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Climate Change Inculcate Crop Loss and Livelihood: A Case of Drought in Bangladesh

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Abstract
*Crop loss is multidimensional and associated with drought and the consequences of climate change. Drought damages crops and make losses to the marginalized people and make them more vulnerable in different channels alike other disasters. The work has been carried out in the Northwest region of Barind in Bangladesh to explore relevant issues that may lead crop damage by frequent drought. Research used **v**arious methods in this study to get together both qualitative and quantitative information along with primary and secondary sources. Survey was conducted using semi-structured questionnaire with the sample population. Few selective case studies were made to obtain more information on crop loss and drought. In this study, Ordinary Least Square technique was utilized.*
The model of crop loss:
$C = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + \alpha_9 X_9 + \mu_1$
The study explored few variables including income of the households, their age, sex and migration that have no important influence on crop production and loss owing to drought. Other variables such as frequency of drought, study areas, sustenance, livelihood and agricultural land have the significant influence on crop loss and livelihood. It was mentioned by the households that frequency of drought is increasing two decades with increase the number of hot days. Result indicates the meaningful relationship between drought frequency and crop losses. Few adaptation measures like re-sowing, early sowing, late planting can reduce crop loss. A wide range of alternatives for livelihood activities such as small business, van pulling, handiworks and seedling production for nursery business were identified by this study. Drought insurance policy, early warning system, future research on emerging issues and local level knowledge are important for climate change adaptation and resilience.

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1. Introduction

1.1 Background

Climate and climate change attributes are associated with many factors that may cause direct and indirect economic losses. One of the impacts of climate change is drought that leads the loss of crops and down the livelihood. Drought onset slowly and affect livelihood over a longer span of time (Reza *et al.*, 2018). Islam (2024) pointed that drought reduce crop yields and affects cropping patterns. Local knowledge is an important measure for climate change adaptation and resilience (Islam 2024). A study mentioned the human pressure on the climate and it has the role in changing extreme events of climate, and the frequency (Frame *et al*., 2020). Bangladesh is a agricultural country and its economy depends on various agricultural activities. In Bangladesh, agriculture contributes 22.7 percent alone to the Gross Domestic Product (BBS, 2005). This sector is very much vibrant due to various climatic stressors (Aziz *et al.*, 2022). Many researchers reported that crop cultivation and production is hampering in the many parts of Bangladesh in the past decades (Al-Amin *et al.*, 2019; Amin *et al.*, 2014; Aryal *et al*., 2020). Drought is the combined phenomenon of meteorological and socio-ecological characteristics (Mondol *et al*., 2021). Drought occurs on an average once in 2.5 years in Bangladesh and affect human life likely other natural disasters (Adnan, 1993; Ericksen, 1993; Hossain, 1990).

Droughts do more damage to the crop over flood and other disasters in the recent times making the peasants vulnerable in many countries (Paul, 1995). According to Rahman and Biswas (1995), recurrent drought made 3.5 million tons shortfall of rice production in the northwestern area of Bangladesh. Paul (1998) reported that drought laid enormous crop loss particularly year of 1978-79, 1982 and 1997 in Bangladesh. Drought is interlinked with climate change and both climatic factors & climate stressors. Berrang-Ford *et al*.,(2011) identified the link between climate change factors and stressors, gaps in literature that impose food insecurity and sustainability issues and society. Less rainfall extends the sufferings of drought ina disturbing way to the Barind people. Droughts may generate from consecutive dry spells and less precipitation (Greve, 2016). It affects 3 to 4 million hectares land and reduce production each year (Miah *et al.*, 2005). Reduced rainfall and soil moisture affect the vegetative growth of the crops and production. Many reasons are connected with crop production & losses in drought crisis such as intensity, magnitudes, scales, frequency, and agricultural land, alternatives for livelihood diversification, household income, adapting capacity and sustenance. 8.3 million hectares land (60% of lands) is cultivated for *Aman* rice production in traditional system depending on rain.

