Cognitive Mapping for Flood Risk Management: A case study of rural communities along Indus and Chenab Rivers, Pakistan.

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ABSTRACT

Climate change is one of the contributing factors in increasing the frequency and severity of flood disasters around the globe. Developing countries are being disproportionally affected. In 2010, Pakistan witnessed one of the worst floods in its history. One-fifth of the country was severely affected, leading to major economic losses and casualties. It is vital to understand the public risk perception for effective flood risk management. This study examines flood risk perception and psychological distance to climate change of rural communities along the Indus River and Chenab River in Muzaffargarh, Pakistan. Flood risk perception was measured using three main components, i.e., preparedness, worry, and awareness. Psychological distance to climate change was determined using five dimensions., psychological distance, geographic, social, temporal, and uncertainty. Yamane sampling method was used, and 365 samples were collected. Data was collected using a questionnaire based on a 5-point Likert scale. Respondents were also asked to outline the 2010 flood extent as perceived by them. Moreover, GIS was used for visualization and data analysis, where maps were converted to vector polygons. The indicators considered for generating maps were age and distance to the nearest river. Kernel density was used to show the extent of the 2010 flood delineated by people at risk. Descriptive statistics, chi-square test, ANOVA-test, and Pearson's correlation were performed. Results indicate that overall flood risk perception and psychological distance to climate change was moderate in a high flood risk area. A negative correlation was also observed between uncertainty and worry. This study can facilitate disaster management authorities in designing integrated flood risk management plans. It also highlights the need to improve risk communication strategies which will help people to understand climate change better and adopt sustainable behavior.

Keywords: *Disaster, Flooding, Awareness, Preparedness, Worry, Pakistan, Rural areas, Climate change, Cognitive maps, Spatial extent, Risk perception, GIS, Flood memory*

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Samavia Rasool

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CHAPTER 1

INTRODUCTION

1. Introduction

Climate change affects disaster risk in two major ways. Firstly, the vulnerability of communities to hazards is increased due to changes in livelihood, eco-system degradation, lack of food and water availability. Secondly, it increases the severity and frequency of weather-related hazards (Shaw, Pulhin, & Pereira, 2010). Around one-third of all global disasters were floods. It accounts for one-third of the economic losses and more than half of the casualties related to disaster (Loster 1999). During 1991-2005, floods caused an economic loss of US$ 1,193 billion and 960,000 deaths (Seid 2013). Developing countries being the most vulnerable ones, are disproportionately affected. Over the past few decades, most disasters were meteorological or hydrological, held responsible for 79% of the economic losses and 45% of the deaths(Murray and Ebi 2012). While there is a certain improvement in reporting flood events, evidence indicates an increase in the severity and frequency of floods (Baan and Klijn 2004). Climate change and increasing urbanization are of contributing factors (Douglas, Alam et al. 2008). Moreover, it is increasingly acknowledged that traditional flood mitigation measures based on structural protection are unsustainable to control floods. As a result, there is a paradigm shift in managing floods (Evers, Jonoski et al. 2016). Concerned authorities now focus on multi-faceted flood risk management approaches that include non-structural measures such as land-use planning, flood forecasting, awareness-raising, and relocation (O'Neill, Brereton et al. 2016, Jamshed, Rana et al. 2018). The role of understanding the social aspect of floods is vital for effective flood risk reduction. According to literature, flood risk management is highly dependent on risk perception and hence is important to determine the success of risk management in reducing vulnerability (Aitsi-Selmi, Egawa et al. 2015).

Among the hydro-meteorological disasters, floods have been the most frequent, leading to huge economic losses and causalities. According to the Organization for Economic Co-operation and Development (OECD), floods have caused US $40 billion in damages across the world on an annual basis (Wannous and Velasquez 2017). From 1995 to 2015, the number of flood events that hit the world was 3,062, affecting 2.3 billion people, killing 157,000, and causing an economic loss of US$ 662 billion (Aitsi-Selmi, Egawa et al. 2015). UNISDR reports that there is also a change in the severity of floods in recent years (UNISDR 2015). Coastal flooding, riverine, and flash floods have become more frequent. The effects of floods on agriculture and food led to malnutrition problems in developing countries (Baan and Klijn 2004). Asia is the most vulnerable region to water-related disasters where more than 90% of people were affected and 45% were killed during the disasters between 1980-2006. In 2007, 3300 deaths were reported in Bangladesh and India alone.

Like the other developing countries, Pakistan is also being affected by climate change, where 48% of all-natural hazards attributes to flooding (Khan 2013). Out of 156 districts, 67 are considered at high flood risk (Jamshed, Rana et al. 2019). According to expert's opinion, melting glaciers and changing weather patterns are primarily responsible for changing the frequency and magnitude of floods (Seneviratne, Nicholls et al. 2012). Since 1900, almost 67 floods of various magnitudes have hit Pakistan (Hashmi, Siddiqui et al. 2012, Khan 2013, Hussain, Tayyab et al. 2021). Furthermore, evidence infers the occurrence of one major flood after every three years, which causes significant damages to infrastructure, crops, and human lives (Hashmi, Siddiqui et al. 2012). The flooding of the Indus River in 2010, which led to a humanitarian disaster, is considered the worst one in the history of Pakistan (Jamshed, Rana et al. 2017). These flood events affected 20 million lives, destroyed 1.6 million houses, left 14 million people homeless, and killed approximately 1200 to 2200 people (Khan 2013, Jahangir, Khuhawar et al. 2015). Infrastructure and agriculture were exterminated, leaving millions of people vulnerable to water-borne diseases and malnutrition (Qasim, Qasim et al. 2016). Flood risk management approaches have been evolved and, therefore, demands active participation by the population at risk (Bradford, O'Sullivan et al. 2012). In order to have an effective flood risk management plan, it is vital to apprehend the perception of vulnerable populations about their own flood risk (Bubeck, Botzen et al. 2012, Lechowska 2018). There is currently limited research examining the flood risk perception with climate change and cognitive mapping being used to assess the flood risk situation perceived by the population

(O'Neill, Brereton et al. 2016). However, there are disparate studies available on these issues. This study aims to assess flood risk perceptions and psychological distance to climate change in rural areas of Muzaffargarh, Pakistan. It also highlights the dimensions influencing spatial and temporal risk perception of floods and climate change. Moreover, cognitive maps are used in order to determine the perceived spatial extent of the 2010 flood.

1.1 Objectives

~~3.~~1. To assess flood risk perceptions and psychological distance to climate change.

~~4.~~2. To highlight the dimensions influencing spatial and temporal risk perception of floods and climate change.

~~5.~~3. To determine the perceived spatial extent of the 2010 flood.

~~6.~~4. To suggest strategies for effective Flood Risk Management.

1.2 Scope of the study

1) This research is concentrated on four union councils of Muzaffargarh. The confinement of the study area was necessitated due to limited resources and a time frame within which the research needs to be completed.
2) The study does not include any variable directly related to flooding, making the perception of respondents the prime focus.
3) Climate Change, Vulnerability Assessment, and Flood Risk Mapping have not been covered in this study.
4) Results are entirely based on the information elicited from fieldwork.
5) Results obtained may not be generalized or interpreted to other areas of Pakistan.

This study is based on the following presumptions:

1) It is assumed that the sample population shows similar characteristics with the rest of the population residing in the Muzaffargarh District. Hence, they are considered as a true representation of the Muzaffargarh community.
2) Information given by the respondents is assumed to be true.

