

The Impacts of Climate Change-Induced Floods on Livelihoods in Rural Pakistan: A Case Study of District Charsadda

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This study investigates the impacts of climate change-induced flood on livelihoods in flood-affected areas of district Charsadda, Khyber Pakhtunkhwa Pakistan. The study comprehensively has analysed that how the climate change-induced floods have impacted the various aspects of livelihoods such as: income loss, health issues, house inundation; agriculture, livestock, economic, and small local businesses. The data collected from 350 flood-affected households through a structured questionnaire and analysed quantitatively by using SPSS software. The results indicated a widespread disruption such as of the health-related issues, house inundation, the loss of income. Moreover, the farmers and daily wage laborers were disproportionately affected. Agricultural damages were comprised on crops loss majorly wheat and vegetables, delay in cultivation and disruption in irrigation system; while livestock owner had to deal with distressed sale and shortage of feed and small businesses took a prolong period of recovery and physical damage. Additionally, statistically a significant association found between the asset's loss and house inundation, and shortage of feed and sales of livestock at lower prices; however, there was no significant correlation between housing damage and loss of income, indicating the other factors influence the economic vulnerability. The findings draw attention toward a recurrent exposure to floods, structural vulnerabilities and fragile economic sectors. The study concludes that the affected population remain in a perpetual cycle of debt, repeated loss, and fragile recovery. Hence, a rational intervention is required to boost the disasters risk reduction, development of economically viable livelihood, accessibility to healthcare, resilience agriculture and small businesses recovery.

1. Introduction & Literature Review

Climate change is swiftly becoming a grievous global issue and has encapsulated almost every country in the modern day. Global climate change means the transition in the climate of the earth as a whole, whereas climate change is the shift in the "average weather" of a region experienced over a long period (Hussain 2005; Fakhara et al., 2021); while in other words, Climate change refers to the considerable variations in the temperature and average weather patterns by becoming drier, wetter or warmer over several decades or longer (ADB, UN). All these are measured by understanding the changing features of weather such as changes in temperature, precipitation, rainfall, storms, winds and many other factors.

Several anthropogenic, natural, and socio-economic growth activities are sharply contributing to and are closely associated with the phenomena of climate change (Hassan et al. 2019; Fakhara et al., 2021). Climate change has significant impacts on humans in costs of floods, health, droughts, heat stresses and natural costs of deforestation, landslides, and wildfires (Ashraf et al. 2022). Climate change has already exceptionally affected every part of the world whether they are developing or developed countries but has been punched South Asia vigorously, in the shape of water security and food production, cities, well-being, settlement and infrastructure damages (Ashraf et al., 2022, Fakhara et al., 2021, IPCC, 2022).

Although each country stands on the perils of climate change, risks are more intense for less developed countries in South Asia, particularly Pakistan is among them, which is more vulnerable to droughts, floods and other extreme events due to uncertain climatic changes (Fahad et al. 2020). Individual livelihood has been affected by the decline in agricultural food and health, homes and infrastructure destruction and intense loss of property and income. It has been estimated that throughout the world around 3.3 billion to 3.6 billion people are highly vulnerable to climate change (IPCC, 2022).

It has been predicted that the consequences of climate change-induced floodings will affect from 2035 to 2044 an additional 5-million people annually of the world (ADB, 2021). The most troublesome is displacement or migration to other places, which has directly and indirectly affected the economy, livelihood, agricultural production, and small and big enterprises.

Although, Pakistan contributes less than one per cent (1%) to climate change, and 0.9% to global greenhouse gas emissions, nevertheless, Pakistan was been 12th position in 2012, 8th position in 2015 and currently 5th place among the top countries of the world which has exposed to the caprices of the global warming and climate change (Wahid, 2018; Ghamz et al., 2019; Fahad et al., 2020; Gop, 2021).

The vulnerability of Pakistan to these climate changes can be seen primarily in the form of intense flooding, rise in temperature, droughts and drastic changes in rainfall patterns in recent decades. It has been estimated that between 1961 to 2018, the overall annual winter downpour in Pakistan has sharply increased by 12% and monsoon rains by 18%. It also has noted the rise in monsoon precipitation by 15% to 25% in northern Pakistan. Significantly, the amount of both winter and monsoon rainfall has particularly increased in Khyber Pakhtunkhwa and other provinces of Pakistan as well (Sathar et al., 2023; Farah, 2023).

The mountainous north of Pakistan largely comprises three prominent ranges such as Hindukush, Himalayas and Karakoram which possess suitable glaciers and keep their rivers and attributes flowing smoothly throughout the year. Any change in climate in the region will affect the melting of snow and glaciers over mountains. Consequently, may affect all the ecosystems, and social and economic sectors of the flood-prone regions throughout the rivers (Hussain 2005). The rivers, which flow through the districts of Charsadda and Nowshera, are rivers Swat and Kabul respectively originate from the Hindu Kush mountain ranges in Kohistan and Chitral. These rivers have come out horrendous and devastating for these lower-plan areas several times in the past decades. The most vulnerable flood-prone regions faced shattering results in the shape of agriculture productivity loss, poverty, displacement, trade and business disruption, injuries and deaths.

Pakistan has experienced catastrophic flooding caused by an exceptional monsoon in 2010, consequently, that affected the 20 million people and over 2000 lives were lost, 12 million homes were destroyed with the wounding and missing of numerous people. Additionally, stoke the region hard in the cost of economic terms by damaging 2.4 million hectares of harvested crops with the worth of \$ 5.1 billion (Fakhara et al., 2021; WBG & ADB 2021; Ashraf et al., 2022) and these floods had been inundated the 27 villages in District Charsadda (Fidah, 2020). Similarly, another disastrous flood took place in August 2022 in Pakistan due to the effects of climate change and heavy monsoon in the northern regions of Khyber Pakhtunkhwa.

