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Flood perception and risk communication: understanding the impact of poverty on Vulnerability- A case study from Khyber Pakhtunkhwa, Pakistan

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Abstract

This study investigates the perception of flood risks and the effectiveness of risk communication among residents living near the River Kabul and River Swat in Khyber Pakhtunkhwa (KP), Pakistan, particularly in the flood-prone districts of Peshawar, Charsadda, and Nowshera. Utilizing a quantitative research design, data were collected through structured questionnaires from a randomly selected sample of individuals residing in these regions. Key variables included flood perception (independent) and risk communication (dependent), while the economic consequences of floods were explored through cross-tabulation and chi-square analysis. The results revealed a significant positive correlation between flood experience, awareness, and trust with effective risk communication, while fear did not significantly influence communication levels. Further analysis indicated a strong statistical association between flood exposure and individual economic losses, including savings, earnings, and rising poverty levels. The findings underscore the crucial role of localized risk perception in enhancing communication strategies and mitigating flood-related vulnerabilities. The study highlights the need for targeted interventions focusing on community awareness, preparedness, and poverty alleviation to strengthen flood resilience in the region.

Keywords: flood perception, Risk communication, Economic loss, Poverty, and Flood Risk.

إدراك الفيضانات والتواصل بشأن المخاطر: فهم تأثير الفقر على الضعف ـ دراسة حالة من خيبر باختونخوا، باكستان

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ملخص:

تتناول هذه الدراسة تصوّر مخاطر الفيضانات وفعالية التواصل بشأن المخاطر لدى السكان القاطنين بالقرب من نهري كابل وسوات في إقليم خيبر بختونخوا (KP)في باكستان، لا سيّما في المناطق المعرضة للفيضانات مثل بيشاور وتشارسده ونوشهرة .وباستخدام منهج بحث كمي، تم جمع البيانات من خلال استبيانات منظمة وُزّعت على عينة عشوائية من السكان المقيمين في هذه المناطق .تضمنت المتغيرات الرئيسية تصور الفيضانات على اعتباره متغير مستقل (والتواصل بشأن المخاطر)على اعتباره متغير تابع، بينما تم تحليل الآثار الاقتصادية للفيضانات من خلال التبويب التبادلي واختبار كاي تربيع .وكشفت النتائج عن وجود علاقة ارتباط إيجابية ذات دلالة إحصائية بين تجربة الفيضانات والوعي والثقة من جهة، وفعالية التواصل بشأن المخاطر من جهة أخرى، في حين لم يكن للخوف تأثير معنوي على مستويات التواصل .وأظهرت التحليلات الإضافية وجود ارتباط إحصائي قوي بين التعرّض للفيضانات والخسائر الاقتصادية الفردية، بما في ذلك المدخرات والدخل وازدياد معدلات الفقر .وتؤكد النتائج على الدور المحوري لتصور المخاطر المحلي في تعزيز استراتيجيات التواصل والحدّ من مواطن الضعف المرتبطة بالفيضانات .وتبرز الدراسة الحاجة إلى تدخلات موجّهة تركز على رفع وعي المجتمع، والاستعداد للكوارث، والحد من الفقر، بهدف تعزيز القدرة على الصمود بوجه الفيضانات في المنطقة.

الكلمات المفتاحية: إدراك الفيضانات، التواصل بشأن المخاطر، الخسائر الاقتصادية، الفقر، مخاطر الفيضانات.

1. Introduction

Floods have impacted a larger number of individuals globally than any other form of danger during the twenty-first century (Jha et al., 2012). Climate change forecasts indicate that low-income nations are expected to experience more significant consequences than developed nations. Pakistan, due to its dry geographical characteristics and limited resources, is considered among the most susceptible nations to the impacts of climate change on a global scale (Chinowsky et al., 2011). Based on the global climate index, Pakistan ranks as the fifth most susceptible nation to the impacts of climate change (Eckstein et al., 2019). The investigation of risk perception has emerged as a significant area of study within the field of disaster risk science. This study aims to assess the propensity of vulnerable populations to engage in proactive activities in response to potential external hazards (Ainuddin et al., 2014; Al-Shammary, 2025; Birkholz et al., 2014). Risk perception is widely recognized as a crucial element in the evaluation of social vulnerability and the resilience of communities (Al-Ani & Jabbar, 2023; Birkholz et al., 2014; Rana et al., 2020). Extreme weather events, including floods, droughts, cyclones, heat waves, cold waves, forest fires, and storms, are becoming more frequent due to climate change. In (2021), disaster risk reduction and climate change adaptation indicate the necessity of a paradigm shift to mitigate the consequences of climate change. In order to effectively implement measures for disaster risk reduction and climate change adaptation, local governments and disaster management organizations must possess a comprehensive understanding of vulnerabilities, attitudes, and capacities (Al-Shammary, 2025; Kellens et al., 2013). By warning the public of the impending and looming flood risk and empowering them to take safety precautions. If people know the risks, they are more likely to prepare for and adapt to floods appropriately. Furthermore, proximity to the hazard's source may impact these perceptions and abilities (Ali et al., 2022; Ullah et al., 2020). Risk perception can differ geographically based on factors such as level of exposure, socioeconomic circumstances, cultural influences. In developing nations, particularly Pakistan, research has been carried out to investigate the perception of risk and the factors that influence it. Therefore, examining the perception of danger and the factors that can impact communities is crucial (Rana et al., 2020(Alkatb, 2022)). Research quantifies the perception and communication of risk and its correlation in the vicinity of the river. The study also examines the socioeconomic factors that impact how

danger is perceived and communicated in selected rural areas around the Indus River in Pakistan (Ali et al., 2022). Research studies have shown the community perspectives on improving the flood management and socio-economic impacts of the flood at the Indus River. Still, the data was collected before the 2022 flood (Ashraf et al., 2023). This paper fills a gap in the literature to find the effect of risk perception and risk communication on individual economic loss leading to poverty. Most of the published papers used the data before the 2022 flood. This paper collects the data after the 2022 flood. The research tries to answer two questions: "What is the effect of risk perception on risk communication?" and "Does the flood loss leads to poverty in that region?". The main objective of this paper is to find the risk perception and risk communication and find the flood loss that leads to poverty. The study area is the most affected by the flood. People live near the River Swat and River Kabul Peshawar, Charsadda, and Nowshera the rest of the paper is a literature review, methodology, results discussion and last conclusion.

