.01$ and 0.198 , $p < 0.01$), and significant negative correlation with knowledge of mitigation actions (-1.255 , $p < 0.01$ and -0.109 , $p < 0.01$) and controllability (-0.756 , $p < 0.01$ and -0.081 , $p < 0.05$), respectively. Following the drought and earthquake risk perception, experiences of past flood events did not significantly influence the respondents on their perception of that hazard. Age has a significant negative relationship with perceived likelihood, threat to life, effects on quality of life, and anticipation of financial loss. Education is a significant positive factor to influence perceived likelihood, threat to life, effects on quality of life and anticipation on financial loss, and significant negative relationship with controllability. Respondent's family size significantly influences perceived likelihood, threat to life, knowledge of mitigation action, and controllability. Housing type significantly affects the quality of life (-0.163 , $p < 0.1$), knowledge of mitigation actions (-0.177 , $p < 0.05$), and controllability (0.321 , $p < 0.01$) of the respondents. The monthly income of the respondents did not show any significant correlation with perceived likelihood, the threat to life, and effects on quality of life (Table 3).

Table 3
Factors influencing flood risk perception of the respondents

Explanatory variables	PL	TL	EQL	AFL	DR/FR	KMA	CR
Age	-0.041*** (0.009)	-0.030*** (0.010)	-0.018** (0.009)	-0.055*** (0.010)	0.024*** (0.008)	-0.002 (0.008)	-0.002 (0.00)
Gender	0.415* (0.196)	0.980*** (0.238)	0.197*** (0.209)	0.803*** (0.231)	0.459*** (0.170)	-1.255*** (0.172)	-0.756*** (0.211)
Education	0.730*** (0.094)	0.496*** (0.100)	0.560*** (0.094)	0.717*** (0.109)	-0.103 (0.076)	-0.093 (0.075)	-0.200** (0.087)
Family size	-0.111*** (0.039)	0.111*** (0.042)	-0.053 (0.039)	0.028 (0.041)	0.047 (0.036)	-0.062* (0.034)	-0.091** (0.042)
Monthly income	0.025 (0.051)	-0.013 (0.055)	-0.139** (0.055)	0.072 (0.056)	0.086* (0.049)	-0.126*** (0.047)	-0.102* (0.053)
Income source	0.170*** (0.040)	0.205*** (0.044)	0.085** (0.042)	0.202*** (0.045)	0.198*** (0.039)	-0.109*** (0.038)	-0.081** (0.040)
Housing type	0.017 (0.092)	-0.046 (0.101)	-0.163* (0.095)	-0.162 (0.099)	0.084 (0.085)	-0.177** (0.085)	0.321*** (0.094)
Exp. of flood	-0.261 (0.260)	-0.139 (0.264)	-0.275 (0.261)	0.068 (0.295)	0.015 (0.231)	0.198 (0.225)	0.097 (0.253)
Number of samples	300	300	300	300	300	300	300
<i>Note.</i> N = 300. Standard errors are in parentheses. (***, **, and * indicates variable significant at 1%, 5% and 10%, respectively).							

3.6 Gender based drought, earthquake, and flood risk perception

RP varies from person to person, region to region, gender to gender. The present study also reveals the same thing (Figs. 3, 4 and 5). In terms of the likelihood of the occurrence of the future hazards very few respondents believed that there will be very small and small chance. Several participants kept their opinions private because of unknown reason. However, majority of the respondents thought that hazards will be occurred on large or very large scale, except earthquake. As earthquake is rarely occurred, so people perceived little knowledge on it. Whereas, a number of female participants reported that earthquake will be occurred on large scale at their locality. Female perceived higher threat (except earthquake), fear, and

impacts (expect for flood) on average. Approximately, similar degree of expected loss perceived by both male and female for flood and earthquake. On the contrary, male perceived higher degree of anticipated loss in terms of drought. Very clear knowledge of mitigation actions lacked among the respondents and a handsome number of participants perceived very unclear knowledge. Overall, in respect of the knowledge of mitigation action similar number of both male and female perceived the similar knowledge. Although, female participants perceived bit more very unclear knowledge of mitigation actions than their counterparts. Like the knowledge of mitigation action, similar number of both male and female perceived the similar knowledge on controllability except drought. However, majority of the female believed that they will not able to control the disasters at all. It can be stated that the female respondents perceived more risks, lack enough knowledge, and will be less capable of controlling the upcoming hazards than male.

4. Discussion

Maximum respondents perceived the likelihood of occurring future hazards in the study areas. Two-third of the respondents perceived that flood, drought, and earthquake creating a threat to life putting negative impacts on the quality of life and financial losses. During the hazardous or disastrous event, most of the respondents felt fear for any unpleasant situation. Very few respondents know mitigation actions for respective disasters and can manage the disastrous or hazardous situation. Plapp and Werner (2006) reported that respondents perceived that the windstorm, flood, and earthquake will occur frequently in Germany. Peacock et al (2005) explored that experience of the hazardous event help households to take mitigation options which in turn play a vital role in lowering the negative threat to their quality of life.

