Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146
https://doi.org/10.5281/zenodo.17064792
Vol. 3 No. 10 (October) (2025)

Impact of Climate Change Induced Flood Hazards of 2022 on Livelihoods of Rural Communities in Khyber Pakhtunkhwa Pakistan

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Abstract
This study was conducted to explore how climate change induced floods, particularly the 2022 flood, have affected the livelihoods of rural communities in Khyber Pakhtunkhwa, Pakistan. The study focused on two severely affected districts Swabi and Dera Ismail Khan where a total of 2,500 households were identified. A multi-stage sampling approach was applied to ensure diverse and accurate data collection across both districts. Both primary and secondary sources were used for data collection. Secondary information was obtained from official reports, government records, and other relevant documents. Primary data was collected through a structured questionnaire, with each household head personally interviewed. The data was then analyzed using SPSS software. Various statistical methods were applied, including paired sample t-tests, and multiple linear regression. The findings of paired t-test showed that there is a significant difference for landownership before and after the flood (5.63), significant difference of landholding size before and after the flood (6.114), significant difference of livestock ownership before and after the flood (5.34), primary income before and after the flood (6.10). The regression model showed that from natural parameter i.e. climate (4.132) and agriculture (3.430) indicators showed significant effect on the livelihood. The indicators of financial parameters showed that assets is having significant (2.138) while financial support has insignificant (1.50) effect on the livelihood. The results of physical parameter showed that infrastructure (2.10) and water availability (2.77), from human parameter both health (3.60) and mental health (2.05) and from social parameter community (4.153), governmental support (2.16) and re-allocation (3.14) have significant effect on the livelihood of rural community.
Keywords: Flood, livelihood, rural, financial, physical, Swabi, DI Khan, questionnaire etc

INTRODUCTION

Climate change refers to long-term shifts and alterations in temperature and weather patterns, predominantly caused by human activities such as the burning of fossil fuels, deforestation, and industrial processes. According to the Intergovernmental Panel on Climate Change, climate change is defined as "a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" (Usman and Kundiri, 2024). Developing nations face significant challenges in adapting to climate change due to their limited financial and economic resources, inadequate technological capabilities, high poverty

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rates, and heavy reliance on climate-sensitive sectors like agriculture (Huq et al, 2016). Climate change is a critical global issue, causing rising temperatures, extreme weather, and environmental disruptions. Human activities like burning fossil fuels and deforestation have intensified the problem by increasing greenhouse gas emissions. This has led to melting glaciers, rising sea levels, and threats to biodiversity and agriculture. Despite international agreements like the Paris Agreement, many regions still face severe climate-related disasters. Addressing this crisis requires global cooperation, renewable energy adoption, and sustainable practices. This paper examines the current state of climate change, its impacts, and potential solutions for a sustainable future (Abbas *et al*,. 2022)

Pakistan is highly vulnerable to climate change due to limited resources, economic challenges, and frequent extreme weather events like floods, droughts, and melting glaciers. These environmental changes threaten agriculture, biodiversity, and human well-being, despite the country's minimal contribution to global greenhouse gas emissions. Climate-related damages are estimated to cost Pakistan between $7–14 billion annually, affecting key sectors such as water, energy, and food security. Addressing these challenges requires strong government policies, better resource management, and effective climate adaptation strategies for long-term sustainability (Hussain *et al*., 2020). Climate change is an established reality, evidenced by the continuous rise in temperatures and decreasing rainfall, resulting in severe environmental impacts. However, rising temperatures in the mountainous areas threaten water security by accelerating glacier melt, potentially disrupting the flow of the Indus River (Donatti *et al*., 2024).

Extensive research on climate change indicates that there is a projected temperature increase of almost three degrees by the 2040s, with some studies even predicting a rise of 5-6 degrees by the end of this era. This environmental transformation has had devastating economic consequences, particularly for the agricultural sector (Khan *et al*., 2016). Pakistan, located in South Asia, particularly vulnerable to climate change-related disasters, as highlighted in a World Bank report 2009. The region experiences frequent and extensive climate change-induced disasters, further exacerbating the already significant impacts on the agriculture sector. It is evident that climate change poses a significant threat to the agricultural landscape of Pakistan and requires immediate attention and effective strategies to mitigate its adverse effects (Dube and Nhamo 2020).

Pakistan's agricultural sector is facing severe challenges due to climate change, which has led to rising temperatures, unpredictable rainfall, and frequent natural disasters like droughts, floods, and storms. As a country highly vulnerable to climate change, these environmental shifts have negatively impacted crops, livestock, fisheries, and water resources, threatening the livelihoods of millions. The agricultural sector is struggling with lower crop yields, increased pests and diseases, and worsening water shortages. The dry regions are expected to suffer the most, leading to serious socioeconomic and environmental consequences. To safeguard agriculture and food security, Pakistan must adopt sustainable farming methods, improve water management, and implement effective climate adaptation strategies (Fahad and Wang 2020).