1.2. Literature review

Critical Review of literature on Climate Change, Flooding and Socioeconomic Vulnerability in Pakistan: Climate change has intensified the frequency and severity of extreme weather events globally, including floods, which are among the most destructive due to their widespread human, economic, and environmental impacts. In Pakistan, flood vulnerability stems from both fluvial (river overflow) and pluvial (intense rainfall) sources, particularly within the Indus River System. The 2022 floods exemplified this, with unprecedented rainfall 390 mm nationwide, nearly twice the 30-year average, and 470% above average in Sindh leading to over 1,200 deaths and the destruction of more than 372,800 homes. While studies consistently affirm that floods cause widespread displacement, crop loss, and economic disruption (Gurjee., Hussein., 2023), there is limited analysis of the mechanisms through which floods exacerbate poverty. For example, although some research touches on agricultural loss and rising inflation, few explore how inadequate risk perception and communication amplify these impacts. Additionally, while many studies discuss climate vulnerability in Pakistan, they often treat communities as homogenous and overlook differences in risk awareness, information access, and decision-making capacity, particularly among women, the elderly, and low-income groups. Some literature emphasizes top-down structural

mitigation, while others advocate for community-based adaptation, but there is a lack of synthesis between these approaches. Conflicting views also exist on whether experience with past floods improves preparedness or leads to helplessness and fatalism, revealing a critical research gap. Moreover, studies rarely explore how cultural beliefs, local knowledge, and social networks influence risk perception and preparedness in the Pakistani context. This review identifies a need for research that bridges the gap between climate-induced flooding, risk perception, and poverty outcomes, particularly by examining how social, informational, and psychological factors mediate this relationship. The current study aims to address this gap by analyzing flood-prone communities' risk perception and communication practices in Khyber Pakhtunkhwa and assessing their economic vulnerability post-2022 floods. Climate change poses a worldwide peril, and its repercussions are becoming increasingly prevalent compared to previous decades in several aspects—severe weather phenomena, including tornadoes, tsunamis, cyclones, hurricanes, and floods (Hassan et al., 2022; Sabti, 2022). Climate change is leading to a rise in the frequency and severity of rainfalls, resulting in more frequent and severe flooding (Hussein Saeed et al., 2022; Khan et al., 2021). Pakistan is prone to floods in the main rivers of the Indus River System as a result of disrupted weather patterns during the monsoon season and snow melting. This indicates that Pakistan encounters both rainfall-induced floods and floods caused by river overflow (Shah et al., 2022; Tariq & Van De Giesen, 2012). Increased rainfall intensity leads to pluvial flooding, but rising river water levels lead to fluvial flooding (Tanaka et al., 2020). However, floods are widely regarded as one of the most devastating disasters globally due to their significant economic consequences, destruction of property, and loss of life (Noonan & Sadiq, 2019). The most recent flooding incidents in Pakistan were the devastating floods of 2022, which were again brought on by poorly managed floodplains. Additionally, Pakistan recently received 390 mm, or twice as much rain as the thirty-year average, with Sindh accounting for most of the precipitation with a value of 470% above average. Nationally, the previous 30 years have had the most significant impact, impacting 50 million people. More than 1200 casualties from these floods were reported. Additionally, about 372,800 homes were destroyed (Ashraf et al., 2023; Jabal et al., 2023).

1.2.1. Flood risk perception:

Evaluating Risk Perception and Mitigation in the Pakistani Context:

The evaluation of flood risk perception is crucial due to its strong and statistically significant relationship with disaster preparedness and climate change adaptation. However, authorities in Pakistan often prioritize structural flood mitigation measures such as embankments, levees, and drainage infrastructure while giving less attention to the social and psychological dimensions of risk perception. While structural interventions are essential, their long-term effectiveness is limited without parallel investment in public awareness and behavioral change.

Risk perception is a multi-dimensional construct, encompassing:

- Cognitive perception (knowledge, understanding, and beliefs about flood risks),
- Affective perception (emotions like fear, anxiety, and concern), and
- Experiential perception (personal or community experiences with past flood events).

Understanding these dimensions is key to designing effective communication and intervention strategies. In Pakistan, risk perception is also shaped by sociocultural and religious factors. Many rural communities view floods as an act of divine will, leading to fatalism or passive acceptance, which may reduce proactive behavior. Others rely heavily on local knowledge, such as seasonal signs and traditional coping mechanisms, to assess and respond to flood risks. These belief systems although valuable can both support and hinder preparedness, depending on how they align with scientific risk communication. Existing studies on flood risk perception in Pakistan have largely focused on farmers and rural populations, given their direct dependence on land and vulnerability to climate impacts. However, there remains a need to broaden this scope to include urban informal settlements, women, and youth, who may perceive and respond to risks differently(Ahmad et al., 2023).Thus, for flood mitigation strategies to be effective, Pakistan's disaster management policies must balance structural measures with culturally sensitive, community-driven approaches that integrate cognitive, emotional, and experiential aspects of risk perception. This holistic approach will foster greater public engagement and build long-term resilience. The evaluation of flood risk perception is of

utmost importance due to its strong and statistically significant association with both disaster preparedness and climate change adaptation(Ali et al., 2022). Nevertheless, it is not uncommon for governments and relevant authorities to prioritize structural flood mitigation measures over flood risk perception (Birkholz et al., 2014). The presence of a heightened risk perception is indicative of an increased likelihood of community engagement in programs aimed at mitigating and managing disaster risks (Ainuddin et al., 2014). The country's farmers and rural sector have been the main focus of studies on risk perception in relation to floods (Shah et al., 2017).

