Perceived and Actual Risks of Drought : Household and Expert Views From Lower Teesta River Basin of Northern Bangladesh

Roquia Salam
Begum Rokeya University
Bonosri Ghose
Begum Rokeya University
Badhon Kumar Shill
Begum Rokeya University
Md. Aminul Islam
Begum Rokeya University
A R M Towfiqul Islam (towfiq_dm@brur.ac.bd)
Begum Rokeya University https://orcid.org/0000-0001-5779-1382
Md. Abdus Sattar
Patuakhali Science and Technology University
G M Monirul Alam
Bangabandhu Sheikh Mujibur Rahman Agricultural University
Bayes Ahmed
University College London

Research Article

Keywords: Drought risk perception, Actual risk and perceived risk, Household and expert, Teesta River

Posted Date: March 18th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-310699/v1

Perceived and actual risks of drought : Household and expert views from lower Teesta River Basin of northern Bangladesh

Roquia Salam[1], Bonosri Ghose[1], Badhon Kumar Shill[1], Md. Aminul Islam[1], Abu Reza Md. Towfiqul Islam[1,*], Md. Abdus Sattar[2], G M Monirul Alam[3], Bayes Ahmed[4]

[1]Department of Disaster Management, Begum Rokeya University, Rangpur 5400, Bangladesh

[2]Department of Disaster Risk Management, Patuakhali Science and Technology University, Bangladesh

[3]Department of Agribusiness, Bangabandhu sheikh Mujibur Rahman Agricultural University, Dhaka, Bangladesh

[4]Institute for Risk and Disaster Reduction (IRDR), University College London (UCL), London, UK

[*]Corresponding author: towfiq_dm@brur.ac.bd

Abu Reza Md. Towfiqul Islam, PhD

ORCID: 0000-0001-5779-1382

Tel: +880-2-58616687

Fax: +880-2-58617946

Abstract

Disaster risk perception, as well as risk appraisal, play a pivotal role in making the disaster risk reduction policy. This study examines the actual vs perceived drought risks by constructing risk indices at the household and expert levels using survey data from the lower Teesta River Basin in northern Bangladesh. Survey data were collected from 450 farmers based on the structural questionnaire. A composite drought risk index was developed to understand households' perceived and actual risks in the designated areas. The results show that the actual and perceived risk values differ significantly among the three designated sites of Ganai, Ismail, and Par Sekh Sundar. The risk levels also differ significantly across the household's gender, income, occupation, and educational attainment. People with poor socio-economic status are more prone to drought risk than others. Results also reveal that the mean level of perceived risk agrees well with the actual risk; females perceive comparatively higher risk than males. Expert views on drought risk are similar to the individual household level perceived risk. The outcomes of this study would help the policy-makers and disaster managers to understand the concrete risk scenarios of the study areas and to take timely and appropriate disaster risk reduction actions for ensuring a drought-resistant society.

Keywords: *Drought risk perception, Actual risk and perceived risk, Household and expert, Teesta River.*

1. Introduction

The risk appraisal is an integral component of disaster risk reduction and sustainability perspectives (Zhou et al. 2015; Rana and Routray 2016). Risk perception, as well as people's risk appraisal, are the pivotal element for devising and applying disaster risk reduction strategies and plans (Sattar and Cheung 2019). Risk perception is a component of vulnerability and capacity evaluation (Birkholz et al. 2014; Jamshed et al. 2019). Considering the significance of community involvement in disaster risk reduction strategies, people's risk perception has gained much attention in recent studies related to disaster risk management (Rana and Routray 2016; Sattar and Cheung 2019). However, there is a wide gap between people's risk perception and experts' risk appraisal (Garvin 2001). Ultimately, this gap creates difficulty in implementing disaster risk reduction plans or associated policies. It is evident that women are more concerned about environmental issues than men (Habtemariam et al. 2016; Shrestha et al. 2019). Members of the same community perceived different opinions toward several natural hazards, which influence them to take a different decision on a critical issue, resource allocation, and making policy (Alderman et al. 1995). These households decisions are crucial for alleviating any hazard and disaster risk as this is directly related to resource distribution either intellectual or physical resource. Thus, it is essential to study people's risk perception and to investigate the disaster risk reduction (DRR) plans from both household's and experts' points of view.

According to the Global Climate Risk (GCR) index, Bangladesh is now ranked 5th extreme disaster risk-prone country in the world (Dastagir 2015). Among the extreme climatic disasters, drought is the most complicated, recurring, and least understood natural disaster (Islam et al. 2017; Zhang et al. 2019; Uddin et al. 2020). Drought affects a million people and causes tremendous environmental degradation, social crisis, livelihood problems, economic disruption, and loss of lives compared with other climate-related disasters like floods, cyclones (Habiba and Shaw 2012). Of these effects, drought is a major threat to reduce and loss crop production in Bangladesh, which has been influenced by regional climate change in recent times (Habiba et al. 2014; Islam et al. 2014; Mardy et al. 2018; Zinat et al. 2020). Furthermore, the northern region covering the Teesta River Basin is one of the largest crops producing regions of Bangladesh, of which more than 40% are rain-fed agriculture and, this Basin has experienced different levels (e.g. moderate, severe) of drought risk (Mainuddin et al. 2015). To cope with the detrimental impacts of drought on agricultural crop production and ensure food security it is important to increase the understanding of people's drought risk perception as well as ensure a drought-resistant agricultural system.

Implementation and formulation of drought risk reduction strategies have recently been attracted more attention among policymakers and practitioners in this basin area because of the extensive effects of climate change, increasing the intensity and frequency of drought hazards, and loss of agricultural crop production. Understanding peoples' drought risk perception can assist to devise effective drought risk reduction policies and strategies under changing climate conditions, particularly in water deficit areas in the Teesta River Basin in Bangladesh. Previous studies in Bangladesh have been concentrated on the drought effects on agriculture (Habiba et al. 2012; Islam et al. 2014), food production (Ericksen et al. 1993), economy (World Bank Bangladesh 2000), and society (Ferdous and Mallick 2019). Besides, Habiba et al. (2012) assessed people's perception and adaptation plans to cope with drought in northwest Bangladesh. Few studies exist in some other areas in Bangladesh about drought impacts and adaptations (Mardy et al. 2018; Habiba et al. 2011; Habiba et al. 2013; Shahid 2010).

Actual vs perceived risk assessment is an interesting research area among scholars in recent decades. Sattar and Cheung (2019) assessed the actual vs perceived cyclone risk in three communities of southern coastal Bangladesh and found that female households perceive greater risk than male participants in terms of risk perception and proposed some cyclone risk reduction measures. Rana and Routray (2016) reported actual versus perceived flood risk and found noteworthy spatial variations in three urban cities in Pakistan. Previous studies have explored the coping strategies for drought risk reduction purposes only by examining people's perceptions in Bangladesh (Roy et al. 2020; Al-Amin et al. 2019; Mardy et al. 2018). So far, no prior research has explored the actual vs perceived drought risk based on both household's and expert's views in the Teesta River Basin of, Bangladesh. This study intends to fill this research gap. Thus, the key objective of the current study is to appraise actual vs perceived drought risk at the household and expert level in the Teesta River Basin, Bangladesh. The planners and stakeholders will able to know which gender and socio-economic group need more priority to enlighten and educate for increasing knowledge of hazard. Disaster preparedness and mitigation strategies will reduce drought risks and losses and thus make a drought-resilient society.

2. Material and methods

2.1 Selection of the study area

Teesta River Basin is the home of around 30 million people. The northwest part of Bangladesh occupies about 71%, Sikkim 2%, and West Bengal 27% of the Teesta Basin (Waslekar et al. 2013). Approximately 3 million people are directly and indirectly affected by drought with tremendous damage to infrastructure, livestock, agricultural crop production in the northern Bangladesh (Islam et al. 2014). This Basin often faces temperatures up to $45^{o}C$ or more in the pre-monsoon season and the temperature falls at $5^{o}C$ in some areas in the winter (Islam et al. 2019). This Basin faces frequent climatic extremes that differ from the rest of the country's climatic conditions (Banglapedia 2006).

This study selected the Kaunia, Kishoreganj and Hatibandha Upazilas, respectively, from Rangpur, Nilphamary, and Lalmonirhat districts based on the severity on drought (Figure 1). According to Bangladesh Bureau of Statistics (BBS, 2014) mouza is the lowest administrative unit in Bangladesh that contains one or more villages. For this study, mouza is considered for collecting more precise data. Data were collected from Ganai, Ismail, and Par Sekh Sundar mouza of Tepamadhupur, Kishoreganj, and Saniajan unions, respectively.

From a climatological perspective, this area is distinct from other regions of the country, especially rainfall and temperature. Rainfall is unevenly distributed in this Basin from the ranges of 1120 to 1323 mm at an annual scale (Islam et al. 2017).

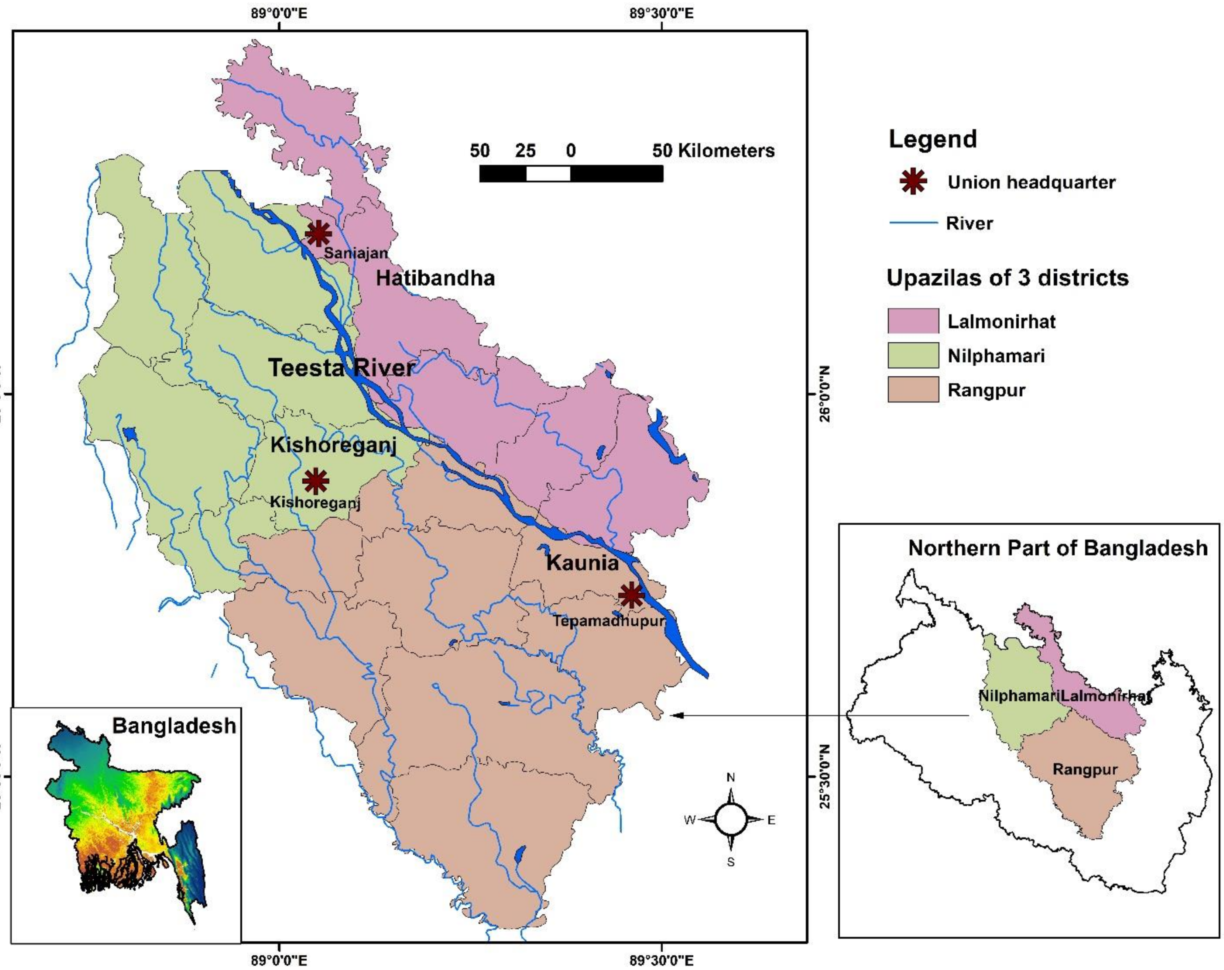

Figure 1: Location map showing the Teesta River Basin of Bangladesh prepared by ArcGIS 10.7 (www.esri.com)

2.2 Sample size, questionnaire design and data collection

Data collection from several extensive field visits was performed to know the basic information of the designated study areas for the subsequent design of the study. The total population of Ganai , Ismail and Par Sekh Sundar were 1055, 1174 and 484, respectively (BBS, 2014; BBS, 2015). The formula proposed by Cochran (1977) was used to calculate the sample size of each mouza. According to Cochran’s formula, the calculated sample size ($p<0.05$ and error value at $<\pm 7\%$) was 165, 168, and 137 for Ganai, Ismail, and Par Sekh Sundar mouza, respectively. The present study took the round number of 160, 160, and 130 as the sample size for Ganai, Ismail, and Par Sekh Sundar mouza, respectively. In total 450 sample sizes were considered for collecting information from households. To complement data from the individual household level, 450 respondents were interviewed about their overall perceptions of drought risk. Opinions of 45 experts from the Government officials, Non-Government officials, researchers, university teachers and practitioners from Bangladesh who are actively involved in the disaster management field were considered for collecting data for perceived drought risk assessment at expert level.

