Determining Economic Losses and Factors Influencing Flood, Drought and Earthquake Risk Perception in Disasters-Prone Areas of Punjab, Pakistan

Dilshad Ahmad¹, Salyha Zulfiqar Ali Shah², Muhammad Ayub³

¹ Department of Management Sciences, COMSATS University Islamabad, Vehari Campus, Pakistan.
Email: dilshad@ciitvehari.edu.pk

² Assistant Professor, School of Economics, Bahauddin Zakariya University Multan, Pakistan.
Email: salyhazulfiqar@bzu.edu.pk

³ Assistant Professor, School of Economics, Bahauddin Zakariya University Multan, Pakistan.
Email: mayub@bzu.edu.pk

ARTICLE INFO

ABSTRACT

Article History:  
Received: August 08, 2022  
Revised: September 26, 2022  
Accepted: September 28, 2022  
Available Online: September 30, 2022

Climate-based natural disaster intensity and destruction severity have risen multifold particularly in developing countries owing to an inadequate understanding of disaster risk perception. In using the household data of 398 respondents and the ordered probit model this study focused to investigate the factors influencing flood, drought, and earthquake risk perception in Punjab, Pakistan. In selected study areas, the majority of respondent's likelihood perceived of happening disasters which caused financial losses and severely influenced their livelihood. Disasters-prone-area inhabitants' inadequate understanding of mitigation measures has increased their vulnerability as they have become ineffective to overcome such natural disasters' severe impacts. Empirical estimates of the study indicated as sources of income generating, education level, gender, status, and age of household significantly affect the respondent's risk perception about flood, drought, and earthquake. Females in contrast to male respondents have a limited understanding of mitigation measures and are not as much of capable of controlling disasters as they have become more vulnerable related to disaster effects. In developing the disaster-prone communities' socioeconomic status urgent-based measures are required such as the understanding of the disaster gender-based gap needs to be reduced through better household appreciative vigilance and alleviation of floods, drought, and earthquake disasters.

© 2022 The Authors, Published by iRASD. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License

JEL Classification Codes:  
D81, I24, O13

Funding:  
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Corresponding Author's Email: mayub@bzu.edu.pk

1. Introduction

Rising environmental degradation and dynamics in the current era has increased the incidence and sternness of natural adversity namely earthquake, cyclones, landslide, floods, storms and drought (Barrett, Zepeda, Pollack, Munson, & Sih, 2019; Kimaro, Mor, & Toribio, 2018; Lecina-Diaz et al., 2021). These natural hazards are persistently influenced by lifestyle choices, risk exposure and geographical locations (Abbas et al., 2018; Ambelu et al., 2017; Daniell, Lin, Yu, & Chang, 2016; Muricho, Otieno, Oluoch-Kosura, & Jirström, 2019) exclusive of the confines of social, political, geographical and cultural margins of countries, communities and continents (Fenta, Hailu, & Hadush, 2019; Kreft, Huber, Wuepper, & Finger, 2021). Recurrent Floods occurrence is a mainly significant cause of human fatalities and usually of social and economic risks (Ambelu et al., 2017; Doocy, Daniels, Murray, & Kirsch, 2013; Mekuye, Jordaan, & Melka, 2018). In the global aspect and more particularly in the region of South Asia, Pakistan is measured most climate change susceptible country in the region for the reason of dangerous geographical locations and underprivileged natural resources.
management (Khan et al., 2020; Kret, Czop, & Pietrucin, 2017; Muricho et al., 2019). In the aspect of regional dynamics of climate change susceptibility and vulnerability severity, Pakistan among most climate change countries as ranked 29th in 2009 while 16th in 2011 and 5th world most vulnerable country in the current era (Eckstein, Künzel, Schäfer, & Winges, 2019; Schilling, Hertig, Tramblay, & Scheffran, 2020; Teo, Goonetilleke, Ahankoob, Deilami, & Lawie, 2018).

Pakistan is consistently and incidentally confronted with severe drought and floods each year whereas earthquakes are not the most commonly happening incident in the region (Khan et al., 2020; Mamun et al., 2021). These disasters cause severe losses of millions of human lives, crops, livestock, psychological issues, crisis, migration, seasonal-based food security, destruction of infrastructure and environmental degradation (Ahmad, Afzal, & Rauf, 2021; A. Alam et al., 2018; Haque, Chiang, & Santos, 2019; Sattar & Cheung, 2019). Past backdrop from 1950 to the current era, flood hazards have long-standing major and minor disaster scenarios in Pakistan (Abbas et al., 2018). Intense and repeated flood disasters confronted by the country from 2010 to 2014 the 2010 flood considered mainly overwhelming caused the displacement of 20 million population, damaged houses 1.5 million, fatalities of 1985 people and wipe out 160,000km² residential and cropped areas (Ahmad, Kanwal, & Afzal, 2022; Pakistan, 2018; Rasul, Neupane, Hussain, & Pasakhala, 2021).