More economic losses of the farmers are caused by Droughts.According to Miah *et al.* (2005), 4.2 million hectares land are inclined to drought risks. Paul (1998) mentionedthat droughtproduction loss in 1978-79 was 50-100 percent more than loss by the flood in the year of 1974. Generally, rice production affected by drought

in three cropping seasons. Land preparation is delayed in March to April;delayed planting in monsoon. Transplanting is also delayed due to lack of adequate rainfall in July to August especially in the highland. If drought occurs in September to October, it reduces the yields of pulses and potatoes. Similarly, *boro* and wheat crops are exaggerated by the drought in dry season (Selvaraju *et al*., 2006). In the high Barind Tract, eighty percent *T.aman* crop loss occurs in September to October owinglate planting (Islam *et al.*, 2011).

1.2 Impact of Drought

Loss generates due to lack of capability to manage drought. It may include inadequacy in adaptation, cost involvement and strategic directions. The chronology of the drought impact is less production; lack of employment and low income. It affects production and increase the price of food and produces. It makes coupled with unemployment and access to food of poor people, especially the marginalized and laborers. Loss and damage (L&D) estimation from drought may help the key people of the state such as researchers, policy makers and practitioners (Bahinipati, 2020). It enhances the capacity of resilience including mitigation and adaptation measures that could be followed. The sufferers are getting support from relatives and neighboring people. It is too difficult to purchase food for them; sometimes they are bound to purchase food by selling their lands, goods, and other assets with below price (Reardon *et al.*, 1988). The victims' dismals their housing structure and go for temporary migration.

It was mentioned by Jallow (1995) that the people consumed wild foods in their hardship. The dilemma of drought expands in the northwestern part of Bangladesh frequently (Murshid, 1987). According to a study, drought reduces around one-million-ton food grains in 1997 (Islam *et al.*, 2011). It was estimated that around 0.6 million tons was *T.aman*, with the value of loss USD 500 million. It affects the sustainability issues and development due to increased magnitude of drought (Warner & van der Geest, 2013).

1.3 Objective of the Study

The main objective of the study is to explore what are the factors influencing crop loss and damage and impacts in relation to drought. The following objectives were achieved through this study:

- Identify the climate and drought stressors with crop loss and responses
- Find out the impacted sectors level
- Explore the factors associated with crop yield lossesand drought management
- Know the ways of crop loss minimization and challenges that are faced by the households.

2. Methodology

2.1 Method

Drought and crop loss related primary information was provided by the household in this study. Study has been conducted in six villages (each village from each union under each Upazila and two Upazila from three districts). The study Upazilas have been selected based on drought severity ranking (Khan and Islam, 2013). The mix methods have been deployed for this study including household survey through interviews and other qualitative data collection techniques.Household's list was obtained from office of the concerned Union Parishad. Sample respondents were selected from the list using simple random sampling technique through online random calculator. In determining total sample, statistical technique and PPS were used for this study. 343 sample populations (70% males and 30% females following quota sampling) were identified from six locations using online random calculator allowing five percent error. Household survey was carried out using semi-structured questionnaire. The questionnaire addressed percentage of crop loss, drought frequency, cultivated agricultural land, income, mitigation and adaptation measures (irrigation, re-sowing) social resilience (support), livelihoods options (Migration, trading, nursery) and dismal of housing structure.

In the first phase, household data including socio-economic, demographic characteristics and income has been collected. Data obtained for this study using vulnerability state of the respondents for particular locations. Part two dealt with drought and the consequences of effects and drought management capabilities. Focus group discussions have been organized to collect added evidence of crop loss and drought, and livelihood impacts. Diverse information and data generation is possible through focus group discussions on gender perspectives and different occupational groups and wealth groups.

