

# Factors Determining the Residents' Preparedness against Natural Disasters: A Case Study of Pakistan Flood-2010

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**Abstract:** The present study was conducted to explore the factors responsible for residents' preparedness against flood-2010 in selected union councils of District Charsadda, Khyber Pakhtunkhwa, Pakistan. Extensive field surveys were carried out in the study area and quantitative and qualitative data were collected through pre-designed questionnaires. The results showed that rural communities have reduced resilience against the flood devastation due to limited livelihood options and lack of resources. Primary livelihood sources like livestock farming, agriculture, and personal business were severely affected by floods. According to the vulnerability analysis, widows (33%), physical disability (20%) and children (47%) were the most vulnerable segments of society. Moreover, poor infrastructure developments and limited access to social services further worsened the situation. Based on this research study, it is recommended that an early warning system, diverse and reliable livelihood options, and infrastructure development are needed to decrease the vulnerability of the locals towards natural disasters.

**Keywords:** Flood-2010; socio-economic effects; Charsadda; monsoon floods; vulnerability.

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## 1. Introduction

Climate change is one of the main global issues of the 21<sup>st</sup> century (Karl and Trenberth, 2003; Nordhaus et al., 2019; Seddon et al., 2019). There is a growing expectation that increases in the concentrations of greenhouse gases arising from anthropogenic activities will lead to significant climate change (Mallakpour et al., 2019). This climate change is exacerbating disaster's frequencies and magnitude which adversely affects the ecosystem services and socio-economic livelihoods of the people (Gunderson and Holling, 2002; Holloway, 2005). Communities experience disaster differently in different regions. People are vulnerable to disasters because of their social, economic and environmental vulnerability (Smith and Ward, 1998; Bronstert, 2003; Van Aalst, 2006; Lind et al., 2009; Pham et al., 2020).

Households resist and can cope with the adverse impacts of disasters through the assets that they possess (Vatsa, 2004). The unfortunate truth is that poorer and more vulnerable people are hit hardest because they have not sufficient resources, skills and knowledge to cope with disasters (ISDR 2004; Hegerl et al., 2007).

During the last two decades, the frequency of climate-induced natural hazards such as floods has been increased (Mallakpour et al., 2019). Humans have influenced the magnitude and behavior of the flood that leads to adverse impacts on communities in the flood plain areas (Nott, 2006; Boshier, 2008). Each year, many people at risk are growing, especially in developing countries with high poverty levels (Alexander, 2008). People have fewer resources due to high poverty levels, which makes them more

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vulnerable to disasters (Ariyabandu and Wickramasinghe, 2005; Azam et al., 2019). Natural disasters have the most devastating impact of the portions of the population that are least able to prepare for, respond to, or recover from its effects (Lindsell and Prater, 2003; Kiefer et al., 2008).

Disaster vulnerability in affected communities is dependent on many factors like gender, their capacities and the options available to them (Ariyabandu and Wickramasinghe, 2005). The impact of disasters is usually quantified by adding up the number of the dead and injured and estimating the physical damage to building material, land, livestock, agriculture, stores and infrastructure (Sadeghi-Pouya et al., 2017; Biswas et al., 2019; Oyediji et al., 2019). Disasters affect men and women differently because of the different roles they occupy and the different responsibilities given to them in life and because of the differences in their capacities, needs and vulnerabilities (Snoussi et al., 2008; Gaillard, 2010; Pham et al., 2020).

A range of socio-economic approaches to hazards and also the perceptions about the natural catastrophe have been regarded as vulnerability analysis (Blaikie et al, 1994; Cannon, 1994). It has also been regarded as a dynamic condition that changes over time rather be a fixed state after the hazard has been over (Pelling, 1997; Pelling, 1997). In other words, it is crucial to recognize that vulnerability is a condition that is based on the economic and political position of the people and is apparent and oblivious to some of the directly affected ones and not the whole society.

In recent years, the frequency and severity of floods have been increased which has resulted in the loss of life, homelessness, damage to infrastructure and critical sectors of livelihoods such as agriculture, livestock and wage laboring (Gurer, 2008). The social disruption caused by floods can seriously affect the quality of life of individuals and impact on the fabric of affected communities (Gordon, 2004). As well as the physical and health impacts of floods, individuals or communities are also severely suffered psychologically (Werritty, 2005).