Khyber Pakhtunkhwa (KP) is located in the northwest of the Pakistan and is a geographically diverse region. Variable climatic circumstances range from

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mild temperatures and substantial rainfall during winter in the northern regions to enough rainfall and high temperatures during summer in the southern regions. For example, Chitral, the northern district of Khyber Pakhtunkhwa, is characterized by mountainous terrain and powerful glaciers, and experiences the lowest temperatures in the province in winter. On the other side, Khyber Pakhtunkhwa South District Dera Ismail Khan has mild winters and favorable weather conditions that make it ideal for agricultural production and pasture growth. The province has two wet seasons during the monsoon season, strong winds take moisture from the Arabian Sea and the Bay of Bengal, while during the winter wet season, and typhoons bring rain and snow to Iran and the Caspian region. Climate change poses a serious threat to agriculture in Khyber Pakhtunkhwa and increases the vulnerability of local people, especially families whose food security and livelihoods are already threatened. Climate change and increasingly unpredictable weather are serious threats to the agriculture sector of Khyber Pakhtunkhwa province (Miller *et al.,* 2021).

Pakistan is situated in south Asia a country with diverse land types and climate changes. The climate in Pakistan is typically considered hot and dry on the other hand it has seen a significant changes in the last few decades. Most of the districts and urban and rural centers located on the banks of rivers are always at great risk of dealing with different types of floods such as river floods, flash floods and urban floods, especially in Punjab and Sindh provinces. In addition to agricultural land, standing crops, urban and rural settlements, the major losses from direct flooding in the country are to other private and public properties (FFC 2020 Annual Report). Commonly River floods are generally caused by highly concentrated rainfall in river channels, during the monsoon season, which is sometimes enhanced by snowfall. Flooding caused of the Indus River and its tributaries represents the greatest danger and worst in Pakistan. Floods usually occur during the summer seasons (July-October). So, the losses to the agriculture sector are generally to standing Kharif crops. Though, in some circumstances the flooded lands do not drain in time and eventually affect the cultivation of rabi crops (Hussain *et al.,* 2018).

Floods in Khyber Pakhtunkhwa, a province in Pakistan, are a recurring natural disaster that has a profound impact on the region's communities and economy. The province is susceptible to both flash floods and riverine floods due to its hilly and mountainous terrain and the monsoon season's heavy rainfall. These floods bring about devastating consequences, causing loss of lives, displacement of people, and extensive damage to infrastructure, including roads, bridges, and houses. Moreover, agricultural lands are often inundated, resulting in significant losses for farmers and affecting food security in the region. The floods also disrupt transportation and communication networks, making rescue and relief operations challenging. The frequency and intensity of floods in Khyber Pakhtunkhwa have increased over the years, exacerbating the vulnerability of local communities. Poor land-use planning, deforestation, and climate change have further compounded the flood risks in the region. Addressing these challenges requires a comprehensive approach, including improved flood forecasting and early warning systems, effective disaster preparedness and response plans, and sustainable land and water management practices. Additionally, investing in resilient infrastructure and adopting climate-smart strategies can help mitigate the impact of floods and enhance the

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province's overall resilience to such natural disasters (Khan et al., 2016).
As we know that agriculture is the main source of livelihood which is mostly affected by floods. As a result, people associated with agriculture have suffered as much as other parts of the economy. In addition, the floods hazards have not only damaged crops, forests and fisheries, but have also causes extensive damage to tube wells, water roots, house storage, housing, animal shelters, fertilizer and various farm of machineries. The irrigation setup in the district was completely damaged due to flood which adversely affected many crops in the selected study area. As a result, the farming communities affected greatly. This flood has carried a considerable quantity of mud that blocks large layers of mud in the plain areas of the districts of Khyber Pakhtunkhwa. This sticky layer of 1-12 feet of sediment devastated the irrigation set up. The problem of water logging and soil erosion was raised in the study area. All the mentioned problems directly and indirectly affected the farming communities and their lives.

Objectives

- To assess the assets and the extent of damage inflicted by the flood-2022.
- To determine the impacts of flood-2022 on the livelihoods of the rural farming communities.

REVIEW OF LITERATURE

Movahednia, (2024) investigated the effects of floods on electrical grids, recognizing the severe economic and social consequences of prolonged power outages caused by floods. Their research emphasized the critical role of electrical grids in supporting essential services, industries, and livelihoods, highlighting the vulnerability of these systems to flood hazards. They proposed strategies for enhancing grid resilience through strategic placement, improved infrastructure design, and implementation of protective measures. Williams et al.'s findings underscored the need for proactive measures to strengthen electrical grid resilience and minimize the impacts of floods on energy supply and societal functioning. Ward *et al.*, (2024) focused on the psychological impacts of floods on affected individuals, shedding light on the increased prevalence of anxiety, depression, and PTSD among flood victims. They advocated for enhanced mental health support services as an integral part of disaster response efforts, emphasizing the importance of addressing psychological well-being alongside physical recovery efforts. By recognizing the psychological toll of floods, Hernandez and Roberts contributed to efforts aimed at promoting holistic disaster recovery that addressed both the physical and mental health needs of affected populations.