The study reveals that household income-generating source, gender, age, and education are significantly correlated with most of the dependent variables of drought, flood, and earthquake. Fernandez et al. (2018) found that age, gender, education, family size, housing type, and monthly household income were the influencing factors for fire, cyclone, and earthquake hazards in Myanmar. Reliable and permanent income generating sources make a positive sense to the respondents to take all the possible initiatives to manage the upcoming disasters properly which could lower the risk of creating any threats or impacts on their life. On the contrary, unstable income sources that may lose any time act as the obstacle to thinking properly by the respondents to take measures for lessening the impacts of upcoming disasters due to their monetary constraint.

Disasters RP differs significantly from individual to individual, from community to community and this RP is significantly associated with several explanatory variables as sex, income, occupation, education, and geographical location that is frequently reported in many studies (For example, Kellens et al., 2011; Wachinger et al., 2013; Mills et al., 2016; Rana and Routray, 2016; Sarker, 2017; Sattar and Cheung, 2019) which is consistent with the findings of this study. RP also varies across gender. Females perceived high risk than males. Aged and adult people can take proper decisions for managing any hazardous situation than the lower aged people due to their past experiences. Ahmad and Afzal (2020) explored quite similar results that gender, age, family size, monthly income, education, and location significantly influenced people to take flood mitigation actions at the household level in Pakistan.

Education plays a vital role in managing any disaster. Educated people know the procedures on how to manage any upcoming disastrous event and the positive effects of taking proper initiatives regarding lower the impacts of disasters. Wang et al. (2018) found that education influenced the RP of floods in China and Pakistan (Abid et al., 2015). Lower monthly income and large family size negatively affect the people for adopting any measures for reducing the upcoming disaster losses. Daramola et al. (2016) explored that lack of money savings, agricultural livelihood, and lack of multiple income sources lead the people to experience negative and severe impacts due to natural disasters in Nigeria. Housing type significantly motivated the respondents about their perceptions of taking initiatives for managing drought hazards and created less threat to life, fear, and impacts on the quality of life. Interestingly, past experiences of facing drought, earthquake, and flood hazards didn't show any significant correlation with the dependent variables which regulate the severity of disaster risk. The present study found that the female respondents perceived more risks, lack enough knowledge, and will be less capable of controlling the upcoming disasters than male which is supported by the findings of Salam et al. (2021). Adequate measures need to be taken to reduce the gap of risk perception between male and female. Otherwise, anticipated progress in increasing the resiliency would be nightmare.

This research can be regarded as important because it is the first work exploring household RP of drought, earthquake, and flood in the LTB. The outcomes of this work would have put significant effect on reducing disaster risk. Some respondents believe that in the time ahead they will be faced by drought, earthquake, and flood that may put severe damage to their daily life. For instance, this perception of the respondents may encourage the public support system of the government intending, that works for lessening disasters risks, to take real-time measures for supporting the respondents. The present work did not perform any investigation toward exploring the level of vulnerability and risk of the selected areas for the selected disasters and future study should investigate those to make a detailed idea how to make the people of the areas resilient against these disasters.

5. Conclusion

This work aims to fill the void in the knowledge gap in risk perception study in the LTB of northern Bangladesh. In this study, we have prepared common statistics on seven RP items based on Likert scale 0–5 for the drought, earthquake, and flood hazards. This study also explored the factors affecting household RP of drought, earthquake, and flood employing the ordered probit model. Maximum respondents perceived that the upcoming disasters will occur at a very large or large scale which can create an economic loss, act as a threat to a normal lifestyle and degrade the quality of life. During the hazardous or disastrous event, most of the respondents felt fear for any unpleasant situation. Very few respondents know mitigation actions for respective disasters and can manage the disastrous or hazardous situation. Respondents' age, gender, education, income-generating sources significantly influence the RP of the hazards. Stable income generating sources, male and educated people perceived more knowledge on RP which helps them taking a proper decision at the right moment to reduce the impacts of drought, flood, and earthquake. It can be stated that the male respondents perceived less risks, possessed enough knowledge, and will be more capable of controlling the upcoming disasters. The findings of this study help the policymakers and

planners to take proper initiatives to raise awareness, create stable livelihood options and motivate people to take appropriate mitigation strategies for reducing the disaster impacts for ensuring sustainable disaster-resilient community.

Declarations

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Consent to Participate

Consents were taken following the standard ethics approval.

Consent to Publish

Consents were taken following the standard ethics approval.

Data availability

Data are available upon request to the corresponding author.

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Author contributions

R.S., and R.A. designed, planned, conceptualized, and drafted the original manuscript; and R.S., and R.A. were involved in statistical analysis and interpretation; A.R.M.T.I., J.M., A.I., and G.M.M.A. contributed in instrumental setup, and validation; A.R.M.T., A.I., and M.N.A.S. contributed in editing the manuscript, literature review, and proofreading; G.M.M.A, J.M., and A.R.M. T.I. were involved in mapping and proofreading during the manuscript drafting stage.

Conflict of interest

No potential conflict of interest was reported by the authors. There were no relevant financial or non-financial competing interests to report.

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Supplementary Tables

Supplemental tables are not available with this version.

Figures

Figure 1

Location map showing the study area

Figure 2

Respondent's degree of perception about drought, earthquake, and flood

Figure 3

Perception of drought based on gender

Figure 4

Perception of earthquake based on gender

Figure 5

Perception of flood based on gender