1.2.2. Risk communication:

Risk communication and perception in context:

Risk communication is a social process that informs people about potential threats and encourages them to adopt protective behaviors and participate in decision-making. According to the World Health Organization, it involves the two-way exchange of information, recommendations, and perspectives between experts and the public to enhance survival, health, and economic security (Al-Ahealy et al., 2024). However, for communication to be effective, it must be grounded in an understanding of the multi-dimensional nature of risk perception including cognitive (knowledge and beliefs about risk), affective (emotions such as fear or anxiety), and experiential (past experiences with similar hazards) components (Al-Ahealy et al., 2024). In the Pakistani context, cultural and religious beliefs play a significant role in shaping risk perception. Some communities interpret natural disasters as acts of divine will, which may lead to fatalism and reduce motivation for preparedness. Additionally, local knowledge systems, including traditional flood indicators and community memory, influence how warnings are interpreted and how people respond. These culturally embedded views must be acknowledged and integrated into communication strategies to build trust and relevance. Furthermore, risk communication must go hand in hand with structural and non-structural mitigation measures. In Pakistan, structural flood mitigation—such as embankments, drainage systems, and flood retention basins—has often been insufficient due to poor maintenance, unplanned urban expansion, and encroachments in flood zones. These measures need to be reinforced with community-based flood mapping, localized early warning systems, and inclusive evacuation planning, especially for vulnerable groups. Research in

countries like Canada, Nepal, and the Philippines has highlighted the limitations of top-down communication approaches and stressed the need for bilateral, community-inclusive strategies. The findings of this study support this, revealing that perceptions of evacuation messaging, transport availability, and shelter access significantly influence decision-making during floods. Therefore, a people-centered, culturally sensitive, and participatory communication model is essential for enhancing preparedness and reducing risk in flood-prone areas of Pakistan. Risk communication is a social process that alerts people to potential threats. It motivates individuals to modify their conduct and take part in the process of making decisions. According to the World Health Organization, risk communication is the simultaneous sharing of knowledge, suggestions, and viewpoints between professionals and the general public in order to improve the latter's health, economic security, and capacity to survive (Al-Ahealy et al., 2024; Ali et al., 2022). Effective risk communication requires a thorough understanding of people's attitudes and perceptions of risk (Rohrmann, 2008). Risk communication is a multifaceted approach utilized at many stages of the disaster life cycle. (Rana et al., 2021). The study's results indicated that views of evacuation messaging, transportation, and shelter accessibility influenced evacuation decisions. Research in Canada, Nepal, and the Philippines has shown the limitations of the top-down approach and the importance of bilateral information exchange in risk communication. (Shrestha et al., 2021).

1.2.3. Flood risk determinants:

Conceptual Framework for Understanding Flood Risk Perception:

Flood risk perception varies across individuals and communities and is shaped by a complex interplay of multiple factors. Building on Burton and Kates (1964), who linked perception to hazard exposure, frequency, and livelihood dependence, this study adopts an integrated framework by categorizing influencing factors into four interrelated domains:

Scientific Factors – These include technical assessments of flood probability, severity, and recurrence. While important, such information often lacks impact unless translated into accessible language for the public.

Personal Factors – Characteristics such as age, gender, and health status shape how individuals perceive and respond to risk. For instance, older adults or women in caregiving roles may perceive greater vulnerability.

Contextual Factors – These refer to socio-economic background, education, past flood experience, and income level. Prior experience may strengthen awareness or lead to fatalism, acting as a moderator in risk perception.

Informational Factors – Access to media, early warnings, and risk communication systems plays a direct role in shaping perception and preparedness. These can act as mediators, enhancing or weakening the effect of other factors. These categories are not isolated; rather, they interact. For example, education (contextual) can enhance understanding of scientific information, while media exposure (informational) may amplify or dampen perceptions formed by personal experience. Among these, contextual and informational factors often have the most immediate influence in low-resource settings like Pakistan, where gaps in education and access to reliable communication channels can amplify vulnerability. Therefore, a multi-dimensional approach is essential to fully understand and address flood risk perception (Burton & Kates, 1963; Hirabayashi et al., 2013; Wachinger et al., 2013).

1.2.4. Occupation and income

Several research indicate that the nature of one's profession and level of money have an impact on how individuals perceive the risk of flooding(Peacock et al., 2005; Sullivan-Wiley & Gianotti, 2017).

1.2.5. Gender and age

Age and Gender Differences in Flood Risk Perception:

Age differences influence cognitive processing and emotional responses, which in turn shape how individuals perceive flood risk. Older individuals may rely on prior experiences and exhibit a heightened awareness of danger, while younger people may underestimate risks due to limited exposure or overconfidence. Research conducted in flood-prone areas of Pakistan, such as Punjab and Khyber Pakhtunkhwa, has shown that older adults tend to have higher flood risk perception and preparedness levels, often because they have lived through multiple flood events and rely on traditional warning

sign. Similarly, gender plays a critical role in shaping risk perception. Studies from Pakistan indicate that women often perceive higher levels of flood risk than men due to their roles in caregiving and household management, which make them more aware of potential consequences. However, women may also face limited mobility and access to information, reducing their ability to act on that perception. These findings highlight the need for gender- and age-sensitive risk communication strategies that ensure vulnerable groups are both informed and empowered to respond effectively during floods (Diakakis et al., 2018; Miceli et al., 2008; Peacock et al., 2005).