Disasters caused fiber, food and animals production reduction (Adu, Kuwornu, Anim-Somuah, & Sasaki, 2018) moved up farming community livelihood vulnerability and insecurity of food for those who depend on agriculture for their continued existence (Paudel et al., 2021; Week & Wizor, 2020; Zhang et al., 2019). Drought considered among the complicated natural hazards emerges with a deficit of rainfall and consequently causes regional losses of agricultural production, water resource loss and energy crisis (Khan et al., 2020; Xu, Yu, Yang, Ji, & Zhang, 2018). From a global perspective and particularly in agro-based developing economies during a couple of decades, several drastic droughts caused a significant decline in agricultural production, deceased livestock and increased the issue of food security (S. Ahmed, 2018; Hoerling et al., 2015; Khan et al., 2020). In Pakistan, over the past decades, several droughts occurred whereas from 1998 to 2002 severe drought was experienced which severely reduced water resources and subsequently influenced the food supply and increased food security issues (N. Ahmed, Thompson, & Glaser, 2019; Khan et al., 2020).

Earthquakes partly occur in Pakistan having a strength of 7.0 which reasons to damage within a radius of 100 km whereas with the aspect of a country size such hazards do not happen frequently (Data, 2021: Pakistan Bureau of Statistics, 2021). In Pakistan, since 1950 earthquakes caused major losses of 83100 human fatalities and the destruction of infrastructure whereas two earthquakes subsequent causes tsunamis which raised resource destruction and human fatalities (Data, 2021). In 2013, one of the strongest earthquakes happened in Kech and Awaran region with a Richter scale of 7.7 with 37-kilometer depth tectonic plates which caused 825 human fatalities (Information, 2021).

From the literature perspective, local-based and household-level integrated research aspects of risk perception of floods, drought and earthquakes are not properly addressed in Pakistan and particularly in the Punjab region according to the best knowledge of the author. In addressing this research gap this study tried to investigate the household-level risk perception and factors affecting their synchronized risk perception of flood, earthquake and drought in Punjab, Pakistan. In this scenario, the current applied risk management measures were applied on various administrative scales while having no household-level risk perception insight causing the issue of locally based feasible application. To enhance motivation levels among local households regarding the application of disaster risk management measures it is obligatory to identify the factors which motivate them to apply the reproving measures. In filling up this research gap this study focused on these specific objectives, firstly to recognize the local level of risk perception of floods, earthquakes and drought in the household level of study areas in Punjab, secondly to become aware of the pragmatic and socioeconomic factors influencing the risk perception of households.

2. **Data and Methodology**

Sindh, Khyber Pakhtunkhwa, Balochistan and Punjab are Pakistan provinces but Punjab is mainly favored for this study for some relevant reasons. First of all, the province of Punjab...
reported the country's ¼ area, contributes 53% agricultural GDP and constitutes 52% population (PBS\(^1\), 2021). Secondly, in the context of frequent floods, erratic rains, drought and earthquakes, Punjab province is adversely affected due to massive climatic change (Pakistan, 2020; Punjab, 2019). Thirdly, the region of southern Punjab in the province is particularly favored owing to constantly confronted higher floods, drought and partly earthquake risks and riverbank erosion as situated adjacent to major rivers of the country (Punjab, 2019). Fourthly, this region's farming community higher vulnerable due to being inhabited adjacent to the bank of a major river directly targeted of floods, drought and earthquakes (B. o. Statistics, 2019). Lastly, among severe natural disasters vulnerable districts Rajanpur, Muzaffargarh and Rahim Yar Khan districts according to the higher severity of the issue more preferably selected as indicated in figure 1 (Punjab, 2019; Punjab Board of Statistics, 2020).

**Figure 1**

![Map of Punjab](image1)

Regarding the data collection procedure, the random sampling method was used for this study as firstly, related to the raised vulnerability of floods two tehsils within each district were selected although two union councils were chosen from each tehsil, depending on the hazard severity information given by land record local officer (patwari), agricultural officer and DDMA\(^2\). Last of all, related to flood hazards vulnerability and destruction from each one union council two villages were selected while interviewed almost sixteen to seventeen respondents from each village. Individuals have an equal chance of selection in random sampling which reduces biases in survey selection. In literature, various sampling approaches are applied while in this research work of Yamane (1967) sampling approach was used as illustrated in equation (1).