2.2 Drivers Inculcate Drought and Crop Losses

Loss directs negative effects of drought that beyond the capacity to cope with or adaptation to address such occurrence. Climate change effects are two types such as economic and non-economic. A study mentioned wide drivers of non-economic loss and damages including loss of biodiversity, ecosystem services, mental depression, loss of occupation, food, disturbance of cultural functions, loss of sovereignty and many more (Islam *et al.,* 2022). Sustainability of livelihood also been affected by loss factors that have been linked up with both dependent and independent variables. The adaptation measures depend on the affordability of costs and the effectiveness. The activities may generate negative effects, extra costs for both economic and noneconomic losses. The study on crop loss was conducted with a view to know the interactions of different variables and drought impacts with livelihoods and social vulnerability in the Barind Tract. The study considered and realized the factors of crop loss in the context of environment, economic background and locations of the study populations, the information gathered in following realms:

- Climate change and drought context: Various context such asless precipitation, extreme temperature, insufficient soil moisture and watercoursemovement. It is related with the weather and climatic extreme events;
- Occurrence and intensity of Drought: This includes occurrences of drought, magnitudes that may happen once a year or more;
- Income of the family: The amount of income that can help or not enough in managing hardship during drought crisis;
- Owing the land: This is another determinant the capacity or factors that influence drought loss and damages through diverse uses of land effectively;
- Coping mechanisms: The temporary way to manage through displacement from rural to urban, neighboring districts, megacity or seasonal migration for immediate cash income, seeking help from kins or networks, adjustment in cropping patterns & time and changes in the food habits (limited quantity and meal per day);
- Adaptation measures: Adopting few viable measures that can minimizes the crop damage through the use of local knowledge and traditional methods in agriculture;
- Occupation and livelihood options: Diverse options having household able to manage drought crisis through alternative options;
- Asset loss: It is the last effort to dispose assets with low price to tackle the situation;

In the dry zone of Myanmar, a study used ordinary least square (OLS) for the evaluation of economic impacts. They used 30 years temperature for the impacts (Tun *et al.*, 2020) assessment. Several studies used OLS to see the impacts of extreme climate events on crop production and yields in different countries of the world (Ben Zaied & Ben Cheikh, 2015; Kumar *et al.*, 2016; Oyebamiji, 2015; Wu *et al.*, 2021). This study was followed the ordinary least square (OLS) to evaluate the impact of drought on crop loss. The study used 39 years precipitation data to determine drought scale and frequency and other factors. The main problem in OLS is heteroscedasticity if arises, and this problem was solved by using heteroscedasticity consistency estimation method (White's method) and weighted least square (Dimitrios, 2006). The Breusch-Pagan / Cook-Weisberg test for heteroskedasticity was conducted and no heterokedasticity found.

2.3 Use of Ordinary Least Square

Ordinary Least Square technique was used to evaluate the effect of drought frequency and other factors on drought and crop loss in the Barind Tract.

Drought and household crop loss model:

$$C= \alpha_0 + \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \alpha_4X_4 + \alpha_5X_5 + \alpha_6X_6 + \alpha_7X_7 + \alpha_8X_8 + \alpha_9X_9 + \mu_1$$

Here,
C = Crop loss in percentage in 2014 due to drought
X_1=Average total income (BDT)
X_2=Drought frequency in year
X_3=Study locations
X_4= Gender of the respondents
X_5= Migration
X_6= Age of the respondents
X_7=Access to support
X_8=Occupation
X_9= Agricultural land (decimal)
α_0= Constant
α_i=Coefficient to be calculated
μ_1= Error term.
The study was also carried out with the assumed hypothesis that crop loss is increasing with the interlinked different variables of drought.

3. Results

3.1 Identification of Drought and Climate Stressors and Responses

Drought and climate stressors were identified by the respondents including less rainfall, lack of groundwater, high temperature and erratic rainfall in this study. Respondents mentioned that the frequency of drought is increasing with the time. The analysis from rainfall data it was found that drought frequency and intensity is increasing.

More severe drought was identified in the late season of *rabi* and start of *kharif-1*. The respondent who is reliant on agriculture affected more than non-agriculture. It was found that more crop loss occurs in Chokghorpakhia village though they adopted measures. The study found increased frequency of drought in terms of year and seasons with the number of hot days. The respondents from FGD and KII is also mentioned the increased frequency of drought and severity. A few non-economic loss and damage including loss of biodiversity, anxiety, disruption in the social bondage, and cultural values are affecting by climate change and drought mentioned by the respondents from FGD and KII.