CHAPTER 2

LITERATURE REVIEW

2.1 Climate Change and Floods

Climate change is emerging as one of the major threats facing our world, adding significant stress to the environment and our societies (Wright, Vermeulen et al. 2014). From shifting weather patterns to rising sea levels leading to lower agricultural productivity and increased risk of calamitous flooding, the unprecedented impacts of climate change are global in scale. A causal relationship has been observed between climate change and floods (Shaw, Pulhin et al. 2010). Flooding is considered a disastrous natural hazard that can inflict significant damage to lives, the environment, infrastructure, and public services. Although flooding is a frequent phenomenon in developed countries, its impacts are more disastrous in developing nations (Aderogba 2012, Alderman, Turner et al. 2012). It is believed that climate change has exacerbated the intensity and frequency of floods worldwide (Baan and Klijn 2004). Over the past 30 years, floods have affected 2.8 billion people, among which 4.5 million were left homeless. The casualties recorded were around 540,000, and injuries were approximately 360,000 (Doocy, Daniels et al. 2013). As a result of past experience of floods and potential costs related to future flooding, a significant change has been introduced in the field of flood risk management. There is a paradigm shift from traditional methods which were based entirely on structural protection to a multi-faceted approach that focuses more on resilience rather than resistance(O'Neill, Brereton et al. 2016). Moreover, these new approaches also incorporate non-structural measures such as relocation, flood forecasting, land-use planning, flood-proofing, and insurance (Werritty 2006, Wolsink 2010).

2.2 Psychological Distance to Climate Change

Climate change has now become a global issue. From rising sea levels to extreme temperatures and unprecedented weather patterns, the repercussions of climate change are prodigious and global in scale, apart from mitigation measures. Societal transformations play a vital role in combating this global issue (Spence, Poortinga et al. 2012). To engage the public, it is important to understand the perception of people related to climate change. Research infers that climate change is perceived as distant (Lorenzoni and Pidgeon 2006, Jones, Hine et al. 2017, Loy and Spence 2020). Construal theory indicates a relationship between the behavior of people and psychological distance. The psychological distance is often classified into four inter-linked yet distinct dimensions: social, hypothetical, spatial, and temporal (Trope and Liberman 2010). Psychological distance is a cognitive separation between self and other instances like time, events, or persons. Psychological distance explains the abstract or concrete perception of the events or objects that surround people (Chu and Yang 2018). An event can be perceived as psychologically close or far away. If it is perceived to be psychologically far away, it is considered as abstract, while when it is psychologically perceived close, the representation is concrete (Liberman, Trope et al. 2007, Chu and Yang 2018). Considering climate change, if a person perceives climate change to be psychologically close to oneself, there is a high possibility that he/she will take it concretely and will be willing to take action (Spence, Poortinga et al. 2012, Singh, Zwickle et al. 2017). In addition, if the distant risk of climate change has to be effectively communicated, it is imperative to underline the disastrous effects of climate change(Chu and Yang 2020).

Studies have been conducted to assess the psychological distance to climate change. Recent research by (Myers, Maibach et al. 2013) indicates an accurate perception of people about the current phenomenon. Each individual's perception was taken into account where different factors were considered, such as changes in temperatures or shifts in weather patterns that were then co-related with different variables, i.e., belief that humans are responsible, climate change is an immediate threat and worry about this global issue. Another study conducted by (Joireman, Truelove et al. 2010) where outdoor temperatures were primed, and the results revealed that cognitive schemas and heuristics influenced the perception of people about climate change. This research supported a causal relationship between personal experience related to climate change and the belief in anthropogenic causes of climate change. However, the impact of personal experience is not the same across the political spectrum. According to some studies, the influence of personal experience is more solid among political independents (Egan and Mullin 2012).

Researchers have also analyzed specific experiences related to weather or climate change. For instance, serious concern was reported among farmers about climate change who perceived significant changes in water availability. Moreover, people who have experienced a flood in their lives are more certain and concerned about climate change than those who do not. Concisely, there is a strong association between perceived exposure to climate change effects and an increase in concern about the phenomenon. Although the individuals reported experiencing changes in weather or temperatures but did not explicitly relate them to climate change. However, these reports are indirectly inferring these experiences as concern about climate change (McDonald, Chai, & Newell, 2015).

2.3 Flood Risk Perception

Flood risk management has become an essential part of disaster risk management and comprehensively considers natural and societal processes related to floods (McGahey 2009). While risk analysis methods are generally based on objective measures, subjective risk measures such as risk perception are currently being acknowledged as critical in the context of flood risk management (Brown and Damery 2002). Since there is always a discrepancy between expert risk assessment and public risk perception, the responsible authorities need to understand the public risk perception to design effective flood risk management policies (Morgan 1997). The behavior and attitude of people help in determining their level of preparedness. In contrast, the knowledge about their perceptions enables researchers to identify qualitative characteristics of risks such as immediate, known to science, voluntary, and not controllable. Moreover, the knowledge of risk perceptions is a pre-requisite to effective risk communication and is meant to increase coping capacity and social resilience (Hillson and Murray-Webster 2004). On the other hand, the limited understanding of perceptions might affect risk communication, which becomes the reason for the failure of risk management strategies (Baan and Klijn 2004, Jonkman, Vrijling et al. 2008).

Over the past few years, research has been published on flood risk perception (i.e., (Boholm 1998, Bradford, O'Sullivan et al. 2012, Bubeck, Botzen et al. 2012); (Kellens, Zaalberg et al. 2011, Wachinger, Renn et al. 2013, Birkholz, Muro et al. 2014, Raška 2015). Bradford et al. (2012) explored the relationships between awareness, worry, and preparedness using responses from 13 countries across Europe, but only demographic factors of flood risk perception were considered. (Bubeck, Botzen et al. 2012) highlighted contributing factors that can influence preparedness. Whereas (Wachinger, Renn et al. 2013), examined two factors: trust in experts or authorities and experience. (Kellens, Zaalberg et al. 2011) considered factors that can influence preparedness and risk perception. (Birkholz, Muro et al. 2014) described the basic constructs to understand flood risk perception. (Raška 2015) examined factors influencing flood risk perception in East-Central Europe.

2.4 Factors affecting Flood Risk Perception

2.4.1 Socio-Demographic Factors

Socio-demographic characteristics of an individual play a significant role in making a risk perception about a specific hazard (Chauvin, Hermand et al. 2007). Studies indicate that risk is highly related to gender, e.g., men are less risk-averse than women (Brody 1984). (Jonkman and Vrijling 2008) observed that around 70% of the flood-related casualties are men as they are more involved in risk-taking measures, emergency plans, supporting services and etc. Hence, findings infer that males may have low risk perception than females. Other factors are involved in shaping risk perception, e.g., household composition, age, etc. A positive correlation was found between risk perception and age (Grothmann and Reusswig 2006). However, there are various findings in the literature about household composition's impact on risk perception. For instance, one study concludes that the presence of children and women leads to higher vulnerability, but no co-relation has been found about their presence on risk perception (Houts, Lindell et al. 1984). Moreover, education is also an important factor while considering risk perception(Savage 1993). Findings indicate that less educated people tend to have a high level of risk perception. Other relevant studies also indicate a negative correlation between the two. According to (Ho, Shaw et al. 2008), highly educated people have low risk perception as they better understand flood information and government actions regarding flood mitigation. Therefore, they might feel more capable of controlling a disaster. Risk perception is also strongly associated with homeownership. Researchers have concluded that owners of the house have a high level of risk perception than lessee and the length of residency in vulnerable areas may also amplify risk perception (Burningham, Fielding et al. 2008).

2.4.2 Economic Factors

Many studies have shown that there is a correlation between employment and level of risk perception. Members employed outside the district show a high level of risk perception as they are uncertain about the situation in their hometown. Although there is no statistically significant relationship between employment factors and flood risk perception, empirical studies infer that self-employment is positively related to risk perception where self-employed respondents have to bear the losses by themselves (Reynaud and Nguyen 2016). Moreover, respondents with higher monthly income tend to have low levels of risk perception as they are aware that they can sustain any kind of losses. (Kellens, Zaalberg et al. 2011) Evaluated many studies and concluded that monthly income was negatively co-related to risk perception(Reynaud and Nguyen 2016). With regard to trust in government, various findings show a high level of trust in government results in a low level of risk perception (Su, Sun et al. 2017). Similarly, people taking insurance show the similar results whereas respondents who have borrowed loan increases their vulnerability, and hence might have a higher risk perception (Roder, Hudson et al. 2019).