1.2.6. Experience

Households that have previously encountered floods are generally more aware of potential dangers and are likely to make more informed decisions in future events. Individuals with prior exposure to hazards often perceive a heightened risk of flooding and may adopt preventive behaviours. However, not all experiences lead to increased preparedness. In some cases, repeated exposure to floods without adequate support or successful coping outcomes can result in learned helplessness a state where individuals feel powerless to change outcomes or fatalism, where people believe that floods are unavoidable and beyond their control. These attitudes can undermine proactive behavior, reduce trust in authorities, and diminish participation in risk communication efforts. Therefore, experience must be supported by effective education, social support, and recovery assistance to prevent these negative psychological outcomes and to ensure that experience translates into resilience rather than resignation (Franklin et al., 2014; Kellens et al., 2011).

1.2.7. Knowledge and experience

Communities or individuals lacking formal education often have limited access to critical information when making decisions during disasters. Under-informed communities are typically more vulnerable to hazards than they realize. Research consistently shows that both formal education (e.g., school-based disaster education programs) and informal knowledge (e.g., community awareness campaigns, local disaster drills, and indigenous knowledge) significantly enhance an individual's risk perception and preparedness behavior. Among the most effective are practical, localized educational initiatives that teach people how to interpret early warning messages, respond to

evacuation alerts, and understand flood risk maps. In addition, visual tools, participatory learning sessions, and mobile-based information systems have been shown to improve understanding in low-literacy communities. These types of targeted, accessible knowledge-sharing approaches play a vital role in reducing vulnerability and promoting proactive risk-reduction behavior (Botzen et al., 2009; Li et al., 2023; Peacock et al., 2005).

1.2.8. Flood loss leads to poverty of the local people

Food imposes financial burdens on households due to its negative impact on their livelihoods and economic status. This is exacerbated by the lack of sufficient financial assistance from the government, which could otherwise alleviate these losses through the provision of micro-financing, loans, food insurance subsidies, structural rehabilitation, and livelihood restoration (Botzen & Van Den Bergh, 2009). The detrimental effects of food on rural agricultural production increase due to the alteration of rural landscapes caused by settlements near river catchments. The alteration of natural landscapes resulted in deforestation and soil erosion, which in turn caused changes in the courses of streams and the speed of water flow (Salman & Li, 2018; Wheater & Evans, 2009). The high population density along the banks of rivers, combined with increased exposure to flooding, exacerbates the devastating effects of flooding on rural communities (Khayyam & Munir, 2022; Mohammed et al., 2018). The primary tendency observed among low-income earners is the adverse effect of food on income loss. Consequently, economically disadvantaged households suffer more significantly. This is attributed to the limited assets available for consumption in such impoverished families (Huang et al., 2008). As a result, impoverished households experience hardship due to the loss of agricultural livelihoods, savings, and the need to borrow money. Additionally, they also suffer from the loss of livestock, which could otherwise be used as an alternative way to improve their livelihood chances (Takasaki et al., 2004). Therefore, this study identifies the relationship between risk perception and risk communication and the economic effects of floods on individuals living near the Swat and Kabul rivers. By focusing on the flood-affected areas of Peshawar, Charsadda, and Nowshera after the 2022 floods, the study fills a gap in the literature by demonstrating that effective perception and communication are crucial in reducing flood risk and vulnerability. The findings further reveal that flood-induced economic losses—such as damage to farmland, livestock, and personal savings directly

contribute to rising poverty levels. These losses disrupt livelihoods, particularly in agriculture-dependent communities, and contribute to food insecurity and inflation by reducing local food production and increasing market dependence. Despite these challenges, the role of social safety nets and disaster relief programs remains underutilized in Pakistan. Strengthening government-led support systems such as cash transfer programs, subsidized inputs for farmers, emergency shelters, and crop insurance schemes could significantly mitigate the long-term economic impact of floods. Future policies must integrate poverty alleviation, food security, and disaster risk management to build resilience in flood-prone communities and reduce socio-economic vulnerability in the wake of climate-induced disasters.

2. Methodology

2.1. Material and methods

Based upon the perception of the local people in Khyber Pakhtunkhwa province. This research study examines the local people who live near the River Kabul, their sensitivity, experience of the flood. In this research the most effected areas of the Khyber Pakhtunkhwa namely (Peshawar, Charsadda, and Nowshera). According to (KPNDMA) 2022 flood these areas were mostly affected by the river Kabul flood. This research uses quantitative analysis. A questionnaire was developed based on previous literature and the primary data was collected from people who live near River Kabul and River Swat. These areas were selected for the study to find flood perception and risk communication. Flood impact on individual economic loss. Peshawar city is situated about 160 kilometers west of the capital Islamabad. Peshawar has an area of 1257km square. Since it lies in the Centre of the province.