According to the National Disasters Management Authority (NDMA), the August 2022 flood affected 33 million people, around 15% of the total population of Pakistan, including 8 million who were displaced. Consequently, Pakistan faced total damages of worth \$14.9 billion and a total loss of worth \$15.2 billion. Khyber Pakhtunkhwa's share in that whole damages was equal to \$935 million while the lost cost was equal to \$658 million (NDMA & PDMA, 2022). Overall, eighty-one (81) districts have been declared as a calamity hit across Pakistan; of which 17 districts were included in Khyber Pakhtunkhwa province. It has affected around 4350490 population directly leaving 306 human loss and 369 injuries along with the destruction of houses, infrastructure, agriculture and livestock (OCHA, 2022).

Despite the growing body of literature on climate change-induced floods in Pakistan, majority of the studies focus the immediate economic and physical damages such as loss of income, housing destruction and assets loss, crops and livestock. This study undertakes the assessment of flood-impacts on livelihoods including the income sources, agriculture, livestock, and local small businesses in district charsadda. It encompasses the whole picture of August-2022 flood which left many sectors of livelihoods affected and vulnerable.

1.1 Research Objectives

The main objectives of this research are to identify the key factors that drive the performance measurement of the Inbound Material Supply Chain (IBMSC) of Pakistan Railways, examine the major constraints and challenges affecting the existing performance measurement practices, and develop a comprehensive performance measurement framework based on Key Performance Indicators (KPIs). The study further aims to determine suitable strategic, tactical, and operational KPIs from internal and external perspectives to enhance

supply chain efficiency, effectiveness, transparency, accountability, and sustainability. Additionally, the research seeks to provide recommendations for improving performance measurement practices in public sector supply chain organizations by addressing existing gaps and establishing a structured system for continuous monitoring and performance improvement.

Understanding the demographic profile of respondents for the vulnerability and susceptibility to the flood impacts is very crucial. Hence, table 1 explores the demographic characteristics such as age distribution, education level, occupation, and family size of the sample areas for this study.

The demographic profile of the respondents reveals critical insights into the socioeconomic vulnerabilities of the population under study. The sample is comprised exclusively on only male respondents (100%), while the underrepresentation of women is reflecting the social restrictions, cultural conventions or practical challenges of the society. Although the respondents comprised a wide range of age groups, the majority fall into the category of 31-45 years (52.3%) and the smallest age group is 60-70 years (6.0%). It shows that these people, particularly the middle-aged respondents, are actively involved in their professions and supporting their families' livelihoods by making crucial decisions regarding their income.

Table No 1: Demographic analysis of the respondents (an integrated table)

Demographics	Frequency (f)	Percentage (%)
Gender		
Male	350	100%
Female	0	0%
Age distribution		
18-30	59	16.9%
31-45	183	52.3%
46-60	87	24.9%
60-70	21	6.0%
Education level		
Graduation	13	3.7%
Illiterate	114	32.6%
Inter	26	7.0%
Matric	58	16.6%
Middle	66	18.9%
Primary	73	20.9%
Family size		
1-3	10	2.9%
4-6	112	32.0%
7-9	119	34.0%
10-12	82	23.4%
13-15	21	6.0%
16-20	5	1.4%
Occupation		
Business	37	10.6%
Farmer	180	51.4%

Government employee	13	3.7%
Labor	120	34.3%

Source: Author's calculation using survey data

Education data shows a concerning literacy gap, with (32.6%) are illiterate while (3.7%) have completed their graduation, highlighting the barriers to access and persistent educational deprivation. The family size is notably large, with (34.0%) having between 7 to 9 members. The findings revealed that larger families play an important role in the household stability and resilience, but it may present both potentials as well as challenges for a family. On one hand, it may provide additional financial support to the working hands, but sometimes it may further put an additional pressure on other earning hands of the family and making it difficult to sustain themselves, especially in flood-prone areas. Moreover, the financial or other household loss due to climate change or floods may inflict the most heads per household in the existence of large families. The occupation in sample area shows that striking (51.4%) respondents are farmers and dependent for their livelihoods on agricultural products and weather conditions. Additionally, the second most frequency is of labourforce (34.3%), who are engaged in daily wages, construction, and seasonal work. This indicates that farmers and laborsforce's livelihoods are at greater risk, comparatively of few people associated with professions like government services and business activities which may have access to the stable alternative incomes sources.

Conclusively, this paper analyses that how climate change-induced flood have been affected on people's livelihoods including health, income, agriculture, livestock, housing and infrastructure and local economic activities in district Charsadda's flood-affected areas.

2. Methodology

The impacts of flood induced disasters in August 2022 on the people's livelihoods such as income, agriculture, housing, health, livestock and local small businesses etc were assessed through a field survey. The data were collected through structured questionnaires in five most flood-affected villages: Agra Payan, Agra Bala, Gulshan Abad, Awan Abad and Jangai Koroona in Union Council Agra, district Charsadda. These areas lie near river Swat and are historically vulnerable to seasonal flooding. The questionnaire was designed to gather the information about the impacts of flood experienced by the households. Therefore, in a randomly manner 350 households were selected that had been experienced the direct damage of flooding on their agriculture, livestock, income and business activities. The respondents were comprised on only male; while the women were excluded after the pilot test due to the limitations of cultural and social norms of the society. In the targeted respondents were included the farmers, labours, employees, livestock keepers and small business holders to investigate the whole picture of livelihood impacts. For more valid results the statistical software such as Statistical Package for Social Science (SPSS) has been used for the discovery of frequency and percentage of impacted people in August 2022 flood. Additionally, other tests such as cross tabulation and Chi-Square tests have also been conducted for the verification of association and correlation between different varibales and interpretation of their predictable patterns.