Before finalizing the structured questionnaire, in July 2019 a pre-testing questionnaire survey was conducted for checking the validity and relevancy of the questions. The final questionnaire was developed based on the feedbacks found from the respondents by a pre-testing survey. The questionnaire was divided into 2 main parts. One was for collecting data for assessing actual risk and the other one was for collecting data for perceived risk assessment. The second section (perceived risk assessment) of the questionnaire was used for collecting information from both households and experts. On the contrary, the first section was used for collecting data from only households. Thus, the questionnaire was divided into 6 parts in total as: i) socio-economic status; ii) hazard component of disaster risk; iii) exposure (vulnerability) component of disaster risk; iv) sensitivity (vulnerability) component of disaster risk; v) capacity component of disaster risk and vi) perceived risk assessment. The ii, iii, iv, and v sections were under the part of the actual risk assessment. The vi section was used for collecting the opinions from both the households and experts.

Household heads both males and females were considered for data collection. The list of respondent was collected from the Department of Agricultural Extension (DAE). Respondents were selected randomly and they were first informed about the purpose of the study. If someone denied providing any information, then the interviewers proceeded to the next household. Face-to-face interviews of the respondent were conducted in August-September 2019. All the answers needed for the detailed questionnaire were close-ended. The answers were then coded and interpreted employing Statistical Package for the Social Science (SPSS) software (version 23). The indicators and their weights are defined in the next sub-section.

Table 1: Socio-economic status of the respondents

Socio-economic Characteristics	**Description**	**Ganai (Frequency)**	**Par Sekh Sundar (Frequency)**	**Ismail (Frequency)**
Age	<30	30	43	31
	31-45	64	46	53
	46-60	47	30	56
	>60	13	11	20
Sex	Male	110	102	117
	Female	50	28	43
Educational status	Illiterate	37	42	59
	Primary	76	50	58
	Secondary	32	25	32
	Higher Secondary	11	7	9
	Graduate	4	6	2

Occupation	Unemployed	10	14	12
	Agriculture	64	60	44
	Business	10	17	43
	Day labor	64	25	28
	Govt./Other services	12	14	33
Income	<5000	59	50	56
	5000-10000	84	53	51
	10000-15000	11	14	21
	15000-20000	5	10	19
	>20000	2	3	13

Table 1 represents the socio-economic status of the participants. Most houses (made of bamboo and mud) are kutcha. The light of education has not enlightened the area well. Most of the respondents who involve in farming practices are male. Maximum farmers are illiterate here. Some are involved in other secondary jobs such as business, day laborer, and so forth

2.3 Indicators and weights

Based on the extensive review of the previous literature (Supplementary Table S1 and Table S2), 32 and 6 indicators were selected for assessing actual and perceived risks for this study. Descriptions of each indicator along with the related weight values are presented in the supplementary material of Table S1 and Table S2. Here, 0 to 1 score based on various indicator classes of actual and perceived risk components were allocated. For instance, the lowest hazard, sensitivity, exposure, and capacity classes are allocated the lowest weight values of less than 1 and higher is 1. Generally, 1 and 0 weights are utilized for yes and no classes. Three classes are assigned as 0.33, 0.67 and 1; four classes are assigned as 0.2, 0.4, 0.6, 0.8 and five classes are assigned as 0, 0.2, 0.4, 0.6, 0.8 and 1. Therefore, the values of both the actual and perceived risk indices are between 1 and 0. The weights were assigned based on previous studies carried out in different parts of the world, where scholars utilized the same weights for the same indicators as used in the present study (Saha 2009; Flanagan et al. 2011; Udmale et al. 2014; Barua et al. 2016; Rana et al. 2010; Roy et al. 2015; Nhuan et al. 2016; Karim and Thiel 2017; Zhang et al. 2017; Sattar and Cheung 2019). The justification of the selection of indicators is given in the supplementary material of Table S1 and Table S2.

2.4 Actual and perceived risk index

The scientific community is widely accepted the drought risk equation (1) that is the combination of hazards, a vulnerability multiplied by capacity or manageability (Zhang et al. 2017; Zhang 2004; Bollin et al.2016).

$$Drought\ risk = \frac{Hazard \times Vulnerability}{Capacity\ or\ manageability} \qquad (1)$$

Where,

Risk =Probability of damage and loss due to drought,

Hazard=Potential occurrence of a natural or man-made event, and physical effect of the disturbance,

Vulnerability =Lack of capacity of a community to face and adapt to a hazard, and

Capacity =Community assets and available resources that lessening community susceptibility.

In the present study, the following equation (2) has been adopted for computing the actual drought risk at the intra-household level in the Teesta River Basin, northern Bangladesh (Sattar and Cheung 2019; Bollin et al. 2016).

$$\text{Drought risk (R)} = \frac{\text{Hazard (H)} \times \text{Exposure(E)} \times \text{Sensitivity (S)}}{\text{Adaptive capacity (C)}} \qquad (2)$$

32 indicators/questions were constructed (6, 6, 10, and 10 for hazard (H), exposure (E), sensitivity (S), and capacity (C) component of risk, respectively) for assessing actual drought risk at the household level. This was based on the respondents' previous experience of severe drought. Perceived risk was also assessed from both the households and expert perspectives. For assessing perceived risk, 6 indicators/questions were asked. This was also based on the respondents' previous experience of severe drought. For computing the H, E, S, C, and PR indices, equation 3 was considered followed by Rana and Routray (2016); Gain et al. (2015); Bashierr and Jayant (2014).

$$\mathrm{Cl} = \frac{\mathrm{W_1+W_2+W_3+\cdots W_n}}{\mathrm{n}} = \sum_{\mathrm{i=1}}^{\mathrm{n}} \frac{\mathrm{Wi}}{\mathrm{n}} \qquad (3)$$

Where,

CI ¼ = composite index,

W1 to Wn ¼ = respective weights employed to indicators and

n ¼ = number of the indicators used for computing the CI.

Following the composite index, Hazard Index (HI), Exposure Index (EI), Sensitivity Index (SI) and Capacity Index (CAI), and Perceived Risk Index (PRI) are computed which are defined as follows:

$$Hazard\ Index\ (HI) = \frac{\sum_{i=1}^{6} HW_i}{n} \qquad (4)$$

$$Exposure\ Index\ (EI) = \frac{\sum_{i=1}^{6} EW_i}{n} \qquad (5)$$

$$Sensitivity\ Index\ (SI) = \frac{\sum_{i=1}^{10} SW_i}{n} \qquad (6)$$

$$Capacity\ Index\ (CI) = \frac{\sum_{i=1}^{10} CW_i}{n} \qquad (7)$$

$$Percieved\ Risk\ Index\ (PRI) = \frac{\sum_{i=1}^{6} PW_i}{n} \tag{8}$$

$$Actual\ Risk = \frac{HI*(EI*SI)}{CAI} \tag{9}$$

2.5 Data homogeneity

Risk indices were analyzed using one-way analysis of variance (one-way ANOVA) using SPSS software. To observe data homogeneity, a one-sample t-test was performed and the results reveal that the actual risk and perceived risk (both households and experts) values are 99% (p-value 0.000) significant (Supplementary Table S3). One sample Kolmogorov–Smirnov test also indicates that all risk values are 99% ($p < 0.01$) significant. The chi-square test gives the same result as all risk values are 99% significant (Supplementary Table S3). All the above test results indicate that the estimated risk values are valid for further analyses.

2.6 Ethics

Participants were informed of the specific aim of this work before proceeding to the survey. Participant's consent was taken before the questionnaire survey and their anonymity was confirmed. The survey was done only once, and the survey could be completed/terminated whenever they wished. The questionnaire survey content and procedure were properly reviewed and approved by the proposal evaluation and ethical committee of the Department of Disaster Management of Begum Rokeya University, Rangpur.

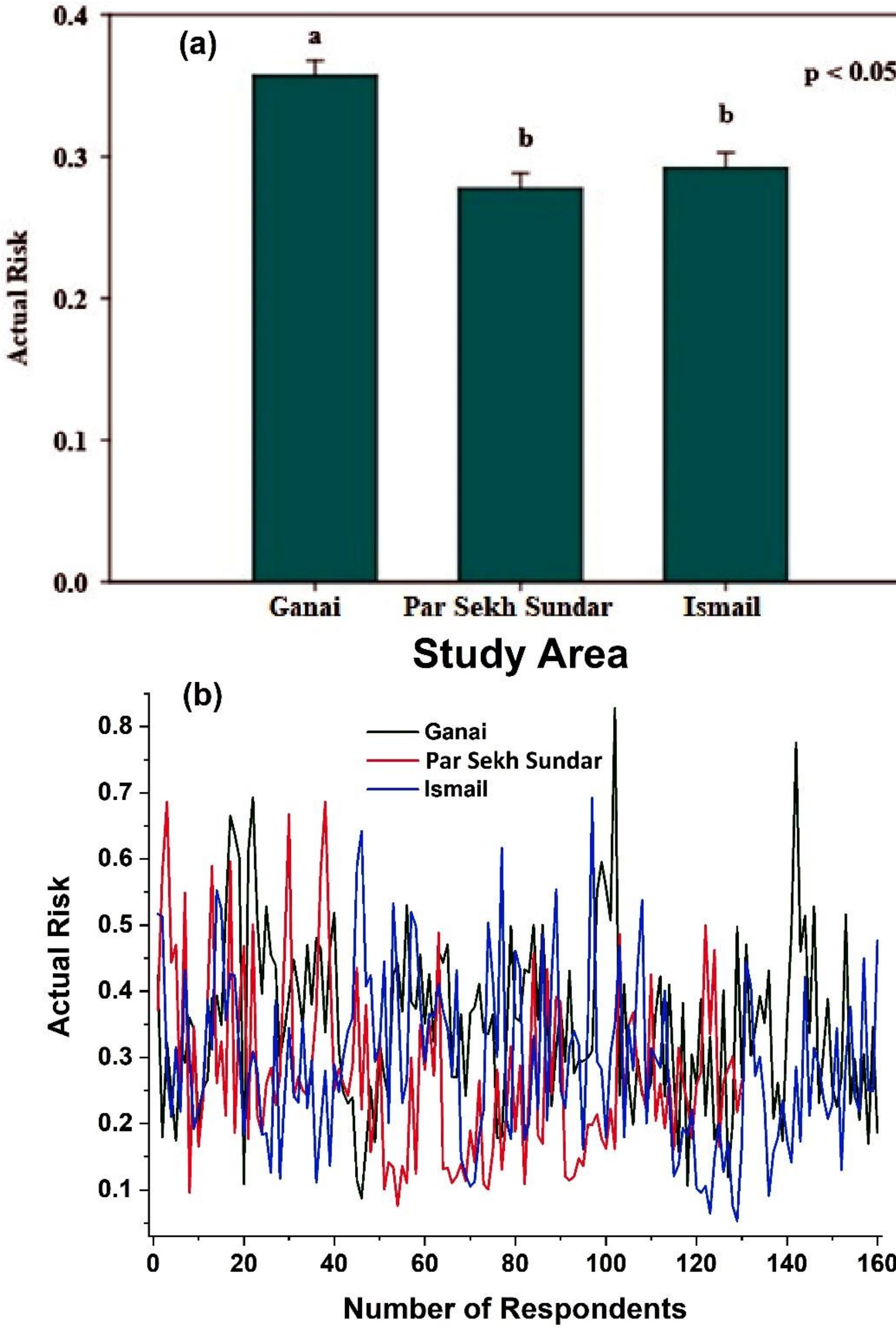

Figure 2: Index of actual risk: (a) Mean value, and (b) Individual value for the three study areas

3. Results

3.1 Actual risk assessment at the household level

Among the three sites, Ganai shows the highest risk value of 0.35, whereas Par Sekh Sundar (0.27) and Ismail (0.29) show the lowest risk. The people of Ganai pose a higher vulnerability to drought hazards. ANOVA test also reveals that there exists no significant difference between the area of Par Sekh Sundar and Ismail, but there exists a significant difference between Ganai and the other two areas (Par Sekh Sundar and Ismail). It is widely reported that the risk of a hazard extremely varies from individual to individual, and the results of the present study also comply with this general fact (Figure 2b). An enormous variety of risks is evident among the participants, ranging from 0.1 to 0.8 in this study. Furthermore, the highest risk (0.33) value is reported by female respondents and the lowest risk (0.30) value is reported by male respondents, which are statistically significant ($p<0.05$) (Figure 3).