Pakistan is suffering from hydro-meteorological disasters, including floods, droughts, and landslides for the last two decades. Changing climate, however, has increased the potentiality of flash flooding in semi-mountainous and mountainous regions causing huge socio-economic losses. The floodwaters that swept south along Pakistan's Indus River starting in

July 2010 created a humanitarian emergency that was the worst disaster in history. The monsoon induced floods displaced millions of people, including deaths and injuries and destroyed millions of houses and damaged infrastructure. The flood is estimated to have eventually affected more than 20 million people, including 1,802 deaths and 2,994 confirmed as injured (NDMA, 2010). Floods have severely affected all sectors of livelihood, including agriculture, livestock and other valuable assets. People were internally displaced from their homes and were living in temporary shelters in camps. These camps were densely populated and overcrowded. Camps were mostly occupied by the rural areas/union councils (UCs) displaced population. Due to flood-disabled communication and power supply, the population was deprived of electricity, telephone, and natural gas. The majority of flood-affected, have no proper shelter. Destroyed bridges and roads linking urban to the flood-impacted rural areas have produced a drastic lack of supply chain for food items and commodities.

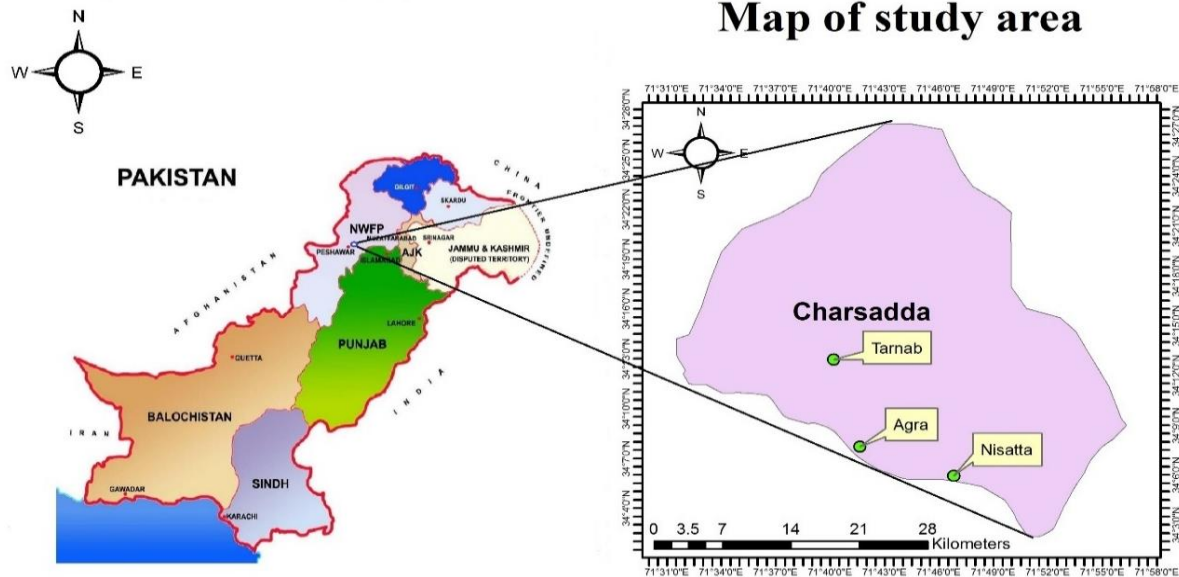
The present study was conducted to identify the factors responsible for residents' preparedness against Flood-2010 in selected union councils of District Charsadda, Khyber Pakhtunkhwa, Pakistan. This will contribute to inform the ongoing response in Pakistan, to improve models for the future, and to expand the knowledge-based research on the disaster. Furthermore, it is envisaged that the outputs of the study will also be key inputs in the designing of sustainable mitigation measures to minimize the impact of floods and the associated risks.

## 2. Materials and Methods

Both primary and secondary data sources were exploited to achieve the objectives of the study. For primary data collection, questionnaires, personal observations and global position systems (GPS) were used while secondary data were acquired from the concerned government departments.