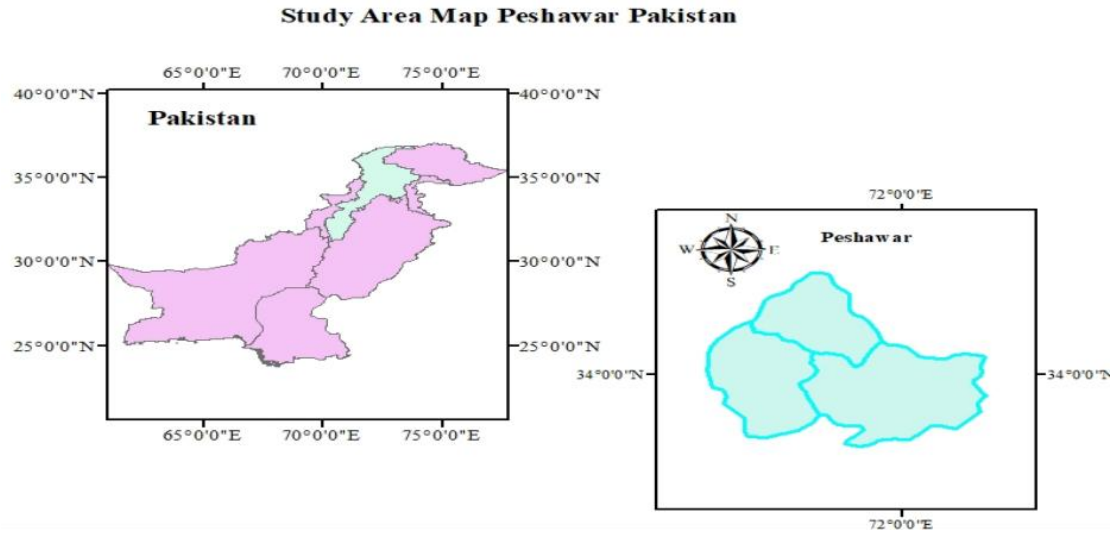

Figure 1: study area mam Peshawar Pakistan.

The river Kabul passes through some areas and most of the area effected by floods. The Nowshera covers about the area in kilometers 1748 and the population is about 1.5 million. This area is the most effected in every flood and in the 2010 flood, the area was too much effected by the flood. The district Charsadda is part of the main irrigated area and covers 996 kilometers and the northwestern part of the Peshawar valley. There are two rivers Kabul and Swat that run around the district farming is the primary source of the income (Shah et al., 2023).

2.2. Variables

Flood perception is the independent variable and flood communication is the dependent variable in this research (Ali et al., 2022). The floods and poverty using chi-squared test (Khayyam, 2020).

2.3. Data collection and sampling

2.3.1. Sampling Method:

This study employed a simple random sampling technique to select participants from the population living near the River Kabul and River Swat in the districts of Peshawar, Charsadda, and Nowshera. A simple random sample was chosen because it provides every individual in the population an equal chance of being selected, thus

minimizing selection bias and ensuring the results are representative of the broader population.

2.3.2. Justification

The primary objective of the study was to assess general public perception, awareness, and risk communication related to floods in highly vulnerable areas. Since the study aimed to capture diverse views from a geographically defined but demographically varied population, simple random sampling was suitable for achieving statistical generalizability and maintaining objectivity in participant selection. The method ensured that responses reflected a cross-section of the local population, which was essential for making valid inferences about the broader community's experience with floods and their economic impact. The primary data was collected from the local people living near the river Kabul and swat from Peshawar, Charsadda, Nowshera district Khyber Pakhtun Khwa province region Pakistan. The population near the river Kabul is approximately 7000 people, according to Provincial Disaster Management Authority (PDMA). Random sampling techniques was used.

n= N/1+N(e)2

The variable "n" represents the sample size, "N" is the estimated population in the vicinity of the two rivers within the study region (7,000), and "e" signifies the level of precision (0.07).(Ali et al., 2022).

2.4. Data analysis

2.4.1. Reliability Analysis (Cronbach'sAlpha)

This test was used to assess the internal consistency of the indicators measuring risk perception and risk communication. A Cronbach's alpha value above 0.6 confirmed that the items were reliable and measured consistent constructs.

2.4.2. Correlation Analysis (Pearson's Correlation):

Pearson's correlation test was used to examine the strength and direction of the linear relationship between risk perception components (e.g., awareness, fear, trust) and risk communication variables (e.g., accuracy, ease,reliability).

2.4.3. Linear Regression Analysis:

A regression model was applied to determine how well the components of risk perception (independent variables) predicted risk communication (dependent variable). The model's R-squared value indicated the proportion of variance in risk communication explained by perception factors.

2.4.4. Chi-Squared Test:

This test was used to identify associations between categorical variables such as the impact of floods on savings, earnings, poverty, and loss of farmland. A p-value less than 0.05 indicated a statistically significant relationship between these variables.

2.4.5. GIS Mapping (ArcGIS):

ArcGIS software was used to map the flood-affected study areas (Peshawar, Charsadda, and Nowshera), providing spatial visualization of the flood zones and population proximity to the rivers.

2.5. Selection of indicators

Indicators are selected from the literature to measure risk perception, risk communication (Ali et al., 2022)(Rana et al., 2020; Sato et al., 2020). The poverty indicator is measure (Khayyam, 2020). A total of 36 indicators were used from the previous literature. The data was collected on a. All 36 indicators used to assess risk perception and communication were measured using a 5-point Likert scale, which is a common psychometric scale for capturing attitudes, opinions, and perceptions. Respondents were asked to indicate their level of agreement with each statement, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. This scale allows for a nuanced understanding of the participants' views and helps in quantifying subjective perceptions for statistical analysis.

3. Results and Discussion

The socio-demographic characteristics of the respondents were shown in Table (1).

Table 1: Demographic Analysis.

		Frequency	Percentage %
Gender	Male	140	67.0
	Female	69	33.0
Age	30 year and below	67	32.1
	31-40	75	35.9
	41-50	45	21.5
	50- above	22	10.5
Qualification	Bachelor	70	33.5
	Master	90	43.1
	Matric	25	12.0
	Ph.D.	24	11.5
Income	30000	47	22.5
	40000	34	16.3
	50000	56	26.8
	60000 and above	72	34.4

3.1. Reliability test

A reliability test was used to determine the internal consistency of the measurement. How the questions are related to each other? Cronbach's alpha served the desired purpose of finding the internal consistency between the variables. The value of the Cronbach's alpha is between 0 and 1. The value should be greater than 0.6, which is considered to be an acceptable range. Selected variables conform to higher internal consistency, as shown in the study result in Table (2).

Table 2: Cronbach's alpha

Variables	Cronbach's alpha	Items
Risk perception	0.885	27
Risk communication	0.897	13

3.2. Correlation analysis

Correlation analysis: The relationship between risk communication and perception was examined using Pearson's correlation test. The correlation matrix was developed to ascertain the coefficients of risk communication and perception.