---

\(^1\)Pakistan Bureau of Statistics  
\(^2\)District Disaster Management Authority
\[ SS = \frac{N}{1 + N(e)^2} \] (1)

In equation 1, \( SS \) indicated the sample size, \( N \) as the size of the population whereas, \( e \) as the precision level. A precision level of 10\% and confidence level of 95\% as a sample size of 398 respondents was collected by application of random sampling from the research area. In literature, particularly in estimating the hazards disasters risk perception aspect various econometric models such as ordered probit model, multinomial logit model, binary logit model and probit models have been employed in literature (Fadina & Barjolle, 2018; Fernandez, Tun, Okazaki, Zaw, & Kyaw, 2018) whereas the few studies applied the ordered probit model owing to reliable outcomes, calculation of simple statistics and robustness (Gbetrofitouo, 2009; Ullah, Akhtar, & Zaeferian, 2018). A Likert scale ordered format has benefitted from the ordered probit model as such this model is considered best fitted in ordered data to steer clear of any assumption about the interval data. In the estimation procedure for ordered form data more feasible method is the ordered probit model. Based on such aspects, this research work applied the ordered probit model to investigate the factors influencing the flood, drought and earthquake perception of households as the study model is illustrated in equation 2.

\[ Y^* = \beta' x + e \] (2)

In the above equation dependent variable is denoted by \( Y^* \) illustrating controllability (CR), mitigation action knowledge (MAK), life equality effects (LEA), financial losses anticipation (FLA), life threat (LT), dread fear (DF) and likelihood perceived (LP). In this equation \( \beta' \) showing estimated vector parameters, \( x \) as explanatory variable vectors such as disaster experience, type of house, sources of income generating, size of family, income per month, respondents schooling, gender status and age while model error term denoted as \( e \). In this model, the study focused to investigate the factors influencing flood, drought and earthquake risk perception. In this research work ordered probit model was applied which is mostly used in some significant studies.

3. **Empirical results of the study**

   Descriptive statistics, standard deviation and mean of explanatory and explained variables are illustrated in Table 1.

Table 1: Explained and explanatory variables description statistics

| Explained variables               | Flood    | Earthquake | Drought   | Description of variables               |
|----------------------------------|----------|------------|-----------|----------------------------------------|
| Likelihood perceived             | 4.76(0.91) | 2.47(1.12) | 3.96(2.37) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Life threat                      | 4.18(0.98) | 3.21(1.34) | 3.71(1.02) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Quality of life threat           | 4.86(0.87) | 2.98(1.76) | 4.21(1.16) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Financial loss anticipation      | 4.43(1.02) | 3.11(2.11) | 3.99(1.28) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Fear/Dread                       | 3.89(1.29) | 3.44(2.36) | 4.08(1.36) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Mitigation action knowledge      | 4.73(0.86) | 2.19(1.87) | 3.77(2.51) | The categorical variable rang 1-5 (5 very high, 1 very small) |
| Controllability                  | 4.84(0.93) | 2.89(1.92) | 4.11(1.31) | The categorical variable rang 1-5 (5 very high, 1 very small) |

Explanatory variables description with a mean and standard deviation

| Explanatory variables | Mean and standard deviation | Description of explanatory variables |
|-----------------------|-----------------------------|------------------------------------|
| Respondents age       | 41.87(13.74)                | Continuous variable (age in years) |
| Size of family        | 6.29(2.41)                  | Continuous variable (family member in number) |
| Gender status         | 1.56(1.28)                  | Dummy variable (male=1, female=2) |
| Educational level     | 4.28(1.71)                  | Dummy variable (14 year or above schooling =1, 12 to 14 years schooling=2, 10-to-12-year schooling=3, 5 to 10 year schooling=4, up to 5 year schooling =5) |
| Household monthly income | 15,798(8254.31)          | Continuous variable (family income in PKRs) |
Figure 3: Respondents’ risk perception about flood, drought and earthquake

3.1. Likelihood occurrence perception

3.2. Life threat perception

3.3. Quality of life impacts perception

3.4. Financial losses anticipation perception

3.5. Fear/Dread perception

3.6. Mitigation action knowledge perception
3.1 Factors affecting flood risk perception of respondents:
Empirical estimates coefficient values of flood-related ordered probit model indicated in Table 2 are as follows.