### 2.1. Selection of study area

According to National Disaster Management Authority-2010 (NDMA, 2010), about 20.1 million people were severely affected with 1.9 million households damaged or destroyed during flood-2010. Overall, around 78 districts of Pakistan were affected, but three districts viz. Charsadda, Mardan, and Nowshera were identified as severely flood-affected (NDMA 2010).



**Fig. 1.** Map showing study area (District Charsadda as green and Union Councils as yellow).

These districts were declared as priority areas for rescue by different government and non-government organizations. The present study was conducted in three UCs namely Agra, Tarnab, and Nisatta in District Charsadda, Khyber Pakhtunkhwa (Fig. 1), for detailed and intensive analysis to achieve the target objectives of the present micro-level study.

These UCs are located between  $34^{\circ}8'43"N$   $71^{\circ}43'51"E$  with an altitude of 276 meters above sea level. District Charsadda was selected as the sampling area for this study, where almost 70% of the area was affected by the flooding and 75% of people lost their properties and basic livelihood assets. Charsadda is one of the most fertile areas of the Khyber Pakhtunkhwa province. Three rivers, including River Jindi, Kabul River and Swat River flow through the province, which provides water for irrigation purposes, but at the same time, these rivers are also considered high threats of flooding during monsoon season.

## 2.2. Primary Data Acquisition

A semi-structured questionnaire was designed to collect information about the socio-economic characteristics of the sample population like access to education, age-wise categories of widows and respondents with a physical disability and accessibility ways to the study areas. The second part was comprised of the questions related to the vulnerability analysis e.g. vulnerability of livelihoods to floods, its causes and overall analysis of different vulnerable groups. There were 3500 households in the three UCs of the study area (Agra = 1200, Nisatta =

700 and Tarnab = 1600). Out of the total households, the damaged households in Agra, Nisatta, and Tarnab were 800, 637 and 1200, respectively. The randomly sampled households used for questionnaire surveys in Agra, Nisatta and Tarnab were 265, 210 and 400 (Cooper and Emory, 2000; Sekaran, 2003). Global positioning system (GPS) was used to acquire geo-location of the respondents in different union councils.

## 2.3. Data Analysis

The collected data were critically managed and then entered into Microsoft excel sheet for data management and analysis. The student T-test was applied to evaluate the impact of flood-2010 on the livelihood of the affected people in the study area using Microsoft Excel. The study area map was prepared using Arc GIS10.2.

## 3. Results and Discussion

### 3.1. Socio-economic Impacts of Flood-2010

#### 3.1.1. Livelihood

Before the flood, agriculture was the principal means of livelihood for more than half of the population (65%) in the study area while livestock rearing and casual wage laboring contributed about 15 and 10% for their primary livelihood, respectively (Table 1). During the flood, principal means of livelihood were severely affected as revealed through the majority of the households.

**Table 1. Household population (total, affected by flood and sampled) in the selected Union Councils (UCs) of Charsadda**

Union Councils	Total household	Household affected by Flood	Sampled household (interviewed)
Agra	1200	800	265
Nisatta	700	637	210
Tarnab	1600	1200	400
<b>Total</b>	<b>3500</b>	<b>2637</b>	<b>785</b>

They had also lost their assets which resulted in their deprivation of basic essential items such as food, medicine, fuel, school items, etc. as they did not have enough money to buy. After the flood, there was a drastic reduction in their livelihood dependency on agriculture, livestock and wage laboring by 30, 5 and 6%, respectively. The effect of Flood-2010 was statistically significant as clear from the data analyzed through the t-test (Table 2). Earlier, high loss of agriculture crop, infrastructure, and livestock of small-scale farmers was reported (Smith and Ward, 1998; Biswas et al., 2019). Moreover, floods in South Africa during the 1980s caused severe damage to the farming sector. It has been found that deprivation of affected people from necessities, causing an economic burden that reduced their resilience against natural hazards like floods.

