Available Online
Journal of Economic Impact
ISSN: 2664-9764 (Online), 2664-9756 (Print)
http://www.scienceimpactpub.com/jei

ANALYSIS OF THE VULNERABILITY OF FARM HOUSEHOLDS TO FLOOD RISK IN PUNJAB, PAKISTAN

Waqas Manzoor

Institute of Agricultural and Resource Economics, University of Agriculture Faisalabad, Pakistan

ARTICLE INFO

Article history
Received: March 08, 2021
Revised: March 25, 2021
Accepted: March 26, 2021

Keywords
Climate change
Flood disasters
Rural area
Household vulnerability

ABSTRACT

Climate change is the most important challenge for developing as well as developed countries. Pakistan is a developing country and has faced different types of natural disasters such as floods in the last 10 years. The rural areas of Pakistan are adversely affected by floods, which cause significant losses to crops, assets, and the household members face illness, health problems, loss of family income, and displacement. Approximately, 7016 villages with a cropped area of 473998 acres have been affected only in Punjab due to floods during the last four years. The impact of floods is not the same among the different regions, races, ages, classes, and gender. In this regard, a study was conducted to analyze the vulnerability of farm households in three flood-prone districts of Punjab province of Pakistan. These three flood-prone districts have different population size, and are located in high-risk flood region of Punjab was selected for empirical analysis. A well-structured questionnaire was used. Minimum 120 respondents were selected through a random sampling technique. A farm household survey was conducted and a vulnerability index was developed by using well-defined indicators. Three major dimensions of vulnerability were analyzed in detail such as exposure, adaptive capacity, and sensitivity. A multiple linear regression model was used to formulate the results. The analyzed results showed that flood was the main cause of the destruction of houses, livestock, and destruction of agriculture production. Results showed that farm household communities were the most vulnerable and floods hazard has a negative impact on the livelihood of human beings and the economy of Punjab as well.

* *Email: waqasali421@yahoo.com*
https://doi.org/10.52223/jei3012104

INTRODUCTION

Climate change is one of the biggest challenges faced by developing as well as developed countries. Climate change is the reason for melting ice glaciers, rise in sea level, changing temperature, and other natural disasters like floods. Since the 1970s, nearly 3.3 million deaths have been caused by floods while 825 thousand deaths were caused annually by this hazard (Arouri *et al.*, 2015). According to the 3rd Intergovernmental Panel on Climate Change (IPCC) report, nearly 1.1C^o to 6.4C^o temperatures will rise and nearly 100 cm to 2100 cm sea level will rise after a century that will cause greater flooding (IPCC, 2013). The word disaster is used in various ways, frequently referred to as some rapid or unexpected change, irrespective of the number of people affected, country, dimension of the area, the whole world (Proag, 2014). When a natural disaster occurs in a country due to global or any other climatic change then the economy of that country will start falling (Smith and Anthony, 1996*).* A flood is an unexpected runoff of water on land causing disturbance to normal behavior. River flooding occurs due to spilling over of river while flash floods caused due to heavy rainfall in a short time intervals. This is a usual perception that heavy rain is encouraged by global warming and caused a deadly flood. In developing countries like Pakistan, Bangladesh, and India, one of the prominent reasons for the flood is insufficient plans to control the flood. If we do not focus to change those plans until then the threat to flood will enhance. The development plans to control flood is not working properly especially in developing countries. During the era of 1970 to 1995, more than 1500 million people become the victim of floods around the globe, more than 3 million victims were dead while more than 81 million lost their homes. From 1991 to 1995, the world spends more than US$200 billion only to overcome the damages caused by floods without considering the inflation (PIelke and Anthony, 2000).

People of poor countries are mostly affected due to bad housing quality, shortage of infrastructure, and poor conditions of emergency. According to the World Bank report of 2006 the Asian and especially Pakistan, India, Bangladesh, Thailand, and Philippine floods have brought severe threats in the past and caused uncountable damages to lives, livelihood, and property (World Bank, 2006). Research conducted by the International disaster database shows that in the last thirty years, the number of natural disasters had been enhancing significantly. According to this research 428 disasters were recorded that hit the globe during the period of 1994 to 1998 and 707 during the time lap of 1999 to 2003 almost double to the previous record. Pakistan is an agriculture-based economy, contributing almost 20% to National Gross Domestic Product (GDP) and providing employment to almost 42% of the total labor force of the country. Unfavorable climate change caused a reduction in agricultural productivity and level of income (GoP, 2017). Pakistan had encountered various kinds of natural hazards in the last decade. Due to which the country had to face enormous damages in terms of human life and other personal assets. In 2013, Tharparker was affected by drought, which greatly influenced the livelihood, health condition, and nutrition value of local bodies. The total number of death under 5 were reported 173 in 2011, raised from the previous year's 188 in 2012, 234 in 2103 and 326 in 2014. Pakistan has faced 23 harsh effects of floods (GoP, 2015). The flood of 2010 was the worst in the history of Pakistan and affected the 78 districts of the county. This flood started in late July due to the extreme rainfall (GoP, 2016).