3. Survey area's profile

Geographically, District Charsadda encapsulates the total 996 Km² area (243,753 acres). District Charsadda is occupied by Tehsil Shabqadar on the West side, and district Nowshera and Peshawar on the South side, Mardan on the East side, and Tehsil Tangi on the North. Basis on the location, district Charsadda lies between the 71°53" to 71°28" East longitude and 34°03" to 34°38" North Latitude (Misbah Fidah, 2021). According to the 2023 census report, the total population of district Charsadda comprised 1,835,504 with 6.9 average household size and a high 2.20% average annual growth rate (Pakistan Bureau of Statistics, 2023). The three main rivers included river Swat, Kabul and Jindi flow through district Charsadda, and they are the primary sources of irrigation in the region, but it also possesses a great potential for the flood hazards to the adjacent villages based on their location, geography, and drainage system. In the spring season, the discharge rate of these rivers gradually increases due to the snowmelt on the Hindu Kush mountains range and it further reaches to the highest level in June to July months by summer rainfalls. Consequently, the erratic rainfall and monsoon may cause periodic flooding annually from Northern to the plan areas including district Charsadda.

4. Results and Discussion

4.1 Floods Impacts on the People's Livelihoods

As a result of the August 2022 flood, the households in district Charsadda suffered significantly in terms of physical and economic losses. An integrated findings about the respondent's health issues, loss of income, housing damages, post-flood swing in income level and frequency of flooding have combined in the table (2) to give a comprehensive view of how the flood-induced disasters have affected the well-being of households.

Table No 2: Flood impacts on people's livelihoods (an integrated table)

Impact indicators	Response option	Frequency (f)	Percentage (%)
Health Problems (rash, cough, diarrhea, & temperature depression)	Yes	307	87.7%
	No	43	12.3%
Loss of Income*	Yes	276	78.9%
	No	74	21.1%
House Inundation	Yes	345	98.6%
	No	5	1.4%
Loss of household assets	Yes	345	98.6%
	No	5	1.4%
Post-flood Income Level	Decreased	266	76.0%
	Not Affected	84	24.0%
Frequency of Flooding in past two decades	1-2 times	133	38.0%
	3-5 times	217	62.0%

Loss of Income*: It means the loss of on daily basis income such as loss of income from food stall, boats, hotel, daily wages and retail shops etc.

Source: Author's calculation using survey data

Findings of the data table 2 revealed that the majority of the people (87.7%) reported health issues including skin infections, temperature and diarrhea in flood affected areas.

Additionally, the respondents also reported mental-health problems including depression, sleeplessness, and other psychological impacts. The contaminated and stagnant flood water causes diseases like skin infections, intestinal, malaria and dengue fever cases. Consequently, the unstable health conditions affect income. In contrast to this the 12.3% respondents chose to not have health issues due to access to hygienic and drinkable water.

A significant percentage (78.9%) of the surveyed individuals answered that flooding had severely lowered their income. Importantly, this is associated with the flood-prone areas and agrarian economy of district Charsadda, where flooding directly affects the huge portion of livelihoods particularly agriculture, daily wages laborers, food stalls, retail shops, and other small businesses. The least percent (21.1%) of individuals disclosed that their income has not been affected by the flood in August 2022. It indicates that either their houses were safe from effects of flood or probably were government or private salaried or getting earnings as remittances from abroad. Hence, this economic divide suggests that floods disproportionately affect the vulnerable and low-income households.

98.6% of the respondents answered that their houses were flooded. This indicates that the entire communities are exist on an extreme vulnerable location and frequently flooded, which is reflective of the poor flood protection system including embankments, drainage system, elevated houses. However, the 1.4% of the individuals chose that their houses have not been flooded. It suggests that their houses were located on the more elevated land or in areas with greater protection from flooding. In fact, the mud or semi-permanent material houses in rural areas are more susceptible to collapse and damages due to floods. Additionally, the houses inundation reinforces the losses of household assets, particularly of the poor families who do not have a safe storage for valuable items and essentially many households lose furniture, cooking items, dresses, doors and important documents etc, which makes the post-flood recovery most complicated.

76% of the respondents reported the decrease of their income after the flood. Due to the presence of a high ratio of farmers and daily wages laborers, it mostly affected the agricultural land and various crops and vegetables, small businesses like picnic parks, hotels and boats. On contrary to this, 24% of the respondents opted to not affected of their income, possibly due to the diversified income sources. This indicates that a high ratio of people in flood affected areas are struggling with long-term financial problems.

In the surveyed area 62% of the respondents reported that they have experienced 3-5 times; while 38% reported 1-2 times of flooding in the past two decades. In other words, flooding is not an occasional disaster, but a recurring phenomenon. Significantly, the repeated exposure to the flood disasters continuously keeps people in a cycle of loss and recovery. In addition to this, by spending on reinforcement and reconstruction of the houses after every few years, making the financial stability hopeless in such a vulnerable society and consequently bear the seeds of generational poverty for a long run.

4.2 Cross Tabulation

Table 3 is representing correlationship between the two key variables, such as loss of income and house inundation.

A Pearson chi-square value of 1.082 (df = 1, significance, $p = 0.298$) was calculated from the chi-square test for the association between loss of income and house flooding. Since, the result proved that we are unable to reject the null hypothesis, as the p -value (0.298) is greater than that of conventional p -value (<0.05), as in other words $p>0.05$. In light of this, there is no statistically significant correlation between income loss and house flooding. Significantly, the 276 or 78.9% of the respondents reported both loss of income and house inundation, but the statistical analysis does not confirm the substantial relationship. Additionally, the result suggests that house inundation may not be a single vigorous predictor for income loss, but the external factors like resilient strategies, assistance and economic factors may reduce financial loss despite of house inundation, as in this case some people reported the houses inundation, but had not affected their income.