### 3.1.2. Building material

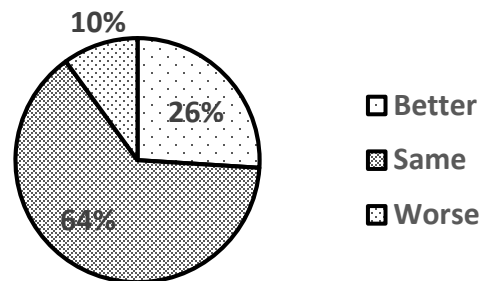
The floods caused total or partial damage to housing units in the study areas during September 2010. The extent of damage was higher in Kutcha houses (built of mud) compared to Pucca houses (built of substantial material such as stone, brick, cement, concrete or timber). The formers were severely affected due to floods. The reconstruction of damaged houses was based on appropriate, cost-effective, hazard-resistant engineering standards to reduce the risk to life and property. Houses located in flood plain were vulnerable and possess the potentiality of future damage.

The number of people assessed was still in vulnerable conditions having a safety net. Table 3 showed the percentage of damage, reconstructed and

houses under the reconstruction process in the study areas. It was identified that damaged houses were 12, 48 and 38% in Nisatta, Tarnab, Agra, respectively. The majority of houses were reconstructed (Nisatta 8%, Tarnab 32% and Agra 37%) while some were still in the reconstruction process (Nisatta 4%, Tarnab 12%, and Agra 5%). Different organizations were still working in the study area union councils to improve the livelihoods of affected people and provide technical support to them. As revealed through community group discussions, about one-third of households, impacted by floods were forced to relocate to other alternative areas, others shifted to a new area altogether while some displaced households sent their children to stay with other relatives which affected their pattern of life and social networks (Oyediji et al., 2019).

### 3.1.3. Infrastructure

Cutting off many communities from essential supplies and rescue operations was observed due to severe damage to the road infrastructures, school and health facilities such as hospitals, phone lines, electricity supply, and other installations. Some areas were inaccessible due to collapsed bridges. Till September 20, 2010, reconstruction and rehabilitation of damaged infrastructure were completed in some areas where non-government organizations (NGOs) and other charitable agencies got access. However, in some areas, the reconstruction and restoration of physical infrastructure would continue in the long-term developmental program.

**Fig. 2. Respondents' Access to Education****Table 2. Effect of flood on the livelihood of the affected population in the selected UCs of Charsadda**

	Pre-Flood	Post-Flood	Difference	Student t-test (P value)	Union Councils	Total household	Household affected by Flood	Sampled household (interviewed)
<b>Agriculture</b>	65%	30%	35%	0.000	Agra	1200	800	265
<b>Livestock</b>	15%	5%	10%	0.000	Nisatta	700	637	210
<b>Wage Laboring</b>	10%	6%	4%	0.002	Tarnab	1600	1200	400



**Table 3. Impacts of flood on building material of households in different union councils of the study area (UCs) of Charsadda**

Union Council	Damages	Reconstructed	Reconstruction in progress
Agra	304 (38%)	256 (32%)	40 (5%)
Nisatta	76 (12%)	51 (8%)	25 (4%)
Tarnab	576 (48%)	444 (37%)	144 (12%)

An emergency was called throughout the country and the local as well other peoples from different districts and provinces collected money and other utensil and provided the affected people privately. The damage to the houses and loss of animals during the flood caused poor people to suffer from severe economic losses which weakened them financially and their resistance against flood vulnerability.

### 3.1.4. Water

Due to the flood, water was severely contaminated which resulted in waterborne diseases. The majority of the underground tube wells were severely contaminated due to siltation. The households' access to clean water was substantially affected after the flood. About 75% of households had better access to safe drinking water in terms of quantity and quality while 15% of households had not sufficient water for their basic needs and were facing water shortage and 10% of households were using drinking water from contaminated sources such as river and unprotected wells. This contamination of drinking water exacerbated the chances of waterborne diseases. The flood caused severe damage to the water systems installed in every house of the study area and was required to install as fresh which caused an extra expenditure and a financial burden too. Moreover, with the drinking of contaminated water, health issues emerged which also caused health and financial issues.

### 3.1.5. Education

A total of 34 educational institutions in the study area were severely damaged due to the flood; out of these 34, 15 were fully damaged while 19 were partially damaged. However, affected institutions have been reconstructed and were currently operational. Respondents reported 26% better, 64% the same, and 10% worse access to education services after floods in these study areas (Fig. 2).