Crop loss (%)	Drought & climatic stressors	Experienced climatic stressors (%)	Study villages	Adopted measures (%)
98	Less rainfall	100	Chokghorpakhia	100
92	Less rainfall	100	Nizampur	95
90	Lack of groundwater	100	Bhabicha	98

82	Lack of groundwater	92	Mollapara	77
79	High temperature	100	Aye-Hi	98
59	Erratic rainfall	100	Parisho	98

Source: field survey

Table1: Drought and climate Stressors, responses and crop loss (% of households)

Only 59 percent respondents mentioned that they loss their crops by adopting measures (98%) due to climate change stressor (erratic rainfall). In Parisho village, 100 percent respondents were experienced erratic rainfall as climatic stressors and performed 98 percent adaptation measures and lost crops 59 percent (Table 1). The respondents from KII and FGD are also opined about the drought and climatic stressors in the same way. As they told erratic rainfall, less rainfall, depletion of groundwater table and high temperature give birth of the drought and put stress to the rural economy. More severe drought found in the *Kharif* and *Rabi* season.

3.2 Impacted sectors and level

This study considers only three levels of impact sectors as perceived by the respondents. The study villages and the drought and climatic stressors also added in this table to evaluate the relationship of impact sector levels with locations and climatic stressors. Less rainfall was mentioned as the drought related climatic stressors by the respondents from chokghorpakhia village with 98 percent crop loss (Table 2) as the impact sector 1 followed by economic loss sector 2 and houses sector 3 levels respectively. Similarly, the participants from focus group discussion mentioned that climate sensitive agriculture and reliance on agriculture make the people more vulnerable. The women headed households and poor are suffering more due to climate change issue like drought as they have limited access to diverse livelihood options.

Study villages	***Impact sector 1 (%)***	***Impact sector 2 (%)***	***Impact sector 3 (%)***
Chokghorpakhia	Crops (98)	Economic loss (100)	House (67)
Nizampur	Crops (96)	Economic loss (29)	Livestock (83)
Bhabicha	Crops (89)	Economic loss (57)	Livestock (70)
Aye-Hi	Crops (77)	Economic loss (47)	Livestock (71)
Mollapara	Crops (77)	Economic loss (45)	Phys. assets (80)
Parisho	Crops (54)	Economic loss (19)	Livestock (87)

Source: field survey

Table 2: Drought impact sectors (% of households)

A range of variables including (1) income of the family, (2) scale, intensity and frequency of drought, (3) study place with severity, (4) gender (5) temporary

displacement (internal or external), (6) respondent'sage, (7) direct and indirect support, (8) profession and (9) own land was treated as self-determining variables.

Considerable Variables	Coefficient	t-value	Significance
Age (years)	-.4551044	-1.96	0.051
Sex of respondent (Male and Female)	-.1078469	-1.21	0.226
Profession	.466802	2.79	0.006
Income (BDT)	.0505201	1.77	0.078
Places of the study	-.0896118	-7.62	0.000
Frequency of drought (dummy)	.9467631	-6.67	0.000
Displacement (dummy)	.0751319	0.32	0.753
Sustenance (dummy)	-.185442	-3.46	0.001
Agricultural land (decimal)	.3468439	20.18	0.000
Constant	2.541278	5.79	0.000
R-square: 0.6095			

Source: Author's Survey

Table 3: Factors considering drought impact and crop loss

The dependent variable was crop loss in this model. It was found that rather than income, sex, displacement and age, other variables had significance effect on crop damage (Table 3). Frequency, places, sustenance, professions and agricultural land were identified as the significant variables for this model. Drought affects and cause lot of damage to the crops in different study locations. Respondents (from survey, FGD and KII) mentioned about the negative consequences of drought such as impacts of climate change, groundwater withdrawal and inconsistent precipitation. The frequency of drought and crop losses has the significant relationship. Results showed significant difference of crop loss with the places of study. It was found that study locations-based drought severity and support is essential parameters for crop loss and damage.