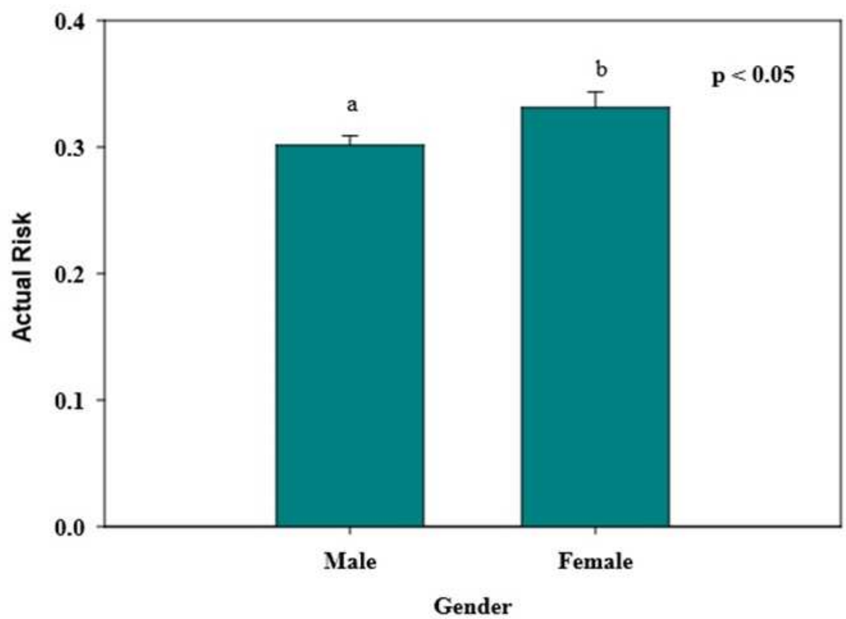

Figure 3: Actual risk variability based on gender

Figure 4 shows that the actual risk varies with the variation of respondent educational status, occupation, and income level. Figure 4(a) shows that illiterate and lower educated (primary passed) people have experienced comparatively high drought risk (0.3) than as secondary (0.25) and higher secondary (0.24) competed people. The Graduate people have experienced moderate drought risk (0.27). Although graduate people hold more knowledge about the impacts of drought and better know how to reduce the risk, they face a higher risk than higher secondary and secondary completed people. This is the result of their negligence towards taking appropriate drought risk reduction strategies. Figure 4(b) shows that day labor experienced a comparatively higher risk (0.35) than others as their work is uncertain and is not permanent. Unemployed (0.32) and agricultural workers (0.30) experienced moderate risk. Businessmen (0.26), govt. employees and other services (0.27) holders experienced the lowest risk because their income sources are permanent. Figure 4(c) shows that whose income <5000 taka (0.31) and 5000-10000 taka (0.32) were experiencing high risk and moderate risk (0.26-0.29) was experienced by the income groups of 10000-15000 and 15000-20000. Low risk (0.22) was experienced by the income group of >20000 taka. This result indicates that higher income groups have a high drought risk reduction capacity, except for the unemployed group.

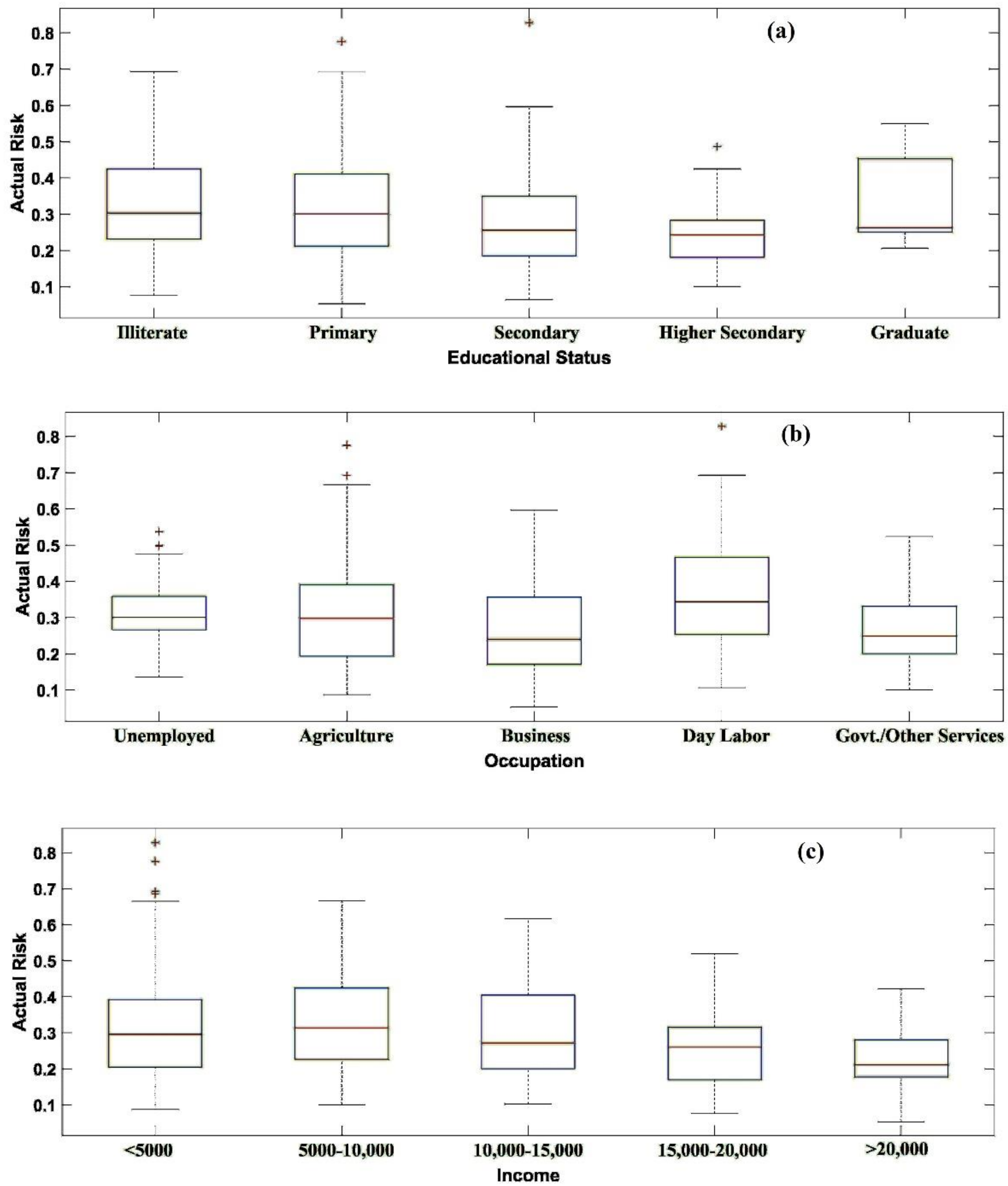

Figure 4: Dependence of actual drought risk on education, occupation, and income (Bangladeshi Taka)

3.2 Perceived risk assessment from households and experts views

The perceived risk (both households and experts) indices for three areas of Ganai, Par Sekh Sundar, and Ismail was assessed. Figure 5a shows that the people of Ismail perceived high risk (0.69), people of Ganai perceived moderate risk (0.59) and the people of Par Sekh Sundar perceived low risk (0.55). ANOVA test reveals that there exists a significant difference between the three areas.

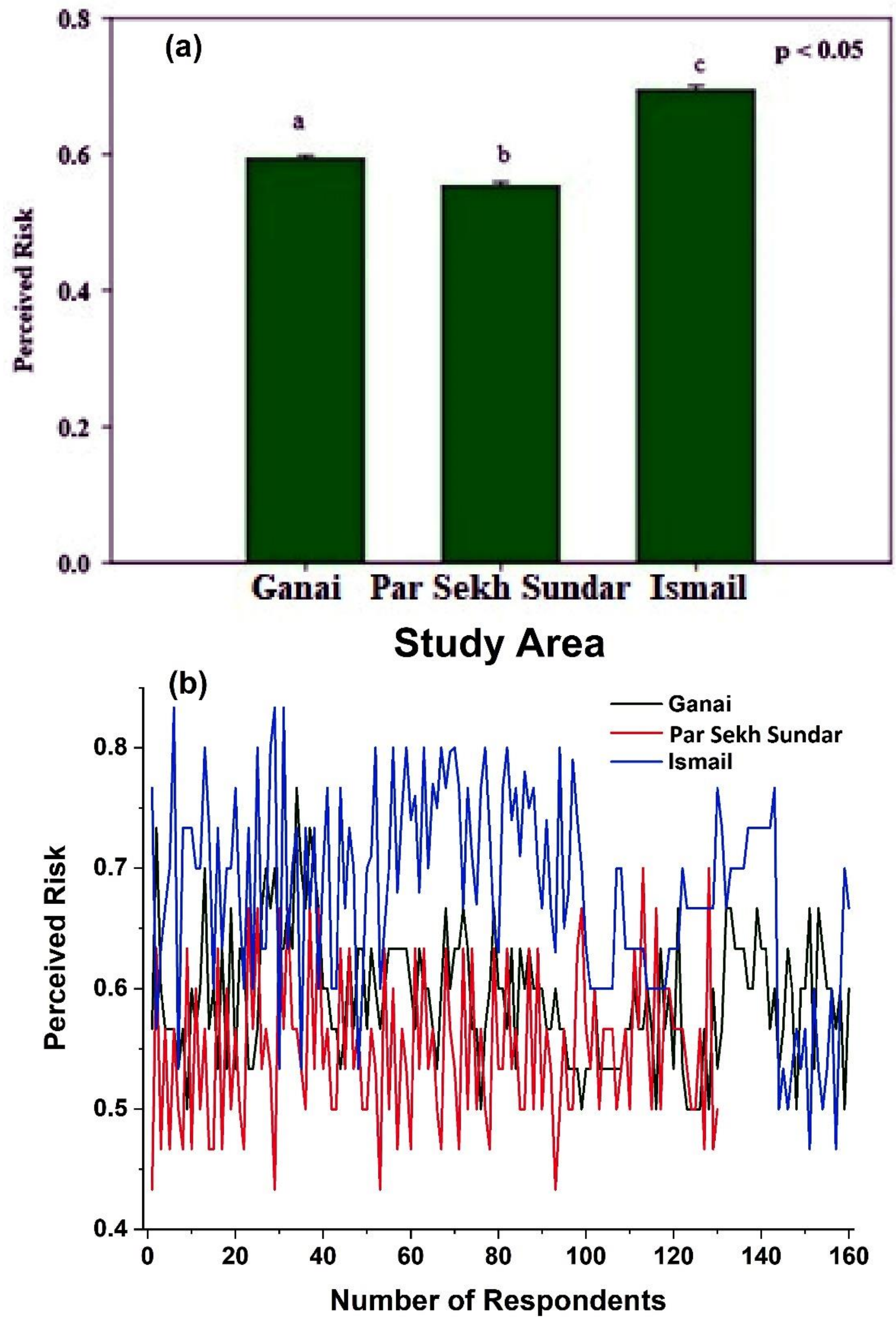

Figure 5: Index of perceived risk: (a) Mean value, and (b) Individual value at household level for the three study areas

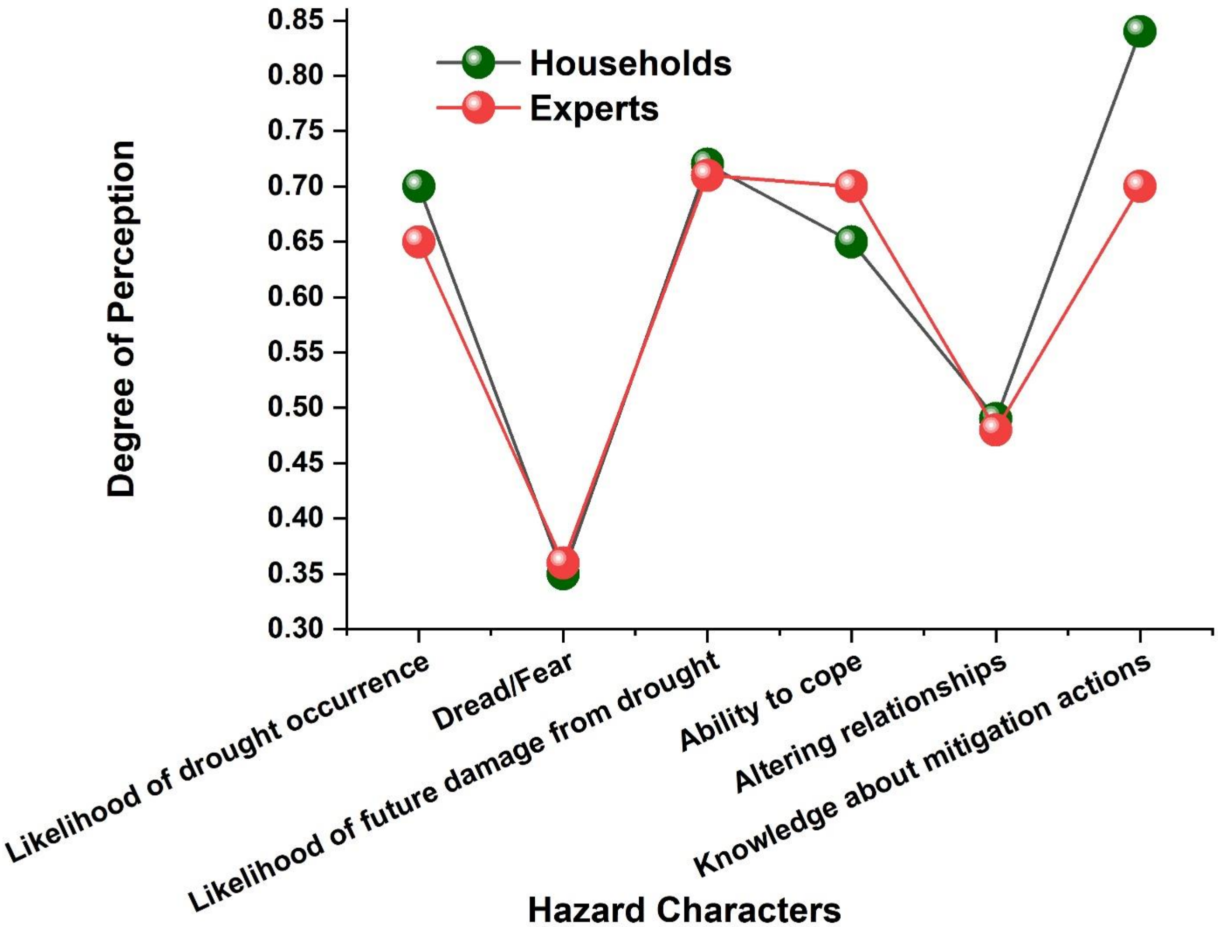

Figure 6: Degree of perceived risk at household's vs experts

Similar to actual risk, perceived risk also differs significantly among individuals, ranging from 0.42 to 0.84 (Figure 5b). There is no notable difference between experts and household views on perceived drought risk (Figure 6). A slight difference is found in 3 hazard characters which are likelihood of drought occurrence (0.7 for households and 0.65 for experts), ability to cope (0.65 and 0.7 for households and experts, respectively) and knowledge about mitigation actions (0.84 and 0.7 for households and experts, respectively). The degree of perceived drought risk for the hazard characters of dread (fear), likelihood of future damage from drought and altering relationships were similar between households and experts (Figure 6). Approximately similar views are found from both households and experts.