### 3.1.6. Access to Health Services

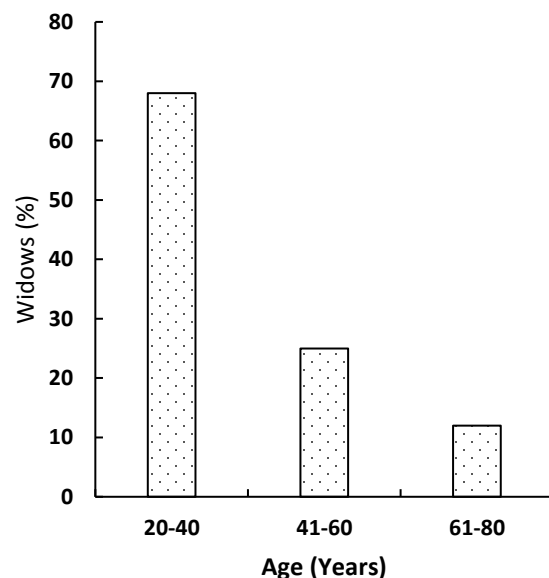
Flooding caused extensive damage to the infrastructure of health centers, which resulted in the limited provision of basic health care services to the

affected communities. Through focused group discussions, the present study revealed that about one third sampled households experienced poor access to basic health care services. The main reasons were the cost and distance to health care facilities, however different relief agencies provided short term health services to affected communities and implemented long term development programs to restore and reconstruct basic health units (BHUs) and other health centers. Majority households reported that their access to basic health services has been improved.

## 3.2. Factors contributing to vulnerabilities

### 3.2.1. Rational of the vulnerability Assessment

Vulnerability assessment is an important diagnostic tool that provides analytical data to the decision-makers for planning and implementation of any policy regarding disaster risk management (Holloway 2005). An effective vulnerability assessment would help find out the nature and level of risks associated with natural hazards (Alexander 2008). Moreover, it is also helpful to identify the worst affected communities, their available means/resources to reduce the risks and what initiatives could be undertaken to reduce vulnerability and strengthen the resilience capacities of people at risk (Holloway 2005, Hegerl et al., 2007; Pham et al., 2020).

**Fig. 3. Age-wise categories of widows**

### 3.2.2. Vulnerable groups

#### Widows

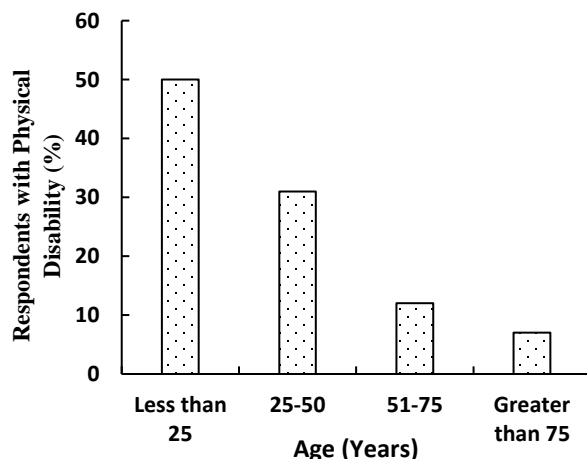
Widows are the most marginalized members of society. They completely fail to effectively use their resources and protect their assets, including land, crops, animals, etc. during disasters (Hegerl et al., 2007). Fig. 3 is representing the age-wise widows' vulnerability to disasters in the study areas. There were 68, 25 and 7% widows from the age groups (20-40 y), (40-60 y) and (60-80 y), respectively.

#### Physical Disabilities

Women, men, and children can particularly be vulnerable to the negative impacts of disaster for their physical disability and age status. Figure 4 showed that there were 50% physical disability in less than 25 ages, 31% between 25-50 ages, 12% between 50-25 ages and 7% between 25-100 ages, respectively. People with disabilities were more vulnerable to disasters like floods.