Table No 3: Loss of income and house inundation

Cross tabulation				
		House Inundation		Total
		No	Yes	
Loss of Income	No	2	72	74
	Yes	3	273	276
Total		5	345	350

Table No 3.1 : Chi-Square Tests

	Value	Df	Asymptotic Significance (2- sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)
Pearson Chi-Square	1.082 ^a	1	.298		
Continuity Correction ^b	.239	1	.625		
Likelihood Ratio	.926	1	.336		
Fisher's Exact Test				.286	.286
N of Valid Cases	350				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.06.

Source: Author's calculation using survey data

Similarly, the table 4 shows a cross tabulation and Chi-Square test for the correlation between loss of household assets and house inundation.

A Pearson chi-square value 350.00 including (df=1, significance $p = < 0.001$) resulted from the chi-square test for the relationship between the loss of household assets (furniture and other appliances) and house inundation. Hence, the result shows that p -value (<0.001) is less than that of conventional <0.05 , in this case ($p<0.05$), which revealed a strong relationship and reject the null hypothesis (H_0), but support an alternative (H_1). This indicates that the residents

of flood affected areas experienced the direct floodwater damages of household assets and highlights the vulnerability of household assets in flood-prone areas.

Table 4: Loss of household assets (furniture and appliances etc.) * house inundation (cross tabulation)

		House Inundation		Total
		No	Yes	
Loss of Household Assets (Furniture and Appliances etc.)	No	5	0	5
	Yes	0	345	345
Total		5	345	350

Table 4.1: Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	350.000 ^a	1	<.001		
Continuity Correction ^b	282.588	1	<.001		
Likelihood Ratio	52.413	1	<.001		
Fisher's Exact Test				<.001	<.001
N of Valid Cases	350				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .07.

Source: Author's calculation using survey data

4.3 Impacts on Agriculture

In rural Charsadda, agriculture continues to be a main source of food security and livelihood, but it is disproportionately vulnerable to the flood threats and has exacerbated by the unpredictable climate change events. The table 5 shows the impacts flood on agricultural sector.

Table No 5: Impacts on agriculture (an integrated table)

Impact Indicator	Response Option	Frequency (f)	Percentage (%)
Crops loss			
Wheat	Yes	25	7.1%
Vegetable	Yes	25	7.1%
Sugarcane	Yes	6	1.7%
Wheat & vegetables	Yes	93	26.6%
Wheat & sugarcane	Yes	66	18.9%
Delay in cultivation	Yes	100	28.6%

and harvesting	No	116	33.1%
Disruption of	Yes	85	24.3%
Irrigation water	No	131	37.4%

Source: Author's calculation using survey data

The result indicates that wheat-related losses either alone or in combination with other crops, highlight its extreme vulnerability to the flood damages. Consequently, it put economic pressure and grain shortages on affected households, particularly on the small farmers. In contrast to wheat, the least damage crop is sugarcane which represent its resistance to flood impacts. The 33.1% farmer reported that there was no delay in the cultivation and harvesting. It signifies the variances in crop types, drainage conditions or intensity of the flood; while 28.6% reported the delay in cultivation and harvesting of crops due to flood damages. The result indicates that delay in cultivation and harvesting due to floods may significantly affect the yield, timing of income, food supply to household and economic sustainability of those families associated with agriculture. The floods cause damage to irrigation infrastructure or interfere with the usual water flow. Consequently, the irrigation loss may adversely affect the future plantation, particularly in the region where farmers rely on the tubewells or canals system. Additionally, the variation of flood impacts on the irrigation system throughout the sample, may be driven by the factors like proximity to river [river Kabul], elevation or the endurance of the infrastructure. These patterns reflect a systematic vulnerability in agrarian livelihoods and emphasize on the targeted interventions in climate-resilient agriculture.

4.4 Impacts on Livestock

Livestock ownership, in rural Charsadda, is essential for both diversification of income and household sustainability. The August 2022 flood has impacted the livestock from various aspects including loss of livestock, sale of livestock at lower prices, shortage of feed. The empirical findings of flood impacts on livestock from the household's surveyed data have presented in the table (6).

Table No 6: Flood impacts on Livestock (an integrated table)

Impact Indicator	Response option	Frequency (f)	Percentage (%)
Type of livestock			
Owned	Cattle	152	43.4%
	Cattle and Goats	76	21.7%
	Cattle and Poultry	25	7.1%
	Goats and Poultry	37	10.6%
Loss of livestock	1	43	12.3%
	2-3	19	5.4%
	4-5	8	2.3%
Sale of livestock at lower prices	Yes	126	36.0%
	No	164	46.9%
Shortage of Feed	Yes	150	42.9%
	No	140	40.0%

Source: Author's calculation using survey data

The big size cattle including cow, bull and buffalo, were the most common form of rearing livestock, followed by the mixed ownership of goats and poultry. The cattle combined

with poultry indicate the lower integration in livestock and suggest that poultry is less common or more vulnerable to the flood impacts in the surveyed communities. The cattle dominance and mixed ownership of livestock suggests that it plays a crucial role in the rural economy of district Charsadda. Furthermore, 12.3% of the respondents reported the loss of only one animal in flood. A smaller portion of participants 5.4% reported the loss of two to three animals, while 2.3% reported the loss of four to five. It indicates that there would have been dire financial implications for the individuals, who lost multiple livestock, particularly for the households who exclusively depended on the cattle and others livestock income. Moreover, the table (7) shows an overall loss of livestock and poultry on tehsil charsadda level in august 2022 flood, recorded by the fishries and livestock department, charsadda.

Flood caused the local animal market to be uncertain by forcing a significant portion of people to sell their livestock on unfavorable pricing in the face of feed shortage and declining of household incomes. The division between those who reported the shortage of feed 42.9% and those who do not experience such constraint 40.0% for their animals during and after the flood. It indicates that the shortage for feed was common and localised in flood affected areas.