Table 2: Factors affecting flood risk perception of the respondent

| Explanatory variables          | Likelihood perceived | Life threat | Quality of life threat | Financial loss anticipation | Fear/Dread | Mitigation action knowledge | Controllability |
|--------------------------------|----------------------|-------------|------------------------|-----------------------------|------------|----------------------------|-----------------|
| Respondents age                | -0.037***            | -0.024**    | -0.008***              | -0.046**                    | 0.026***   | -0.016                    | -0.018          |
|                                | (0.008)              | (0.009)     | (0.007)                | (0.008)                     | (0.003)    | (0.002)                   | (0.001)         |
| Size of family                 | -0.041               | -0.058      | -0.178***              | 0.006                       | 0.074***   | 0.004                     | 0.058**         |
|                                | (0.037)              | (0.043)     | (0.043)                | (0.031)                     | (0.37)     | (0.033)                   | (0.037)         |
| Gender status                  | 3.147**              | 2.421**     | 1.974***               | 2.870**                     | 1.265***   | -1.894**                  | -1.751**        |
|                                | (0.198)              | (0.289)     | (0.249)                | (0.234)                     | (0.241)    | (0.154)                   | (0.146)         |
| Educational level              | 0.834**              | 0.617**     | 0.711***               | 0.294**                     | 0.216***   | -0.537**                  | -0.492**        |
|                                | (0.143)              | (0.077)     | (0.081)                | (0.078)                     | (0.067)    | (0.071)                   | (0.091)         |
| Household monthly income       | -0.034**             | -0.043      | 0.128***               | 0.084                       | 0.027      | 0.316***                  | 0.257**         |
|                                | (0.051)              | (0.069)     | (0.047)                | (0.049)                     | (0.051)    | (0.041)                   | (0.053)         |
| Sources of income generating   | 0.139**              | 0.171**     | 0.158***               | 0.321**                     | 0.056      | -0.084**                  | -0.038          |
|                                | (0.054)              | (0.036)     | (0.039)                | (0.057)                     | (0.029)    | (0.047)                   | (0.049)         |
| Type of housing                | 0.26                 | -0.058      | -0.221***              | -0.294***                   | 0.92       | -0.147**                  | 0.268**         |
|                                | (0.089)              | (0.098)     | (0.089)                | (0.087)                     | (0.079)    | (0.077)                   | (0.074)         |
| Flood disaster experience      | -0.319               | -0.287      | -0.144                 | -0.034                      | -0.268     | 0.039                     | 0.149           |
|                                | (0.279)              | (0.259)     | (0.248)                | (0.198)                     | (0.219)    | (0.311)                   | (0.278)         |
| Sample size                    | 398                  | 398         | 398                    | 398                         | 398        | 398                       | 398             |

3.2 Factors affecting drought risk perception of the respondent
In Table 3, drought hazards estimated coefficient values ordered probit models are illustrated where expected signs about all explanatory variables indicated the model goodness of fit.

Table 3: Factors affecting drought risk perception of the respondent

| Explanatory variables          | Likelihood perceived | Life threat | Quality of life threat | Financial loss anticipation | Fear/Dread | Mitigation action knowledge | Controllability |
|--------------------------------|----------------------|-------------|------------------------|-----------------------------|------------|----------------------------|-----------------|
| Respondent age                 | 0.018**              | 0.013       | 0.006                  | 0.029**                     | 0.027***   | 0.021***                   | 0.014**         |
|                                | (0.011)              | (0.010)     | (0.008)                | (0.011)                     | (0.009)    | (0.005)                    | (0.005)         |
| Size of family                 | -0.034               | -0.055      | -0.186***              | 0.008                       | 0.089***   | 0.002                     | 0.071**         |
|                                | (0.047)              | (0.43)      | (0.049)                | (0.037)                     | (0.56)     | (0.031)                    | (0.046)         |
| Gender status                  | 2.798**              | 1.954**     | 2.321***               | 2.971**                     | 1.764***   | -2.453**                  | -1.376**        |
|                                | (0.239)              | (0.267)     | (0.198)                | (0.269)                     | (0.231)    | (0.188)                   | (0.201)         |
| Educational level              | 0.684**              | 0.499**     | 0.586***               | 0.233**                     | 0.187***   | -0.397**                  | -0.581**        |
|                                | (0.127)              | (0.081)     | (0.079)                | (0.091)                     | (0.074)    | (0.086)                   | (0.077)         |
| Household                      | -0.041               | -0.029      | 0.134***               | 0.068                       | 0.019      | -0.298***                 | -0.273**        |

3.7 Controlability of risk perception

Flood
Drought
Earthquake
3.3 Factors affecting earthquake risk perception of the respondent

Ordered probit model empirical estimates about earthquake hazard determinants indicated in table 4, portraying as respondents perceived risk was significantly influenced by all explanatory variables except earthquake experience and education.