2.4.3 Infrastructure and Utility Services

Past research work indicates that people living farther away from a hazard source express a low level of risk perception, and those residing near medical facilities also exhibit the same behavior (Kreibich, Thieken et al. 2005). Various findings reveal that people living on the ground floor perceive a higher level of risk than those living in buildings with a greater number of floors. Moreover, the type and age of buildings also have a strong correlation with risk perception (Reynaud, Aubert et al. 2013). Houses with no alleys or with more age are more vulnerable to flood risk, resulting in a high risk perception (Koks, Jongman et al. 2015). The material used in building a house also has a strong association with risk perception (Fedeski and Gwilliam 2007). Residents of pakka houses are less exposed to floods as compare to people living in katcha houses, and hence perceive a low level of risk. Accessibility to utility services is strongly related to risk perception (Ahsan and Warner 2014). These services include electricity, sanitation, water and gas supply, transportation, and means of communication. The absence of any of these leads to high risk, which increases the risk perception of residents.

2.4.4 Flood Related Information

In various studies, flood information is found to strongly associate with the feeling of security (Raaijmakers, Krywkow et al. 2008). Respondents were having greater flood information or knowledge exhibit a high level of risk perception compared to those with less knowledge (Botzen, Aerts et al. 2009). Furthermore, the opinion about flood protection responsibility can have an impact on flood risk perception (Becker, Aerts et al. 2014). Individuals who consider themselves to be responsible for flood protection measures proclaim to have a high flood risk perception. This may indicate their doubt in the effectiveness of measures taken by the government, and hence they perceive a high level of risk and prefer to adopt self-protection measures (Birkholz, Muro et al. 2014). Researchers have also found a negative relation between flood risk perception and trust in the government (Lin, Shaw et al. 2008). The trust in government also includes the trust in mass media and experts. Individuals having a high level of trust in the government do not focus on preparedness measures and entirely rely on the coping capability of the government to deal with floods (Hung 2009). On the other hand, respondents who doubt the government's early warning systems and rescue plans perceive a high level of risk perception. They are willing to learn flood-related information and mitigation measures (Terpstra 2011). Published studies highlight the role of previous hazard experience in shaping peoples' perception about risk (Pagneux, Gísladóttir et al. 2011). The experience can be either direct or indirect. Direct experience refers to the recent occurrence, number of deaths and damage experienced by the individual whereas indirect experience is related to social communication i.e., knowing about the impacts of hazard via social media, friends, TV, newspapers, mobile phones and etc. Direct experiences tend to have more impact on risk perception as they are more accessible in the memory of an individual (Kellens, Zaalberg et al. 2011).

2.5 Risk perception through various lens.

2.5.1 Preparedness

Preparedness encompasses the flood preparedness measures, implementation of mitigation measures, and coping capability and focuses on the resilience afterward (Raaijmakers, Krywkow et al. 2008). Studies indicate that highly prepared individuals respond to a flood better, which in turn improves community resilience and reduces the repercussions (Van Der Veen and Logtmeijer 2005). A research study conducted in Germany, Belgium, and Finland investigated respondents' self-assessed level of preparedness for future floods. The results were found to be contradictory to the general perception that a high level of awareness will lead to a high level of preparedness. This indicates that action-oriented preparedness is not dependent on awareness alone but other factors as well. Although no correlation was found between risk awareness and flood preparation, findings reflected that previous flood experience was strongly related to the level of preparedness (Bradford, O'Sullivan et al. 2012). It is expected that people are prepared to avoid the negative feelings of helplessness, insecurity, and fear (Slovic 2000). Furthermore, individuals are likely to imitate the same mitigation measures as the previous flood, which might be inappropriate for future floods (Weinstein 1989, Burn 1999). Regarding past experiences, failure of mitigation measures in the prior event can lead to a feeling of helplessness where respondents infer that damage will occur regardless of any measure taken. According to some studies, gender differences can influence the perceived level of preparedness (Bradford, O'Sullivan et al. 2012, Khan, Rana et al. 2020). The reasons are still unclear, but it can be said that a higher confidence level of men may be influenced by their role in the society. Self-efficacy proved to have a positive impact on preventive behavior (Lechowska 2018).

2.5.2 Awareness

Awareness is an integral part of flood risk management and may give an idea about the coping capacity of the exposed community. Awareness and proper knowledge highly influence the risk perception of the exposed community, affecting their capability to deal with floods (Lechowska 2018). Knowledge, on the other hand, influence the attitude of individuals. A better understanding of flood-related knowledge and awareness can improve the capability to cope with floods (Pagneux, Gísladóttir et al. 2011). Studies proved a positive correlation between previous experience and awareness and thus highlighted the role of past flood experience in improved behavior towards dealing with future floods (Weinstein 1989, Bradford, O'Sullivan et al. 2012). Flood events act as reminders to keep the exposed community cautious, while frequent occurrences keep the level of risk perception high. Conversely, the level of awareness tends to reduce as the period between flood events increases in a community. Moreover, in the exposed area where residents are mostly mobile, the flood knowledge which is supposed to be passed on between generations may not occur (Blyth, Baltas et al. 2001). People with no flood experience lack flood risk awareness and consider themselves safe (Bradford, O'Sullivan et al. 2012). Residents with past flood experience also lack flood risk awareness. Results showed that individuals residing in structurally protected areas exhibited low awareness by considering themselves to be flood immune (Terpstra 2010, Ludy and Kondolf 2012). It was presumed that the structural defense reduced the level of worry and hence affected the level of awareness.

2.5.3 Worry

Several studies indicate that exposed individuals are more inclined towards preventive measures if they are worried or frightened (Weinstein 1989). Therefore, case studies were carried out in Finland, Germany, Belgium, and Italy to analyze self-assessed levels of worry among the people (Bradford, O'Sullivan et al. 2012). Findings revealed that past experiences and flood risk awareness have some association with the level of worry. Moreover, less educated people were found to be worried more about floods. Based on the relation between income level and education, it can be deduced that people with higher income are less worried about the damage caused by floods (Hansen 1970, Sjöberg 1998). This social group perceives a low level of risk and worries less, as they can recover more easily due to better insurance and more resources. However, according to some researchers, there is no relation between risk awareness and worry or education and worry (Pagneux, Gísladóttir et al. 2011, Poortinga, Bronstering et al. 2011). Furthermore, literature infers that women are found to worry more about flood risks than the opposite gender. However, another modern trend of thoughts believes that worry and awareness do not correlate with a high level of preparedness (Lechowska 2018).

2.6 Case Studies on Flood Risk Perception

There are only a few studies for risk perception in Pakistan. A recent study on risk perception by (Khan, Rana et al. 2020) in a multi-hazard environment showed gender differences in Gilgit, Pakistan. The research used four components of risk perception: fear, attitude, awareness, and trust. Results showed that risk perception between both genders was low, and fear among them was found to be disproportionately higher. Another study by (Rana and Routray 2016) worked on three flood-prone cities of Pakistan: Rawalpindi, Sialkot, and Muzaffargarh. Actual risk and perceived risk were found to be positively correlated. Furthermore, a study by (Ullah, Saqib et al. 2020) measured risk perception in two districts of Khyber Pakhtunkhwa province. Results revealed multiple factors, including age, household location, and education level, have a statistically significant effect on risk perception. Recent research by (Rana, Jamshed et al. 2020)examined the factors associated with risk perception. Vulnerable urban communities were chosen and the findings showed that past experience and close proximity to hazards were the major contributors to higher risk perception-. (Fahad and Wang 2018) surveyed four districts of Khyber Pakhtunkhwa, Pakistan. Findings revealed that the farmers of the four districts are trying to cope with climate change but the obstacles such as lack of market access and shortage of labor are restricting the process of adaptation to climate change. Another research was conducted in flood prone districts of Punjab: Muzaffargarh, Rajanpur, and Rahim Yar Khan. Results inferred that age, income, location, gender, household size, disability, education level, and home–ownership were significant factors in influencing mitigation measures at the household level (Ahmad and Afzal 2020). However, no study was found that simultaneously assessed flood risk perception and psychological distance to climate change.