Wang *et al.*, (2023) examined the impact of floods on public infrastructure in China. The study found that floods often damage critical infrastructure such as water supply systems, electricity grids, and communication networks, leading to widespread service disruptions. The authors noted that these disruptions have serious consequences for public health and safety, especially in flood-prone regions. They recommended that governments prioritize the upgrading of public infrastructure to make it more resilient to flooding and ensure the continuity of essential services during flood events. Khan *et al.*, (2021) Studied that flood is often a slow and challenging process, demanding significant financial investment and time. Rebuilding

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infrastructure, homes, and agricultural lands requires not only money but also careful planning and coordination. The displacement of communities due to floods further complicates recovery efforts. When people are forced to leave their homes, they lose their livelihoods, face disruptions in education, and experience a breakdown of social cohesion. This displacement exacerbates existing social and economic problems, such as poverty and unemployment, making it harder for affected regions to bounce back. Long-term support and comprehensive recovery strategies are essential to address these challenges and help communities rebuild their lives and regain stability.

Singh *et al.*, (2020) examined the prolonged economic impacts of floods on rural economies, revealing that these natural disasters lead to significant income losses and increased poverty rates. Their study found that floods severely disrupt agricultural activities, which are often the primary source of income in rural areas, resulting in reduced crop yields and loss of livestock. This disruption not only affects immediate income but also hampers long-term economic development as farmers struggle to recover. Singh and Chen emphasize the urgent need for comprehensive disaster management plans that include economic support and recovery programs for affected rural communities. They argue that without such measures, the cycle of poverty and underdevelopment in these regions will persist, making them more vulnerable to future floods. Ahmed *et al.*, (2019) noted that in Pakistan, floods have frequently caused severe damage to homes, infrastructure, and agricultural lands. These floods result in substantial economic losses as they destroy crops, displace livestock, and ruin essential infrastructure such as roads and bridges. The 2010 floods were a prime example, leaving millions homeless and causing billions of dollars in damages. Recovery efforts are often hampered by the extensive destruction, requiring significant financial resources and time to rebuild. The displacement of communities due to floods also disrupts social networks and local economies, making recovery even more challenging. Addressing these impacts necessitates comprehensive planning and robust disaster management strategies to support affected populations and mitigate future risks. Hassan *et al.*, (2023) investigated the impact of flash floods on infrastructure in arid regions of the Middle East. The study revealed that flash floods, though infrequent, cause severe damage to roads, bridges, and pipelines, particularly in areas with poorly maintained infrastructure. The authors suggested that governments in arid regions should implement better flood forecasting systems and invest in infrastructure maintenance to minimize the damage caused by flash floods.

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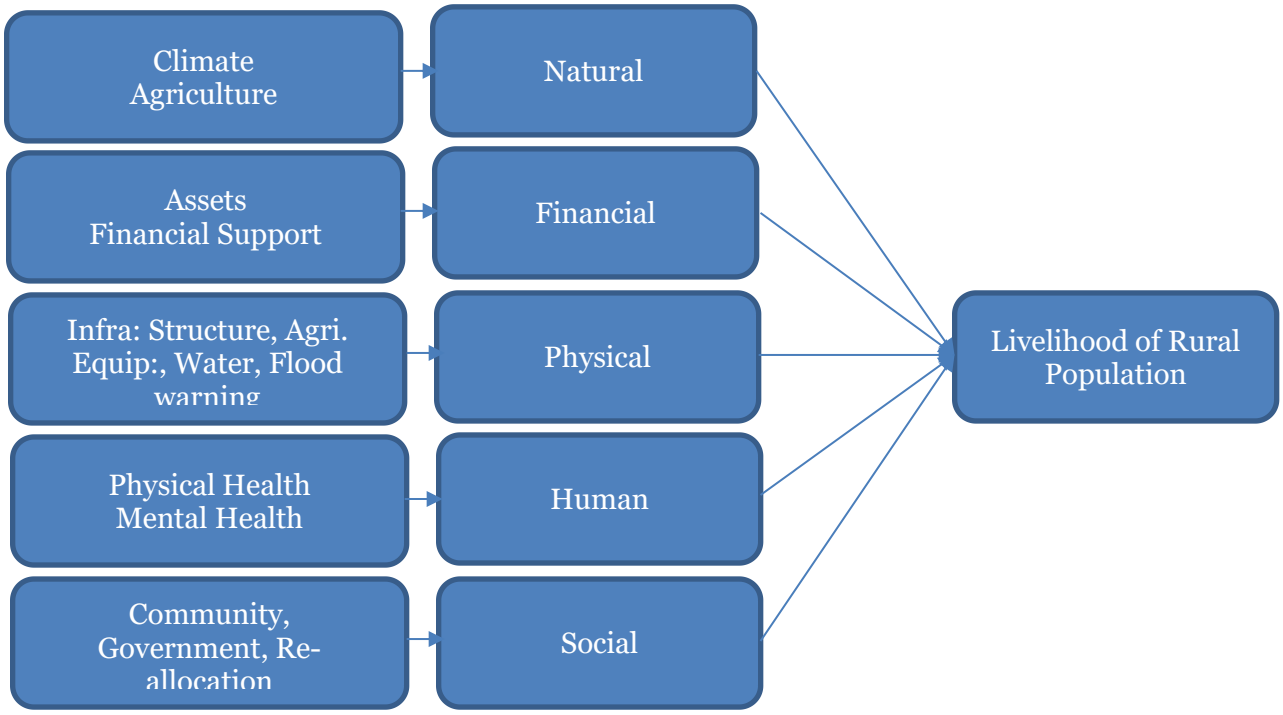
Research Framework



Hypothesis

H_1: The 2022 floods caused no significant damage to productive assets.
H_2: The 2022 floods had no significant socio-economic impact on livelihoods.