Table No 7: Tehsil Level Livestock and Poultry Losses in 2022 Flood (Tehsil Charsadda)

Tehsil Level Livestock and Poultry Losses in 2022 Flood (Tehsil Charsadda)			
Type of Livestock	Baseline (Nos)	Numbers Lost	Lost Amount (PKR)
Sheep	19272	7	0.42M
Goat	59767	15	0.75M
Cows	165501	60	16.5M
Buffalo	32292	17	4.24M
Back-Yard Poultry	350534	4300	2.58M
Commercial Poultry	NA	7200	1.8M
Tehsil Total		11599	26.3M

Source: Livestock and Fisheries Department Charsadda, KP (2022).

The table depicts the numbers of livestock and poultry losses during flood 2022 in Tehsil Charsadda. It revealed that the households dependent on the breeding of livestock and poultry, which is essential to local livelihoods, have adversely affected. The baseline population including cows (165,501), buffalo (32292), goat (59767) and back-yard poultry (350,534) indicates the animal husbandry's vulnerability to flood disaster in the region. The total number of losses may appear minimal, but their financial impacts are disproportionately severe. In contrast to this the sheep and goat, respectively 7 and 15, represent a small amount of loss, but it's essential for small scale-farmers. Moreover, the loss of back-yard and commercial poultry can significantly impact the household's nutrition and women-led income, because they are often managed by women at their houses. The total economic loss for tehsil Charsadda is estimated at 26.3 million, and this figure does not represent their indirect impacts

on milk supply in the market, future herd reduction and psychological trauma linked with the damages of these livelihood assets

4.5 Cross Tabulation

The Chi-Square tests were performed on the two significant factors in order to statistically validate the correlations between the livestock related variables such as: (1) type of livestock owned and livestock loss due to flood, (2) Shortage of feed and sale of livestock at lower prices. The tests provide an empirical support for comprehending of how family coping mechanisms and livestock vulnerability are affected by the climate related constraints.

Table No 8: Type of livestock owned * Livestock lost due to flood (Cross tabulation)

		Livestock Lost Due to Floods					Total
		1	2-3	4-5	NA	Not Died	
Type of Livestock Owned	Cattle	15	7	0	0	130	152
	Cattle and Goat	20	10	1	0	45	76
	Cattle and Poultry	4	1	1	0	19	25
	Goat and Poultry	4	1	6	0	26	37
	NA	0	0	0	60	0	60
Total		43	19	8	60	220	350

Table No 8.1: Chi-Square Test

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	411.234 ^a	16	<.001
Likelihood Ratio	361.245	16	<.001
N of Valid Cases	350		

a. 12 cells (48.0%) have expected count less than 5. The minimum expected count is .57.

Source: Author's calculation using survey data

The cross tabulation reveals a statistically significant association ($p < 0.001$) between the type of livestock owned and the number of livestock loss due to flood in 2022, which reject the null hypothesis (H_0) and verify the alternative hypothesis (H_1). The households with holding of goats and poultry suffered comparatively with greater losses than those of having simply only cattle. It may reflect the susceptibility of smaller livestock to floodwaters, sensitivity, drowning and death, and may also reduce the ability to evacuate multiple species all at once. Noticeably, the expected count is less than five (< 5), which has compromised the reliability of the result. Although the result is statistically significant, precaution should be

mindful when interpreting its practical ramifications. In order to verify these patterns, additional qualitative evidence must be required, such as field interviews, discussions and focus groups. Figure-1 shows the stacked bar chart for cross tabulation of table (8).

Figure No 1: Type of livestock own and loss of livestock due to flood

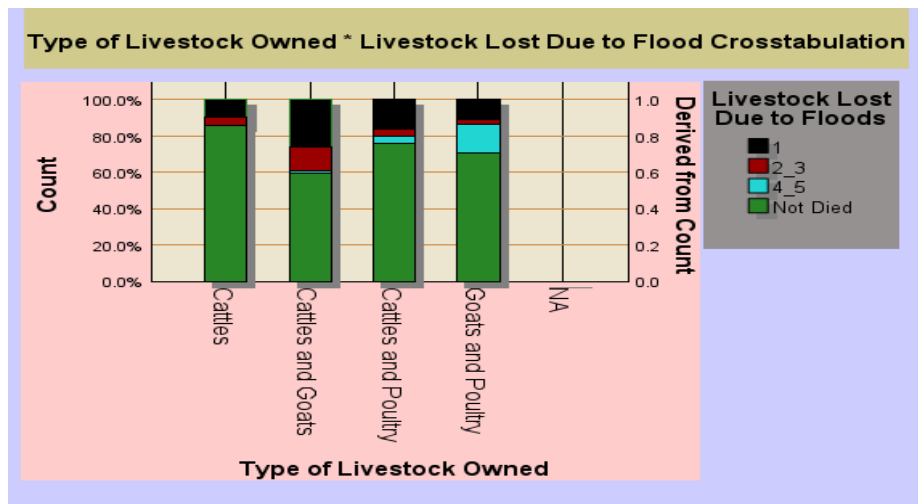


Table No 9: Shortage of feed and sale of livestock at lower prices (cross tabulation)

		Sale of Livestock at Lower Prices			Total
		NA	No	Yes	
Shortage of Feed for Livestock	NA	60	0	0	60
	No	0	80	60	140
	Yes	0	84	66	150
Total		60	164	126	350