The result is shown in table 3. The research study was the same as the previous study research (Ali et al., 2022; Gotham et al., 2018; Kellens et al., 2011; Khayyam, 2020; Lindell & Hwang, 2008; Rana et al., 2021; Rana et al., 2020; Rana & Routray, 2016; Rohrmann, 2008; Sato et al., 2020; Shrestha et al., 2021; Ullah et al., 2020).

Table 3: The correlation matrix

		fear	Awareness	trust	attitude	ease	accuracy	Reliability
Risk perception	fear	1						
	awareness	0.587**	1					
	trust	0.471**	0.617**	1				
	attitude	0.530**	0.589**	0.556**	1			
Risk communication	ease	0.355**	0.445**	0.399**	0.478**	1		
	accuracy	0.356**	0.506**	0.415**	0.540**	0.697**	1	
	Reliability	0.381**	0.515**	0.457**	0.521**	0.538**	0.629**	1

3.3. Linear regression

Linear regression analysis was conducted to predict risk communication based on risk perception (experience, fear, trust, and awareness). The predictor variable statistically significantly predicted risk communication, $F(4,204)= 38.650$, $p<0.000$, R-Square=0.431. An adjusted R-squared of 0.420 suggested that the model can account for approximately 42% of the variance in the risk communication.

Regression model summary:

The regression model equation is as follows:

Risk Communication=0.804+0.290(experience)+0.018(Fear)+0.220(Awareness)+0.083(Trust)

The standard error of the estimate was 0.45215, indicating the typical distance that the observed values fall from the regression line.

3.4. Coefficient Analysis

Experience: had a significant positive effect on risk communication (B=0.290, SE=0.057, beta =0.361, p<0.000), indicating that as experience increases, so does the level of risk communication.

Awareness was also a significant predictor of risk communication (B=0.220, SE=0.062, beta= 0.274, p<0.000), suggesting that higher awareness is associated with improved risk communication.

Trust was not a statistically significant predictor (B=0.083, SE=0.052, beta=0.113, p=0.012), suggesting that higher trust is associated with improved risk communication.

3.5. Predicting risk communication in this model

Fear showed no significant association with risk communication (B=0.018, SE=0.076, beta=0.016, p=0.815), suggesting that fear does not significantly affect communication levels.

The 95% confidence interval provides further insights into the precision of our estimates, indicating that the actual value of the coefficients is likely to fall within these ranges.

3.6. ANOVA result

The ANOVA result indicates that the regression model statistically predicted the outcome variable, F(4, 204) = 38.650, p<0.000. The regression model was a significant fit for the data. The regression model result indicated that experience, awareness, and trust are essential predictors of risk communication. Experience, awareness, and trust significantly increase the communication trend. Fear was not a significant predictor in the mode. These findings also suggest that interventions aiming to improve risk

communication mainly focus on increasing the awareness, experience, and trust related to the risk subject.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.657[a]	.431	.420	.45215	.431	38.650	4	204	.000

a. Predictors: (Constant), experience, fear, trust, awareness

b. Dependent Variable: risk communication

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.606	4	7.901	38.650	.000[b]
	Residual	41.705	204	.204		
	Total	73.310	208			

a. Dependent Variable: risk communication

b. Predictors: (Constant), experience, fear, trust, awareness

In flood-prone regions, it is imperative for relevant agencies, including governmental bodies and flood control authorities, to develop a comprehensive flood reduction strategy and enhance risk communication and risk perception. The results provide an intriguing examination of the factors that impact the perception and communication of risk. There is a favorable association between risk communication and perception, as evidenced by the same factors that affect both indices. Research indicates that age and gender have little impact on any specific phenomenon (Kellens et al., 2011; Gotham et al., 2018; Lindell & Hwang, 2008; Rana & Routray, 2016; Ullah et al., 2020).

It's interesting to note that persons who lived far from floods thought there was a greater chance of flooding and were more willing to accept and heed danger warnings. Therefore, as other researchers have shown, hazard proximity is crucial in influencing risk perception and building trust in risk communication. (Rana et al., 2020; Ullah et al., 2020). The local agencies in the respective study areas could enhance their strategy for mitigating flood risk by focusing on bettering the risk perception and method of communication of these risks. This approach improves how risks are understood and relayed as a means to effectively reduce the impact of flooding.