RESEARCH METHODOLOGY

The focus of this research is District Swabi and Dera Ismail Khan in Khyber Pakhtunkhwa (KP) province of Pakistan. Reports indicate that many residents migrated to safer areas following the 2022 floods, as numerous homes were completely or partially destroyed, and agriculture, crops, water canals, and infrastructure were severely damaged (NDMA, 2022). Study used a multi-stage sampling method. First, Khyber Pakhtunkhwa (KP) province was chosen because it faced severe flood damage in 2022. Then, the districts of Dera Ismail Khan and Swabi were selected. After that, two tehsils were chosen from each district. In the next step, three villages were randomly picked from each tehsil. Finally, households from these villages were randomly selected for data collection. As per the sampling technique adopted, 218 households were selected from DI Khan and 127 were included from District Swabi. Total of 345 sample size has been used for the data analysis. Primary data was collected from the households head in the study area. For the study purpose, a semi-structured questionnaire was formulated.

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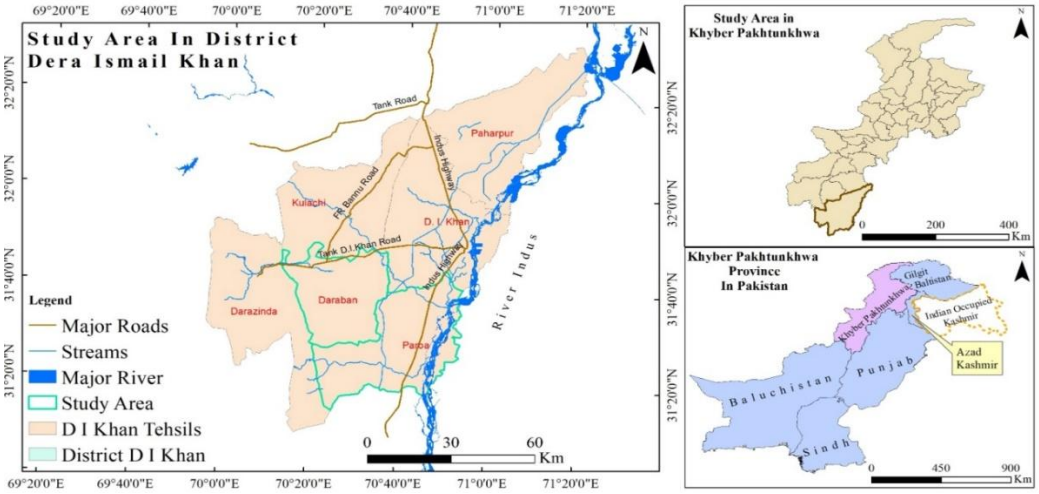

Fig 1. Showing Dera Ismail khan District in the South of KP Province.
Source: Authors by using GIS

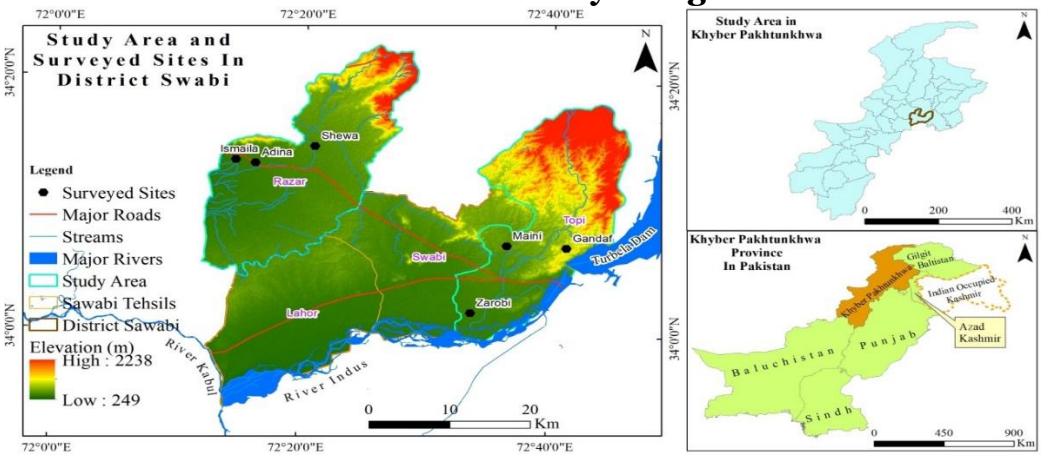

Fig 2. Showing Swabi District in the North of KP Province.
Source: Authors by using GIS

Independent sample t-test to assess the assets and the extent of damage inflicted by the flood 2022 in the study area. Taken the climate hazards, Environmental Impacts, Agriculture livelihood hazards and examined these hazards on the basic of impact before and after with the help of paired sample t-test. The paired t-test assesses the situation before and after the floods by analyzing variations in mean and determining whether the means differences are statistically significant, or not significant. The paired t-test is a statistical method used to compare two related sets of data.