3.3 Ways to crop loss minimization and drought management

It was found that those respondentsgot help in different forms like money, materials, technical support for irrigation, input support for drought tolerant variety able to manage drought risks on crops efficiently. These types of help come from kins, networks, adjoining people, respective Department of Agricultural Extension, Non-Governmental Organizations, and Barind Multipurpose Development Authority. Those people who have more support and able to manage crop loss recovering than other people. The profession is also another determinant to manage the crop loss. The agriculture profession is very vulnerable to crop loss. Usually, who have fewer alternatives to tackle the drought impacts? Rather than agriculture, the farmers able

to manage their losses with other incomes. The agricultural land has an importantinfluence in crop damage. The people having more agricultural land are vulnerable to drought and crop damage. It was explained earlier that the poor and marginalized people who depends on agriculture are severely affected by drought. The wealthier groups are in well of position to tackle the crop loss during drought crisis with their own assets. The study found that the well of groups are getting more support, access in credit and cash or kind support from others to manage to drought risks during their hardship.

It was found that the support of any forms helpful to succeed the drought. Barind Multipurpose Authority is providing hands on support to fight the drought crisis. Results showed thathas significance role as the dependent variable of the model. The study found that the situation very inclined with the withdrawal of supports. The number of earning members in the family has the great role in crop loss management.Adult active members of the family who have the capacity to earn can contribute more in managing crop loss due to drought. Bangladesh rural economy is mostly depending on agriculture. Bangladesh's agriculture relies on manual labor that indicates family labor. The study found that food adjustment strategies, migration, diversification of livelihood activities are very helpful in adjusting the crop loss (FGD and KII). Mostly women sacrificed meals followed by adult men in respect of number of meals in a day and also quality and quantity. Farmers are trying to adjust drought losses by using water saving irrigation system (Alternate Wet and Dry method). It may be assumed from this study that the family having adult active member, diverse livelihood options are able to manage crop loss and drought risks. It is essentially important the secondary occupation can help the drought victims effectively. The respondents from survey, FGD and KII mentioned that preparedness, mitigation and adjustment strategies are essential for the minimization of crop loss and drought management in this climate change era.

4. Discussion and Conclusions

The definition of drought differs from region to region, country to country, place to place and context. In understanding crop damage and drought risks, different opinions were observed among the stakeholders in terms of scale, magnitudes, time scale and perception (Slovic, 1987). The study found that rise of awareness is a useful concept to reduce drought risks and crop loss. Early warning and prediction system on drought through specific software might help in crop loss and drought risk management. The prediction and assumption on drought risks are not easy task. Asymmetrical features (Powell and Leytham, 2014) and complication in calamity management in different countries is difficult to survive with such catastrophe (Olson, 2000; Tierney, 2007). The study focused on different variables that have great impacts on crop damage and drought risks. Many factors affect negatively the recuperating process on or after ruins (; Gil-Rivas and Kilmer 2016; Wisner *et al*. 2014). According to Joffe *et al.*, 2016; Joffe *et al.*, 2019 cited in Massazza *et al.*, 2019, alertness on several efforts such as usefulness, behavioral intent, confidence,

accountability were initiate as upright creativities for preparedness. It was found that the women are affected more than men due to all types of calamities and household sustenance safety. Women scarified their own food with quality and amount; even women reduce number of meals two times from three in a day.

This study identified the vulnerability of women in drought risks. Similarly, many research showed that women are more prone to natural calamities for their poor economic circumstances (Aryal 2014; Sohrabizadeh *et al.*, 2016; Whelan, 2018; Sim *et al.*, 2019). More research is necessary to discover the association and modifications of duty amongst drought risk and responsibility for catastrophic loss. Massazza *et al.*,(2019) recommended for future research to find differences amid metaphors of accountability aimed at the threat besides calamity. This study showed the representation of three cropping seasons, but a study reported that only *Kharif* and *Rabi* season is visible in Bangladesh (Faridatul & Ahmed 2020).