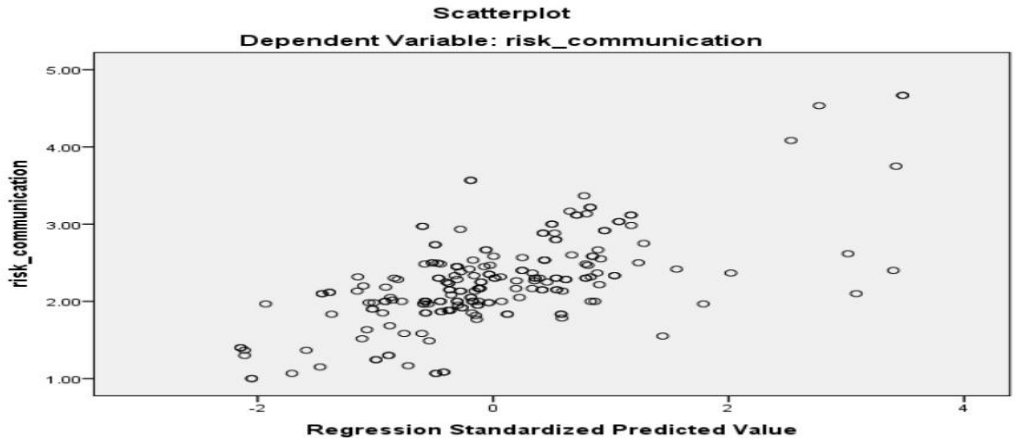

Figure 2: Histogram chart of the data

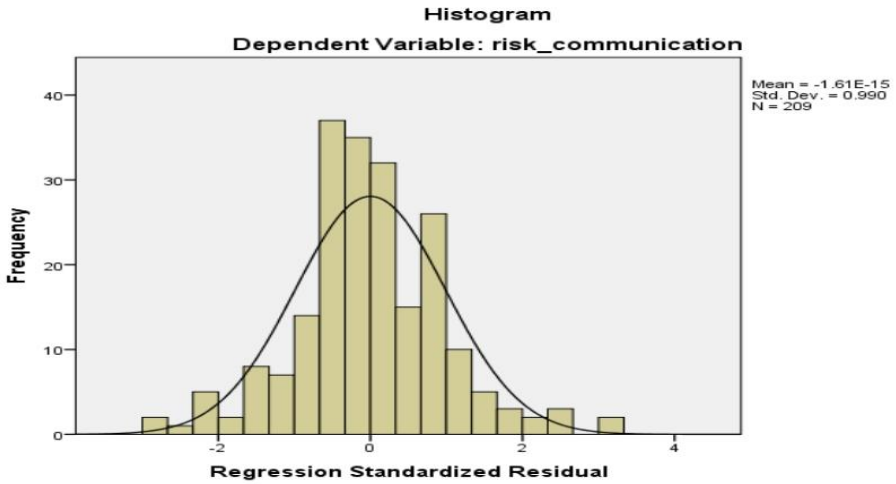

Figure 3: Scatterplot of the data

The data shown in the Figure 2 is normally distributed and the Figure 3 shows that there is a trend line between risk perception and risk communication. The data shows the linear regression analysis.

Individual Economic status of the flood:

Investigating the impact of floods on individual savings and the loss of farmable land is crucial for understanding the multifaceted consequences of natural disasters. To explore this relationship, a crosstabulation analysis was conducted using SPSS software. (χ^2 = 63, p-value=0.00) The p-value of 0.00 indicates a significant association between the questions "does the flood affect the loss of farmable land? And "Does the flood affect individual savings? The two factors are not independent, which means that the occurrence of a flood does impact individual saving. A p-value of 0.00 is typically interpreted as highly significant because it's less than the conventional significance level of 0.05. This suggests a strong relationship between the flood effect on farmable land and its impact on individual savings. There is a statistically significant association between floods effecting farmable land and effecting individual savings based on this chi-squared test, as shown in the table 4 below

Table 4: Chi-Square Test of Association between Loss of Farmland and Impact of Floods on Individual Savings.

Loss of farmland	**Flood effect on savings**	**Total**
	No	Yes
No	29 Expected (10.3)	8 Expected (26.7)
Yes	29 Expected (47.7)	143 Expected (124.3)

As depicted in Table 4, the results suggest a significant association between flood impacts on savings and the subsequent loss of farmable land, highlighting the interconnected nature of economic and environmental vulnerabilities in disaster contexts.

Flood effect the individual saving and flood effect the earning:

The p-value of 0.00 indicates that there is a significant association between the questions "Does the flood effect on the individual savings? And "Does the flood effect on the earnings? The two factors are not independent, which means that the occurrence of a flood decreases individual earnings.

Table 5: Relationship Between the Impact of Floods on Individual Savings and Earnings: A Statistical Analysis

Flood effect the individual saving	Flood effect on earning	Total
	No	Yes
No	1 Expected (0.8)	42 Expected (14.4)
Yes	2 Expected (2.2)	139 Expected (37.6)
Total	3 Expected (3.0)	181 Expected (52.0)

A p-value of 0.00 is typically interpreted as highly significant because it is less than the conventional significance level of 0.05 ($\chi^2 = 54$, p-value=0.00). This suggests a strong relationship between the flood effect on individual savings and its impact on individual earnings in your data. The crosstabulation analysis revealed a significant association between flood effects on individual savings and earnings p-value=0.02.. These results suggest a strong relationship between flood effects on individual savings and subsequent impacts on earnings, indicating potential financial vulnerabilities exacerbated by flood events.

Flood effect earning and rise in Poverty:

The p-value of 0.00 indicates that there is a significant association with the question “Does the flood effect on the earnings? And “Does the flood effect on the rise in absolute poverty? The two factors are not independent, which means that the occurrence of a flood decreases individual earnings as shown in table 6.

Table 6: Association between the Impact of Floods on Earnings and the Rise in Absolute Poverty

Flood effect the earning	Rise absolute poverty	Total
	No	Yes
No	1 Expected (0.8)	35 Expected (14.4)
Yes	2 Expected (2.2)	130 Expected (42.7)
Total	3 Expected (3.0)	166 Expected (58.0)

A p-value of 0.00 is typically interpreted as highly significant because it's less than the conventional significance level of 0.05. This suggests a strong relationship between the flood effect on earnings and its impact on rising absolute poverty. The crosstabulation analysis demonstrated a notable association between flood effects on earnings and rising absolute poverty (χ^2 = 23, p-value=0.05). Among the 209 respondents surveyed, 52 reported no impact of floods on earnings, while 154 experienced some effect. Among those unaffected by floods on earnings, 1 reported no rise in absolute poverty, whereas 35 reported an increase. Conversely, 22 reported no rise in absolute poverty among those affected by floods on earnings, while a substantial majority of 130 reported an increase. These findings underscore a significant relationship between flood effects on earnings and subsequent changes in absolute poverty levels, indicating potential economic vulnerabilities exacerbated by flood events.