2.7 Cognitive Mapping

With the growing threat of frequency and severity, floods have become a major natural disaster affecting millions of people around the world (Barredo 2007, Newbery, Echenique et al. 2010). Furthermore, billions of dollars' worth of property and infrastructure are being devastated, inflicting significant economic losses(Merz, Kreibich et al. 2010, Alderman, Turner et al. 2012). However, the damage done by floods can be reduced or prevented by incorporating modern tools in flood risk management strategies(Schanze 2006, Lennon, Scott et al. 2014). GIS and Remote sensing play a vital role in the mapping and modelling of floods(Wang and Xie 2018). Flood inundation maps are essential in order to provide reliable flood risk information to people and hence are required in planning, emergency plans, flood insurance strategies and Risk communication etc. (Goodell and Warren 2006). Remote sensing also has a significant contribution in every field of flood risk management(Uddin, Gurung et al. 2013). Satellites with various spectral characteristics and periodicity enable them to acquire information of a broad-spectrum area. Comparisons before and after floods can be easily determined. Communication satellites provide real-time information contributing to early warning systems, whereas earth observational satellites continuously monitor the atmospheric factors which are responsible for causing the phenomenon(Khanna, Agrawal et al. 2005). Geographic Information Systems (GIS) has also made a substantial contribution to flood risk management (Rincón, Khan et al. 2018). It is being utilized to visualize flood extent maps and analyze flood maps to generate flood risk and flood damage estimation maps(Wiles and Levine 2002). Besides visualization and data analysis, GIS can be used in developing hydraulic and hydrologic models for evaluating flood profiles with a specific return period (Gutry-Korycka, Magnuszewski et al. 2006). These advancements can provide structural and technical fixes and hence improve the flood management approaches.

Various methodological approaches exist to capture risk perception (Bubeck, Botzen et al. 2012). One of the methods is to use questionnaires to elicit risk perception directly from respondents (Botzen, Aerts et al. 2009). Although their feedbacks can be represented spatially, they do not reflect any spatial extent information at an individual level. Another practice applied to determine risk perception of disasters, especially floods, is cognitive mapping(Gaillard 2008, Leone and Lesales 2009, Pagneux, Gísladóttir et al. 2011). It is a process of mental representation in which a person store, code, decode or recollect information about the characteristics and relative positions of the phenomena in their everyday life (Hirtle and MacEachren 1998). According to (Golledge 1997), cognitive mapping lies under spatial cognition and is a part of environmental cognition. Furthermore, they outlined that environmental cognition consists of many components such as impressions, awareness, beliefs, etc., that people have about their surroundings, thereby adding important integrant to the more established cognitive components. The interest in spatial dimension of human behavioral sciences emerged during the late 20th century. (Ruin, Gaillard et al. 2007) defined cognitive mapping as a tool used to map perception while (Matei, Ball-Rokeach et al. 2001) realized that cognitive maps represent perception compared to objective data. According to literature, cognitive mapping can be categorized into two main comprehensive branches: firstly, abstract concepts with no external representation of spatial component; secondly, formation of spatial maps due to external representation of perception maps (Brilly and Polic 2005, Wagner 2007).

2.8 Case Studies on Cognitive Mapping

Cognitive mapping has been used in various studies to map the spatial extent of risk perception. In (DeChano and Butler 2001), the perception of people was assessed related to debris flow where they were asked to mark the land sliding prone areas. (Huber 1979) evaluated flash floods by using an ethnographic approach and sketched his maps. In another study by (Brilly and Polic 2005), the exercise of cognitive mapping was included in the questionnaire where respondents were asked to outline the area they believed was flood-prone. A review article by (Pagneux, Gísladóttir et al. 2011)compared flood risk perception of people with flood hazard maps generated by the officials. (Reichel and Frömming 2014) identified the importance of cognitive mapping in determining quantitative and qualitative details. Although they mentioned the benefits of these maps in highlighting the differences between groups and individuals, they did not apply them further. Recently, many review articles have created a single risk perception map by combining various cognitive maps generated by people. The classification of areas is done according to the percentage of participants who consider the specific area at risk, e.g., 0-10%, 11-20%, 21-30% of the respondents (Pagneux, Gísladóttir et al. 2011).

CHAPTER 3

RESEARCH METHODOLOGY

Four flood-prone rural communities of Muzaffargarh, Pakistan, were selected along Indus and Chenab rivers. Sampling was done using the Yamane sampling technique, and a household survey was conducted. Cognitive maps were designed considering age and distance to the nearest river. Flood risk perception was also measured using three main components, i.e., preparedness, worry, and awareness. Psychological distance to climate change was determined using five dimensions, psychological distance, geographic, social, temporal, and uncertainty. The results were analyzed using descriptive statistics, chi-square, one-way ANOVA, and Pearson's correlation tests.

3.1 Study Area

Muzaffargarh is an old district located in the south-western part of Punjab and is situated between the Indus River and Chenab River. On the west, the Indus River lies within 35km from headquarter, while Chenab is situated 8km away from the main city, on the east. The district extends from 28.57' to 30.46' north and 70.30' to 71.47' east longitude. There are four main administrative units (Tehsils): Alipur, Kot Addu, Jatoi, and Muzaffargarh. These tehsils are further divided into 93 Union Councils. The annual average temperature is 25.6 °C, and 40% of the area is contributed to cultivation where rice, sugarcane, wheat, and cotton are the most significant crops. The district is situated between two rivers and therefore is highly vulnerable to flooding during the monsoon season. The active period of the Chenab River is from mid-July to September, while River Indus is active during August-October (Qurratulain and Munazza 2014). In this research, it was not feasible to conduct an exhaustive survey as the population of Muzaffargarh is greater than 1000 households, along with geographical dispersion. Therefore, four union councils were selected. The criteria of selection included: close proximity to rivers and past experience of the 2010 flood. Among these union councils, Muradabad and Rangpur are located near River Chenab, while Ghazi Ghat and Shareef Chajra lie close to River Indus (Mahmood, Rahman et al. 2019).

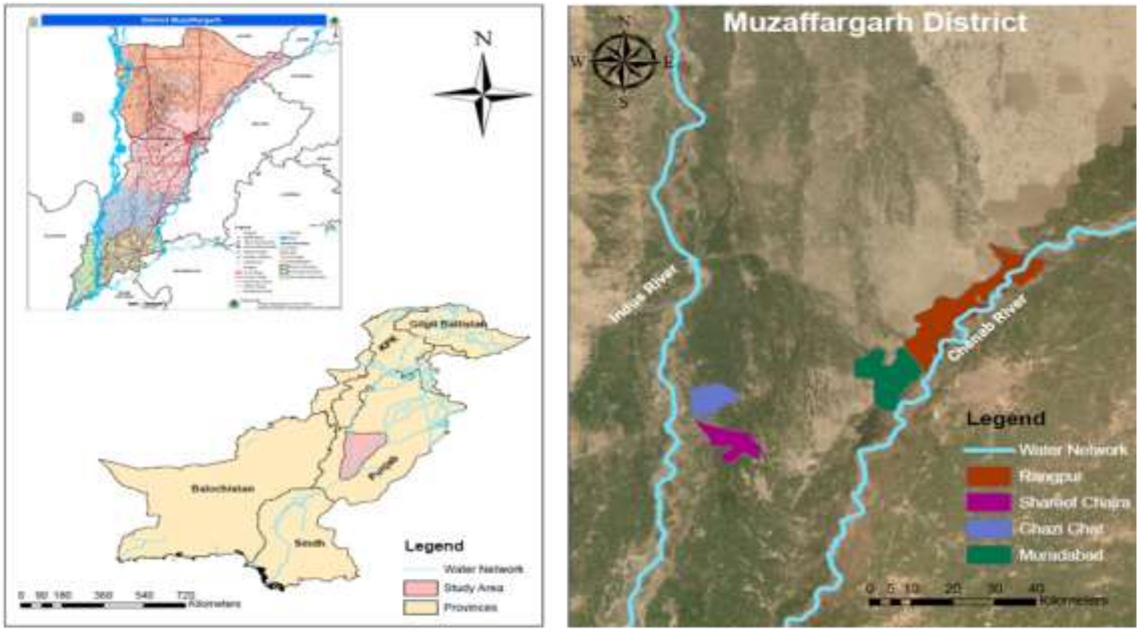

Figure 3.1:Study Area Map of Muzaffargarh

3.2 Sampling and Data Collection

Random sampling is a type of probability sampling method where everyone is selected entirely on a chance, with each one having an equal probability of being chosen. The reason for adopting random sampling was to reduce selection biases in the survey and to be able to calculate sampling error. Besides, the geographical area was not too wide, and hence it was appropriate to use a random sampling technique in the study area (Israel, 1992). There are various methods mentioned in the literature to determine the sample size. For example, Yamane is a simplified formula for the calculation of sample sizes (Eq. 1).

$$n = \frac{N}{1+N(e)^2} \quad \text{Eq. 1}$$

Where n is the sample size, N denotes the size of the population, and e is the precision level.