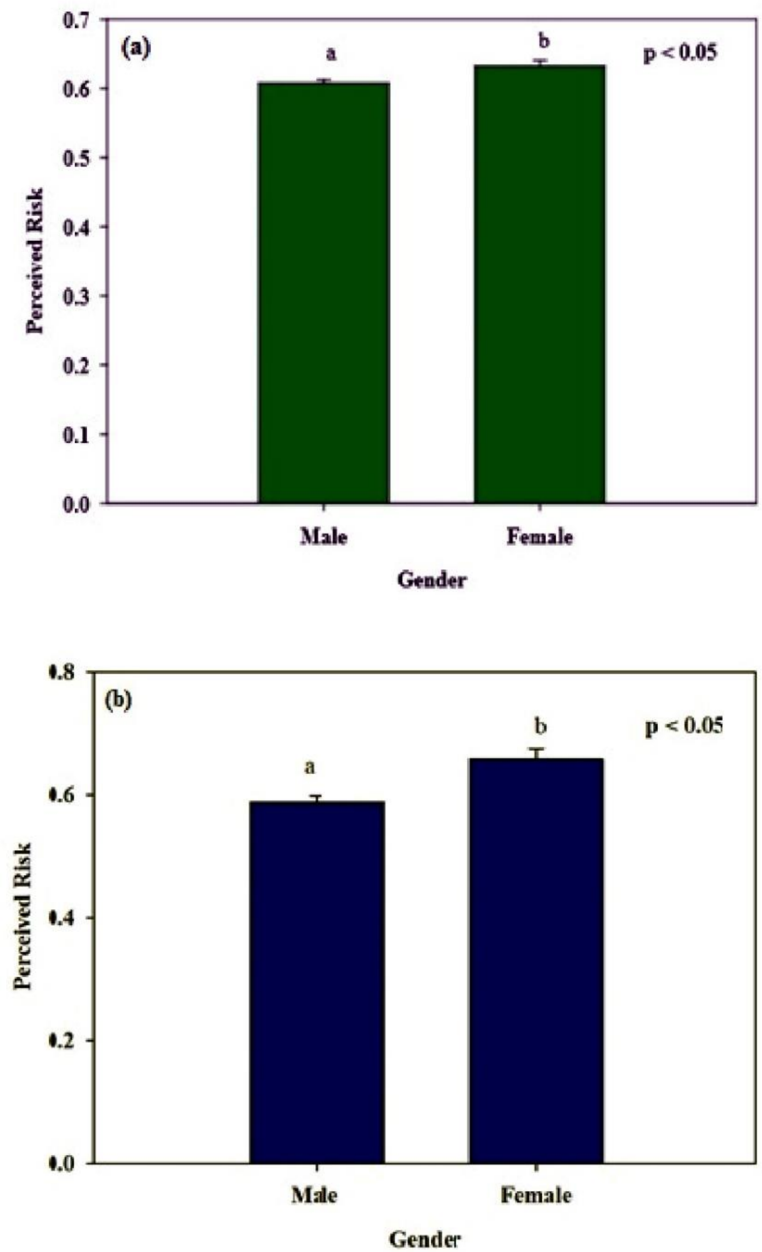

Figure 7: Risk perceptions from gender perspectives for both (a) households and (b) experts

Notable risk difference is found from gender perspectives (Figure 7). Females perceived higher risk (0.63 for households and 0.66 for experts) than males (0.60 for households and 0.57 for experts). Perceived risk (households) also varies with the variation of respondent educational status, occupation, and income level (Figure 8).

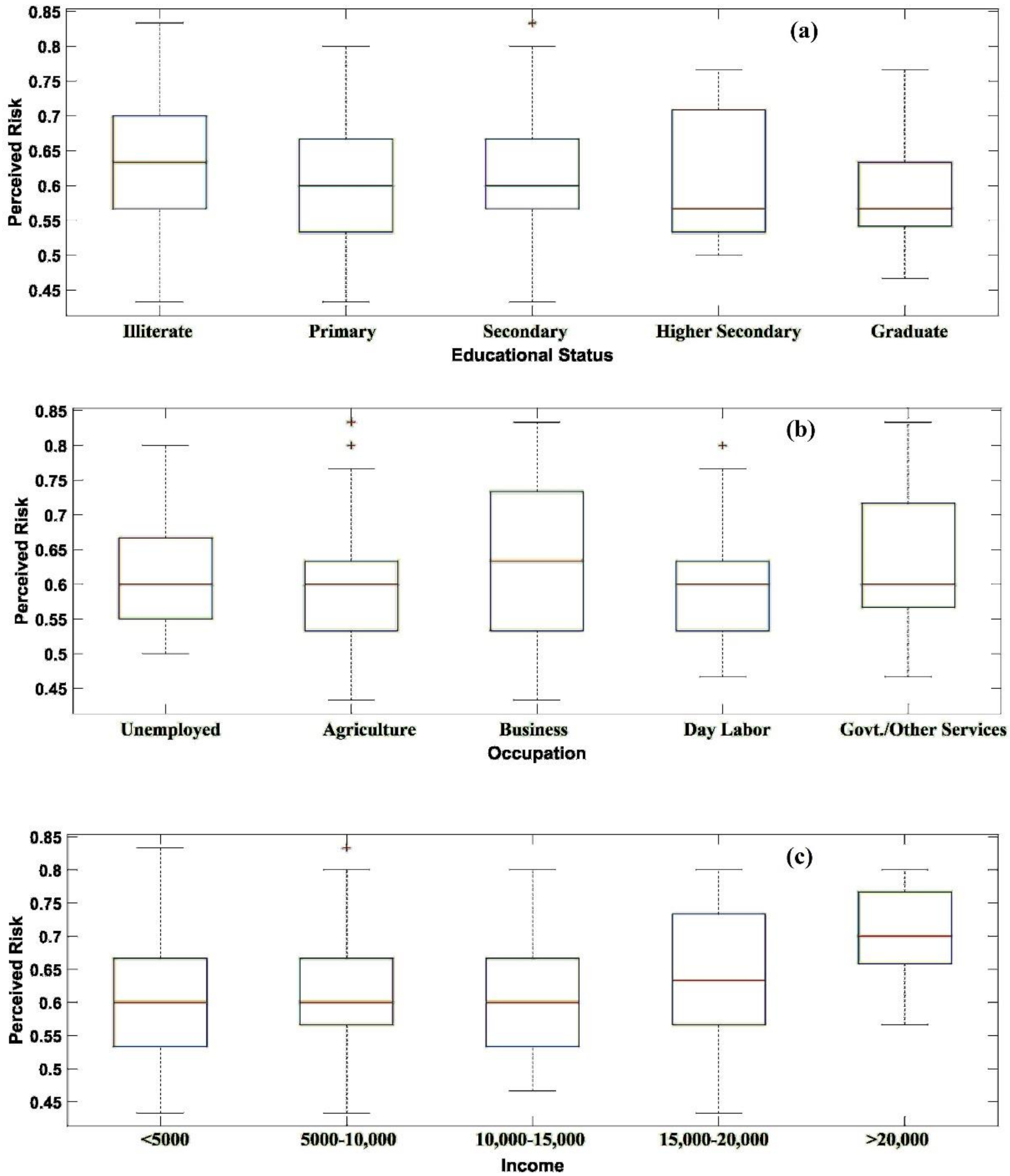

Figure 8: Dependence of perceived drought risk (households) on education, occupation and income (Bangladeshi Taka)

Figure 8(a) shows that illiterate people perceived higher risk (0.64), moderate risk (0.6) is perceived by primary and secondary school passing people, and lower risk (0.57) is perceived by higher secondary passed as well as graduate people. Figure 8(b) shows that business holders perceived higher risk (0.649) and lower risk (0.6) is perceived by other occupation groups and unemployed people. Figure 8(c) shows that the people who earn >20,000 taka perceived higher risk (0.69) and moderate risk (0.60–0.64) is perceived by other income groups.

3.3 Correlation between actual risk and perceived risk at the household level

There is a positive correlation between the actual risk and perceived risk (Figure 9). The values of correlation are ranged from -1 to +1. A positive value indicates a proportional relation between variables and a negative value indicates an inverse relationship between variables (Salam et al., 2019). Figure 9 indicates that there exists a weak positive correlation between actual risk and perceived risk. Kendall's tau_b and Spearman's rho test results indicate an insignificant (r<0.3) positive correlation between actual risk and perceived risk (Supplementary Table S4). Pearson correlation (Table S4) indicates a significant (r>0.3) positive correlation between actual risk and perceived risk. All these results and the figure testify that actual risk is increased with the increase in perceived risk and vice versa.

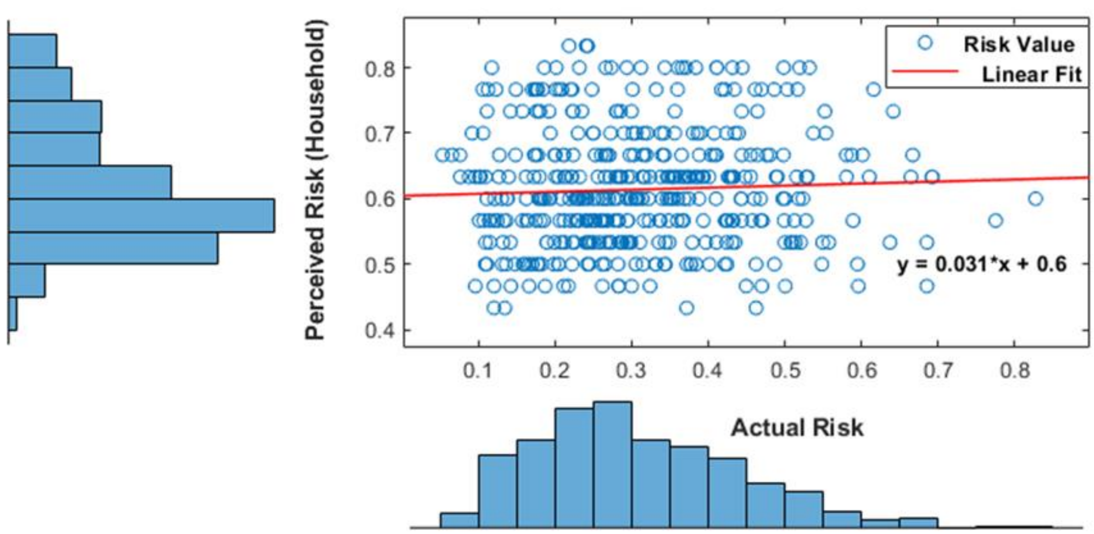

Figure 9: Correlation between actual and perceived risk at the household level

4. Discussions

Drought is a silent disaster that causes serious consequences including crop production loss, the deficit of drinking water, and so on. More research and studies on drought phenomena are urgent because of its inadequate literature on perceived and actual drought risk in northern Bangladesh. Therefore, this study is intended to fulfilling the existing gap by adding new knowledge into current knowledge. We found that actual and perceived risks vary with the variation of gender, educational status, geographic location, occupation, and monthly income which is consistent with the findings of Kellens et al. (2011), Wachinger et al. (2013), Mills et al. (2016), Rana and Routry (2016), Sarker (2017) and Sattar and Cheung (2019). No identical difference is found between the opinions of experts and households regarding perceived drought risk except gender. People of Ganai experienced high actual drought risk. On the contrary people of Ismail and Par Sekh Sundar experienced lower actual drought risk. Unlike actual risk, the people of Ismail, Ganai, and Par Sekh Sundar perceived high, moderate, and low risk, respectively. Buurman et al. (2020) reported based on a household survey that upstream communities experienced high drought risk than downstream communities in central Vietnam. For both actual and perceived (both household's and expert's) drought risk, high risk is reported by female participants. The female perceived more risk (0.63 for households and 0.66 for experts) than the male (0.60 for households and 0.57 for experts). Sattar and Cheung (2019) also found a similar outcome that females perceived and experienced high risk than males. According to the previous research, women experienced comparatively high disaster risk than men due to their poor socio-economic conditions, traditional practices, etc (UN, 2015; Neumayer & Plümper, 2007). Khan et al. (2020) explored that girls perceived higher disaster risk than boys that is highly analogous to this present study.