Table No 9.1: Chi-Square Tests

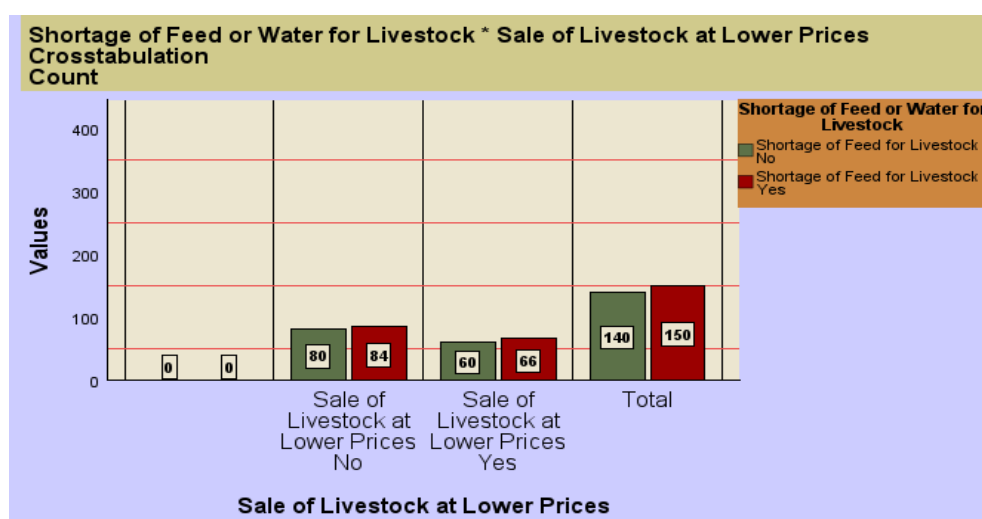
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	350.046 ^a	4	<.001
Likelihood Ratio	320.739	4	<.001
N of Valid Cases	350		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.29.

Source: Author's calculation using survey data

The test provided a strong and statistically reliable result ($p < 0.001$) which shows a strong and accurate correlation between the scarcity of feed and sale of livestock at reduced rates. It demonstrates that hundreds and may possibly thousands are pushed into a distress sale after the floods due to lack of resources. The cross tabulation also reveals that some livestock owners also sold their cattle at lower prices, although they have not reported the shortage of feed, possibly due to the financial crisis caused by the flood. These lower prices may compromise the livelihood security for a long-term in addition to suffering of financial loss for an excessively dependent on livestock's income. Significantly, in contrast to the prior test, this analysis satisfies all the assumptions of the Chi-Square test. The lower expected count cell such as <5 in this case increases confidence in the conclusion. Therefore, the result is reliable and dependable from a statistical and practical basis. Figure-2 shows the clustered bar graph for the cross tabulation of table (9).

Figure No 2: Shortage of feed and sale of livestock at lower prices



4.6 Economic Impacts (asset loss and debt)

The economic pressure caused by the flood is not only associated with the debt increase, but also an accumulated loss of income and valuable assets. These damages carry a long-term consequence, particularly in rural areas like Charsadda, where the savings are very low, shattered ownership of assets and access to formal financial system is restricted. The economic impacts of flood 2022 have presented in an integrated form in table (10).

Table No 10: Economic impacts (an integrated table)

Impacts Indicator	Response option	Frequency (f)	Percentage (%)
Debt incur due to flood	Yes	243	69.4%
	No	107	30.6%
Loss of assets (property & machinery)	Yes	58	16.6%
	No	292	83.4%
Estimated value of lost assets	10,000-50,000	75	21.4%
	50,000-100,000	57	16.3%
	100,000-200,000	78	22.3%
	200,000-500,000	87	24.9%

Source: Author's calculation using survey data

The analysis indicate that 69.4% of the inflicted households incurred debt after flood for the recovery of agriculture and land loss, houses rebuilding, walls reinforcement, foundations elevation, and for the restarting of local businesses such as shops, hotels and boats. The pushing of a larger portion into loans of the surveyed areas is indicating the fragile financial situations among the hard-hitted households. Besides this, a small percent (30.6%) respondents claimed that they had not received flood-related borrowing indicating several factors like a well economic status and external income resources or slightly less impacted by flood due to their houses location and resilience structure or had adequate coping strategies.

A small fraction 16.6% households reported the loss of tangible possessions like property of agricultural land, equipment and tools. There are two potential explanations for this low percentage of assets loss: either the flood's impacts were not evenly distributed and disproportionately concentrated in certain areas or the majority of the people did not own these assets before the flood disaster. Besides this, the range for asset's loss opted from 10,000 to 500,000 and divided into four different categories. Out of four categories the 24.9% of the respondents reported a largest and considerable magnitude of assets loss, ranging from 200,000-500,000.

4.7 Impacts on small local businesses

An informal and undercapitalized small local businesses in district Charsadda, particularly in flood-affected areas, form a critical part of rural economies. Additionally, due to the lack of insurance system, institutional recovery mechanism and physical infrastructure make them weak and vulnerable to floods. In this section, the flood impacts on various small local businesses have discussed an integrated form in table (11).

Table No 11: Impacts on small local businesses (an integrated form)

Impacts Indicators	Response option	Frequency(f)	Percentage (%)
Types of small Businesses	Animal Farm	2	0.6%
	Black Smith	1	0.3%
	Boats business	3	0.9%
	Electronic Shop	2	0.6%
	Food Stall	13	3.7%
	Gold Smith	1	0.3%

		Hotel Business	4	1.1%
		Poultry Farm	3	0.9%
		Retail Shop	58	16.6%
		Stamp Vendor	1	0.3%
		Stationary Shop	1	0.3%
Physical damage	Yes		77	22.0%
To business	No		13	3.7%
Ability to reopen	Yes		75	21.4%
Business	No		15	4.3%
Time to restore	1 month	28		8.0%
Business operation	2-3 months	25		7.1%
	4-5 months	5		1.4%
	Not reopened	5		1.5%
Change of business	Yes	5		1.4%
	No	85		24.3%

Source: Author's calculation using survey data

An overall (25.7%) individuals were associated with a miscellaneous local small business including blacksmith, goldsmith, boats, hotels and retail shops etc. Whereas, (16.6%) dominated only the retail shop business, followed by the food stalls (3.7%), hotels (1.1%) and poultry farms (0.9%). The data shows the existence of common small-scale, low-capital and informal businesses in the flood-prone areas, making this miniature scale activities vulnerable to the flood-induced disruptions. Moreover, (22.0%) individuals who were associated with the business's activities reported the physical damage to their business. In addition to this, a small portion (3.7%) claimed have no physical damage to their business. It is evident that physical damage was a significant issue, but it was not universal for all firms and was likely concerned to the low-lying and exposed areas to flood.