Using a confidence level at 95% and e= $\pm$ 10%, the sampling method proposed a sample size of 392. random sampling was chosen to carry out the survey. A total of 365 samples were finalized after discarding the incomplete questionnaires.

3.3 Selection of Indicators and Questionnaire Design

After a detailed literature review of empirical studies related to flood risk perception and climate change, indicators were selected after a detailed literature review of flood risk perception and climate change. Based on these indicators, a questionnaire was designed. It was employed to measure specific variables such as preparedness, worry, awareness, psychological distance, geographic, social, temporal distances, and uncertainty. All the indicators were based on a 5-point Likert scale, with 1 being the lowest value and 5 being the highest value. To encourage maximum participation, it was made sure that it should not take more than 20 minutes to complete the survey. The purpose of the questionnaire and principles related to confidentiality were highlighted. It was done to assure respondents that their responses would be voluntary and would be compiled together and analyzed as a group. Some of the indicators used in the survey are mentioned below while the rest are discussed in chapter 6.

Table 3.1: Indicators

SR. NO	INDICATORS	EMPIRICAL EVIDENCES BY STUDIES
HOUSEHOLD INFORMATION		
1	Age	(Sjöberg 1998, Kellens, Zaalberg et al. 2011)
2	Gender	(Baan and Klijn 2004, Hung 2009)
3	Marital Status	(Botzen, Aerts et al. 2009, Ludy and Kondolf 2012)
4	Head Education Level	(Hahn, Riederer et al. 2009, Ahsan and Warner 2014)
5	Household size	(Cutter, Boruff et al. 2003, Flanagan, Gregory et al. 2011)
6	No of children<18	(Turner, Kasperson et al. 2003, Flanagan, Gregory et al. 2011)
7	No of adults >60	(Cutter, Mitchell et al. 2000, Khan 2012)
8	No of females	(Cutter, Boruff et al. 2003, Phung, Rutherford et al. 2016)
9	No of people with special needs	(Balica, Wright et al. 2012, Birkmann, Cardona et al. 2013)
10	No of people with chronic illness	(Flanagan, Gregory et al. 2011, Kaźmierczak and Cavan 2011)
11	No of educated family members	(Khan 2012, Phung, Rutherford et al. 2016)

12	Length of residency (in years)	(Grothmann and Reusswig 2006, Działek, Biernacki et al. 2014)
ECONOMIC		
13	Head's employment	(Cutter, Boruff et al. 2003)
14	No of people employed in the household	(Nhuan, Tue et al. 2016)
15	No of household members employed outside the district	(Hahn, Riederer et al. 2009)
16	Monthly income	(Khan 2012)
17	Monthly Savings	(Browne and Hoyt 2000)
18	Livelihood options	(Hahn, Riederer et al. 2009, Nhuan, Tue et al. 2016)
19	Type of home ownership	(Cutter, Boruff et al. 2003, Khan 2012)
20	Insurance	(Browne and Hoyt 2000, Birkmann, Cardona et al. 2013)
21	Have you borrowed loan in past few years?	(Hahn, Riederer et al. 2009)
22	Have you gone to local government in past few months?	(Hahn, Riederer et al. 2009)
INFRASTRUCTURE		
23	Distance to nearest medical facility (in km)	(Miceli, Sotgiu et al. 2008, Botzen, Aerts et al. 2009, Botzen, Aerts et al. 2009, Hahn, Riederer et al. 2009)
24	Distance to nearest river (in km)	(Lindell and Hwang 2008, Miceli, Sotgiu et al. 2008)
25	No of floors	(Fedeski and Gwilliam 2007, Birkmann, Cardona et al. 2013)
26	Construction material	(Fedeski and Gwilliam 2007, Gain, Mojtahed et al. 2015)
27	Building age (in years)	(Koks, Jongman et al. 2015, Qasim, Khan et al. 2015)
28	Housing Type	(Kaźmierczak and Cavan 2011, Gain, Mojtahed et al. 2015)
29	Presence of basement	(Mazzorana, Simoni et al. 2014)
UTILITY SERVICES		
30	Access to electricity	(Hahn, Riederer et al. 2009)
31	Access to sanitation	(Ahsan and Warner 2014)
32	Access to drinking water	(Ahsan and Warner 2014, Zhou, Liu et al. 2015)
33	Access to gas supply	(Hahn, Riederer et al. 2009, Mwale, Adeloye et al. 2015)
34	Access to means of communication (TV, Radio, Mobile)	(Khan 2012)
35	Access to means of private transportation	(Flanagan, Gregory et al. 2011, Kaźmierczak and Cavan 2011)

FLOOD RELATED INFORMATION		
36	Have your residence flood previously?	(Kienzler, Pech et al. 2015, Nhuan, Tue et al. 2016)
37	Indirect experience to flood	(Biernacki, Bokwa et al. 2009, Terpstra, Lindell et al. 2009)
38	How many times have you experienced flood?	(Wisner, Blaikie et al. 2004, Kates, Travis et al. 2012)
39	When was the last time your house was flooded?	(Grothmann and Reusswig 2006, Siegrist and Gutscher 2006)
40	Severity of previous flood (on a scale of 1-5)	(Takao, Motoyoshi et al. 2004, Miceli, Sotgiu et al. 2008)
41	Height of flood measured inside your house (in meters)	(Kappes, Keiler et al. 2012, Kates, Travis et al. 2012)
42	Have you or your family members suffered from any disease as a result of flood?	(Lindell and Hwang 2008, Armaş and Avram 2009)
43	Do you have any knowledge about first aid?	(Wisner, Blaikie et al. 2004)
44	Frequency of drills or awareness programs attended by your family?	(Bollin, Hidajat et al. 2006, Mwale, Adeloye et al. 2015, Nhuan, Tue et al. 2016)
45	Reasons for staying in flood prone area	(BA 2010)
46	How do you think we can control flood?	(Thieken, Petrow et al. 2006)
47	Whose responsibility do you think it is to provide protection against floods?	(Siegrist and Gutscher 2008, Botzen, Aerts et al. 2009)
HAZARD INFORMATION		
48	How much do you rely on traditional information?	(BA 2010)
49	Whom do you prefer to contact in order to get information related to floods?	(Becker 2007)
50	Who would you contact for information during a flood?	(Becker 2007)
51	What was your source of information during previous floods?	(Bell 2007)
RESCUE AND RELIEF		
52	Did you evacuate successfully during previous flood?	(Botzen, Aerts et al. 2009, Wouter Botzen and Van Den Bergh 2012)
53	Duration of evacuation as a result of flooding in your area?	(Botzen, Aerts et al. 2009, Wouter Botzen and Van Den Bergh 2012)

54	Who provided relief aid during the past flood?	(Botzen, Aerts et al. 2009, Wouter Botzen and Van Den Bergh 2012)

3.4 Data Analytical Methods

Descriptive statistics were applied on each indicator for the selected Rural communities of Muzaffargarh. Chi-square and ANOVA tests were also performed to assess the differences in flood risk perception and psychological distance to climate change among rural communities. The indicators were then grouped into three components of flood risk perception and five dimensions of psychological distance to climate change. The following equation (Eq. 2) was used to determine the index values of these 8 components. These values were then analyzed to make comparisons for overall flood risk perception and psychological distance to climate change among four communities. Pearson correlation was used to determine the associations among dimensions of psychological distance to climate change and flood risk perception.

$$CI = \frac{W_1+W_2+W_3+\cdots W_n}{n} \quad \text{(Eq.2)}$$

$$= \sum_{i=1}^{n} W_i/n$$

3.5 Designing Cognitive Maps

As part of the survey, each individual was provided a base map of their Union Council. These maps were designed by NDMA with the help of inhabitants and were represented in the local language. The individuals were asked to outline the flood extent of 2010, and therefore, cognitive maps were generated. These maps illustrate the extent of the 2010 flood as perceived by the people. Each map was scanned and then georeferenced with the help of a reference layer. Digitization was performed to convert them into GIS vector polygons. A shapefile of points was added where each point represents one village (Basti), and values were assigned to them based on the results of cognitive maps. The factors that were taken into account were age and distance to the nearest river. Kernel density was applied to generate maps showing the stretch of the 2010 flood. A map was made for each interval of the aforementioned indicators to compare how these indicators affect the flood risk perception.