The dependent variable livelihood index (Shannon Diversity Index) is constructed by developing index based on a series of related questions, ensuring no reversed responses were included. The respondents' answers were summed and categorized using two cutoff points: values less than or equal to the average were assigned a value of '0,' while values greater than the mean were assigned a value of '1.' A minimum livelihood Index measured by Shannon Diversity Index indicates a magnitude of the variances explained by the individual parameters in the livelihood and also characterized by severe challenges, such as the loss of arable land, significant reductions in crop production, loss of livestock, and the unavailability of alternative employment opportunities. These factors collectively represent a diminished capacity to sustain basic livelihood needs. Conversely, a

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cutoff (Least Affected, Moderated Affected and Extreme Affected) has been used to measure the magnitude of variances explained by the parameters included in the livelihood Index reflects a more favorable scenario, marked by the availability of farmable land, stable or increased crop production, adequate livestock ownership, and access to alternative employment opportunities.

(Livelihood = Natural Indicators (Climate, Agriculture) + Financial Indicators (Assets, Financial Support) + Physical Indicators (Infrastructure, Agriculture Equipments, Water and Flood Warnings) + Human (Health, Mental Health) + Social (Community, Government Support and Re-allocation).

The responses were collected at multiple scale showing the extent of phenomena asked for all the 5 main variables and 13 Sub-variables. The units of the Likert scale were consisting of multiple options based on the questions asked from the sampled respondents. All the responses for the variables were added in Shannon Diversity Index and then the calculations were made for the Index analysis and then on the basis of index variances have been calculated and cutoff points have been verified.

Following the study of Lahon & Mahanta (2021), used the index of least diversified, moderately diversified, highly diversified and extremely diversified. But the current study will modified the cut-off by the flood affected.

Index Value	**Affected**
0 – 20%	Least Affected
21% - 40%	Moderately Affected
41% - 60%	Highly Affected

The linear regression has been used in the current study due to the fact that the model is consists of independent and dependent variables and these variables have been measured by different scales and also the study has the objective based on cause-and-effect.

Multiple linear regression model was used in the present study, which indicates the relationship between dependent variable i.e natural, physical, financial, human and social parameters explanatory variables and sub-indicators i.e Climate and agriculture from natural parameter, assets and financial support from financial parameter, infrastructure, agriculture equipment's, water and flood warnings from physical, health and mental health from human parameter and community, government support and re-allocation were taken from social parameter and used in regression. The study was conducted with the purpose to analyze the effect of farmer's livelihood in the selected study area. The general form of this model is prescribed as:

$$Y = f\left(X_1 + X_2 + X_3 + X_4 + U_i\right)$$

DATA ANALYSIS

Assets Evaluation (Before-After flood 2022)

It is been concluded that the flood always have negative effects on the assets of the local community farmers. According to Shaikh *et al.,* (2018), flood affects the crop, agriculture land, livestock and other assets of the farmers. It has been argued that the assets will always be seen negative effects due to flood.

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Landownership

Land ownership	Swabi		DI Khan		Paired t-test	
	Before	After	Before	After	t-value	p-value
Landowner	72	41	64	52		
Tenant farmer	24	43	97	110	5.63	.000
Landless laborer	15	26	40	51		
Shared tenure	16	17	17	5		
Total	**127**	**127**	**218**	**218**		

Data Source: Own Data, 2023

The table has demonstrated the results of landownership before and after the flood. The findings showed that the landownership has been decreased from 72 to 41 in Swabi and from 64 to 52 in DI Khan. This shows that flood shows negative effect on the landownership. The values of tenant farming decreased increased from 24 to 43 in Swabi and from 97 to 110 in DI Khan. The value of landless labor is increased from 15 to 26 in Swabi and from 40 to 51 in DI Khan.

Landholdings Size

Crop Damaged	Swabi		DI Khan		Paired t-test	
	Before	After	Before	After	t-value	p-value
< 1 acre	31	59	83	113		
1-5 acres	85	61	92	77	6.114	.000
> 5 acres	11	7	43	28		
Total	**127**	**127**	**218**	**218**		

Data Source: Own Data, 2023

The table included the findings of landholding size before and after the flood. The findings showed that the landholding size of < 1 acre has been increased from 31 to 59 respondents in Swabi and from 83 to 113 in DI Khan. This shows that flood shows negative effect on the landholding size. The values of 1-5 acres decreased from 85 to 61 in Swabi and from 92 to 77 in DI Khan. The value of > 5 acres is decreased from 11 to 7 in Swabi and from 43 to 28 in DI Khan.