Due to the effect of the flood 1,608.184 houses were completely damaged, 17,553 villages and 20 million peoples were affected by the floods. A total area of 160,000 sq km was affected by flood and 2.1 million hectares of agricultural land were fully covered by the flood water. Health and education sectors were badly affected by the flood. In the whole country 10,436 health and educational related facilities were damaged and the country faced more economic losses. In 2011, due to the result of floods 516 people and 38,700 villages were affected. The economic losses were 3730 million US dollars and 27,581 sq km area affected by the flood. In 2012, due to the effect of floods, 571 people died and 14,159 villages were affected. The economic losses were 2640 million US dollars and a total 4,746 km^2 area was affected due to the flood. In 2013, due to the effect of floods, 333 people died and 8,297 villages were affected. The economic losses were 2000 million US dollars and 4,483 sq km area affected by the flood. In 2014, due to the effect of floods, 367 people died and 4,065 villages were affected. The economic losses were 440 million US dollars and 9,779 sq km area affected by the flood. In July 2015 all provinces of Pakistan were affected by a huge flood. The majority of the dead were reported in the KPK as 238 people were died in KPK province due to the effect of the flood, as well as 58 were reported in Punjab, 16 were reported in Baluchistan, 13 were reported in FATA and 21 were reported died in the Gilgit Baltistan. There was no death causality reported in Sindh. About 148 people were injured due to the flood effect in the province of KPK, 21 were injured in Gilgit Baltistan by the effect of flood, 34 were injured in Baluchistan, 13 were in FATA, 11 were injured in the province of Punjab, 5 were reported in Azad & Kashmir and people were not injured in the Sindh. Due to the effect of the flood large number of houses were destroyed. In KPK 4799 houses were completely damaged by the effect of flood, In Punjab 3096 houses were damaged due to the effect of flood, 1176 houses were destroyed in Baluchistan, and 812 were completely damaged in Gilgit Baltistan, 425 in FATA, 408 houses were destroyed in Azad Jammu & Kashmir. While in the Sindh is being assessed also any house was affected by flood or not. The flood mostly affected rural community and many lose bear. The cropped area was completely damaged. About 3202 villages were affected by the flood. About 568 villages were affected in Punjab,19 were in FATA. About 286 villages were disturbed due to floods and 17 villages were affected in the Azad Jammu & Kashmir and KPK (GoP, 2015).

The presented flood supervision plan includes floods flow directive by three main reservoirs (Chashma on Indus, Tarbela, and Manglaon Jhelum) defending of main private and public infrastructure, urban/rural people, and connecting with agricultural land situated along with river banks by the flood wall and spurs, early warning system, further flood forecasting, rescue and relief dimension in case of the flooding situation. The provincial irrigation departments (PIDs) maintain about 6,807 km of flood protection wall and approximately

1410 spurs on major rivers. The natural disaster bias has been increased massively and created tragic losses that generally cause a high level of vulnerability and exposure of occupants and their assists (Atta-ur-Rahman and Khan, 2011). It is predicted that the human number that is disclosed to life-threatening through natural disasters would be double or more by 2050 (Wilkinson and Brenes, 2014). Surrounding all of the natural disasters humans are exposed to floods are the basic and main causes of causality including economic and social risk for the society (Doocy *et al*., 2013). Exposure and vulnerability to flooding disasters have become an alarming indication due to over urbanization (Tariq, 2013). Vulnerability implies evaluation of risk linked with social, physical, and economic aspects and implication result starting the structure able to manage through the resulting incident (Proag, 2014). Vulnerability estimation is considered an essential part of climatic change and disaster risk reduction (IPCC, 2012). Vulnerability is frequently intensified through socioeconomic poverty, inequalities, population, weak administrative institution, and lack of awareness, education, facilities, and safety protection (Adger, 1999; Cutter *et al*., 2003).

Vulnerability is defined as a possible threat to properties and humans in such a way that combines with the destructive loss experienced from the calamitous hazard (Alexander, 2012). Vulnerability depends on the potentiality to cope and adapt to the inverse impact of the hazard and the society become highly vulnerable due to shortage of adaption measure to conflict extreme weather events. Pakistan is blessed with full natural resources but due to the lack of expertise and unsustainable utilization approaches to the natural resources, quick growth, and poor hazard s forecasting, environment degradation, and lack of advanced level of hazard warming system, experience and there is no assessment of the vulnerability which is the main reason of the occurrence. Anyhow, this situation is very complex for the lower class in the country and can be more forced by the high rate of adaptive capacity of the society native with respect to climate trend (Rahman *et al*., 2016). The basic purpose of the vulnerability approaches is to measure the vulnerability area, also identify the risk reduction and development planes and adoptive plans to connect with hazard. The vulnerability approaches commonly focused on three basic indicators i.e. adaptive exposure, which indicates the ability of society to consist environmental hazard (Scheuer *et al*., 2011), and sensitivity that shows the degree of affected structure (Ginige *et al*., 2009).