CHAPTER 4

PROFILE OF RESPONDENTS

Introduction

Studies related to social sciences are highly influenced by the personal characteristics of respondents. Therefore, in this chapter, specific characteristics of around 400 individuals are analyzed and presented.

4.1 Age

While analyzing the behavior and responses of individuals, age plays an essential part as it indicates maturity level. The table below shows that most respondents (41%) from all union councils belonged to the age group 31-40, followed by the number of adults (21-30). Respondents lying in the lower and upper end are almost negligible.

Table 4.1: Age of Respondents

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	% age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Age										
<=20	4	4	5	6.2	1	1.1	6	6.3	16	4.3
21-30	33	33	27	33.3	24	26.1	30	31.3	114	30.9
31-40	31	31	25	30.9	48	52.2	48	50	152	41.2
41-50	26	26	20	24.7	18	19.6	11	11.5	75	20.3
51+	6	6	4	4.9	1	1.1	1	1	12	3.3

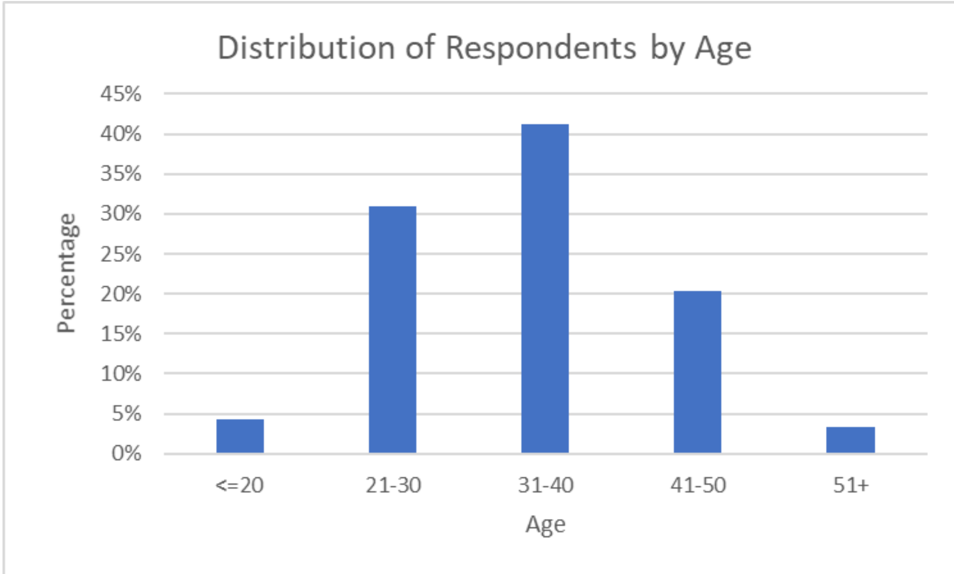

Figure 4.1: Age of Respondents

4.2 Gender

Considering the social situation in Pakistan, gender plays a significant role in any economic or social issue. However, this study is based on responses from males due to religious and cultural constraints.

4.3 Marital Status

The marital status of a person highly influences the behavior and attitude of people. In developing countries like Pakistan, married people are considered more responsible and show a high level of maturity with more understanding. As evident by the following table, around 89% of the respondents were married.

Table 4.2: Marital Status of Respondents

Marital Status	Frequency	Percentage
Married	330	89.4 %
Unmarried	34	9.2%
Divorced	3	0.8 %
Widowed	1	0.3 %
Separated	1	0.3 %

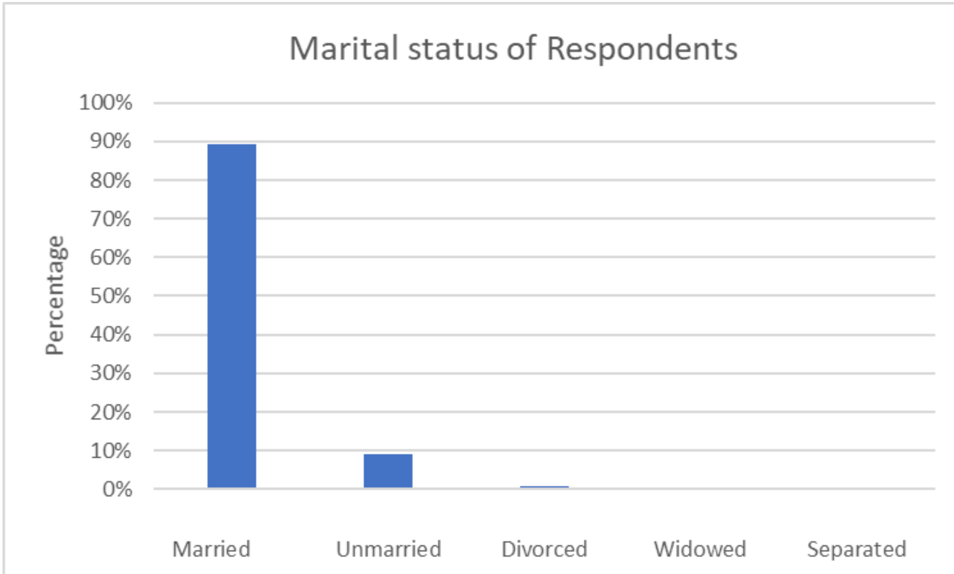

Figure 4.2: Marital Status of Respondents

4.4 Head Education Level

In Pakistan, there is one person who is responsible for making decisions and taking care of the whole family. In most cases, the patriarchal system is observed. Since the role of the household head is important in our society, their response can be judged by knowing their educational status. Education modifies a person's perception of any specific phenomena. The following table shows that majority of the household heads were educated up to high school. The number of respondents achieving higher education was negligible. A significant number of respondents belonged to the category "functionality literates". As shown by the table, people from all four Union Councils were not completely illiterates and were inclined towards education. However, the idea of attaining higher education seems far off.

Table 2.3: Head Education Level

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Head Education Level										
Primary school and below	36	36	14	17.3	27	29.3	27	28.1	104	28.2
Middle school	23	23	44	54.3	22	23.9	15	15.6	104	28.2

High school	40	40	22	27.2	42	45.7	51	53.1	155	42
Undergraduate	0	0	0	0	0	0	2	2.1	2	0.5
Postgraduate and above	1	1	1	1.2	1	1.1	0	0	3	0.8

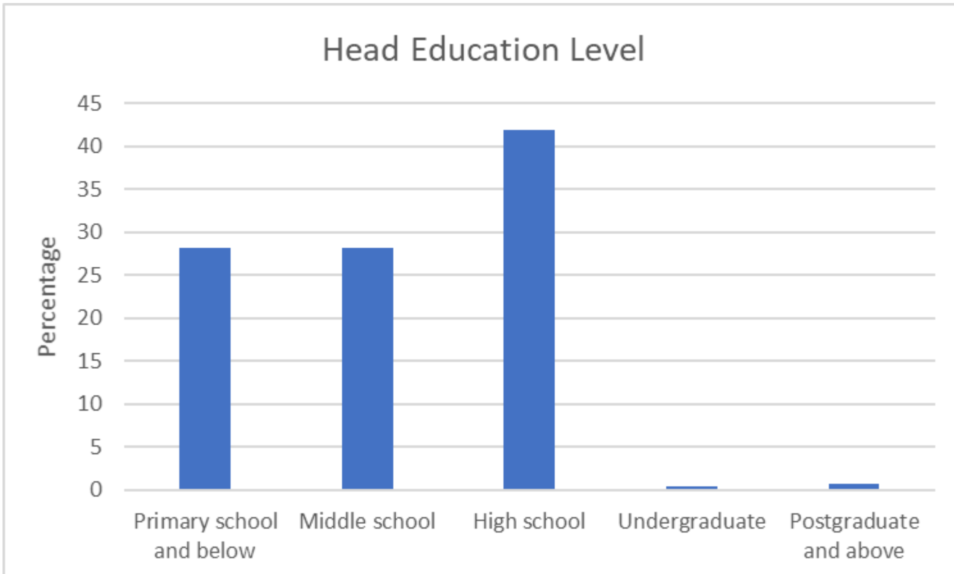

Figure 2.3: Head Education Level

~~6.5~~4.5 Head Employment Level

The personality of a person and how he perceives things is affected by the level of employment. The quality of life is dependent on the income generated and hence, on the occupation. In this study, most household heads were engaged in full-time jobs, indicating they had exposure to their social environment. Around 19% of the heads were unemployed.