Livestock Ownership

Livestock ownership	Swabi		DI Khan		Paired t-test	
	Before	After	Before	After	t-value	p-value
None	2	36	10	37		
1-2 animals	82	64	74	62	5.34	.000
3-5 animals	26	19	111	103		
> 5 animals	17	8	23	16		
Total	**127**	**127**	**218**	**218**		

Data Source: Own Data, 2023

The table exhibits the final output of livestock ownership before and after the flood. The findings showed that the livestock ownership of none livestock has been increased from 2 to 36 respondents in Swabi and from 10 to 37 in DI Khan. This shows that flood shows negative effect on the livestock ownership. The values of 1-2 animals decreased from 82 to 64 in Swabi and from 74 to 62 in DI Khan. The value of 3-5 animals is decreased from 26 to 19 in Swabi and from 111

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to 103 in DI Khan.

Primary Income

Primary Income	Swabi		DI Khan		Paired t-test	
	Before	After	Before	After	t-value	p-value
Crop production	51	44	137	123		
Livestock	37	26	55	43	6.10	.000
Daily wage labor	14	44	18	48		
Remittances	12	9	6	3		
Small enterprise	13	4	2	1		
Total	**127**	**127**	**218**	**218**		

Data Source: Own Data, 2023

The table concluded the results of primary income before and after the flood. The findings showed that the primary income of crop production has been decreased from 51 to 44 respondents in Swabi and from 137 to 123 in DI Khan. This shows that flood shows negative effect on the crop production as primary income. The values of livestock as primary income decreased from 37 to 26 in Swabi and from 55 to 43 in DI Khan. The value of daily wage labor is increased from 14 to 44 in Swabi and from 18 to 48 in DI Khan.

Impact on Household

Crop Damaged	Swabi		DI Khan		T-test	
	Freq:	%	Freq:	%	t-value	p-value
Severe (complete loss)	33	26	81	37		
Moderate (partial loss)	58	46	86	39	8.17	.000
Mild (minimal damage)	31	24	41	19		
No impact	5	4	10	5		
Total	**127**	**127**	**218**	**218**		

Data Source: Own Data, 2023

The table carries the results of severity of 2022 flood impact on household. The findings showed that the complete loss were agreed by 33 respondents in Swabi, 58 respondents were in favor of moderate (partial loss) and 31 respondents were agreed to mild (minimal damage). The findings showed that the complete loss were agreed by 81 respondents in DI Khan, 86 respondents were in favor of moderate (partial loss) and 41 respondents were agreed to mild (minimal damage).

The results demonstrating a significant difference in landownership, landholding size, livestock ownership, and primary income before and after the flood in Swabi and D.I. Khan are strongly supported by contemporary literature on the socio-economic impacts of climatic disasters. The finding that landownership patterns changed, with a likely increase in landlessness and fragmentation of holdings, aligns with the concept of "distress sales" where households liquidate critical assets to cope with post-disaster shocks. This process is a well-documented driver of accelerated poverty cycles and a decline in owner-operated farming, as noted in studies of flooding in South Asia (Usman et al., 2024). The reduction in average landholding size further reflects this forced asset disposal and is consistent with findings that small and marginal farmers,

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with limited access to credit and insurance, are often pushed to sell portions of their land, leading to increased land concentration (Fahad et al., 2020).

The severe decline in livestock ownership is a critical finding that resonates with literature identifying livestock as a highly vulnerable asset class during disasters, serving as a primary source of both immediate financial loss and long-term livelihood insecurity. The loss of these assets directly undermines household resilience, as they are a key source of nutrition, draft power, and liquid capital, a impact extensively documented in post-flood scenarios (Kumar et al., 2020). Consequently, the significant shift in primary income sources away from agriculture and towards non-farm labor is a predictable outcome of losing the core productive assets land and livestock that enable agrarian livelihoods. This forced "livelihood diversification" is often not a choice but a distress-driven shift into lower-security, often informal, sectors, which increases economic vulnerability and reduces long-term resilience, a pattern confirmed by recent studies on climate-induced migration and labor market changes (Khayam et al., 2020). Collectively, these results confirm that the flood acted as a profound shock, triggering a cascade of asset depletion that aligns with established models of how climate disasters exacerbate socio-economic vulnerabilities and reshape rural economies.

Index Analysis

This study has used Shannon Diversity Index for the calculations of the dependent and independent variables and then these variables have been used to measure the magnitude of variances explained by the Shannon Index. This table has included the individual score of H' calculated for the parameters and sub-indicators used for the index analysis.