Table 4: Factors affecting earthquake risk perception of the respondent

| Explanatory variables                  | Likelihood perceived | Life threat | Quality of life threat | Financial loss anticipation | Fear/Dread | Mitigation action knowledge | Controllability |
|---------------------------------------|----------------------|-------------|------------------------|-----------------------------|------------|------------------------------|----------------|
| Respondents age                       | -0.024**             | -0.018*     | -0.007                 | 0.016**                     | 0.013      | 0.009                       | 0.028**        |
|                                       | (0.009)              | (0.010)     | (0.009)                | (0.012)                     | (0.011)    | (0.011)                     | (0.009)        |
| Size of family                        | -0.087**             | -0.009      | -0.031                 | -0.026                      | -0.011     | 0.057                       | 0.041          |
|                                       | (0.041)              | (0.048)     | (0.037)                | (0.039)                     | (0.043)    | (0.038)                     | (0.039)        |
| Gender status                         | 0.941***             | 0.578**     | 0.874***               | 0.723                       | 0.799**    | -0.857**                    | -0.598**       |
|                                       | (0.216)              | (0.171)     | (0.147)                | (0.189)                     | (0.213)    | (0.193)                     | (0.234)        |
| Educational level                     | 0.234                | 0.076       | 0.068                  | 0.059                       | 0.199**    | -0.037                      | 0.278**        |
|                                       | (0.089)              | (0.089)     | (0.081)                | (0.083)                     | (0.083)    | (0.093)                     | (0.081)        |
| Household monthly income              | -0.017               | -0.034      | -0.011                 | -0.008                      | 0.014      | -0.181***                   | -0.009         |
|                                       | (0.057)              | (0.041)     | (0.048)                | (0.036)                     | (0.039)    | (0.054)                     | (0.047)        |
| Sources of income generating          | 0.123**              | 0.027       | 0.016                  | 0.081**                     | 0.136**    | -0.043                      | 0.049          |
|                                       | (0.046)              | (0.043)     | (0.049)                | (0.041)                     | (0.038)    | (0.051)                     | (0.038)        |
| Type of housing                       | -0.298**             | 0.187***    | -0.013                 | -0.071                      | 0.094      | -0.297***                   | -0.009         |
|                                       | (0.102)              | (0.098)     | (0.087)                | (0.088)                     | (0.117)    | (0.097)                     | (0.078)        |
| Flood disaster experience             | -0.213               | 0.097       | -0.063                 | -0.211                      | -0.158     | -0.084                      | 0.079          |
|                                       | (0.184)              | (0.194)     | (0.187)                | (0.171)                     | (0.179)    | (0.176)                     | (0.163)        |
| Sample size                           | 398                  | 398         | 398                    | 398                         | 398        | 398                         | 398            |

Figure 4: Gender-based flood risk perception
4.3. Flood impact on quality of life

4.4. Flood based financial losses anticipation

4.5. Flood based Fear/Dread

4.6. Flood based mitigation action knowledge

4.7. Flood based controllability

5.1. Drought based likelihood perceived

5.2. Drought based life threat

Figure 5: Gender-based drought risk perception
3.4 Gender-based flood, drought and earthquake respondents’ risk perception

The significant variation aspect regarding risk perception was estimated from gender to gender, person to person and region to region as such scenarios were particularly discussed in this research work. In the aspect of various factors gender-based flood risk perception is indicated in figure 4(4.1 to 4.7), drought risk perception in figure 5(5.1 to 5.7) and earthquake risk perception in figure 6 (6.1 to 6.7).

On an average basis, females have a higher perception regarding impact and fear related to drought and earthquakes while a higher perception of threat regarding flood and drought disasters. In comparing both genders, female respondents rather than males are having significant lacking of mitigation understanding and measures due to cultural and traditional constraints with a confined role in decision-making empowerment.
In the context of controllability regarding disasters both genders have the same understanding of floods and earthquakes except drought whereas the majority of females have serious perceptions and are depressed as they will not capable to control disasters. In the conclusion, it is indicated as a female in contrast to males will be incapable to overcome upcoming disasters, have insufficient awareness about mitigation measures and have higher risk perception.
4. **Discussion**

In the research area, most respondents have likely perceived the consecutive and intense happening of upcoming disasters in the future whereas more than 70% of respondents have perceived earthquakes, drought and flood disasters as causing financial losses, negatively influencing the quality of life and causing a severe threat to life status. In normal routine, disaster areas inhabited by population livelihoods have become more vulnerable due to being frequently confronted with the destruction of these disasters. Hazards-prone areas communities have to consecutively remain in fear due to the anticipated incidence of any unfavourable circumstances mostly during devastating or dangerous events where limited people have the mitigation measures understanding to manage such type of dangerous and devastating circumstances. Accurate mitigation understanding about extreme adverse effects is mandatory for minimizing the severe effects of such hazards otherwise the losses will increase on multiple bases. The study findings showing the higher likelihood perceived of flood, drought and earthquake disasters which are consistent with the literature illustrated the higher perception frequently and incidentally happening of storms, earthquakes, flood and drought disasters in future so findings consistent with studies of (E. Alam, 2019; Plapp & Werner, 2006; Udmale, Ichikawa, Manandhar, Ishidaira, & Kiem, 2014).