#### Children Vulnerability

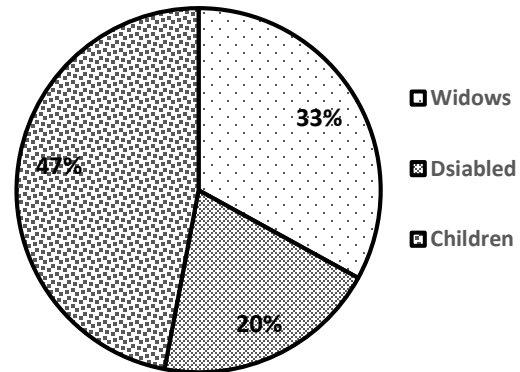
Children are the most vulnerable and unprotected group of any society facing disasters whether natural or man-made. They may experience malnutrition and have an increased risk of diseases (Hegerl et al., 2007). They may also become victims of abuse, neglect, and violence when they lose their families in disasters. It was identified through focused group discussions that more than 70% of children were in the situation of vulnerability. As earlier mentioned, children and women are the most vulnerable groups of society under natural disasters. This situation becomes more adverse where the household is headed by a female (Azam et al., 2019).



**Fig: 4. Age-wise distribution of respondents with physical disability**

### 3.2.3. The overall analysis of vulnerable groups

Fig. 5 shows that the mean percentage of the vulnerability of widows, disable people and children was 33, 20 and 47% for disaster particularly floods. The data clearly showed that the children were the most vulnerable among the three components investigated. The results are in line with the results of alone vulnerability analysis regarding children.



**Fig. 5. The overall analysis of different vulnerable groups**

The reason might be due to the more chances to undergo malnutrition and an increased risk of diseases (Hegerl et al., 2007). Several studies have confirmed that women and children were the most vulnerable groups of society under natural disasters (Nasreen, 2008; Pham et al., 2020). Additionally, women face more problems due to their more chances of victimization of violence (Nasreen, 2008, Nasreen, 2012).

#### 3.2.4. Infrastructure

Poor infrastructure often increases people's vulnerability. Accessibility plays a key role in disaster management, particularly ineffective evacuation. The study areas were found to be accessible in terms of roads and other communication, but this communication system passed through flood-prone areas where more chances of damages to infrastructure exist. Consequently, this potential damage to infrastructure would increase the vulnerability of the people (Azam et al., 2019). These UCs were found accessible, 31% by vehicle (4×4), 33% by car, 33% by truck and 3% by walk (Fig. 6). It was important to enhance communication and transportation systems so that the people would effectively respond to disasters.

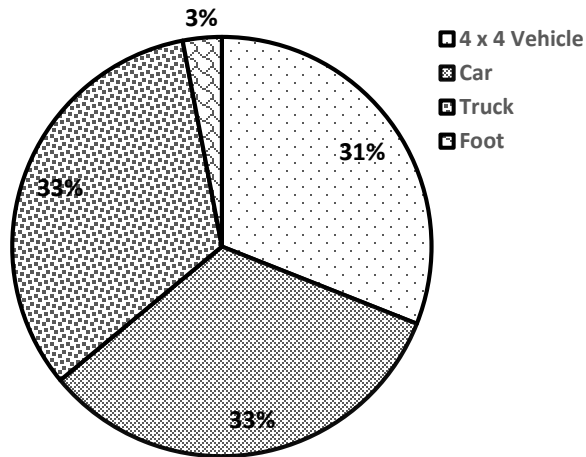


Fig. 6. Possible accessibility ways to the study areas.

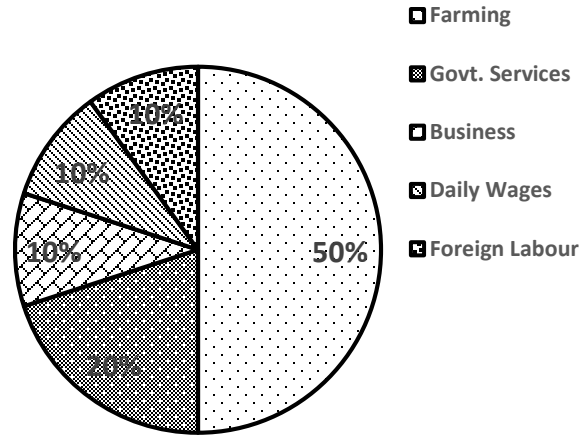


Fig. 7. The vulnerability of livelihoods to floods

### 3.2.5. Livelihood

During the focus group discussions, it was found that about 50% of the community’s population was affiliated with farming and it was the main livelihood activity of the study areas (Fig. 7). The remaining people were involved in government services (20%), businesses (10%), daily wages (10%) and labor in foreign countries (10%). These livelihoods were vulnerable to disasters like floods and it was important to make the livelihoods more resilient (Azam et al., 2019; O’Donnell and Thorne, 2020).