Resilience should be positive and oriented towards the long-term. It is social and political, as well as technical. Governance and power structures within public organizations need to adapt. Allow new ways of working, sharing of knowledge, and collaboration. Democratic engagement provides a greater capacity to adapt over the long term than technocratic management. It requires more effective use of knowledge and a better understanding of places. It needs to incorporate and manage unpredictability and randomness. Cimellaro *et al*. (2010) described resilience as expertise to confirm a specific part of functioning for the lifeline network, bridges, and building. In other specific research papers on disaster resilience, the idea is usually defined in terms of capacity building and managing capacity. Normally, it is inverse relationship consist between vulnerability and resilience Although for the resilience measure you need to fulfill a perfect understanding that which kind of parameter is essential to certify the assumption another which is performed by (Joerin *et al*., 2012). The essential indicator of social resilience comprised of well-built social networking, demographic characteristics the facts about a specific dangerous risk and societal norm, communication, strong value, and confidence based organization (Joerin *et al*., 2012).

Although, the physical, economically and technical resilience are larger or smaller in similar nature. The main sub-indicators of technical and physical resilience are irrigation, transportation, communication, sewerage, water-saving system, institutional establishment, and housing stock (Joerin *et al*., 2012). Riwthong *et al*. (2017) paid attention to the revolution of the agriculture sector in lower-income nations from sustenance to market sloping production structures has significant inferences for farmers' threat experience and risk administration. For this, data were collected through 240 Thai upland farmers specialized by 10 stages of agricultural commercialization. Results indicate that risk observations and administrative plans are intensely related to stages of agricultural commercialization. A study suggested some crucial policies for commercial farmers. Rahman *et al*. (2016) examined the vulnerability of flash flooding in Riyadh, the city of Saudi Arabia by taking data from 2006-13 through field surveys. They found a significant impact of a flash flood on vulnerability by applying the models of Gridded Surface Subsurface Hydrologic (GSSHA) for flood simulation. Overall the vulnerability by using a model of different indicators Composite Flash Flood Vulnerability Index (CFVI), Positive Value Index (PVI) for the square root of physical variables, and Social Vulnerability Index (SVI) for population density. Finally, the study concluded that flash floods affected the economy, housing and transportation structures, and community health and security of the peoples in Riyadh. The objective of the current study was to analyze the vulnerability of farm households to floods in the study area. The study was conducted to investigate the determinants affecting the vulnerability of the households to floods in the study area and to suggest policy recommendations based on the results of the study.

METHODOLOGY

The present study was conducted in three districts Jhang, Chiniot, and Layyah of Punjab province which is prone to flood risk and has faced this risk in the recent past using a random sampling procedure. The subjects for this study was comprised of farm households of flood-prone areas in the selected districts. A multiple linear regression model was used to evaluate the impact of various farm and households' attributes on vulnerability indices. Major dimensions and sub-dimensions of households' vulnerability were specified based on the nature of the data and relevant to the rural communities. Three major dimensions of vulnerability were examined in detail i.e. sensitivity, exposure, and adaptive capacity. Moreover, the Vulnerability Variability Index (VVI) was constructed based on various demographic, socioeconomic, physical, and environmental aspects related to flooding in the study area. The scores for Livelihood Vulnerability Index were estimated and used to evaluate their role in the level of flood damage experienced in a recent flood event.

Study Area Description

The areas that were affected by the Chenab River in Punjab province were selected for the study. This area was selected because these regions are mostly affected by floods almost after every year in monsoon season and caused serious damages to the local property and death penalties. During the last two decades, more than 22 floods were recorded in Punjab.

Sampling and Data Collection

A field survey was conducted with a main focus on the household heads in April and May 2018. Information was collected from 120 male household heads by using an appropriate questionnaire. Ten households from each village were selected. The distribution of sample size is given in Table 1. After primary data, the Variable Vulnerability Index was calculated by putting household data in MS excel and for analysis, the latest version of SPSS was used.

Table 1. Population and affected households and sampled size in the selected villages.

District	Union council	Village	Sampled households
Jhang	Pabar Wala 39	Thatha Khangar	40
	UC#35	Ali Pur	
	HasuBalail	Dosa	
	Kot Bahadar Shah	Jamali Kalan	
Chiniot	UC#20	Qaziya	40
	UC#21	Hasra Sheikh	
	UC#22	Moza Suleman	
	UC#17	Thaata Naseera	
Layyah	Bait Wasawa	Bait Wasawa Shumali	40
	Jhakhar	Jhakhar Pacca	
	LohanchNashaib	Chak no. 151/TDA	
	Tail Indus	Chak no. 121/TDA	

To bring perfection in results, the selection of model was free from any type of favoritism. A random sampling technique was used which is the best way to save from favoring.

Vulnerability

For the present research, three main components of vulnerability have been chosen i.e. exposure, susceptibility, and adaptive capacity (IPCC, 2001) to define and calculate the flood vulnerability at the household level. Most of the variables used in the present study cannot be calculated. The index was utilized to determine the vulnerability and give insights into fundamental processes and determinants that could be helpful for the policymakers and further development practitioners. For the 1st vulnerability component i.e. exposure, two indicators were utilized which include previous flood experience (%age of household head (HH) who experienced and affected by the previous flood events) and the houses were built in the proximity of the river source. Sensitivity is explained through the various number of indicators i.e. poor building material (% of HH who built their houses with mud), meals (% of HH number meal per day), food quality (% of HH who took adequate food quality), and the coping mechanism (% of HH who adopted risk management tools and livestock (% of HH who lost livestock due to flood). The final and third vulnerability component i.e. adaptive capacity or resilience is calculated during indicators that contain; credit facility (% of HH who got access to credit facilities provided by the government or NGO's), Access to information source (% of HH who have any information source), education (% of HH who have 1-10 years of schooling education), family size (% of HH who many adult males, females, and children), family type (% of HH family type), multiple income sources (% of HH with more than one income source), and employment (% of HH who were employed), household monthly income (% of HH monthly income).