5. **Conclusion and Suggestions**

This research work investigated the factors influencing households' risk perception of flood, drought and earthquake in disaster-prone areas of Punjab, Pakistan. The study used the sample data of 398 respondents and applied an ordered probit model for empirical estimation. The majority of respondents in the study area have a higher perception of upcoming disasters of floods; drought and earthquakes which subsequently cause to humiliate their quality of life, life threat, resource depletion and economic losses. Disasters' consecutive and destructive experience makes them serious about the adoption of mitigation measures to the increased level of disaster perception. Recurrent distasteful disaster events make disaster-prone populations more feared and vulnerable. In the aspect of mitigation understanding and managing practices about unpleasant disaster events, only a minor proportion of the population has such capabilities to manage the adverse situation. Households' sources of income generating, education level, gender status and respondent's age significantly affect the risk perception of flood, drought and earthquake disasters. Literate communities, sources of permanent income and both gender should have an appropriate understanding of suitable decisions at the correct moment to minimize the effects of disasters. Fewer risks were perceived by male respondents according to the findings of the study while having an appropriate understanding of certain risks will be more competent in controlling future disasters. In the aspect of financial constraints study remained limited to selected study areas while in the future it is more appropriate to investigate the study to select disaster to such disaster areas to have a comprehensive idea concerning respondents of the area to be resilient with such disasters. The estimates of this study will facilitate the planners and policymakers to take appropriate strategies to stimulate people to adopt proper mitigation measures, formulate secure livelihood preferences and move up consciousness for minimizing the effects of disasters to make certain sustainable disaster resilience communities.

References
Abbas, A., Amjath-Babu, T., Kächele, H., Usman, M., Amjed Iqbal, M., Arshad, M., . . . Müller, K. (2018). Sustainable survival under climatic extremes: linking flood risk mitigation and coping with flood damages in rural Pakistan. *Environmental Science and Pollution Research, 25*(32), 32491-32505. doi:10.1007/s11356-018-3203-8

Adu, D. T., Kuwornu, J. K., Anim-Somuah, H., & Sasaki, N. (2018). Application of livelihood vulnerability index in assessing smallholder maize farming households' vulnerability to climate change in Brong-Ahafo region of Ghana. *Kasetsart journal of social sciences, 39*(1), 22-32. doi:10.1016/j.kjss.2017.06.009

Ahmad, D., Afzal, M., & Rauf, A. (2021). Flood hazards adaptation strategies: a gender-based disaggregated analysis of farm-dependent Bait community in Punjab, Pakistan. *Environment, Development and Sustainability, 23*(1), 865-886. doi:10.1007/s10668-020-00612-5

Ahmad, D., Kanwal, M., & Afzal, M. (2022). Climate change effects on riverbank erosion Bait community flood-prone area of Punjab, Pakistan: an application of livelihood
Ahmed, N., Thompson, S., & Glaser, M. (2019). Global aquaculture productivity, environmental sustainability, and climate change adaptability. *Environmental management*, 63(2), 159-172. doi:10.1007/s00267-018-1117-3

Ahmed, S. (2018). Assessment of urban heat islands and impact of climate change on socioeconomic over Suez Governorate using remote sensing and GIS techniques. *The Egyptian Journal of Remote Sensing and Space Science*, 21(1), 15-25. doi:10.1016/j.ejrs.2017.08.001

Alam, A., Bhat, M. S., Farooq, H., Ahmad, B., Ahmad, S., & Sheikh, A. H. (2018). Flood risk assessment of Srinagar city in Jammu and Kashmir, India. *International Journal of Disaster Resilience in the Built Environment*, 9(2), 114-129. doi:10.1108/IJDRBE-02-2017-0012

Alam, E. (2019). Importance of long-term earthquake, tsunami and tropical cyclone data for disaster risk reduction in Bangladesh. *Progress in Disaster Science*, 2, 100019. doi:10.1016/j.pdisas.2019.100019