Illiterate and lower educated (primary) people experienced higher risk and graduate people experienced moderate risk. The rest of the groups were reported low risk. Like the actual drought risk, illiterate and lower educated (primary) people perceived higher risk, and comparatively high educated (graduate and higher secondary) people perceived low risk. Roco et al. (2015) stated that comparatively educated people perceived a clear idea of disaster risks that made them understand how to deal with those disasters to reduce the risks. Ullah et al. (2015) and Lucas and Pabuayon (2011) reported that education expands people’s knowledge on disasters and climate risk which influences people to take proper initiatives to lower the disasters risks. The income group that has no permanent income source (e.g. day labor) has faced higher risk. In converse, the income group that has a secure source of income (e.g. Govt. employees and other services holders) has faced the lower drought risk. Businessmen perceived higher risk than other income-generating groups. Sam et al. (2019) explored that unemployed people experienced high drought risk which is analogous to the present study. The relation between participant's monthly income (BDT) and drought risk showed a converse relationship. With the increase of income, drought risk decreases and vice-versa. De Silva and Kawasaki (2018) explored the same findings as this study that lower-income generating people experienced high drought risk than comparatively high-income generating people. The relation between participant's monthly income (BDT) and perceived drought risk showed a proportional relationship. With the increase of income, perceived drought risk increases and vice-versa. This perception leads to positive change in the way that people who perceived high risk and also have sufficient financial support taking timely strategies to reduce the upcoming drought risks. Furthermore, this study finds a difference in risk perception between expert and layperson and this finding is consistent with other studies (Peacock et al. 2005; Garvin 2001; Li 2009). An enormous variation in risk perception is found among the household, it is, therefore, urgent to promote awareness-raising programs for drought risk and adaptation so that farmers and community people are well-prepared and fully equipped to face future drought events.

It is a general belief that a person perceives higher risk, who has already been experienced with the higher impacts by any kind of disaster. Similar to Rana and Routray (2016), this study found a slightly positive correlation between actual and perceived risk, but this relationship is not statistically significant, whereas Sattar and Cheung (2019) reported reverse or no correlation. It implies that risk perception is a very complex issue that is controlled not only by experience with the hazard but also by some other demographic and socioeconomic factors. This provides some crucial information for both the disaster management practitioners, farmers, and government officials for better preparedness for drought even in these study areas. Furthermore, it gives valuable information about the risk areas.

5. Conclusions

This study aims to appraise actual versus perceived risk in the lowerTeesta River Basin of northern Bangladesh. A risk index was constructed to assess the farmer's perceived and actual risks in the study sites. Among the three study sites, the people of Ganai experienced a high actual risk that is significantly diverse from the other two sites of Ismail and Par Sekh Sundar. A significant relationship was found between the actual risk and socio-economic conditions of the respondents. Results from the perceived risk appraisal reveal that the mean level of perceived drought risk is high from both the household and expert perspective, and the average perceived risks of females are comparatively higher than male and expert levels in the Teesta River Basin. Risk varies with the variation of the respondent's gender, educational status, occupation, and monthly income. Furthermore, the local inhabitants have little knowledge of drought risk reduction and climate change residences. Droughts have more impact on the Ganai of northern Bangladesh because most people are below the average income level and little educational qualification compared to Ismail and Par Sekh Sundar. The outcomes of this study exhibit a strong correspondence with reality and these outcomes can help policymakers and practitioners to prepare appropriate drought risk reduction strategies. This study contributes to scientific knowledge effectively that adequately appraises the factor influencing actual drought risk and shows the gaps between them. Overall, this study implies that drought risk perception appraisal is a prerequisite for applying any drought risk reduction policy or action plan.

Acknowledgment

We would like to acknowledge the Department of Disaster Management, Begum Rokya University, Rangpur for other sorts of support. We thank all participants who have provided valuable information regarding this research.

Data availability

Data are available upon request on the corresponding author

Conflict of interest

There is no conflict of interest to publish this research

Funding

Self-funding

References

Ahsan MN, Warner J (2014) The socioeconomic vulnerability index: A pragmatic approach for assessing climate change led risks–A case study in the south-western coastal Bangladesh. Int. J. Disast Ri Reduc 8:32-49. doi: 10.1016/j.ijdrr.2013.12.009.

Alam E, Collins AE (2010) Cyclone disaster vulnerability and response experiences in coastal Bangladesh. Disast 34(4) (2010) 931-954. doi: 10.1111/j.1467-7717.2010.01176.x.

Al-Amin, A. A., Akhter, T., Islam, A. H. M. S., Jahan, H., Hossain, M. J., Prodhan, M. M. H., Mainuddin, M. & Kirby, M. (2019). An intra-household analysis of farmers' perceptions of and adaptation to climate change impacts: empirical evidence from drought prone zones of Bangladesh. Climatic Change, 156(4), 545-565.

Armaş I, Avram E (2009) Perception of flood risk in Danube Delta, Romania. Nat Hazar 50(2):269-287. doi: 10.1007/s11069-008-9337-0.

Banglapedia (2006) Drought in Bangladesh. http://banglapedia.search.com.bd/HT/D_0284.htm. Accessed 5 Sept 2019

Barua U, Akhter MS, Ansary MA (2016) District-wise multi-hazard zoning of Bangladesh. Nat Hazar 82(3) :1895-1918. doi: 10.1007/s11069-016-2276-2.

Bashier AH, Jayant KR (2014) Vulnerability to flood-induced public health risks in Sudan. Disas Prev and Manag 23(4)395-419. doi: 10.1108/DPM-07-2013-0112.

BBS, (2014). Small Area Atlas Bangladesh, Bangladesh bureau of statistics, statistics and information division, ministry of planning. Government of the People's Republic of Bangladesh, Dhaka.

BBS, (2015). Small Area Atlas Bangladesh, Bangladesh bureau of statistics, statistics and informationn division, ministry of planning. Government of the People's Republic of Bangladesh, Dhaka.

Birkmann J, Cardona OD, Carreño ML, Barbat AH, Pelling M, Schneiderbauer S, Welle T (2013) Framing vulnerability, risk and societal responses: the MOVE framework. Nat Hazar 67(2):193-211. doi: 10.1007/s11069-013-0558-5.

Bollin C, Cardenas C, Hahn GH, Vatsa KS (2016) Disaster Risk Management by Communities and Local Governments.

Boruff BJ (2009) Environmental Hazards: Assessing Risk and Reducing Disasters. Geo. Research. 47(4) 454-455. doi: 10.1111/j.1745-5871.2009.00611.x.

Buurman, J., Bui, D. D., & Du, L. T. T. (2020). Drought risk assessment in Vietnamese communities using household survey information. International Journal of Water Resources Development, 36(1), 88-105.

Cochran, W.G. (1977). Sampling techniques, 3rd edn. John Wiley, New York.

Cutter SL, Boruff BJ, Shirley WL(2003) Social vulnerability to environmental hazards. Soci sci quart 84(2) :242-261. doi: 10.1111/1540-6237.8402002.

Dastagir MR (2015) Modeling recent climate change induced extreme events in Bangladesh: A review. Wea Clima Extre 7:49-60. doi: 10.1016/j.wace.2014.10.003.

De Silva, M. M. G. T., & Kawasaki, A. (2018). Socioeconomic vulnerability to disaster risk: a case study of flood and drought impact in a rural Sri Lankan community. Ecological Economics, 152, 131-140.

Dilley M, Boudreau TE (2001) Coming to terms with vulnerability: a critique of the food security definition. F Poli 26(3): 229-247. doi: 10.1016/S0306-9192(00)00046-4.

Ekpoh IJ (1999) Rainfall and peasant agriculture in northern Nigeria. Glob J Pure Appl Sci 5(1999): 123-128.

Ericksen NJ, Ahmad QK, Chowdhury AR (1993) Socio-economic implications of climate change for Bangladesh. (p. 1). Dhaka: Bangladesh Unnayan Parishad.

Fedeski M, Gwilliam J (2007) Urban sustainability in the presence of flood and geological hazards: The development of a GIS-based vulnerability and risk assessment methodology. Lands Ur Plann 83(1):50-61. doi: 10.1016/j.landurbplan.2007.05.012.

Ferdous J, Mallick D (2019) Norms, practices, and gendered vulnerabilities in the lower Teesta Basin, Bangladesh. Env Develop 31: 88-96.

Field CB, Barros V, Stocker TF, Dahe Q (2012) Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change. Cambridge University Press.

Flanagan BE, Gregory EW, Hallisey EJ, Heitgerd JL, Lewis B (2011) A social vulnerability index for disaster management. J. Homeland Sec. Emer. Manage. 8(1). doi: 10.2202/1547-7355.1792.

Gain AK, Mojtahed V, Biscaro C, Balbi S, Giupponi C (2015) An integrated approach of flood risk assessment in the eastern part of Dhaka City. Nat. Hazards 79(3)1499-1530. doi: 10.1007/s11069-015-1911-7.

Garvin T (2001) Analytical paradigms: the epistemological distances between scientists, policy makers, and the public. Ri Analy. 21(3) :443-456. doi: 10.1111/0272-4332.213124.

Habiba U, Shaw R, Hassan A (2013) Drought Risk and Reduction Approaches in Bangladesh. 131-164.

Habiba U, Shaw R, Takeuchi Y (2011) Drought risk reduction through a Socio-economic, Institutional and Physical approach in the northwestern region of Bangladesh. Env Hazard 10:121-138.

Habiba U, Shaw R, Takeuchi Y (2012) Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh. Int J Disas Ris Reduc 1:72-84. doi: 10.1016/j.ijdrr.2012.05.004.

Habiba U, Shaw R, Takeuchi Y (2014) Farmers' adaptive practices for drought risk reduction in the northwest region of Bangladesh. Nat Hazar 72(2) :337-359. doi: 10.1007/s11069-013-1011-5.

Hahn MB, Riederer AM, Foster SO (2009) The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. Glob Env Chan 19(1) :74-88. doi: 10.1016/j.gloenvcha.2008.11.002.

Islam ARMT, Shen S, Hu Z, Rahman MA (2017) Drought hazard evaluation in boro paddy cultivated areas of western Bangladesh at current and future climate change conditions. Advan. Meteorol

Islam ARMT, Shen S, Yang S, Hu Z, Chu R (2019) Assessing recent impacts of climate change on design water requirement of Boro rice season in Bangladesh. Theor. Appl. Climatol. 138(2019) 97-113. doi: 10.1007/s00704-019-02818-8

Islam ARMT, Tasnuva A, Sarker SC, Rahman MM, Mondal MSH, Islam MMU (2014) Drought in Northern Bangladesh: social, agroecological impact and local perception. Int. J. Ecosyst 4(3)150-158. doi: 10.5923/j.ije.20140403.07.

Jamshed A, Rana IA, Mirza UM, Birkmann J (2019) Assessing relationship between vulnerability and capacity: An empirical study on rural flooding in Pakistan. Int. J. Disaster Risk Reduc. https://doi.org/10.1016/j.ijdrr.2019.101109.

Karim MR, Thiel A (2017) Role of community based local institution for climate change adaptation in the Teesta riverine area of Bangladesh. Clim Risk Manage 17: 92-103. doi: 10.1016/j.crm.2017.06.002.

Kellens W, Zaalberg R, Neutens T, Vanneuville W, De Maeyer P (2011) An analysis of the public perception of flood risk on the Belgian coast. Ris Analy 31:1055-1068.

Khan S (2012) Vulnerability assessments and their planning implications: a case study of the Hutt Valley, New Zealand. Nat Hazar 64(2) :1587-1607. doi: 10.1007/s11069-012-0327-x.

Khan, A. A., Rana, I. A., & Nawaz, A. (2020). Gender-based approach for assessing risk perception in a multi-hazard environment: A study of high schools of Gilgit, Pakistan. International journal of disaster risk reduction, 44, 101427.

Krug EG, Kresnow MJ, Peddicord JP, Dahlberg LL, Powell KE, Crosby AE, Annest JL (1998) Suicide after natural disasters. New Engla J Medi 338(6):373-378. doi: 10.1056/NEJM199802053380607.

Kulatunga U, Wedawatta G, Amaratunga D, Haigh R (2014) Evaluation of vulnerability factors for cyclones: the case of Patuakhali, Bangladesh. Int J Disas Ri Reduc. 9:204-211. doi: 10.1016/j.ijdrr.2014.05.011.

Li GM (2009) Tropical cyclone risk perceptions in Darwin, Australia: a comparison of different residential groups. Nat. Hazar 48(3): 365-382. doi: 10.1007/s11069-008-9269-8.

Lucas, M. P., & Pabuayon, I. M. (2011). Risk perceptions, attitudes, and influential factors of rainfed lowland rice farmers in Ilocos Norte, Philippines. Asian Journal of Agriculture and Development, 8(1362-2016-107714), 61-77.

Mainuddin M, Kirby M, Chowdhury RAR,. Shah-Newaz SM (2015) Spatial and temporal variations of and the impact of climate change on, the dry season crop irrigation requirements in Bangladesh. Irrig Sci 33:107–120. doi:10.1007/s00271-014-0451-3.

Mallick B, Ahmed B, Vogt J (2017) Living with the risks of cyclone disasters in the south-western coastal region of Bangladesh. Env. 4(1) 13. doi: 10.3390/environments4010013.

Mardy T, Uddin M, Sarker M, Roy D, Dunn E (2018) Assessing coping strategies in response to drought: A micro level study in the north-west region of Bangladesh. Clima 6(2):23. doi:10.3390/cli6020023.

Mills, M., Mutafoglu, K., Adams, V. M., Archibald, C., Bell, J., & Leon, J. X. (2016). Perceived and projected flood risk and adaptation in coastal Southeast Queensland, Australia. Climatic change, 136(3-4), 523-537.

Mortimore MJ, Adams WM (2001) Farmer adaptation, change and ‘crisis’ in the Sahel. Glob Env Chan 11(1):49-57. doi: 10.1016/S0959-3780(00)00044-3.