The chi-squared test was performed to find the relationship between the categorical variable individual loss and individual economic loss and individual loss and poverty. The chi-test was performed and found to be significant (p-value=0.000). The individual loss of farmland, crops, and loss of livestock affects the individual economic loss. The chi-squared test was performed for economic loss and poverty (p-value=0.000), and the test showed the significant value that it leads to poverty. The loss from floods over decades shows the rise in the poverty level in the region due to floods. The result of this study was

aligned with previous literature.. (Gotham et al., 2018; Khayyam, 2020; Lindell & Hwang, 2008; Rohrmann, 2008).

The results provide a fascinating understanding of the factors that influence risk communication and perception. Identical indicators influence the two indices. They empirically demonstrate a statistically significant positive correlation between risk communication and perception. According to several studies, the same is influencing (Ali et al., 2022; Gotham et al., 2018; Kellens et al., 2011). The study findings have verified that a rise in floods results in an increase in family poverty levels. The adverse effects of floods on the livelihoods of rural communities can be attributed to the predominant reliance on agriculture in these areas. Agriculture is their primary means of sustenance. The issue of income is prevalent in various rural societies worldwide. The local agriculture sector is highly vulnerable due to the cumulative losses incurred to agricultural land, which subsequently impacts agrarian production.(Brouwer et al., 2007; Chanda Shimi et al., 2010; Khayyam, 2020; McCusker & Carr, 2006). Global studies also validate that floods have a rapid and detrimental influence on rural communities' livelihood patterns and income, even in the months and years following the floods. This significantly hampers efforts to reduce poverty. The adverse effects of floods, such as the depletion of the rural economy and the exacerbation of poverty, are supported by various international research (Brouwer et al., 2007; Khayyam, 2020). The results are in line with the previous research. (Ahmad et al., 2023; Ali et al., 2023; Hussain & Khan, 2023; Maranzoni et al., 2023; Shah et al., 2023) (Salman & Li, 2018). There is a statistically significant association between floods effect and increase the poverty level in the region (Ahmad et al., 2023; Ali et al., 2023; Hussain & Khan, 2023; Maranzoni et al., 2023; Shah et al., 2023).

4. Conclusion and recommendation

This study highlights the critical relationship between flood perception, risk communication, and economic vulnerability among Peshawar, Charsadda, and Nowshera residents in Khyber Pakhtunkhwa. While managing the consequences of floods is vital, addressing the root causes of community vulnerability, such as unregulated land use, poor infrastructure planning, and limited climate change adaptation efforts, is equally important. Strengthening structural measures like embankments, enforcing zoning laws

to restrict settlements in high-risk areas, and promoting climate-resilient infrastructure can reduce flood vulnerability. The research findings stress the need for targeted and actionable strategies by local governments and flood control authorities. These should include developing community-based early warning systems, clearly marked evacuation routes, accessible flood shelters, and financial relief programs for affected families. Additionally, risk communication must be institutionalized through continuous education, drills, and two-way information exchange with local communities—especially those near River Kabul and River Swat—to inform and empower people to act during emergencies. Future work should include longitudinal studies to monitor flood perception and preparedness changes over time and comparative research across other flood-prone regions to improve generalizability. Moreover, integrating qualitative methods such as focus group discussions or participatory mapping could provide deeper insights into community-specific needs. Advancing technological solutions such as mobile-based alert systems and GIS flood risk modelling should also be prioritized to support adaptive risk management strategies.

Limitation

This study acknowledges several limitations. Flood perception is subjective and influenced by personal experiences, socio-economic factors, and cultural contexts, which may not always align with actual flood risks, limiting the generalizability of the findings. Additionally, flood communication is affected by external factors such as media exposure, education, and trust in authorities, complicating the assumed direction of causality. Other variables, such as socio-economic status and community preparedness, may also influence both flood perception and flood communication. Lastly, the use of the chi-squared test to explore the relationship between floods and poverty may not capture all complex interactions, suggesting that more advanced statistical methods could offer deeper insights in future research.

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Data availability:

Data will provide on request to the corresponding author

Appendix

Questionaire:

The questionnaire collect the data on the likert scale

From strong agree to strong disagree

Dread and perception:

PR1 I have perceived like hood of the flood

PR2 I have perceived dread and fear of the flood

PR3 I have perceived threat to life

PR4 I have seen increase the occurrence of the flood

PR5 I have expected the damage of the flood in the future

PR6 I have seen flood de value the property

PR7 I have concern about the human interaction with flood

PR8 I have fear the flood from previous knowledge.

Awareness and knowledge:

PR10 I have seen perceived the settlement protection.

PR11 I have knowledge about the climate change.

PR12 I have knowledge about the dykes.

PR13 I have perceived understanding of flood cause.

PR14 I possess expertise in the rescue and evacuation processes.

PR15 I have knowledge about the emergency protocols.

Social Trust:

PR16 I have confidence in the information obtained from many sources..

PR17 I possess a sense of confidence in disaster management authorities.

PR14 I possess confidence in the efficacy of management policies.

PR15 I have confidence in the government's emergency strategy.

PR16 I possess confidence in the policies implemented by the local administration.

Disaster experience:

PR17 I have experience a flood.

PR18 I have experience an earthquake.

PR19 I have experience a landslide.

PR20 I have experienced a typhoon

Flood risk communication:

RC1 I have received announcement on radio.

RC2 I have received announcement text messages.

RC3 I have received announcement on mobile speakers.

RC4 I have received announcement through pamphlets.

Accuracy:

RC5 I have received Accuracy on radio broadcasts.

RC6 I have received Accuracy on television broadcasts.

RC7 I have received Accuracy on text messages.

RC8 I have received Accuracy on pamphlets.

Reliability:

RC9 The dependability of information obtained from radio, television, and other sources is evident.

RC10 The information provided by NDMA, PDMA, and local government is reliable.

RC11 The information provided by community members and local leaders is deemed reliable.

RC12 I possess confidence in the reliability of the information made available by the army and police departments.