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

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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 be 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°C or more in the pre-monsoon season and the temperature falls at 5°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 <±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

<table>
<thead>
<tr>
<th>Socio-economic Characteristics</th>
<th>Description</th>
<th>Ganai (Frequency)</th>
<th>Par Sekh Sundar (Frequency)</th>
<th>Ismail (Frequency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;30</td>
<td>30</td>
<td>43</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>31-45</td>
<td>64</td>
<td>46</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>46-60</td>
<td>47</td>
<td>30</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>&gt;60</td>
<td>13</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>110</td>
<td>102</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>50</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>Educational status</td>
<td>Illiterate</td>
<td>37</td>
<td>42</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>76</td>
<td>50</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>32</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Higher Secondary</td>
<td>11</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Occupation</td>
<td>Unemployed</td>
<td>10</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Agriculture</td>
<td>64</td>
<td>60</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>10</td>
<td>17</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Day labor</td>
<td>64</td>
<td>25</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Govt./Other services</td>
<td>12</td>
<td>14</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income</th>
<th>&lt;5000</th>
<th>59</th>
<th>50</th>
<th>56</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000-10000</td>
<td>84</td>
<td>53</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>10000-15000</td>
<td>11</td>
<td>14</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>15000-20000</td>
<td>5</td>
<td>10</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>&gt;20000</td>
<td>2</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

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).

\[
Drought \ risk = \frac{Hazard \times Vulnerability}{Capacity \ or \ manageability}
\]  

(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).
Drought risk \( R \) = Hazard (H) × Exposure (E) × Sensitivity (S) \[2\] Adaptive capacity (C)

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); Bashier and Jayant (2014).

\[
Cl = \frac{W_1 + W_2 + W_3 + \cdots W_n}{\sum_{i=1}^{n} \frac{W_i}{n}} \tag{3}
\]

Where,

CI \(\frac{1}{4}\) = composite index,

W1 to Wn \(\frac{1}{4}\) = respective weights employed to indicators and

n \(\frac{1}{4}\) = 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:

\[
\text{Hazard Index (HI)} = \frac{\sum_{i=1}^{6} HW_i}{n} \tag{4}
\]

\[
\text{Exposure Index (EI)} = \frac{\sum_{i=1}^{6} EW_i}{n} \tag{5}
\]

\[
\text{Sensitivity Index (SI)} = \frac{\sum_{i=1}^{10} SW_i}{n} \tag{6}
\]

\[
\text{Capacity Index (CI)} = \frac{\sum_{i=1}^{10} CW_i}{n} \tag{7}
\]
\[ \text{Perceived Risk Index (PRI)} = \frac{\sum_{i=1}^{6} PW_i}{n} \quad (8) \]

\[ \text{Actual Risk} = \frac{HI \ast (EI \ast SI)}{CAI} \quad (9) \]

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.
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
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 Pabuyon (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 service 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 lower Teesta 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.

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**Data availability**

Data are available upon request on the corresponding author

**Conflict of interest**

There is no conflict of interest to publish this research

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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
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

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- Supplementarymaterials07032021.docx