Neumayer, E., & Plümper, T. (2007). The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981–2002. Annals of the Association of American Geographers, 97(3), 551-566.

Nhuan MT, Tue NT, Hue NTH, Quy TD, Lieu TM (2016) An indicator-based approach to quantifying the adaptive capacity of urban households: The case of Da Nang city, Central Vietnam. Urban Clim 15:60-69. doi: 10.1016/j.uclim.2016.01.002.

O'bryan J (2016) A Systematic Review Of Sexual Violence And Hiv In The Post-Disaster Context: Latin America And The Caribbean.

Peacock WG, Brody SD, Highfield W (2005) Hurricane risk perceptions among Florida’s single family homeowners. Landsc. Urb Plan 73 :120–135. doi:10.1016/j.landurbplan.2004.11.004.

Phung D, Rutherford S, Dwirahmadi F, Chu C,Do CM, Nguyen T, Duong NC (2016) The spatial distribution of vulnerability to the health impacts of flooding in the Mekong Delta, Vietnam. Int J Biometeorol 60(6) 857-865. doi: 10.1007/s00484-015-1078-7.

Qasim S, Khan AN, Shrestha RP, Qasim M (2015) Risk perception of the people in the flood prone Khyber Pukhthunkhwa province of Pakistan. Int J Disas Ri Reduc 14 :373-378. doi: 10.1016/j.ijdrr.2015.09.001.

Rana IA, Routray JK (2016) Actual vis-à-vis perceived risk of flood prone urban communities in Pakistan. Int. J. Disast Risk Reduc 19 :366-378. doi: 10.1016/j.ijdrr.2016.08.028.

Roco, L., Engler, A., Bravo-Ureta, B. E., & Jara-Rojas, R. (2015). Farmers’ perception of climate change in mediterranean Chile. Regional Environmental Change, 15(5), 867-879.

Roy C, Sarkar SK, Åberg J, Kovordanyi R (2015) The current cyclone early warning system in Bangladesh: Providers' and receivers' views. Int. J. Disas Risk Reduc. 12 (285-299). doi: 10.1016/j.ijdrr.2015.02.004.

Roy, D., Datta, A., Kuwornu, J. K., & Zulfiqar, F. (2020). Comparing farmers’ perceptions of climate change with meteorological trends and examining farm adaptation measures in hazard-prone districts of northwest Bangladesh. Environment, Development and Sustainability, 1-23.

Saha CK (2015) Dynamics of disaster-induced risk in southwestern coastal Bangladesh: an analysis on tropical Cyclone Aila. Nat Hazards 75(1) (2015) 727-754. doi: 10.1007/s11069-014-1343-9.

Sam, A. S., Abbas, A., Padmaja, S. S., Kaechele, H., Kumar, R., & Müller, K. (2019). Linking food security with household's adaptive capacity and drought risk: Implications for sustainable rural development. Social Indicators Research, 142(1), 363-385.

Sarker MAR (2017) Farmersperception on climate change-driven rice production loss in drought-prone and groundwater-depleted areas of Bangladesh: An ordered probit analysis.University of Queensland, School of Economics.

Sattar MA, Cheung KK (2019) Tropical cyclone risk perception and risk reduction analysis for coastal Bangladesh: Household and expert perspectives. Int J Disast Risk Reduc 41:101283. doi: 10.1016/j.ijdrr.2019.101283.

Sattar, M. A., & Cheung, K. K. (2019). Tropical cyclone risk perception and risk reduction analysis for coastal Bangladesh: household and expert perspectives. International Journal of Disaster Risk Reduction, 41, 101283.

Saunders ME, Senkbeil JC, Perceptions of hurricane hazards in the mid-Atlantic region. Meteor Applic *24*(1) : 120-134. doi: 10.1002/met.1611.

Shahid S (2010) Drought Risk Assessment in the Western Part of Bangladesh. Nat Hazar 46.

Syed A (2017) The Teesta Basin Enough water for power and agriculture for all? Himalayan Adaptation, Water and Resilience Research (HI-AWARE).

Syed A, Haq A, Uzzaman A, Goodrich CG, Mallick D, Mini G, Sharma G, Nyima K, Mamnun N, Varma N., Singh P. (2017) The Teesta Basin: Enough water for power and agriculture for all. HI-AW Work Pape 12.

Terpstra T, Gutteling JM (2008) Households' perceived responsibilities in flood risk management in The Netherlands. Int. J. Water Res. Dev. 24 : 555–565.

Uddin MJ, Hu J, Islam ARMT, Eibek KU, Zahan MN (2020) A comprehensive statistical assessment of drought indices to monitor drought status in Bangladesh, Arabian Journal of Geosciences, 1.327, 13: 323, DOI: 10.1007/s12517-020-05302-0.

Udmale P, Ichikawa Y, Manandhar S, Ishidaira H, Kiem AS (2014) Farmers′ perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India. Int J of Dis Ri Reduc 10 :250-269.

Ullah, R., Shivakoti, G. P., & Ali, G. (2015). Factors effecting farmers' risk attitude and risk perceptions: The case of Khyber Pakhtunkhwa, Pakistan. International journal of disaster risk reduction, 13, 151-157.

United Nations International Strategy for Disaster Reduction. (2015). Women's leadership in risk-resilient development good practices and lessons learned. Bangkok: Thammada Press.

Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox—implications for governance and communication of natural hazards. Risk analysis, 33(6), 1049-1065.

World Bank Bangladesh, Bangladesh agriculture in the 21st century 2000. World Bank Bangladesh, Dhaka.

Zhang F, Chen Y, Zhang J, Guo E,Wang R, Li D (2019) Dynamic drought risk assessment for maize based on crop simulation model and multi-source drought indices, Jour of Clean Produc 233(100-114)

Zhang J (2004) Risk assessmentBollin of drought disaster in the maizegrowing region of Songliao Plain, China, Agriculture. Ecosys Env 102(2):133–153.

Zhang W, Wang W, Lin J, Zhang Y, Shang X, Wang X, Ma W (2017) Perception, knowledge and behaviors related to typhoon: a cross sectional study among rural residents in Zhejiang, China. Int J Env Rese Pub Heal 14(5) :492. doi: 10.3390/ijerph14050492.

Zhou Y, Liu Y, Wu W, Li N (2015) Integrated risk assessment of multi-hazards in China. Nat Haza 78:257–280. doi:10.1007/s11069-015-1713-y.

Zinat MRM, Salam R, Badhan MA, Islam ARMT (2020) Appraising drought hazard during Boro rice growing period in western Bangladesh, International Journal of Biometeorology, DOI:10.1007/s00484-020-01949-2.

Shrestha UB, Shrestha AM, Aryal S, Shrestha S, Gautam MS, Ojha H (2019) Climate change in Nepal: a comprehensive analysis of instrumental data and people's perceptions. Climatic Change. 154(3-4): 315. https://doi.org/10.1007/s10584-019-02418-5.

Habtemariam LT, Gandorfer M, Kassa GA, Heissenhuber A (2016) Factors influencing smallholder farmers'climate change perceptions: a study from farmers in Ethiopia. Environ Manag 58(2):343–358.

Alderman H, Chiappori PA, Haddad L, Hoddinott J, Kanbur R (1995) Unitary versus collective models of the household: is it time to shift the burden of proof? World Bank Res Obs 10(1):1–19.

Figures

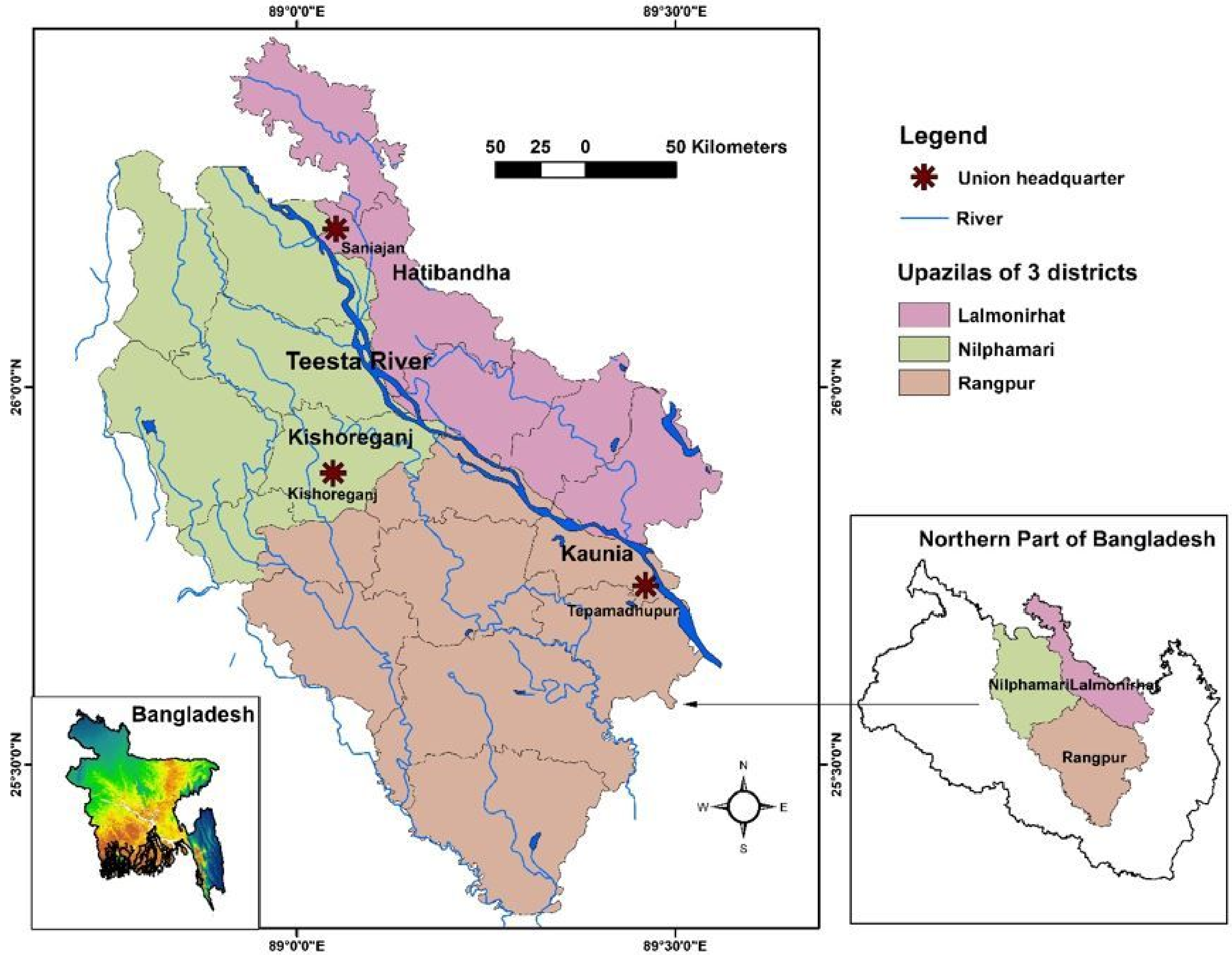

Figure 1

Location map showing the Teesta River Basin of Bangladesh prepared by ArcGIS 10.7 (www.esri.com) Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

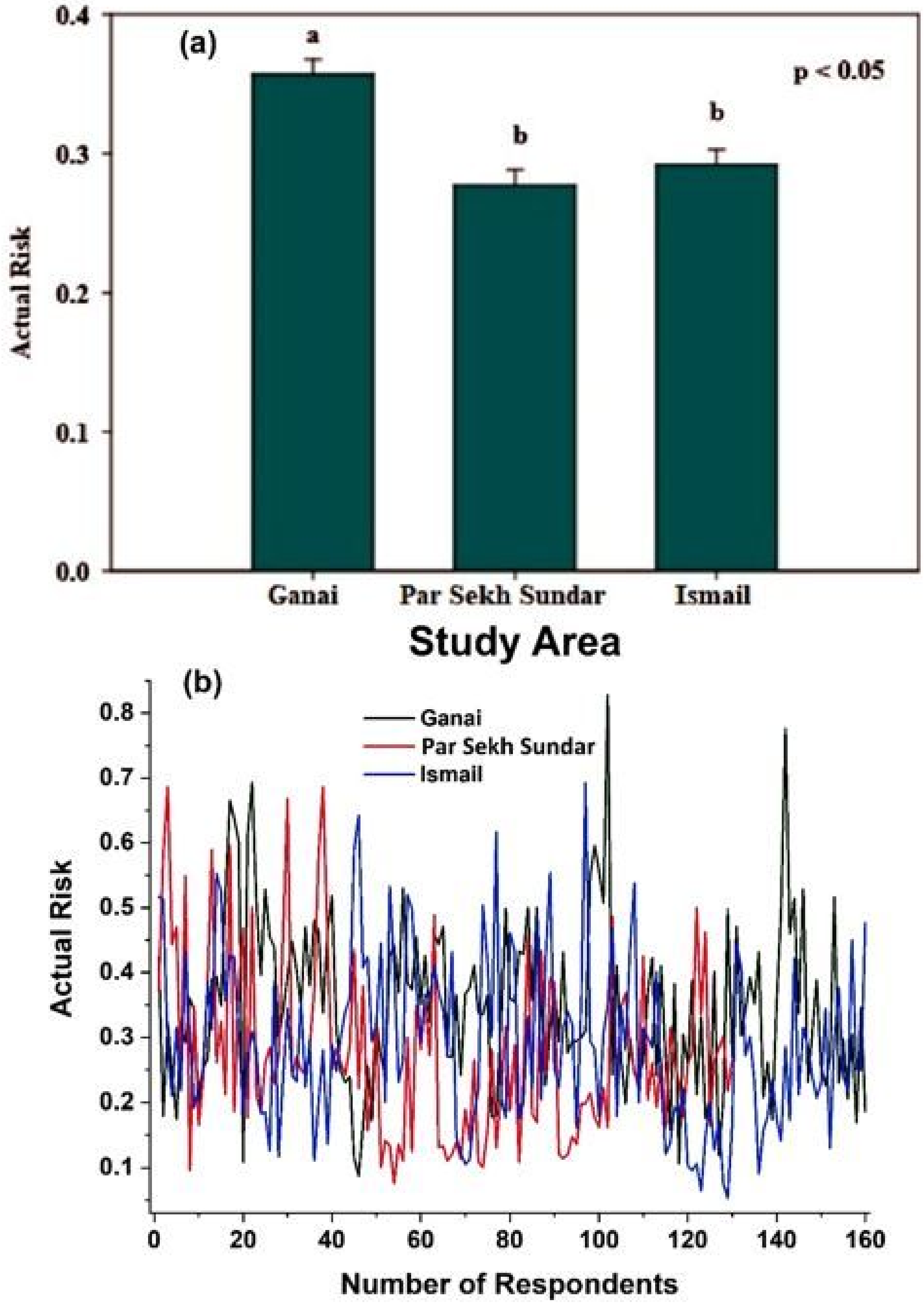

Figure 2

Index of actual risk: (a) Mean value, and (b) Individual value for the three study areas