Post-flood disaster, the greater number (21.4%) of people were able to reopen their businesses again. While (4.3%) were unable to reopen their businesses. This wide gap of business reopening in flood-prone areas suggests a long-term economic paralysis, and the recovery process impeded by the loss of capital, feeble economic status, lack of support and psychological stresses. In business restoration aspect, only a small portion (8.0%) restored their businesses very quickly within one month. Whereas, 1.4% claimed to not restore their business certainly due to financial hurdles. This supports the argument that floods have a long-lasting impact on the local economies and small businesses, particularly in a financially desperate and flood vulnerable communities.

Summary table of Key Findings, observed pattern and prediction

An overall representation of the key findings has been integrated in the table (12) for comparatively studies of observed pattern and prediction.

Table No 12: Summary Table of Key Findings

Indicators	Key Findings	Observed Pattern	Prediction
Survey Area's Profile	District Charsadda is geographically sensitive due to its vicinity to rivers.	The risk of flooding is relatively very high.	A large-scale devastation may be expected in future.

Gender Representation	100% male respondents have been included; while women were excluded.	The gender biases in data recovery strategies.	In post-disaster responses the women needs will remain overlooked
Age Distribution	(52.3%) a dominated aged group was 31–45 years.	People of the working age are bearing heavy obligations.	People of the middle-ages are likely to encounter a rising stress of their livelihoods.
Education Level	Majority 32.6% are illiterate; while only 3.7% graduate.	Adaptive capacity is restrained by the limited education.	Resilience will persist to be inadequate, despite lack of education.
Family Size	Majority families were existed on 7-9 members (34%)	Heavy families are bearing dual challenges of labor and burden.	The vulnerability and resource stress will boost in future floods.
Occupation	Farmers 51.4%, while 34.3% daily wage laborers.	Economy is heavily reliant on fragile sectors.	Floods will continuously destroy several livelihoods.
Loss of Income	78.9% reported a substantial suffering of their income after the flood.	Financial instability after the flood catastrophes	The poverty cycle will exacerbate, if not an organized intervention took place.
Houses Inundation	98.6% of dwellings were flooded.	A significant structural sensitivity to floodings.	Future floods will destroy the assets, if housing structures are not improved.
Income Level After Flood	76% reported decrease in income after the flood.	Income shocks frequently occur and last for a long time.	Economic recovery will persists, if not introduced a multi-sectors initiatives
Health Issues	87.7% experienced health problems after the flood.	Collapsed health-facilities following flooding.	If not addressed, future flooding will cause public-health issues again.
Frequency of Flooding	62% households faced floods 3–5 times in the past decade.	Flooding is a persistent and recurring risk.	Repeated flooding will fragile the resilience capacity of households.
Loss of Household Assets vs House Inundation (Chi-Square)	A robust statistical link was discovered.	Housing vulnerability and asset loss is closely related	Improvement in storage and safety of assets is vital.
Health Issues vs Disruption to Healthcare (Chi-Square)	A significant association confirmed	Limited access to the healthcare services, worsen public health.	Investment is essential in post-flood health resilience.
Crop Loss Due to Flood	Sugarcane is a resilient crop; whole wheat is majorly affected.	A great number of crops in agriculture are sensitive to flooding.	Food insecurity will rise, if sustainable farming is not adopted.

Delay in Cultivation and Harvesting	28.6% experienced delay.	Disruption in the cropping cycle is common.	Food supply and income timings will be adversely affected.
Disruption of Irrigation Water	24.3% irrigation disturbance reported.	Irrigation system's damage is common.	Food production for the long-term is at risk, if infrastructure is not improved.
Type of Livestock Owned	Ownership of cattle is widespread.	Heavy reliance on big-size cattle.	Shows the possibility to affect the cattle based economy in future flooding.
Livestock Loss	17.1% experienced loss of livestock.	Livestock are at risk of flood-disasters.	Future loss is inevitable; if early evacuation plans are not implemented.
Sale of Livestock at Lower Prices	36% reported to sale of livestock at desperated prices	Caused desperate financial conditions after post-flood	If future disaster is not prevented; distress sale is inevitable again.
Livestock Type vs Loss (Chi-Square)	A significant correlation exists, but cautious interpretation may be needed.	Goats and poultry is extremely vulnerable	It is essential to devise species-specific plans.
Shortage of Feed vs Sale at Lower Prices (Chi-Square)	Robust and statistically reliable links existed.	Distress sale is directly linked with feed shortage.	Feed security is a must in livestock's recovery programs.
Debts Incurred Due to Flood	69.4% of households are economically impoverished.	Heavy financial distress after flooding.	Without assistance; poverty will worsen in future flood-induced disasters.
Loss of Assets (Property/Machinery)	16.6% claimed assets loss.	Machinery, tools and equipment are under peril of disasters.	Program for asset recovery and stabilizing livelihoods is essential.
Estimated Value of Asset Loss	Highest losses reported between PKR 200,000–500,000.	Loss of high-value assets are common among those impacted.	A prolonged period is expected for restoration; with compensation
Local Small Businesses	25.7% associated with small businesses, mostly retail.	Informal economy is extremely flood-prone.	In the absence of financial assistance; local economy will collapse.
Physical Damage to Businesses	22% experienced business impairment.	The structure of the local economy is highly vulnerable .	If infrastructure is not improved; future floods will damage local businesses again.
Ability to Reopen Businesses	Only 21.4% reported to reopen their businesses.	Business recovery process is extremely slow.	Small businesses are under risk of decline; if microfinance and technical aids are not provided.