Intensity, frequency and magnitudes of drought is growing as the accelerate event of global climate change. A study from India reported that 4 to 5 times drought frequency increase during the study (Bhanipati, 2020). It is also well known to all that Bangladesh is less resilient to climate change impacts due to population density and geographical settings (Mondol *et al.*, 2021). It is impossible to ignore the consequences of drought crisis. It needs to acclimatize sustainable actions tackling the crisis in timely manner. The marginalized people are not able to manage it due to their incapability and other factors (lack of skills, assets, income and social networks). Now a day, the farmers are getting information in advance on weather and they are preparing themselves accordingly to save their livelihood from adverse effects of extreme climate change effects. Insurance policy, incentives for farming and guidance from the concerned department may help them from the huge loss of crops and impacts of drought.

It was found that more land owing farmers able to grow multipole crops (some are drought tolerant crops). They can manage the environment extreme events efficiently than the marginalized farmers. The study found that non-economic loss and damage is the important concern to understand the climate change impacts. A study from Bangladesh and Japan reported that non-economic loss and damages are neglected to estimate the impacts of climate change and drought like other disasters (Chiba *et al.*, 2017). Time specific and selective irrigation help the farmers for effective water management. The irrigation during night time gives the pathway for effective water management by reducing water loss (transpiration, evapo-transpiration). The system saves energy and money for them. On Farm Research and Development discover the irrigation system of Alternate Wet and Dry method is very effective for crop growth. It reduces the irrigation cost and frequency by increasing irrigation efficiency 40-50 percent. The bondage and networking in the social realm is essential to manage the impacts of any calamities. The people can get support from each other through the social networks. It was found that the wealthier people are getting more support and access from everywhere. Contrarily,

the poor are not getting such support. Delayed planting or sowing, use of drought tolerant varieties, less water required species and sowing again helpful for the crops. Temporary or permanent displacements of the active members help them during crisis. This displacement may either short distance or long distance for their regular earnings. Such earningsassist the poor to sustain and provide back-up support for future crop production. In addition, various livelihood opportunities help them to manage the extreme climate change events.

Surely, the results revealed that the people who have more earnings through diverse livelihood activities are able to achieve good results for adaptation to drought risks. The study found that climate change causes crop loss and reduces production linking several variables of which few are significant and rest are insignificant. Those farmers have the ability to use good seed, timely irrigation are in better position. Cultivation of diverse crops help them to stay safe than the disadvantaged groups. Local and community level responses are useful, but it differs from location to location and community to community and local context. It is very difficult to say the single variable or few variables are intermingled crop production and crop losses. The findings from this study will help in shaping drought policy and future research opportunities.

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Conflict of Interest

Author declares that this manuscript has no any conflict of interests for the publication. The ethical issues, such as checking of plagiarism, publication elsewhereand double submission is verified by the author.

References

Adnan, S., (1993). *Institutional Aspects of Flood Protection Programmes: November 1991-October 1992: Living without floods: lessons from the drought of 1992* (No. 7). Research & Advisory Services.

Al-Amin, A.A., Akhter, T., Islam, A.H.M.S., Jahan, H., Hossain, M.J., Prodhan, M.M.H., Mainuddin, M. and 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*, 545-565.

Amin, M.R., Zhang, J. and Yang, M., (2014). Effects of climate change on the yield and cropping area of major food crops: A case of Bangladesh. *Sustainability*, *7*(1), 898-915.

Aryal, J.P., Sapkota, T.B., Khurana, R., Khatri-Chhetri, A., Rahut, D.B. and Jat, M.L., (2020). Climate change and agriculture in South Asia: Adaptation options in smallholder production systems. *Environment, Development and Sustainability*, *22*(6), 5045-5075.

Aryal, K., (2014). Women's empowerment in building disaster resilient communities. *Asian Journal of Women's Studies*, *20*(1), 64-174.

Aziz, M.A., Hossain, A.Z., Moniruzzaman, M., Ahmed, R., Zahan, T., Azim, S., Qayum, M.A., Al Mamun, M.A., Kader, M.A. and Rahman, N.M.F., (2022). Mapping of agricultural drought in Bangladesh using geographic information system (GIS). *Earth Systems and Environment*, *6*(3), 657-667.