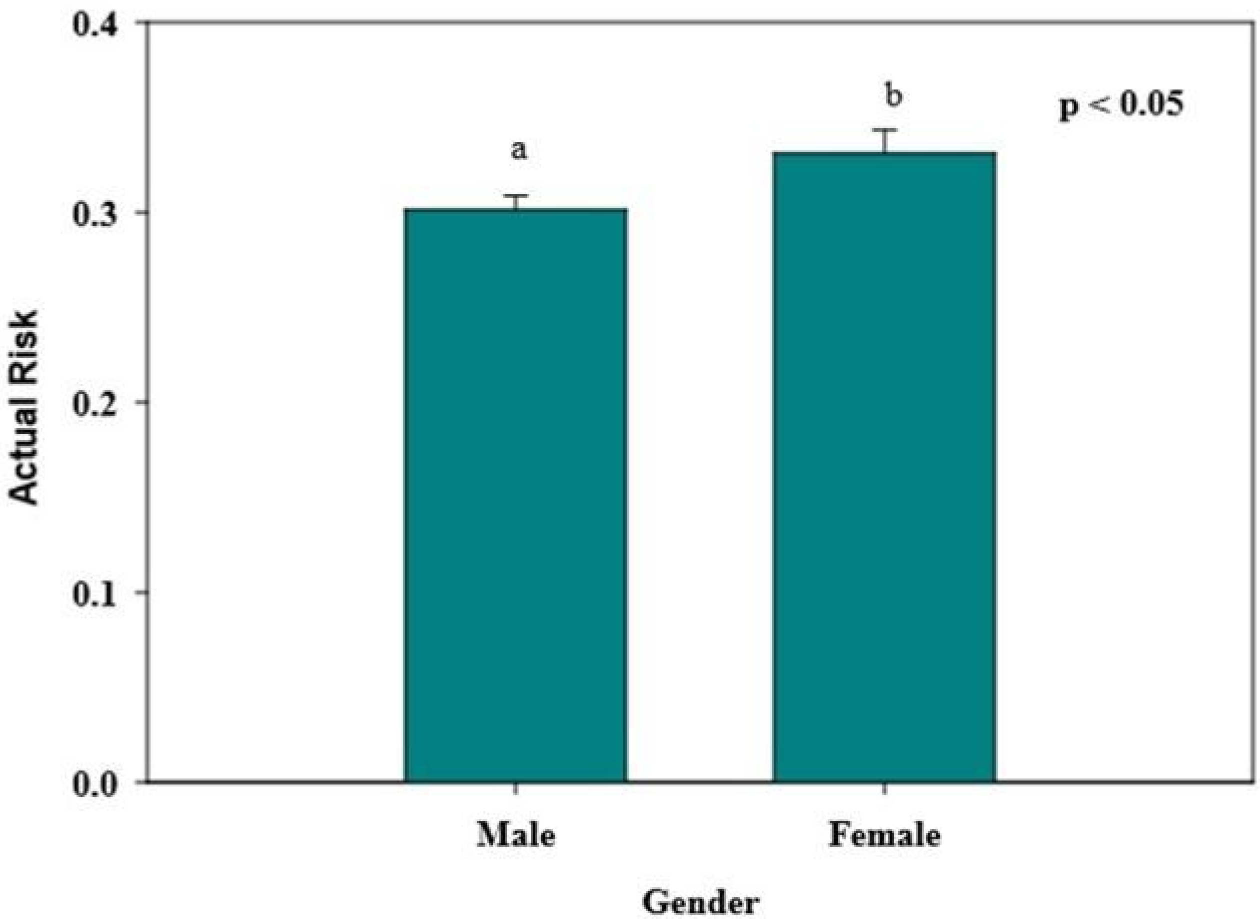

Figure 3

Actual risk variability based on gender

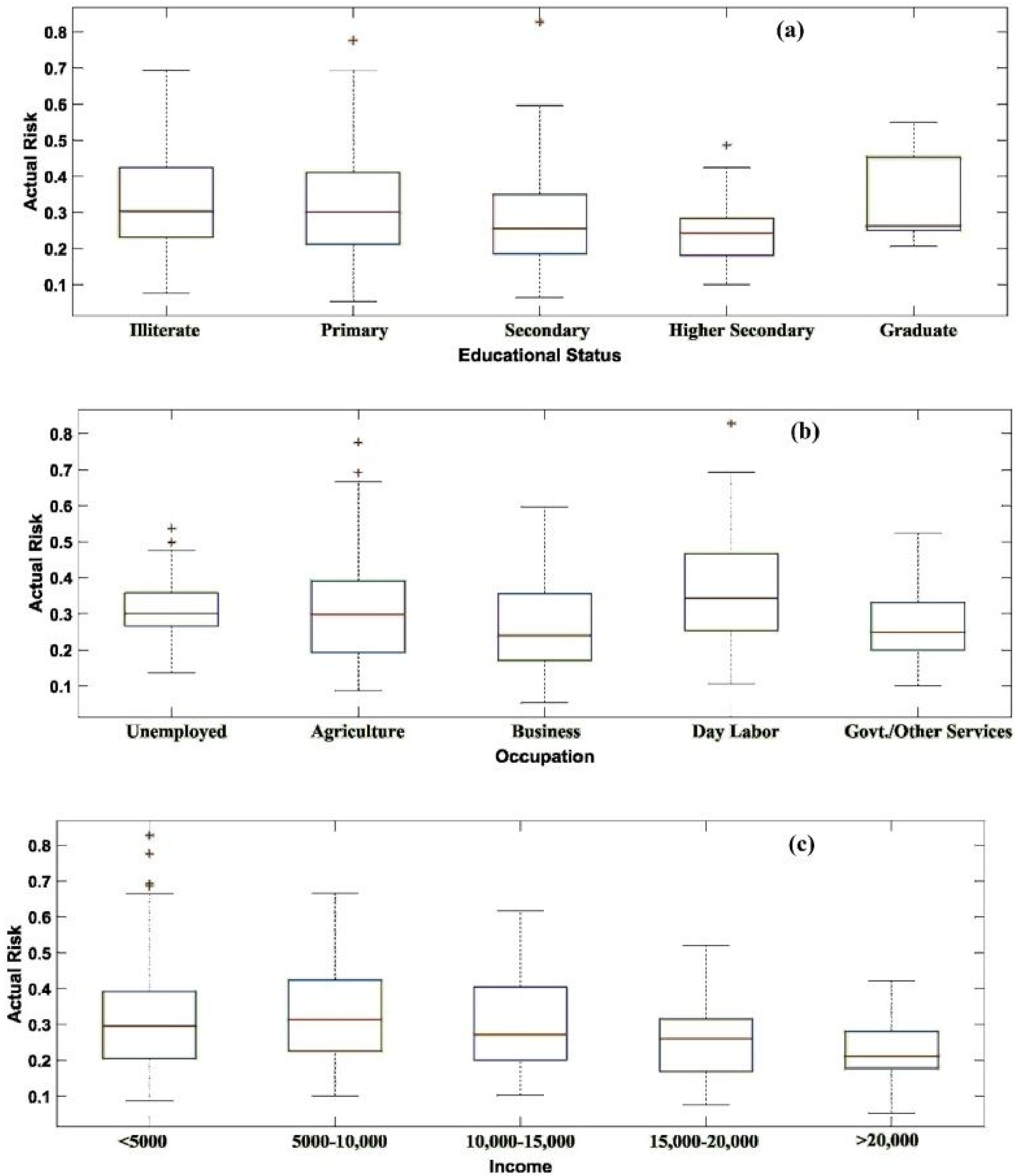

Figure 4

Dependence of actual drought risk on education, occupation, and income (Bangladeshi Taka)

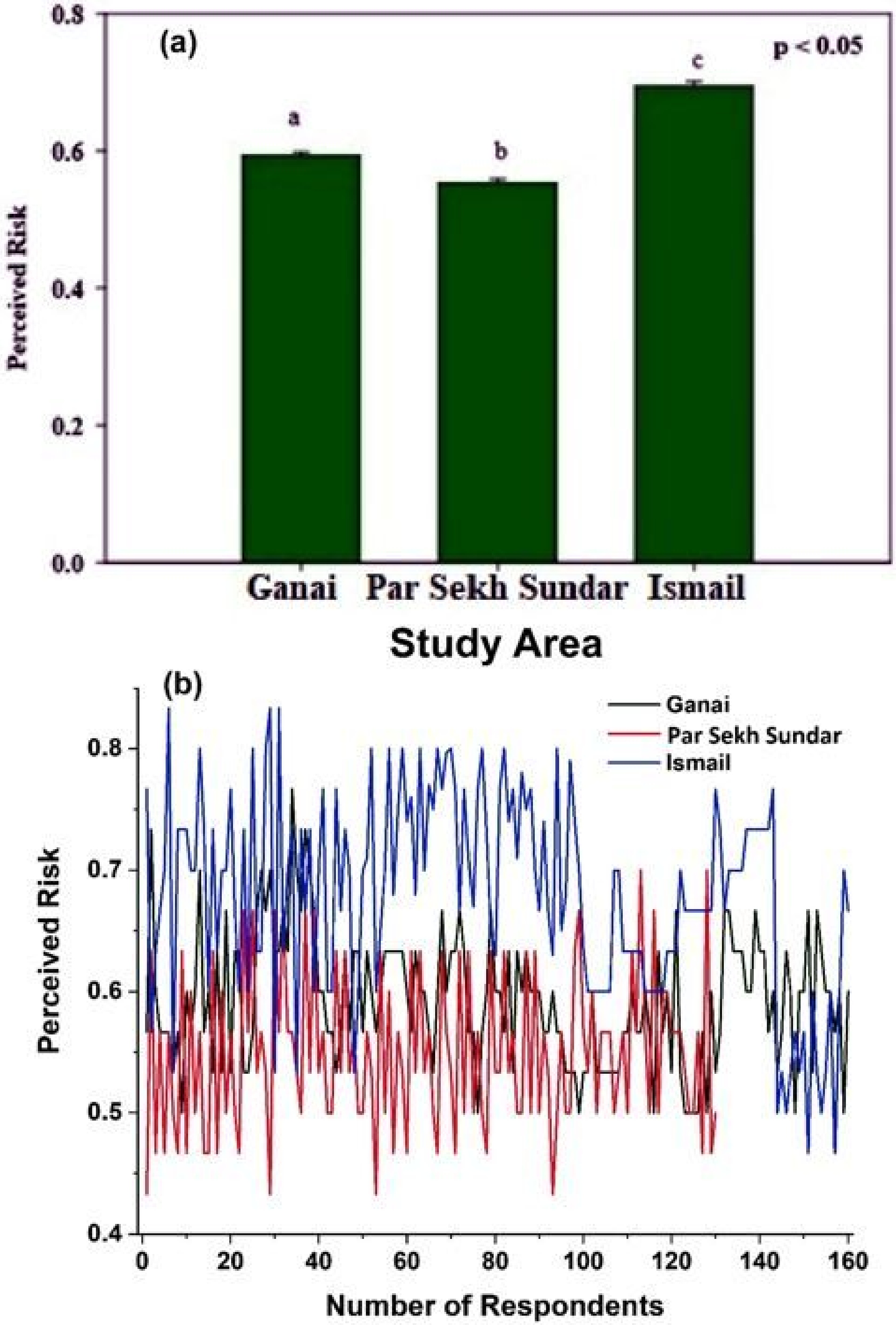

Figure 5

Index of perceived risk: (a) Mean value, and (b) Individual value at household level for the three study areas