Table 4.4: Head's Employment

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Head's Employment										
Full time	65	65	47	58	88	95.7	93	96.9	293	79.4
Part time	2	2	0	0	1	1.1	1	1	4	1.1
Unemployed	33	33	34	42	3	3.3	1	1	71	19.2
Retired	0	0	0	0	0	0	1	1	1	0.3

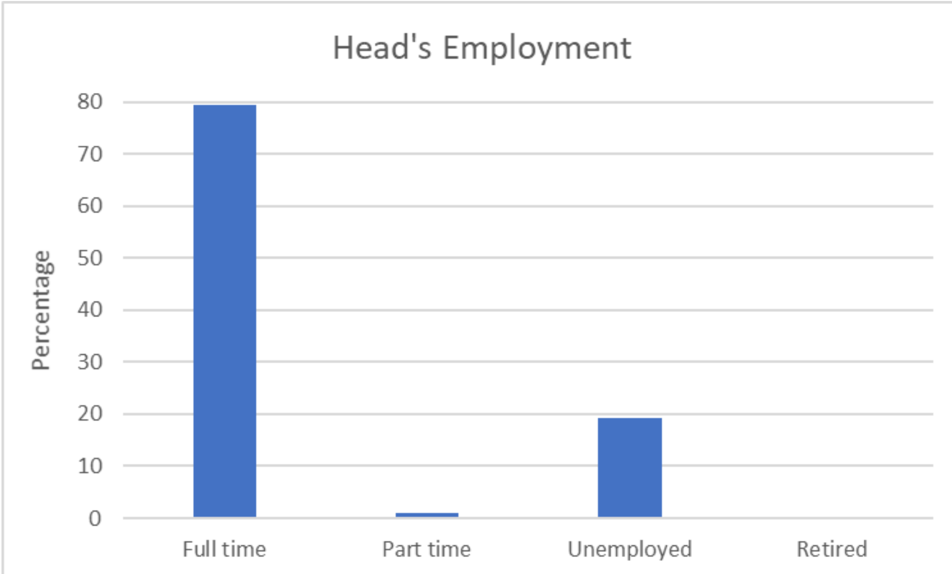

Figure 4.4: Head's Employment

4.6 Livelihood Options

Income can be derived from various options, which can lead to different personalities and behavior patterns. The social environment is different in every field and influences the perception of a person. As evident by the following table, around 71% of the respondents were engaged in private jobs followed by services.

Table 4.5: Livelihood Options

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Livelihood Options										
Agriculture and livestock	12	12	1	1.2	4	4.3	11	11.5	28	7.6
Services	18	18	8	9.9	21	22.8	14	14.6	61	16.5
Private	65	65	63	77.8	66	71.7	69	71.9	263	71.3
Industry	1	1	1	1.2	1	1.1	2	2.1	5	1.4
Others	4	4	8	9.9	0	0	0	0	12	3.3

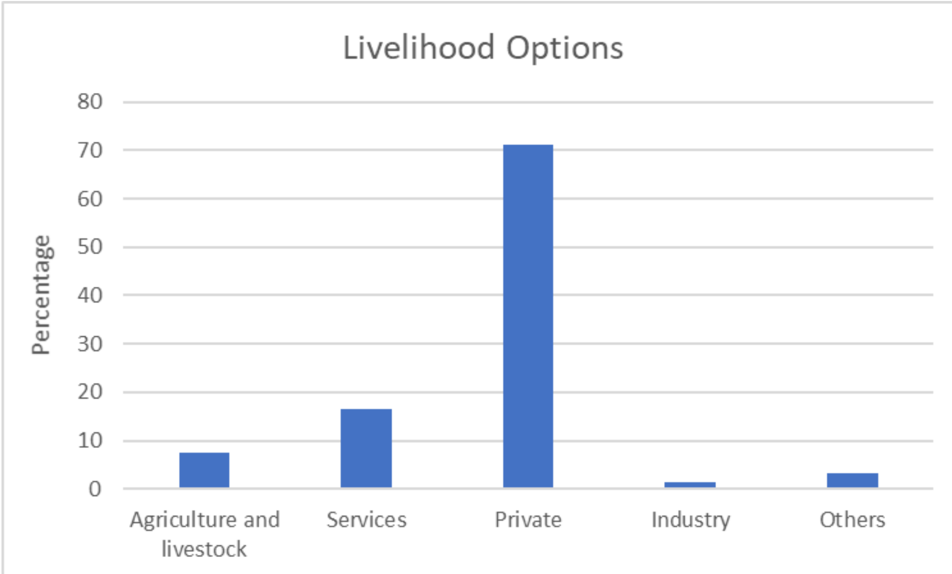

Figure 4.5: Livelihood Options

4.7 Income

Considering income is significant while analyzing the perception of people towards a particular phenomenon. The perception of a person is shaped by his economic conditions. In this research, around 56% of the respondents had a relatively low income (12000-23000). A considerable number of individuals were below minimum wage. Only 0.5% had an income level above > 45000. Therefore, it can be concluded that the poverty level in these four union councils is high.

Table 4.6: Monthly Income

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Monthly Income in PKRs*										
<12000	19	19	3	3.7	25	27.2	23	24	70	19
12000-23000	47	47	56	69.1	41	44.6	62	64.6	206	55.8
23000-34000	19	19	22	27.2	12	13	8	8.3	61	16.5
34000-45000	15	15	0	0	13	14.1	2	2.1	30	8.1
>45000	0	0	0	0	1	1.1	1	1	2	0.5

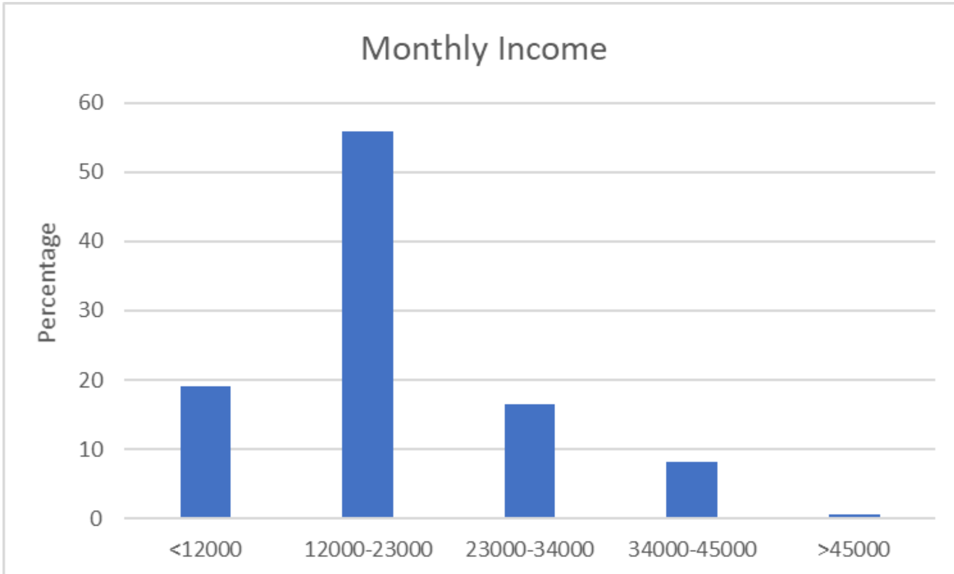

Figure 4.6: Monthly Income

4.8 Type of Home Ownership

The type of home-ownership affects a person's personality and the way he socializes. It also has an impact on his beliefs regarding social issues. Respondents having the ownership of the house tends to behave differently as compared to those who are on rent. In this case, around 59% of the respondents owned the house outright, followed by social housing, which infers that people prefer to live in their own houses. In case of limited resources, people opt for social housing as it is more affordable than the other two options.