Ambelu, A., Birhanu, Z., Tesfaye, A., Berhanu, N., Muhumuza, C., Kassahun, W., . . . Woldemichael, K. (2017). Intervention pathways towards improving the resilience of pastoralists: A study from Borana communities, southern Ethiopia. *Weather and Climate Extremes*, 17, 7-16. doi:10.1016/j.wace.2017.06.001

Barrett, B., Zepeida, E., Pollack, L., Munson, A., & Sih, A. (2019). Counter-culture: does social learning help or hinder adaptive response to human-induced rapid environmental change? *Frontiers in Ecology and Evolution*, 7, 183. doi:10.3389/fevo.2019.00183

Daniell, H., Lin, C.-S., Yu, M., & Chang, W.-J. (2016). Chloroplast genomes: diversity, evolution, and applications in genetic engineering. *Genome biology*, 17(1), 1-29. doi:10.1186/s13059-016-1004-2

Data, W. (2021). *Earthquake in Pakistan*. Retrieved from https://www.worlddata.info/asia/pakistan/earthquakes.php

Doocy, S., Daniels, A., Murray, S., & Kirsch, T. D. (2013). The human impact of floods: a historical review of events 1980-2009 and systematic literature review. *PLoS currents*, 5. doi:https://doi.org/10.1371%2Fcurrents.dis.f4deb457904936b07c09d9a98ee8171a

Eckstein, D., Künzel, V., Schäfer, L., & Winges, M. (2019). Global climate risk index 2019. *Bonn: Germanwatch*. 

Fadina, A. M. R., & Barjolle, D. (2018). Farmers’ adaptation strategies to climate change and their implications in the Zou Department of South Benin. *Environments*, 5(1), 15. doi:10.3390/environments5010015

Fenta, A., Hailu, G., & Hadush, Z. (2019). Integrating climate-smart approaches across landscapes to improve productivity, climate resilience, and ecosystem health. *Climate-smart Agriculture: Enhancing resilient agricultural systems, landscapes and livelihoods in Ethiopia and beyond*. World Agroforestry (ICRAF), Nairobi, Kenya, 15-23.

Fernandez, G., Tun, A. M., Okazaki, K., Zaw, S. H., & Kyaw, K. (2018). Factors influencing fire, earthquake, and cyclone risk perception in Yangon, Myanmar. *International Journal of disaster risk reduction*, 28, 140-149. doi:10.1016/j.ijdrr.2018.02.028

Gbetibouo, G. A. (2009). Understanding farmers’ perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa (Vol. 849): Intl Food Policy Res Inst.

Haque, F., Chiang, Y. W., & Santos, R. M. (2019). Alkaline mineral soil amendment: a climate change ‘stabilization wedge’? *Energies*, 12(12), 2299. doi:10.3390/en12122299

Hoerling, M., Wolter, K., Perlwitz, J., Quan, X., Eischedel, J., Wang, H., . . . Dole, R. (2015). *Northeast Colorado extreme rains interpreted in a climate change context*. Retrieved from Information, N. C. f. E. (2021). NCEI/WDS Global Significant Earthquake Database, 2150 BC to Present. Retrieved from https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ngdc.mgg.hazards:G012153

Khan, I., Lei, H., Shah, I. A., Ali, I., Khan, I., Muhammad, I., . . . Javed, T. (2020). Farm households’ risk perception, attitude and adaptation strategies in dealing with climate change: promise and perils from rural Pakistan. *Land use policy*, 91, 104395. doi:10.1016/j.landusepol.2019.104395

Kimaro, E. G., Mor, S. M., & Toribio, J.-A. L. (2018). Climate change perception and impacts on cattle production in pastoral communities of northern Tanzania. *Pastoralism*, 8(1), 1-16. doi:10.1186/s13570-018-0125-5
Kreft, C., Huber, R., Wuepper, D., & Finger, R. (2021). The role of non-cognitive skills in farmers' adoption of climate change mitigation measures. Ecological Economics, 189, 107169. doi:10.1016/j.ecolecon.2021.107169

Kret, E., Czop, M., & Pietrucin, D. (2017). Requirements for numerical hydrogeological model implementation for predicting the environmental impact of the mine closure based on the example of the Zn. Paper presented at the 13th International Mine Water Association Congress–Mine Water & Circular Economy. Lappeenranta University of Technology, Lappeenranta.