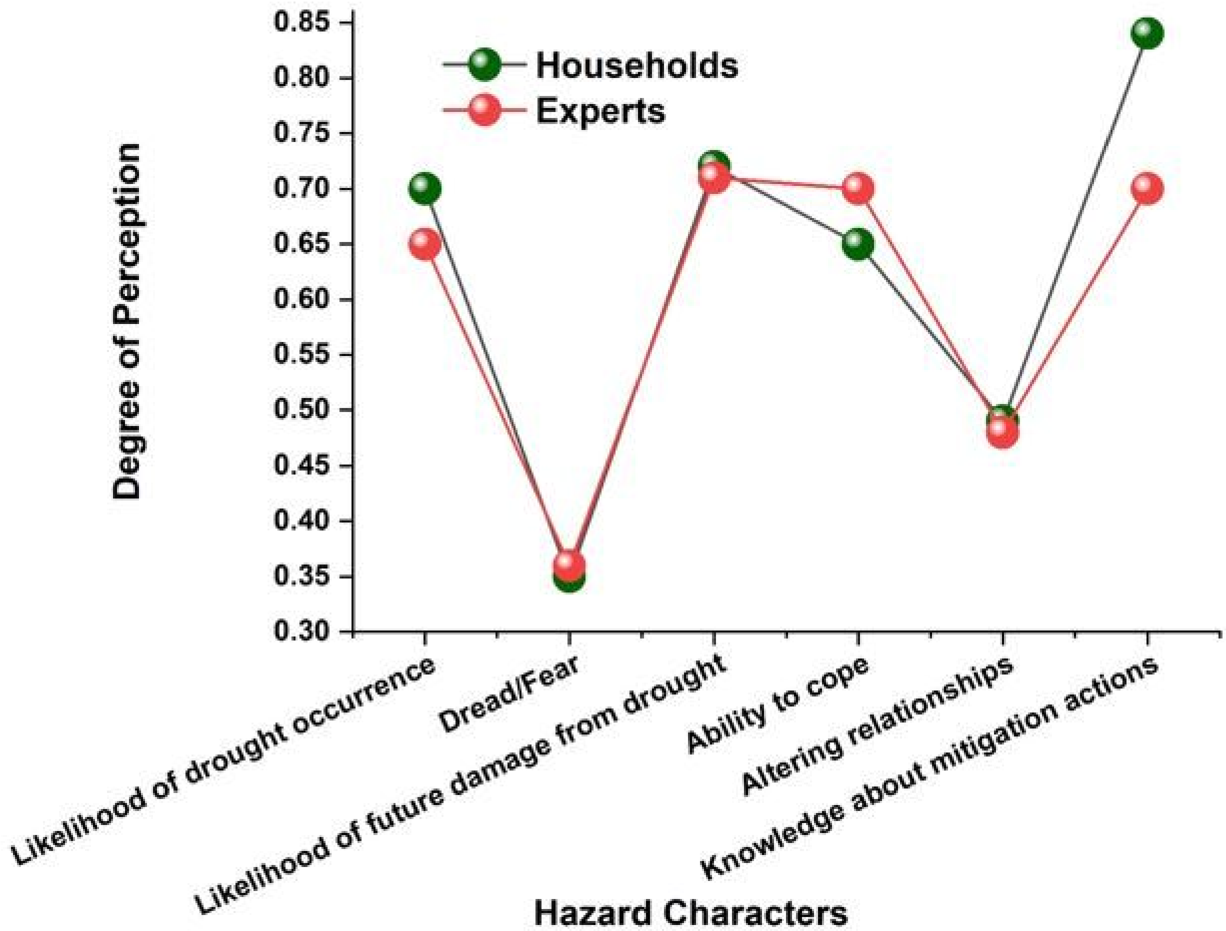

Figure 6

Degree of perceived risk at household’s vs experts

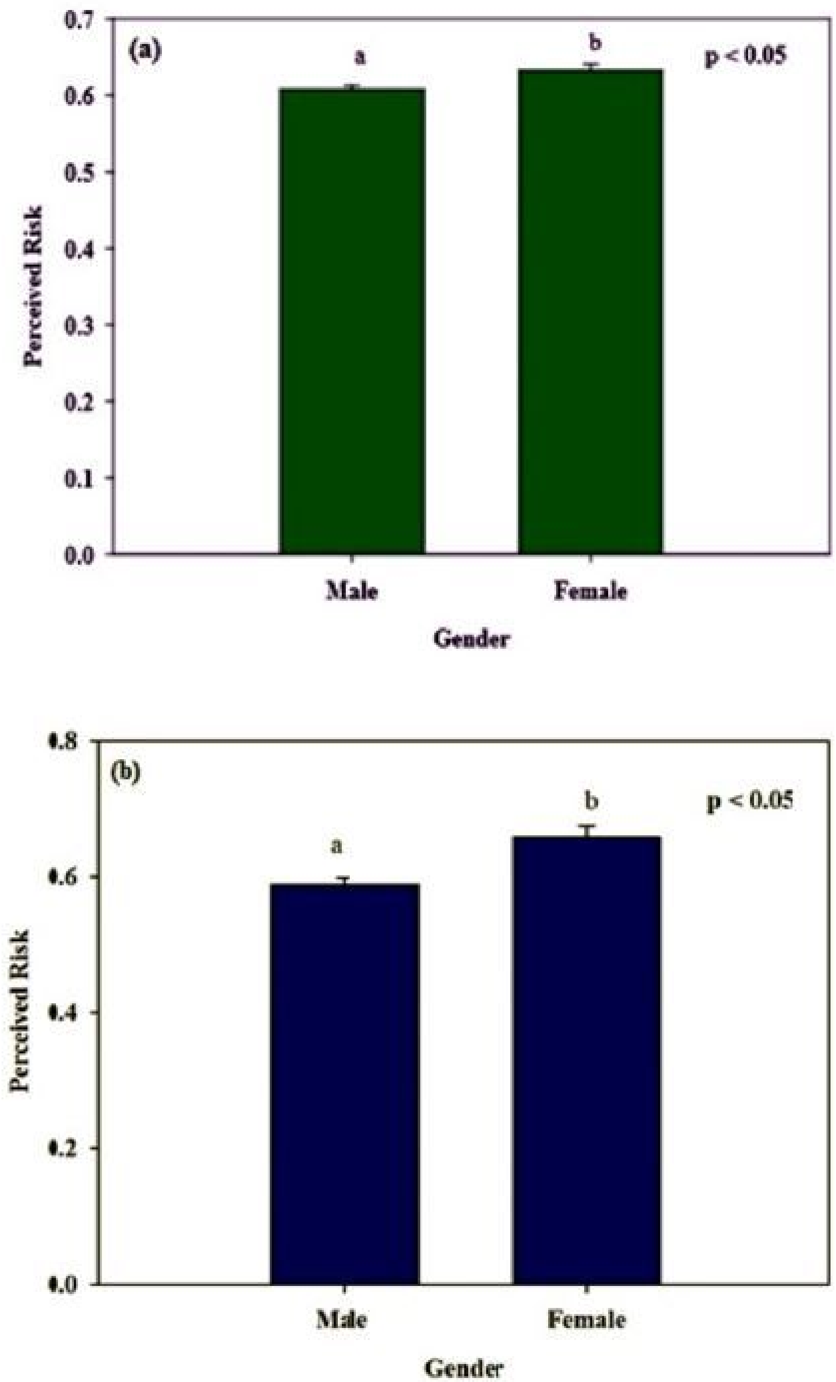

Figure 7

Risk perceptions from gender perspectives for both (a) households and (b) experts Notable risk difference is found from gender perspectives (Figure 7). Females perceived higher risk (0.63 for households and 0.66 for experts) than males (0.60 for households and 0.57 for experts). Perceived risk (households) also varies with the variation of respondent educational status, occupation, and income level (Figure 8).

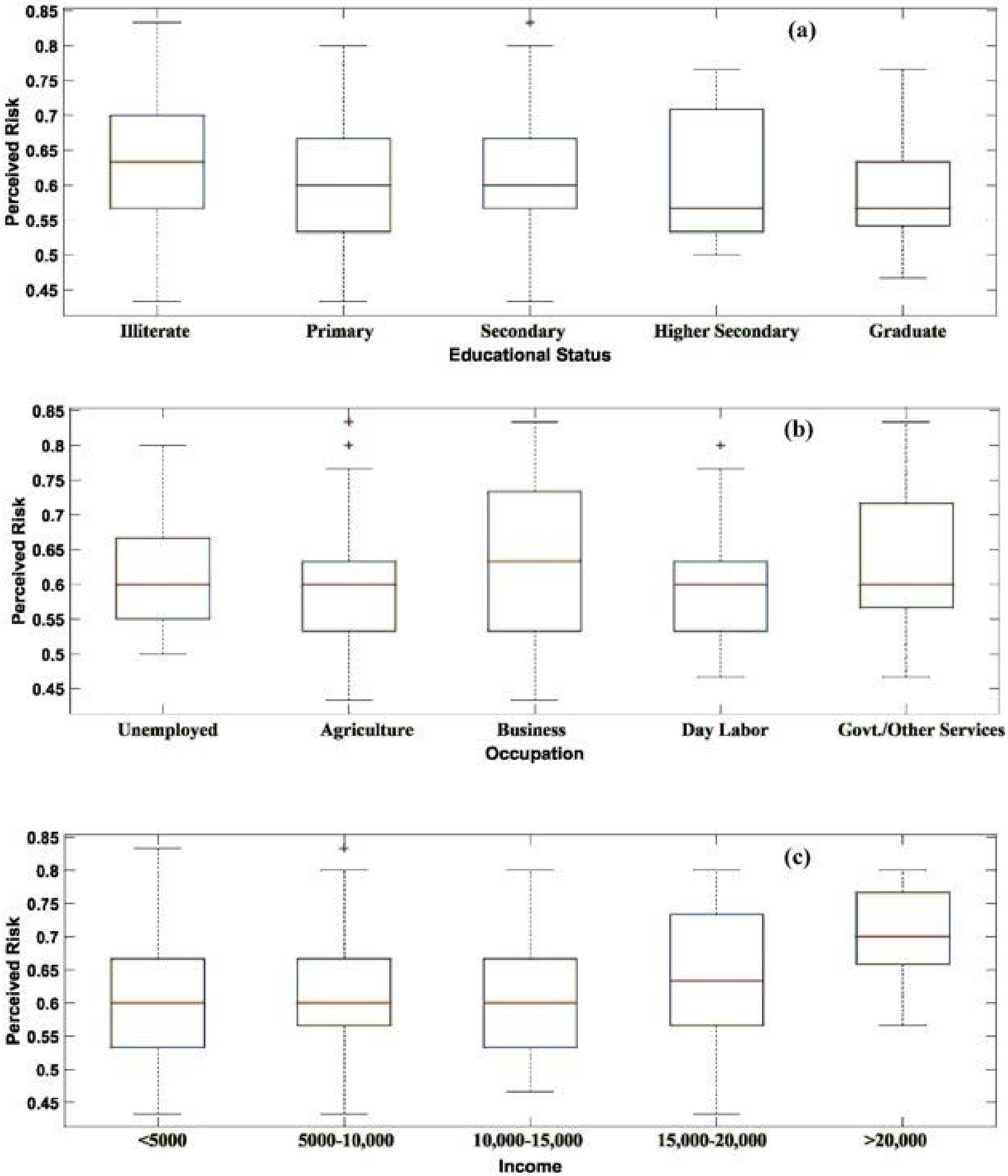

Figure 8

Dependence of perceived drought risk (households) on education, occupation and income (Bangladeshi Taka)

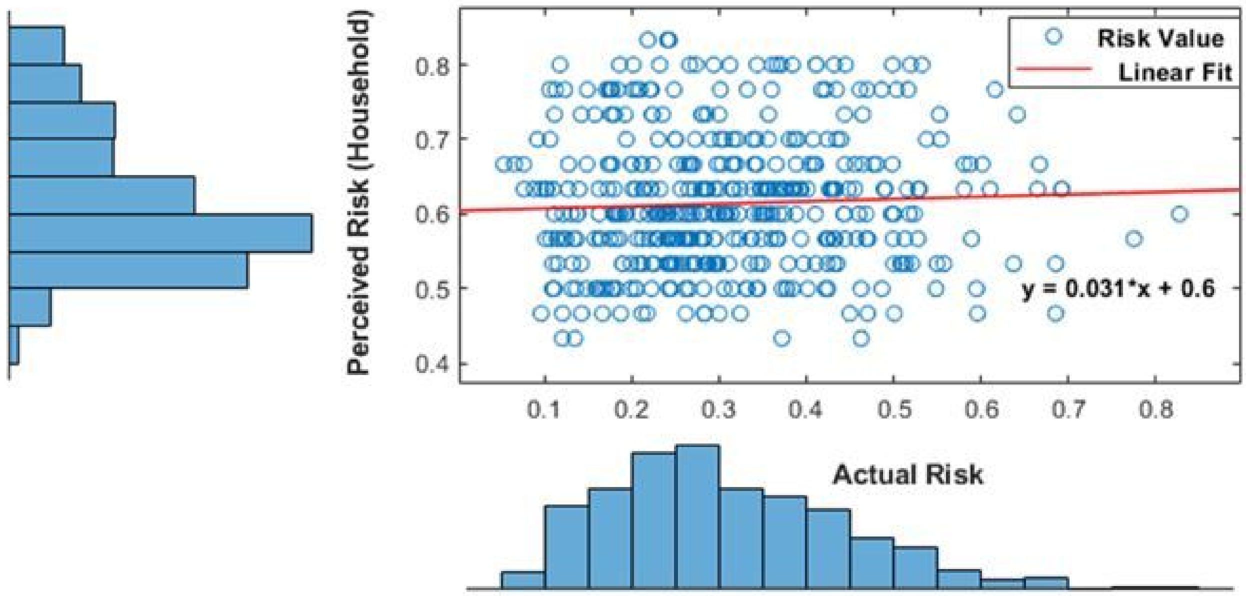

Figure 9

Correlation between actual and perceived risk at the household level

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Suplementarymaterials07032021.docx