### 3.2.6. Overall causes of different vulnerabilities

Various causes of flood vulnerability in the study area were found. The data collected from the sampled households revealed that poverty (32%) and lack of alternative livelihood options (24%) were among the main causes of vulnerability as shown in Figure 8. This was followed by age and physical disability (13%), gender (10%), infrastructure (10%), equity (7%) and cultural beliefs (5%). Poverty is one of the key factors that contribute to vulnerability (Van Aalst, 2006; Azam et al., 2019; Pham et al., 2020). The majority of the people are involved in farming activities and their mode of subsistence is livestock and agriculture. They are susceptible and vulnerable to disasters lack of resources for an emergency (Alexander, 2008, Sadeghi-Pouya et al., 2017).

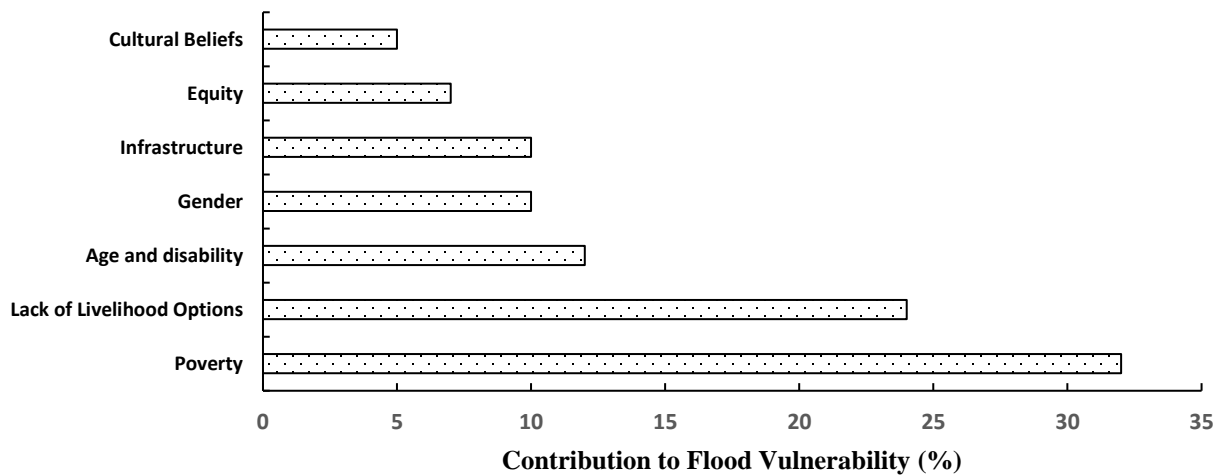


Fig. 8. Causes of flood vulnerability in the selected study area

#### 4. Conclusion

Flood-2010 had adverse impact on the socio-economic status of the people residing in the study areas. To a large extent, livelihood patterns of the affected people have been severely damaged and the livelihoods are exposed to future risk. Various causes have been found responsible for the people's vulnerability to the flood hazards and it poses a challenge for key stakeholders to reduce or minimize vulnerability. The study has also revealed that the effects of floods are interrelated with different sectors of society. Water contamination during floods and its handling from the tube wells had increased the chances of waterborne diseases in the study area. Accessibility to key social services has been disrupted due to severe damage to infrastructure (roads and bridges). The study demonstrated that current coping strategies being employed by most households are not very effective. According to the people's perception, their livelihoods are not sustainable and are more susceptible to disasters. In this regard, communities should be encouraged to build houses using durable materials and away from flood-prone areas. Floods early warning, proper evacuation plans, and mitigation measures can also play an important role in building community resilience against natural hazards. For flood-affected communities, government and non-government organizations can introduce alternative livelihood strategies.

**List of Abbreviations:** ISDR: International Strategy for Disaster Reduction; NDMA: National Disaster Management Authority; UCs: union councils; GPS: Global Position System; NGOs: Non-Government Organizations; BHUs: Basic Health Units; y: Years

**Competing Interest Statement:** All the authors declare that they have no competing interests.

**Author's Contribution:** All the authors have equal contribution to the planning, conduction, and writing of the research article. All the authors have read and approved the final manuscript.

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