Bahinipati, C.S., (2020). Assessing the costs of droughts in rural India: a comparison of economic and non-economic loss and damage. *Current Science*, *118*(11), 1832.

Bangladesh Bureau of Statistics -BBS. (2005). *Statistical Pocketbook of Bangladesh 2003*. Ministry of Planning, Dhaka. 466.

Ben Zaied, Y. and Ben Cheikh, N., (2015). Long-run versus short-run analysis of climate change impacts on agricultural crops. *Environmental Modeling & Assessment*, *20*, 259-271.

Berrang-Ford, L., Ford, J.D. and Paterson, J., (2011). Are we adapting to climate change?. *Global environmental change*, *21*(1), 25-33.

Chiba, Y., Shaw, R. and Prabhakar, S., (2017). Climate change-related non-economic loss and damage in Bangladesh and Japan. *International Journal of Climate Change Strategies and Management*, *9*(2), 166-183.

Dimitrios, A., (2006). *Applied Econometrics: a modern approach using EViews and Microfit.*

Ericksen, N.J., Ahmad, Q.K. and Chowdhury, A.R., (1993). *Socio-economic implications of climate change for Bangladesh, 4*, Dhaka: Bangladesh Unnayan Parishad.

Faridatul, M.I. and Ahmed, B., (2020). Assessing agricultural vulnerability to drought in a heterogeneous environment: a remote sensing-based approach. *Remote Sensing*, *12*(20), 3363.

Frame, D.J., Rosier, S.M., Noy, I., Harrington, L.J., Carey-Smith, T., Sparrow, S.N., Stone, D.A. and Dean, S.M., (2020). Climate change attribution and the economic costs of extreme weather events: a study on damages from extreme rainfall and drought. *Climatic Change*, *162*, 781-797.

Gil-Rivas, V. and Kilmer, R.P., (2016). Building community capacity and fostering disaster resilience. *Journal of clinical psychology*, *72*(12), 1318-1332.

Greve, A.I., (2016). Sustainable development, climate change adaptation and disaster management. In *Sustainable Development and Disaster Risk Reduction*, 13-36.

Hossain, M., (1990). Natural calamities, instability in production and food policy in Bangladesh. *The Bangladesh Development Studies*, 33-54.

Islam, M., Ali, M., Amin, M. and Zaman, S.M., (2010). Climatic variations: farming systems and livelihoods in the high barind tract and coastal areas of Bangladesh. In *Climate change and food security in South Asia*, 477-497.

Islam, M.M., Nipa, T.A., Islam, M.S., Hasan, M. and Khan, M.I., (2022). Economic and non-economic loss and damage to climate change: evidence from a developing country shrimp farms to cyclone Bulbul. *Fisheries and Aquatic Sciences*, *25*(4), 214-230.

Islam, M. S. (2024). Fishermen using social-ecological resilience adapting coastal disasters. *Mitigation and Adaptation Strategies for Global Change*, *29*(2), 17.

Islam, M. S. (2024). Identification of seasonal drought and its impacts on cropping season in Bangladesh. *International Journal of Disaster Resilience in the Built Environment*.

Jallow, S.S., (1995). Identification of and response to drought by local communities in Fulladu West District, The Gambia. *Singapore Journal of Tropical Geography*, *16*(1), 22-41.

Joffe, H., Perez-Fuentes, G., Potts, H.W. and Rossetto, T., (2016). How to increase earthquake and home fire preparedness: the fix-it intervention. *Natural Hazards*, *84*(3), 1943-1965.

Joffe, H., Potts, H.W., Rossetto, T., Doğulu, C., Gul, E. and Perez-Fuentes, G., (2019). The Fix-it face-to-face intervention increases multihazard household preparedness cross-culturally. *Nature human behaviour*, *3*(5), pp.453-461.

Khan, M. F. A. and Islam, M. S., (2013). *Vulnerability to climate induced drought: Scenario and impacts*. CDMP.