Individual H' Values for Parameters and Sub-Indicators

Parameter	Sub-indicators	Index Values (H')
Natural		**0.298**
	Climate	0.197
	Agriculture	0.244
Financial		**0.319**
	Assets	0.258
	Financial Support	0.169
Physical		**0.577**
	Infrastructure	0.426
	Agricultural Equipment	0.241
	Water	0.203
	Flood Warnings	0.316
Human		**0.556**
	Health	0.445
	Mental Health	0.278
Social		**0.479**
	Community	0.338
	Government support	0.401
	Re-allocation	0.385

The above table 4.44 explained the findings of index analysis which has been used on the concept of Shannon diversity index used on the five parameters

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affecting the livelihood of the rural community in Swabi& DI Khan. The findings of the H index shows that natural indicators is having 29 percent of magnitude variance explained in the livelihood of the rural community. The sub-indicators i.e. climate and agriculture have index value of 0.197 & 0.244. The results of financial parameter showed the value of 0.319 and its sub-indicators assets i.e. 0.258 and financial support 0.169. The results of index analysis for physical showed significant higher magnitude explained in the Shannon diversity index i.e. 0.577. The sub-indicators for physical are infrastructure have 0.426, agriculture equipment 0.241, water 0.203 and flood warnings 0.316 which shows overall all the parameters of physical capital showed significant higher variances explained in the livelihood of the rural community. The results of human parameter has te value of 0.556 and also its sub-indicator i.e. health have 0.445. The value of index for social is 0.479 and its sub-indicators i.e. community 0.338, government support 0.401 and re-allocation 0.385. The findings of the index analysis shows that the selected five parameters in the current have overall higher magnitude of variances explained in the livelihood of the rural community in Swabi and DI Khan.

Cutoff Analysis of Index

The study has used cutoff points for measuring the level of variances explained in the Shannon index analysis. The below table has included three cutoff points and then these points have been linked with the index analysis and calculated the 'least affected', 'moderately affected' and 'highly affected'.

Cutoff Analysis of the Index used on the Variables

Index Value	Affected	Swabi	DI Khan
0 – 20%	Least Affected	55	41
21% - 40%	Moderately Affected	41	124
41% - 60%	Highly Affected	31	53
	Total	127	218

The table has shown the magnitude of variances explained by Index analysis conducted on Shannon Diversity Index. The findings of index analysis showed that 55 respondents in Swabi were least affected as they were in the range from 0-20%, 41 were moderately affected as their magnitude variances were from 21% to 40% and 31 respondents were highly affected as their index value are from 41% to 60%. The findings of DI Khan index analysis showed that 41 respondents were least affected as they were in the range from 0-20%, 124 were moderately affected as their magnitude variances were from 21% to 40% and 53 respondents were highly affected as their index value are from 41% to 60%.

Linear Regression

Livelihood	Coefficient	SE	T-value	P-value
Natural				
Climate	0.562	0.136	4.132	.000
Agriculture	0.741	0.216	3.430	.000
Financial				
Assets	0.231	0.108	2.138	.000
Financial Support	0.174	0.116	1.500	.184
Physical				

Dialogue Social Science Review (DSSR)
www.thedssr.com

ISSN Online: 3007-3154
ISSN Print: 3007-3146
https://doi.org/10.5281/zenodo.17064792
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Infrastructure	0.248	0.118	2.101	.000
Agriculture Equipments	0.249	0.147	1.693	0.146
Water	0.316	0.114	2.771	.000
Flood warnings	0.118	0.120	0.983	0.569
Human				
Health	0.364	0.101	3.603	.000
Mental Health	0.224	0.109	2.055	.000
Social				
Community	0.461	0.111	4.153	.000
Government	0.338	0.156	2.166	.000
Re-allocation	0.469	0.149	3.147	.000
R-square	**0.596**			
F-value	**12.478**			
P-value	**.000**			

The above table 4.46 elaborated the findings of linear regression which has been used by the current study to check the effect of selected five indicators on the livelihood of the sample respondents in Swabi and DI Khan. The findings of R-square showed that the natural, financial, physical, human and social indictors have combined 41 percent variances in the livelihood of the household. The results have indicated from parameters natural i.e. climate and agriculture have coefficient value of 0.562 and 0.741and it shows that they have a reasonable percentage of variances in the livelihood on the rural community in Swabi and DI Khan. The t-values for both climate and agriculture have been found 4.132 & 3.430 which is more than the standard value of t-value. It is concluded that both climate and agriculture have significant effect on the livelihood of the rural community. The results of financial parameters have included assets of the rural community and financial support taken from the government. The results showed that assets and financial support have coefficient value of 0.231 and 0.174 and it shows that they have a minimal percentage of variances in the livelihood on the rural community in Swabi and DI Khan. The t-values for both assets and financial support have been found 2.138 &1.50 which is more than the standard value of t-value in case of assets while it is lower in financial support. It is concluded that both assets have significant effect on the livelihood of the rural community. The results of physical parameters have included infrastructure, agriculture equipments, water and flood warnings of the rural community. The results showed that infrastructure, agriculture equipment, water and flood warnings have coefficient value of 0.248, 0.249, 0.316 & 0.118 respectively and it shows that they have a moderate percentage of variances in the livelihood on the rural community in Swabi and DI Khan. The t-values for infrastructure, agriculture equipment, water and flood warnings have been found 2.10, 1.69, 2.771 & 0.983 which is more than the standard value of t-value but in case of flood warnings and agriculture equipment have lower in financial support. It is concluded that infrastructure and water availability have significant effect on the livelihood of the rural community. The results of human parameters have included health of the rural community and mental health. The results showed that health and mental health have coefficient value of 0.364 and 0.224 and it shows that they have a moderate percentage of variances in the livelihood on the rural community in Swabi and DI Khan. The t-values for both health and mental

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Vol. 3 No. 10 (October) (2025)

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health have been found 3.603 &2.055 which is more than the standard value of t-value. It is concluded that both health and mental health have significant effect on the livelihood of the rural community. The results of social parameters have included community, government support & re-allocation of the rural community. The results showed that community, government support & re-allocation have coefficient value of 0.461, 0.338 and 0.469 and it shows that they have a higher percentage of variances in the livelihood on the rural community in Swabi and DI Khan. The t-values for both community, government support & re-allocation have been found 4.153, 2.166 &3.147 which is more than the standard value of t-value. It is concluded that community, government support & re-allocation have significant effect on the livelihood of the rural community.