Lecina-Diaz, J., Martinez-Vilalta, J., Alvarez, A., Banqué, M., Birkmann, J., Feldmeyer, D., ... Retana, J. (2021). Characterizing forest vulnerability and risk to climate-change hazards. Frontiers in Ecology and the Environment, 19(2), 126-133. doi:10.1002/fee.2278

Mamun, A. A., Roy, S., Islam, A. R. M., Alam, G., Alam, E., Chandra Pal, S., ... Mallick, J. (2021). Smallholder Farmers' Perceived Climate-Related Risk, Impact, and Their Choices of Sustainable Adaptation Strategies. Sustainability, 13(21), 11922. doi:10.3390/su132111922

Mekuye, M., Jordaan, A., & Melka, Y. (2018). Understanding resilience of pastoralists to climate change and variability in the Southern Afar Region, Ethiopia. Climate Risk Management, 20, 64-77. doi:10.1016/j.crm.2018.02.004

Muricho, D. N., Otieno, D. J., Olouch-Kosura, W., & Jirström, M. (2019). Building pastoralists’ resilience to shocks for sustainable disaster risk mitigation: Lessons from West Pokot County, Kenya. International journal of disaster risk reduction, 34, 429-435. doi:10.1016/j.ijdrr.2018.12.012

Pakistan, N. (2018). Annual Report 2018. Retrieved from http://web.ndma.gov.pk/

Pakistan, N. (2020). Annual Report 2020. Retrieved from http://web.ndma.gov.pk/

Paudel, B., Chu, T., Chen, M., Sampath, V., Prunicki, M., & Nadeau, K. C. (2021). Increased duration of pollen and mold exposure are linked to climate change. Scientific reports, 11(1), 1-12. doi:10.1038/s41598-021-92178-z

Plapp, T., & Werner, U. (2006). Understanding risk perception from natural hazards: examples from Germany. In RISK21-cooping with risks due to natural hazards in the 21st century (pp. 111-118): CRC Press.

Punjab, P. (2019). Punjab Disaster Response plan report 2019. Retrieved from

Rasul, G., Neupane, N., Hussain, A., & Pasakhala, B. (2021). Beyond hydropower: towards an integrated solution for water, energy and food security in South Asia. International Journal of Water Resources Development, 37(3), 466-490. doi:10.1080/07900627.2019.1579705

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. doi:10.1016/j.ijdrr.2019.101283

Schilling, J., Hertig, E., Tramblay, Y., & Scheffran, J. (2020). Climate change vulnerability, water resources and social implications in North Africa. Regional Environmental Change, 20(1), 1-12. doi:10.1007/s10113-020-01597-7

Statistics, B. o. (2019). Agriculture Information Marketing Services (AIMS) Retrieved from https://bos.gop.pk/publicationreports#PDS

Statistics, P. B. o. (2020). Agriculture Information Marketing Services (AIMS). Retrieved from https://bos.gop.pk/publicationreports#PDS

Statistics, P. B. o. (2021). Economic Survey of Pakistan (2020-21). Retrieved from Pakistan:

Teo, M., Goonetilleke, A., Ahankoob, A., Deilami, K., & Lawie, M. (2018). Disaster awareness and information seeking behaviour among residents from low socio-economic backgrounds. International journal of disaster risk reduction, 31, 1121-1131. doi:10.1016/j.ijdrr.2018.09.008

Udmale, P., Ichikawa, Y., Manandhar, S., Ishidaira, H., & Kiem, A. S. (2014). Farmers' perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India. International journal of disaster risk reduction, 10, 250-269. doi:10.1016/j.ijdrr.2014.09.011

Ullah, S., Akhtar, P., & Zaeefarian, G. (2018). Dealing with endogeneity bias: The generalized method of moments (GMM) for panel data. Industrial Marketing Management, 71, 69-78. doi:10.1016/j.indmarman.2017.11.010
Week, D. A., & Wizor, C. H. (2020). Effects of flood on food security, livelihood and socio-economic characteristics in the flood-prone areas of the core Niger Delta, Nigeria. *Asian Journal of Geographical Research, 3*(1), 1-17.

Xu, S., Yu, Z., Yang, C., Ji, X., & Zhang, K. (2018). Trends in evapotranspiration and their responses to climate change and vegetation greening over the upper reaches of the Yellow River Basin. *Agricultural and Forest Meteorology, 263*, 118-129. doi:10.1016/j.agrformet.2018.08.010

Yamane, T. (1967). *Problems to accompany "Statistics, an introductory analysis"*: Harper & Row.

Zhang, N., Song, D., Zhang, J., Liao, W., Miao, K., Zhong, S., . . . Huang, C. (2019). The impact of the 2016 flood event in Anhui Province, China on infectious diarrhea disease: An interrupted time-series study. *Environment international, 127*, 801-809. doi:10.1016/j.envint.2019.03.063