Kumar, A., Sharma, P. and Joshi, S., (2016). Assessing the impacts of climate change on land productivity in Indian crop agriculture: An evidence from panel data analysis. *Journal of Agricultural Science and Technology*, *18(1)*, 1-13.

Massazza, A., Brewin, C.R. and Joffe, H., (2019). The nature of "natural disasters": Survivors' explanations of earthquake damage. *International Journal of Disaster Risk Science*, *10*(3), 293-305.

Miah, M.M., Rahman, M.S., Islam, A., Paul, D.N.R., Farid, A.T.M., Jahiruddin, M., Sattar, M.A., Panaullah, G.M., Meisner, C.A., Loeppert, R.H. and Duxbury, J.M., (2005). Nationwide survey of arsenic in soils, water and crops in Bangladesh. *Behavior of arsenic in aquifers, soils and plants (Conference Proceedings), Dhaka*.

Mondol, M.A.H., Zhu, X., Dunkerley, D. and Henley, B.J., (2021). Observed meteorological drought trends in Bangladesh identified with the Effective Drought Index (EDI). *Agricultural Water Management*, *255*, 107001.

Murshid, K.A.S., (1987). Weather, new technology and instability in foodgrain production in Bangladesh. *The Bangladesh Development Studies*, 31-56.

Oyebamiji, O.K., Edwards, N.R., Holden, P.B., Garthwaite, P.H., Schaphoff, S. and Gerten, D., (2015). Emulating global climate change impacts on crop yields. *Statistical Modelling*, *15*(6), 499-525.

Olson, R.S., (2000). Toward a politics of disaster: Losses, values, agendas, and blame. *Crisis Management*, *18*(2), 154.

Paul, B.K., (1995). *Farmers' and public responses to the 1994-95 drought in Bangladesh.*

Paul, B. K. (1998). Coping mechanisms practised by drought victims (1994/5) in North Bengal, Bangladesh. *Applied geography*, *18*(4), 355-373.

Powell, T. and Leytham, S., (2014). Building resilience after a natural disaster: An evaluation of a parental psycho-educational curriculum. *Australian Social Work*, *67*(2), 285-296.

Rahman, A. and Biswas, P.R., (1995). Devours resources. *Dhaka Courier*, *11*(42), 7-8.

Reza, S., Islam, M. N., & Rahman, M. M., (2018). Meteorological Drought Monitoring Using Satellite Imagery: A Case Study On Rajshahi, Naogaon And Jaipurhat Of Bangladesh. *1st National Conference on Water Resources Engineering. 21-22 March 2018, CUET, Chittagong, Bangladesh.*

Selvaraju, R., Subbiah, A.R., Baas, S. and Juergens, I., (2006). Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh: Developing institutions and options.

Sim, T., Lau, J., Cui, K. and Wei, H. H., (2019). Post-disaster psychosocial capacity building for women in a Chinese rural village. *International Journal of Disaster Risk Science*, *10*(2), 193-203.

Slovic, P., (1987). Perception of risk. *Science*, *236*(4799), 280-285.

Sohrabizadeh, S., Tourani, PhD, S. and Khankeh, H.R., (2016). Women and health consequences of natural disasters: Challenge or opportunity?. *Women & health*, *56*(8), 977-993.

Tierney, K.J., (2007). From the margins to the mainstream? Disaster research at the crossroads. *Annu. Rev. Sociol.*, *33*, 503-525.

Tun Oo, A., Van Huylenbroeck, G. and Speelman, S., (2020). Measuring the economic impact of climate change on crop production in the dry zone of Myanmar: A Ricardian Approach. *Climate*, *8*(1), 9.

Whelan, J., (2018). Disasters and vulnerable populations: Evidence-based practice for the helping professions. *Australian Social Work*, *71*(4), 457-458.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I., (2014). *At risk: natural hazards, people's vulnerability and disasters*. Routledge.

Wu, J. Z., Zhang, J., Ge, Z. M., Xing, L.W., Han, S. Q., Chen, S.H.E.N. and Kong, F.T., (2021). Impact of climate change on maize yield in China from 1979 to 2016. *Journal of Integrative Agriculture*, *20*(1), 289-299.