Calculation of the Index

The common process is desired to be done to show the variable value within a comparable range (Nelson *et al.*, 2010; Gbetibouo and Ringler, 2009). Percentages of all the selected variables were taken about the household vulnerability to avoid the common procedure. The participants were asked to assign the weight to each chosen variable ranging from 0 to 1. The value which is close to 0 showed less household vulnerability whereas, the value 1 represents households more vulnerable to flooding risks. To calculate Variable Vulnerability Index (VVI) and Total Variable Vulnerability (TVV), it subtracted the minimum value of vulnerability value from each value of vulnerability variable and then divided this by the value which we obtained by subtracting the maximum vulnerability value from the minimum vulnerability value. By this division total variable vulnerability was calculated. Now for the variable vulnerability index added all the calculated vulnerability variables against each number. By this addition, the variable vulnerability index was calculated.

$$TVV = X_i\text{-Min Value} / \text{Max Value- Min Value} \qquad (1)$$

$$VVI = TV_1+TV_2+TV_3+TV_4 \ldots\ldots TV_{11}+TV_{12} \qquad (2)$$

Econometric Model

Economists regularly encounter the research difficulty there by the dependent variable of the structural model is not directly observed. The real value observed may be dependent on the value of other variables or instead may observe a variable that takes on value related to the fundamental unobserved dependent variables.

Multiple Linear Regression: Data analysis is the main significant part of the resources for conducting some kind of research study. For this purpose, descriptive statistics (frequencies and averages) were applied to draw intervention concerning economic and other characteristics of the individuals whereas multiple linear regression models were analyzed to investigate the determinants affecting the vulnerability of the households to floods in the study area.

The common form of the model is;

$$Y_i=\alpha + \sum\beta X_i+ \mu_i \qquad (3)$$

Here,

Yi=dependant variable (vulnerability due to floods)

α = intercept

β= slope of coefficient

X_i= set of different independent variables

where, i= 1, 2, 3……..

μ_i= error term

The significance of the outcome was analyzed by using unusual statistical techniques and computer software techniques like SPSS. The more conservative joint effect of all independent variables on the dependent variable was analyzed by adjusted R square (Johnson and Wichern, 2002).

Therefore, the model calculated the vulnerability of flood household is drawn as below:

$$Y =\alpha + \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5+ \beta_6X_6+ \beta_7X_7+ \beta_8X_8+ \beta_9X_9+\mu \qquad (4)$$

Where,

Y= Vulnerability due to floods

X_1= Age of household head

X_2= Education

X_3=Farm size

X_4=Ownership of land

X_5=Monthly Income

X_6= Family size

X_7=Credit

X_8= Flood experience

X_9= Livestock (no. of cattle)

RESULTS AND DISCUSSION

Total Own Area

Table 2 depicts the average of total own area, standard deviation, and range of farm area operated of three districts of Punjab provinces. In the Jhang district, the average total own area was 12.87 acres while the standard deviation was recorded to be 8.532. Similarly, In the Chiniot district, the average total own area was recorded to be 32.15 acres with a standard deviation was 19.65 while the minimum total own area was 3 acres and the maximum total own area was 70 acres. In district Layyah the average total own area was 33.63 acres with a standard deviation was 30.02 and the range of total own area was recorded to be 3 to 110 acres. In the whole study area, the average total own area was found to be 26.34 acres while the standard deviation was 23.02, and the range of total own area in the whole study area was recorded to be 3 to 110 acres.

Table 2. Descriptive statistics of total own area (acres).

Total own area	Minimum	Maximum	Mean	STD. Deviation
Jhnag	3.00	30.00	12.8718	8.53223
Chiniot	3.00	70.00	32.1500	19.65412
Layyah	3.00	110.00	33.6250	30.02195
Total	3.00	110.00	26.3277	23.20327

Source: Author's calculations from the survey data 2017-18.

Total Farming Area Operated

Table 3 depicts the average farm area operated, standard deviation and range of farm area operated of three districts of Punjab provinces. In the Jhang district, the average farm area operated was 18.025 acres while the standard deviation was recorded to be 18.33. Similarly, in Chiniot district the average farm area operated was recorded to be 33.95 acres while the minimum farm area operated was 3 acres and the maximum farm area operated was 90 acres. In district Layyah, the average farm area operated was 34.75 acres and the range of farm area operated was recorded to be 3 to 125 acres. In the whole study area, the average farm area operated was found to be 28.91 acres.

Table 3. Descriptive statistics of total farming area operated (acres).

Location	Minimum	Maximum	Mean	STD. Deviation
Jhnag	0.00	75.00	18.0250	18.33238
Chiniot	3.00	90.00	33.9500	22.44646
Layyah	3.00	125.00	34.7500	30.95137
Total	0.00	125.00	28.9083	25.47663

Source: Author's calculations from the survey data 2017-18.