The results confirming that natural, financial, physical, human, and social parameters significantly affect the livelihoods of the rural population after the floods in Swabi and D.I. Khan find strong resonance in contemporary theoretical frameworks and empirical studies. This multi-dimensional impact aligns directly with the Sustainable Livelihoods Framework (SLF), which posits that households leverage these five types of capital to construct their livelihoods, and that shocks can disproportionately deplete them. The significant effect of the degraded natural capital (climate, agriculture) such as damaged land and lost water quality is a primary driver of post-disaster poverty, as it undermines the very foundation of agrarian livelihoods. This is extensively documented in the literature, which shows that environmental shocks directly reduce agricultural productivity and ecosystem services, thereby threatening food security (Johnson et al., 2020).

The depletion of financial capital (assets, financial support) and physical capital (infrastructure, agriculture equipment, water & flood warning) forces households into distress strategies like selling assets or taking on high-interest debt, creating long-term cycles of vulnerability. This finding is consistently supported by research on post-disaster economies, which highlights that the loss of physical assets like livestock is a critical setback for recovery, while the lack of financial safety nets pushes households into irreversible coping strategies (Islam & Winkel, 2020). Furthermore, the impact on human capital (physical health and mental health), through health crises, loss of life, and disruption of education, diminishes the workforce's capacity and long-term potential, a effect that recent studies directly link to reduced household resilience and intergenerational poverty.

Finally, the significant role of social capital (community, government and re-allocation) through kinship networks, community support, and informal institutions is a critical finding that corroborates a growing body of literature. Social capital acts as a primary buffer in the immediate aftermath of a shock, facilitating access to resources, information, and mutual aid when formal support is absent or slow. However, as studies note, these networks can be overwhelmed by large-scale disasters, and pre-existing social inequalities can dictate who has access to the most robust support, thereby determining recovery trajectories (Iqbal et al., 2020). Thus, the results from Swabi and D.I. Khan provide a localized validation of a globally recognized model: that the differential erosion of these five capitals dictates the post-disaster inequality and long-term livelihood sustainability of rural households.

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Vol. 3 No. 10 (October) (2025)

CONCLUSION

Based on the findings, it can be concluded that the flood event served as a significant catalyst for change in the agrarian economies of Swabi and Dera Ismail Khan. The disaster precipitated a notable shift in the fundamental structure of landownership, reducing the number of landowners and likely leading to a consolidation of land among fewer individuals. This was accompanied by a clear reduction in the average size of landholdings, suggesting that many smaller and more vulnerable farmers were forced to subdivide or sell portions of their assets to recover from the losses. Furthermore, the livestock population, a critical component of household wealth and food security, suffered a severe decline, diminishing a key source of income and nutritional support for rural families. Consequently, these combined losses in land and capital assets forced a substantial alteration in primary livelihood strategies, with a discernible movement away from agriculture and livestock rearing as the main sources of income towards other, likely less secure, forms of employment. In essence, the flood did not merely cause temporary damage but triggered a profound and negative transformation in the agricultural foundation and economic resilience of the affected communities.

Based on the findings, a multi-faceted policy approach is essential to mitigate future flood impacts in Swabi and D.I. Khan. Authorities should prioritize investing in robust early warning systems that are accessible to remote communities, ensuring timely and understandable information reaches every village to allow for evacuation and asset protection. Critical infrastructure must be strengthened, including the construction and maintenance of flood embankments, spillways, and watershed management structures like check dams and afforestation projects in catchment areas to reduce runoff and soil erosion.

Land-use planning and zoning regulations should be strictly enforced to prohibit construction on floodplains and natural water channels, thereby reducing exposure to risk. Financial resilience must be built among vulnerable households by promoting and subsidizing flood-resistant agricultural practices, livestock insurance schemes, and access to post-disaster credit to prevent the distress sale of assets. Supporting livelihood diversification programs can reduce over-reliance on climate-sensitive agriculture by providing training and opportunities in off-farm sectors.

Public health infrastructure needs fortification to prevent post-flood disease outbreaks, ensuring access to clean water and medical facilities. Crucially, community-based disaster risk management committees should be established and empowered to lead local preparedness, response, and recovery efforts, leveraging local knowledge and social networks. Finally, a dedicated fund for rapid response and rehabilitation should be established to ensure immediate and effective aid delivery, preventing the long-term depletion of household capital that leads to increased poverty.

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Vol. 3 No. 10 (October) (2025)

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