Time to Restore Business	Recovery durations varied; ranging from 1–6 months.	Recovery delayed and inconsistent.	For restoration strategies needed to include a defined timelines.
Change of Business	Only 1.4% reported to have changed their business.	Resistance to switch off previous occupations.	Economic diversification will be delayed by reliance on traditional occupations.

Source: Author's own calculation using survey data.

The analysis confirms that climate change-induced disasters have impacted various sectors of livelihoods including standard of living and sources of income of the residents of district Charsadda. The climate-change induced floods have adversely affected the livelihoods in the studied areas including the post-flood income, crops loss, delay in planting and harvesting, and agricultural productions. The above results of this study are also supported by the study of Ullah (2019) where they found that climate change has made farming difficult and has drastically reduced agricultural production. The consequences of these climatic changes have exposed the social, political and economic lives and livelihoods of the people of district Charsadda to the devastating and negative impacts of climate change. Moreover, these findings are also endorsed by the study of Raza (2023), that Charsadda is a more vulnerable district to the impacts of floods in terms of demography, social network, productivity and food security, and livelihood activities. An analysis has suggested that Charsadda exhibits far more vulnerability to the catastrophic consequences of the flood due to the relatively lack of adaptive capacity and more exposure to floods.

The findings also revealed that a vast majority of the people repeatedly experienced and suffered from the flooding catastrophes in past decades including the house's inundation, health problems, livestock and economic losses. Additionally, the crop distortion, degradation of land and protracted cultivation have heavily affected the normal period of agricultural activities, which are considered the backbone of the local economy. Also, Hossian (2020), indicated the same results that in Char flood-2017 had grievously suffered the farmers and submerged their houses, poultrys and livestock. Additionally, the families that were already attached to other occupations such as agriculture, small businesses, general labor and daily wage labor were greatly affected by the flood disasters. Those who had lost their income sources and occupations, they started rickshaw pulling, boatman, and day labor for their livelihoods in flood-affected regions. This case study is deeply related to the Karlsson's (2016), study of flood impacts in Bangladesh. He found that floods have desperately destroyed several aspects of livelihoods like livestock, fishing, agriculture, and other small businesses. A respondent considered the loss of livestock as the loss of security of livelihood, food, survival, health, family and other essential well-being. Therefore, due to seasonal floods huge numbers of people are compelled to migrate to pursue alternative livelihood options.

Furthermore, the livestock also suffered in terms of feed shortage, which consequently sold out with lower prices and reduced in number by many households. In addition to this, small local businesses also choked with economic losses and it further worsened by the slow recovery process__ including the absence of official financial support or schemes. Therefore,

the coping mechanism adopted by people was not based on institutional support, but reliance on local lenders and family networks.

This study endorsed that the affected population remains stuck in the cycle of debt, repeated loss, and fragile recovery. Therefore, to interrupt the embedded patterns of vulnerability, the findings emphasise rational interventions to counter the disasters risk reduction, development of economically viable livelihood, accessibility to healthcare, resilience agriculture and small businesses recovery.

5. Conclusion

This study was conducted to investigate the effects of climate change-induced disasters on people livelihoods in flood affected areas of district Charsadda. It has analysed the flood impacts on the disruption of income, house inundation, health issues, crops damages, delay in plantation, irrigation disruption, loss of livestock, loss of assets and damages to local businesses. The data was collected through structured questionnaire from 350 households in the five flood-affected villages of Union Council Agra.

The findings of this study show a clear picture of a systematic fragility and repeated exposure to flood as (62%) of the households faced 3-5 times in the past two decades. Nearly, all the households experienced house inundation, loss of income and decrease in post-flood income reported. Health issue was widespread inflicted both physical and psychological consequences of the disaster. Agriculture, a backbone and primary source of economy in the area, has faced a vast collapse particularly wheat and vegetable were the most damaged crops. Moreover, the shortage of feed for livestock and resultantly a distress sale at lower prices was also common. The results indicated that 69.4% families reported the debt trap due to assets loss and economic burden due to the flood damages. In final words, the rural population of district Charsadda is extremely vulnerable to the climate flood-induced disasters due to the lack of diversified income sources, fragile economic sectors, and weak infrastructure.

5.1 Policy Implication

The findings of the study recognized the impacts of flood on various aspects of livelihoods in flood-affected areas in August 2022. It is clear that flooding is a recurring phenomenon, and therefore a preventive and futuristic measures should be adopted to reduced the possible repeated damages. Hence, the study makes several policy recommendations:

- A community-driven based alert system which communicates information through educational institutions, municipal announcement, loudspeaker, and mobile devices and electronic media.
- A local Entrepreneurship Development Cell should be established in the Union Council office with the support of NGOs and government's institutions. Those cells provide funding ranging from 50,000 to 100,000 PKR to the different service providers such as vendors, technicians, retailers, tailors, and mechanics.
- The protection wall of rivers should be reinforced with stone and cement to stop the flooding water.

- The local agricultural communities needed to take in confidence the local NGOs for the establishing a link of agricultural inputs such as seeds and fertilizers in post-flood recovery.
- Farmers need to enlighten with the climate-resilient farming strategies and sustainable irrigation methods.
- Utilize the services of local institutions and non-government organizations for the providence of vocational education, skills, and training to the youth in vulnerable areas to floodings.
- Development of the localized Disaster Management Organizations on Tehsils and Union Councils level with the help of community's members ' engagement, because the locals are more familiar and acquainted with the flood-induced emergency situations and by past experience they know the countering strategies.

Compliance with ethical considerations

Conflict of interest: The authors declare that they have no conflict of interest

Limitations: Women have been excluded from the survey due to the cultural and social norms of the society.

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