Ownership of Land

Table 4 describes that the frequency and percentage of the three districts of Punjab province. In Jhang district, 60 percent sampled respondents indicated that they had ownership of land while 2.5 percent individuals indicated that they were tenants of land and 37.5 percent sample respondents indicated that they had owner-cum-tenant of land, Similarly in Chiniot indicates that 77.5 percent individuals had ownership of land while 0.0 percent individuals tenants of land and 9 percent sample respondents indicated that they have Owner-cum-Tenant of land. Likewise in Layyah indicated that 72.5 percent individuals had ownership of land while 0.00 percent of individuals were tenants of land and 27.5 percent of sample respondents had Owner-cum-Tenant of land. Overall study area indicates that 70.0 percent of individuals had ownership of land while 0.8 percent of individuals indicated that they were tenants of land and 29.2 percent of respondents had Owner cum tenant of the land.

Table 4. Distribution of sampled respondents based on ownership of land.

Ownership of Land	Jhang		Chiniot		Layyah		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Owner	24	60.0	31	77.5	29	72.5	84	70.0
Tenant	1	2.5	0.00	0.00	0.00	0.00	1	.8
Owner-cum-tenant	15	37.5	9	22.5	11	27.5	35	29.2

Source: Author's calculations from the survey data 2017-18.

Weather Related Risk

In Jhang district 85 percent of sampled respondents indicated that they were faced flood risk while 7.5 percent of individuals faced a risk of heavy rains, similarly, there were no sampled respondents who faced the risk of drought, and 7.5 percent sampled respondents have faced the risk of pest and diseases. In Chiniot district 8 percent sampled respondents indicate that they were faced flood risk, while 7.5 percent individuals faced the risk of heavy rain, similarly, there were no sampled respondents who faced the risk of drought and 12.5 percent sampled respondents have faced the risk of pest and diseases. In Layyah district 85 percent sampled respondents indicate that they were faced flood risk, while 15 percent of individuals faced the risk of heavy rain, similarly, there were no sampled respondents who faced the risk of drought and also 0 percent sampled respondents have faced the risk of pest and diseases. Overall district 90 percent sampled respondents indicate that they were faced flood risk, while 7.5 percent individuals faced the risk of heavy rain, similarly, there were no sampled respondents who faced the risk of drought and 2.5 percent sampled respondents have faced the risk of pest and diseases as shown in Table 5.

Table 5. Distribution statistic according to the weather-related risk.

Source related risk	Jhang		Chiniot		Layyah		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Flood	34	85.0	32	80.0	34	85.0	108	90.0
Heavy Rain	3	7.5	3	7.5	6	15.0	9	7.5
Droughts	0	0	0	0	0	0	0	0
Pest and Diseases	3	7.5	5	12.5	0	0	3	2.5

Source: Author's calculations from the survey data 2017-18.

Strategies Adopted

Table 6 indicates the frequency and percentage of three districts of Punjab province. In Jhang district 32.5 percent sampled respondents indicate that they were adapted to diversification to manage weather-related risk. While 62.5 percent individuals indicate that they were adapted precautionary saving to manage weather-related risk similarly 5 percent sampled respondents indicate that they were adapted credit to manage weather-related risk and 0 percent sampled respondents indicate that they were adapted to crop loan insurance scheme manage weather related risk, similarly in Chiniot district 50.0 percent sampled respondents indicate that they were adapted to diversification to manage weather related risk. While 47.5 percent of individuals indicate that they were adapted precautionary saving to manage weather related risk similarly 2.5 percent sampled respondents indicate that they were adapted credit to manage weather related risk and 0 percent sampled respondents indicate that they were adapted to crop loan insurance scheme manage weather related risk. Likewise in Layyah indicate that 60.0 percent individual indicates they were adapted to diversification to manage weather related risk. While 40.0 percent individuals indicate that they were adapted precautionary saving to manage weather related risk similarly 0 percent sampled respondents indicate that they were adapted credit to manage weather related risk and 0 percent sampled respondents indicate that they were adapted to crop loan insurance scheme manage weather related risk. Overall study areas indicate that 47.5 percent individuals indicate that they adapted to diversification to manage weather related risk. While 50.0 percent of individuals indicate that they were adapted precautionary saving to manage weather related risk similarly 2.5 percent sampled respondents indicate that they were adapted credit to manage weather related risk and 0 percent sampled respondents indicate that they were adapted to crop loan insurance scheme manage weather related risk.

Table 6. Distribution of sampled respondents according to the adopted of strategies.

Strategies adopted	Jhang		Chiniot		Layyah		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Diversification	13	32.5	20	50.0	24	60.0	57	47.5
P.Savings	25	62.5	19	47.5	16	40.0	60	50.0
Credit	2	5.0	1	2.5	0	0	3	2.5
CIS	0	0	0	0	0	0	0	0

Source: Author's calculations from the survey data 2017-18.

Incidence of Flood Risk

Table 7 indicates that 0 percent sampled respondents from the district Jhang was showing a very low incidence of the flood, while only 2.5 percent sampled respondents were showing low incidence of flood similarly 42.5 percent sampled respondents were showing the normal incidence of the flood, likewise 35 percent sampled respondents were showing a high incidence of flood and 20 percent individuals were showing a very high incidence of the flood.

Table 7. Distribution of sampled respondents according to the incidence of the flood.

Incidence of flood	Jhang		Chiniot		Layyah		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Very Low	0	0	0	0	0	0	0	0
Low	1	2.5	0	0	0	0	1	.8
Normal	17	42.5	0	0	0	0	17	14.2
High	14	35.0	17	42.5	14	35.0	45	37.5
Very High	8	20.0	23	57.5	26	65.0	57	47.5

Source: Author's calculations from the survey data 2017-18.

Similarly in Chiniot Table 7 indicates that 0 percent sampled respondents were showing very low incidence of flood, while only 0 percent sampled respondents were showing low incidence of flood. Similarly 0 percent sampled respondents were showing normal incidence of flood, likewise 42.5 percent sampled respondents were showing high incidence of flood and 57.5 percent individuals were showing very high incidence of flood. Likewise in Layyah it is indicated that 0 percent sampled respondents were showing very low incidence of flood and 0 percent sampled respondents were showing low incidence of flood. Similarly 0 percent sampled respondents were showing normal incidence of flood and 35 percent sampled respondents were showing high incidence of flood and 65 percent individuals were showing very high incidence of flood. Overall study area indicates that 0 percent sampled respondents from the district Jhang were showing very low incidence of flood, while only 0.8 percent sampled respondents were showing low incidence of flood. Similarly 14.2 percent sampled respondents were showing normal incidence of flood and 37.5 percent sampled respondents were showing high incidence of flood and 47.5 percent individuals were showing very high incidence of flood.

The Severity of Flood Risk

Table 8 indicates that 2.5 percent sampled respondents from the district Jhang was showing very low severity of flood, while 0 percent sampled respondents were showing low severity of flood, similarly also 50 percent sampled respondents were showing normal severity of heavy rain, likewise, 30 percent sampled respondents were showing high severity of flood and only 17.5 percent individuals were showing very high severity of flood. Similarly in Chiniot indicate that 0 percent sampled respondents were showing very low severity of flood, while 0 percent sampled respondents were showing low severity of flood similarly 12.5 percent sampled respondents were showing normal severity of flood, likewise 47.5 percent sampled respondents were showing high severity of heavy rain and 40 percent individuals were showing very high severity of flood.

Table 8. Distribution of sampled respondents according to the severity of flood.

Severity of flood	Jhang		Chiniot		Layyah		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Very Low	1	2.5	0	0	0	0	1	.8
Low	0	0	0	0	0	0	0	0
Normal	20	50.0	5	12.5	0	0	25	20.8
High	12	30.0	19	47.5	23	57.5	54	45.0
Very high	7	17.5	16	40.0	17	42.5	40	33.3

Source: Author's calculations from the survey data 2017-18.

Likewise in Layyah indicate that 0 percent sampled respondents were showing very low severity of flood, while also 0 percent sampled respondents were showing low severity of heavy flood, likewise 57.5 percent sampled respondents were showing high severity of flood, and 42.5 percent individuals were showing very high severity of flood. Overall study area indicates that 11.7 percent sampled respondents were showing very low severity of flood, while only 34.2 percent sampled respondents were showing low severity of flood similarly

36.7 percent sampled respondents were showing normal severity of flood, likewise 12.5 percent sampled respondents were showing high severity of flood and 5 percent individuals were showing very high severity of flood.

Econometric Analysis

An econometric model was developed to estimate the factors of vulnerability. The vulnerability was taken as a dependent variable. The parameters of socio-economic variables and demographic variables were specifically important for this study because they affect the vulnerability positively or negatively. Table 9 shows that the value of the constant co-efficient of the vulnerability is 7.186 and its value is statically significant. Age is considered the most important variable affecting vulnerability. The p-value of age 0.008 ($p<0.05$) showed a positive sign and was highly significant. The significant value of the variable explained that for every one percent increase in age there might be an increase of 0.008 percent affecting the vulnerability, remaining all other factors constant. The result is also relevant to Gunawardena and Wickramasinghe (2010).

Table 9. Multiple linear regression analysis.

Variables	Coefficient	Std.Error	t-value	Sig.
Constant	7.186	0.0537	13.376	0.000
Age	0.12	0.008	1.493	0.008
Education	0.19	0.026	0.721	0.02
Farm Size	0.007	0.007	0.949	0.345*
Ownership of land	0.183	0.117	1.567	0.12*
Income	11.058	0.000	2.2	0.03
Family Size	0.13	0.025	0.499	0.619*
Credit	1.365	0.000	2.854	0.05
Flood experience	0.89	0.83	1.066	0.028
Cattle	0.007	0.018	0.399	0.006

Source: Author's calculations from the survey data 2017-18.
** indicate the non-significant value.*

There might be education is considered to be a vital socio-economic variable as it increases the capacity of flood affectees to get more aid and to use it most effectively. The probability (p) value of education 0.02 ($p>0.05$) showed a positive sign and that was statically significant. The significant value of the variable explained that for every one percent increase in education (Years of Schooling) there might be an increase of 0.02 percent affecting the vulnerability keeping all other factors constant. The result is also supported by Gunawardena and Wickramasinghe (2010).

Income and vulnerability have a positive relationship. The p-value of income is 0.03 that is statically significant. The significant value of the variable explained that for every one % increase in income. There could be an increase of 0.03 percent affecting the vulnerability keeping all other factors constant. The result is also supported by Bari (2011).

Credit is an important variable to reduce the vulnerability of floods. Credit can play an important role to reduce the vulnerability of floods. The p-value of credit in the form of rupees 0.05($p<0.05$) showed a positive sign and was significant. The significant value of the variable explained that for every one percent increase in credit the might be an increase of 0.05 percent affecting the vulnerability remaining all other factors constant.

Family size is an important variable that is affecting vulnerability. When the family size is higher then it causes more vulnerability to flood. The p-value of the family size 0.619 ($p>0.05$) shows a positive sign and was non-significant. Because there are many problems faced during and after flood situation such as migration. The non-significant variable explained that that for every one percent raise in family size there could be an increase 0.619 percent affecting the vulnerability of flood, remaining all other factors constant. The result is also supported by Bari (2011).

Farm size is also important variable which affects the vulnerability of flood in flooding area. If the large farm size there is more risk cause to the vulnerability of flood. The p-value of farm size 0.345 ($p>0.05$) shows a positive sign and was non-significant. Because they faced more damages due to the lack of embankment around the field and flood warning system they cannot easily overcome this damages. The coefficient of variable explained that that for every one percent increase in farm size there could be an increase of 0.345 percent affecting the vulnerability of flood, remaining all other factors constant.

The ownership of land has a positive relationship that also affects the vulnerability of flood. The p-value of ownership of land 0.12 ($p>0.05$) which was statically non-significant. Sine farmer those have ownership of the land they faced more damages as compare to tenants whereas tenants bear low damages as compared to ownership of land. The non-significant value of the variable explained that that for every one percent increase in ownership of land there could be an increase of 0.12 percent affecting the vulnerability of flood, remaining all other factors constant.

The significant value of flood experience with a positive relationship is affecting the vulnerability of flood. Farmer household those who have more experience of the flood they faced less vulnerability of flood because they can easily handle the situation of flood. The p-value of flood experience 0.028 ($p<0.05$) which was statically significant. The p-value of the variable explained that that for every one percent increase in flood experience there might be an increase of 0.028 percent affecting the vulnerability of flood, remaining all other factors constant.

The cattle are also the main variable that is affecting the vulnerability of flood. The significant value of cattle 0.028 ($p<0.05$) shows a positive sign which was statically significant. The p-value of the variable explained that that for every one percent increase in cattle there might be an increase of 0.006 percent affecting the vulnerability of flood, keeping all other factors constant. The significant value of flood experience 0.028 ($p<0.05$) which was statically significant. The p-value of the variable explained that that for every one percent increase in flood experience there might be an increase of 0.028 percent affecting the vulnerability of flood, reaming all other factors constant.

The value of R^2 in the examined was 0.195 which stated that all independent variables mutually explained 19.5 percent variation in the dependent variable i.e. vulnerability. This value also described that rest of 34.2 percent, 12 percent, and 61.2 percent change independent variable was adopted by some other variables, the effect of which could not be explained by the given model. The value of adjusted R^2 in the examined was 0.129 which is significant. The value of adjusted R square means that all independent variables explained a 12.9 percent change in the dependent variable; remaining all other factors constant F-ratio implies that all independent variables are significant or non-significant factors for causing variation in the dependent variable. The F-value in the examined 2.95 that was non-significant described the overall appropriateness of the model.

CONCLUSIONS

Climate change is one of the biggest challenges faced by developing as well as developed countries. Pakistan had encountered various kinds of natural hazards in the last decade. Due to which the country had to face enormous damages in terms of human life and other personal assets. For the current research study, there is main conclusions are drawn, concerning household vulnerability to flooding disaster, Pakistan is blessed with abundant natural resources but due to lack of expertise, unsustainable utilization of available natural resources, rapid growth, environmental degradation, poor hazards forecasting, and lack of advance level of a hazard warning system, awareness, and lack of vulnerability assessments are the main root causes which put the country mass to a great extent of vulnerabilities. Ideally, there should be low vulnerability but in the present scenario, the country is experiencing high vulnerability challenges. Climate change has increased the frequency and severity of floods which prompted the government to take some bold steps and in-placed disaster risk reduction measures into disaster management policies and planning at the local level to build resilient communities against catastrophic extreme weather events. The component vulnerability indices (TVV, VVI) for the study areas help us to compare the variables chosen for exposure, sensitivity, and adaptive capacity. The composite vulnerability indices show that both study areas are prone to flood disasters. The government should restrict the inhabitants to construct their houses in flood-prone areas or provide alternative places, which are far away from the main river source. The sensitivity of the households to flood disasters can overcome by increasing literacy and arrange awareness programs that enable people to shift from the traditional structure (Mud) to flood-resistant structures (concrete or bricks). Similarly, the adaptive capacity of the households in the flood-prone community can be improved through the provision of employment opportunities, multiple livelihoods sources to earn handsome amount of income, and put much emphasis on government and nongovernmental organizations (NGOs) to work closely with the affected community to address their needs. Institutional services e.g. access to extreme weather information and credit facilities should be accessible to all at their doorsteps. It is suggested that government should construct dams and build barriers to stop water flow towards the cities and village. The government should improve the flood forecasting system because flood forecasting systems are increasingly becoming an essential step in the warning process.

REFERENCES

Adger, W.N., and P.M Kelly, 1999. Social vulnerability to climate change and the architecture of entitlements. Mitigation and Adaptation Strategies for Global Change, 3, 253-266.

Alexander, D., 2012. Models of social vulnerability to disasters. RCCS Annual Review. A selection from the Portuguese journal Revista Crítica de Ciências Sociais, 4, 22-40.

Arouri, M., Nguyen, C., Youssef, A.B., 2015. Natural disasters, household welfare, and resilience: evidence from rural Vietnam. World Development, 70, 59-77.

Atta-ur-Rahman, Khan, A.N., 2011. Analysis of flood causes and associated socio-economic damages in the Hindukush region. Natural Hazards, 59, 1239. https://doi.org/10.1007/s11069-011-9830-8

Bari, S., 2011. Citizen characteristics for sustainable rehabilitation of flood affectees. Journal of Applied Natural Disasters, 3, 102-125.

Cimellaro, G.P., Reinhorn, A.M., Bruneau, M., 2010. Framework for analytical quantification of disaster resilience. Engineering Structures, 32(11), 3639-3649.

Cutter, S.L., Boruff, B.J., Shirley, W.L., 2003. Social vulnerability to environmental hazards. Social Science Quarterly, 84, 242-261.

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.

Gbetibouo, G.A., Ringler, C., 2009. Mapping South African farming sector vulnerability to climate change and variability: a subnational assessment (pp. 2-4). Washington, DC: International Food Policy Research Institute (IFPRI) and Center for Environmental Economics and Policy in Africa (CEEPA).

Ginige, K., Amaratunga, D., Haigh, R., 2009. Mainstreaming gender in disaster reduction: why and how?. Disaster Prevention and Management, 18(1), 23-34.

GoP, 2015. Annual report of national disaster management, Prime Minister's Office Premises Islamabad Pakistan.

GoP, 2016. Annual report of national disaster management, Prime Minister's Office Premises Islamabad Pakistan.

GoP, 2017. Economic survey of Pakistan 2016-17. Ministry of Finance, Islamabad, Pakistan.

Gunawardena, A., Wickramasinghe, K., 2010. Targeting and distribution of post-tsunami aid in Sri Lanka. Working Paper No.55, Pp. 10.

IPCC, 2001. Third assessment report (TAR) of the intergovernmental panel on climate change, parts 1, 2 and 3, Synthesis Report and Policy Makers Summaries, Cambridge University Press, Pp. 110-115, Cambridge, UK.

IPCC, 2012. The Physical science basis. Working Group Contribution to the 4th Assessment Report Summary for Policymakers.

IPCC, 2013. The physical Science basis. Working Group Contribution to the Fifth Assessment Report Summary for Policymakers.

Joerin, J., Shaw, R., Takeuchi, Y., Krishnamurthy, R., 2012. Assessing community resilience to climate-related disasters in Chennai, India. International Journal of Disaster Risk Reduction, 1, 44-54.

Johnson, R.A., Wichern, D.W., 2002. Applied multivariate statistical analysis (Vol. 5, No. 8). Upper Saddle River, NJ: Prentice Hall.

Nelson, R., Kokic, P., Crimp, S., Martin, P., Meinke, H., Howden, S.M., de Voil, P., Nidumolu, U., 2010. The vulnerability of Australian rural communities to climate variability and change: part II—Integrating impacts with adaptive capacity. Environmental Science & Policy, 13(1),18-27.

Pielke, J., Anthoni, R., 2000. Flood Impacts on Society: damaging floods as a framework for assessment. Chapter 21 in D. Parker (ed.), Floods. Rutledge Press: London, 133-155.

Proag, V., 2014. The concept of vulnerability and resilience. Procedia Economics and Finance, 18, 369-376.

Rahman, M.T., Aldosary, A.S., Nahiduzzaman, K.M., Reza, I., 2016. Vulnerability of flash flooding in Riyadh, Saudi Arabia. Natural Hazards, 84,1807–1830.

Riwthong, S., Schreinemachers, P., Grovermann, C., Berger, T., 2017. Agricultural commercialization: Risk perceptions, risk management and the role of pesticides in Thailand. Kasetsart Journal of Social Sciences, 38(3), 264-272.

Scheuer, S., D. Haase, and V. Meyer. 2011. Exploring multicriteria flood vulnerability by integrating economic, social and ecological dimensions of flood risk and coping capacity: From a starting point view towards an end point view of vulnerability. Natural Hazards, 58(2), 731–751.

Smith, J., Anthony, 1996. Anthropological research on hazard and disaster. Annual review of anthropology. 25, 303-328.

Tariq, M.A.U.R., 2013. Risk-based flood zoning employing expected annual damages: the Chenab River case study. Stochastic environmental research and risk assessment, 27(8), 1957-1966.

Wilkinson, E., Brenes, A., 2014. Risk-informed decision-making: an agenda for improving risk assessments under HFA2. Produced for the climate and development knowledge network (CDKN) learning network on the use of climate and disaster risk assessments project, London.

World Bank, 2006. Hazard of nature, risks to development: evaluation of World Bank assistance for natural disaster, Washington, D.C, World Bank report no 4, 109-105.