Table 4.7: Type of Home Ownership

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Type of Home Ownership										
Owned	54	54	18	22.2	56	60.9	90	93.8	218	59.1
Owned with mortgage	5	5	28	34.6	14	15.2	3	3.1	50	13.6
Renting privately	0	0	1	1.2	0	0	0	0	1	0.3
Social housing	41	41	34	42	22	23.9	3	3.1	100	27.1

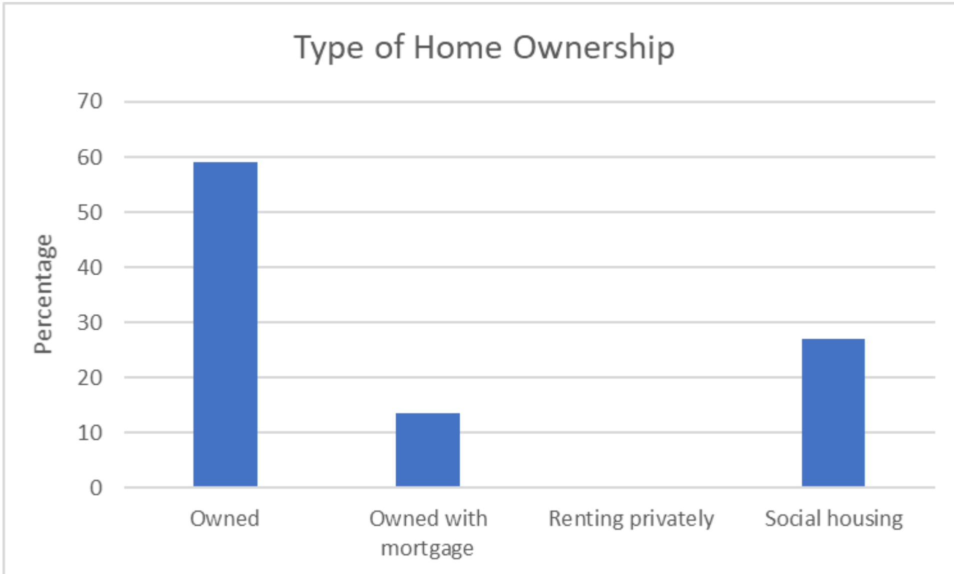

Figure 4.7: Type of Home Ownership

4.9 Length of Residency

The number of floods a person has experienced is linked with his length of residency. For many years, the residents might have more knowledge about his area and have experienced more floods, and therefore, perceives flood risk differently than the other residents. In this study, around 48% of the respondents have been living for 30-50 years. Overall, results reveal that 98% of individuals have lived in their specific union councils for more than 10 years.

Table 4.8: Length of Residency

Characteristics	Ghazi Ghat		Muradabad		Rangpur		Shareef Chajra		Total	
	Fr	%age	Fr	%age	Fr	%age	Fr	%age	Fr	%age
Length of Residency										
<10	3	3	3	3.7	1	1.1	0	0	7	1.9
10-30	26	26	27	33.3	22	23.9	17	17.7	92	24.9
30-50	47	47	27	33.3	47	51.1	55	57.3	176	47.7
50-70	23	23	23	28.4	22	23.9	19	19.8	87	23.6
>70	1	1	1	1.2	0	0	5	5.2	7	1.9

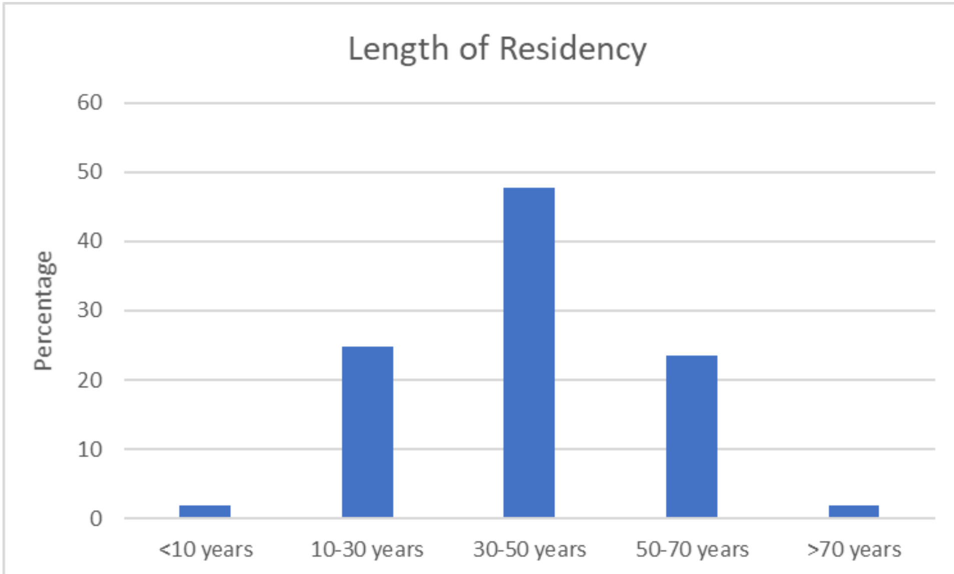

Figure 4.8: Length of Residency

CHAPTER 5

PSYCHOLOGICAL DISTANCE TO CLIMATE CHANGE AND RISK PERCEPTION

According to Construal Level Theory, behavior of people is affected by perceived psychological distance and therefore, plays an important role in mitigation and pro-environmental attitude towards climate change (Trope and Liberman 2010). Scientists believe that climate change is happening and public responses have been equivocal. Moreover, public participation is also low and mitigation measures taken by people is inconsiderable. In order to avoid the repercussions of climate change, it has become imperative to determine factors impeding public engagement. It is observed climate change is perceived as uncertain and psychologically distant phenomenon which affects distant areas (McDonald, Chai et al. 2015). Therefore, psychological distance has been identified as a major obstacle in engaging people towards climate change actions.

The interpretation of psychological distance as abstract or concrete affects the decision making of a person. When objects are perceived as close, people tend to depend on presumed and transient information while they trust on stable information when thinking about distant objects. (Ledgerwood, Trope et al. 2010) proved that people believe on others opinion when they perceive an object to be close and in a psychologically distant perspective, they trust their own information or knowledge. In this study, five dimensions of psychological distance has been analyzed: psychological, geographic, social, temporal and uncertainty. These dimensions are further divided into the following indicators.

Table 5.1: Indicators and dimensions for assessing psychological distance to climate change

Dimensions	Questions/statements asked	Empirical Evidence
Psychological		
PS1	To what extent, do you think climate change is responsible for floods?	(Botzen, Aerts et al. 2009, Wouter Botzen and Van Den Bergh 2012)
PS2	To what extent, do you blame human activities for causing floods?	(Wachinger, Renn et al. 2010)

PS3	Is it possible to quantify climate change?	(Spence, Poortinga et al. 2012)
Geographic		
G1	My local area is likely to be affected by climate change.	(Spence, Poortinga et al. 2012)
G2	Climate change will mostly affect developing countries	(Spence, Poortinga et al. 2012)
G3	Climate change will mostly affect areas that are far away from here	(Spence, Poortinga et al. 2012)
Social		
S1	Climate change is likely to have a big impact on people like me	(Spence, Poortinga et al. 2012)
Temporal		
T1	When, if at all, do you think Pakistan will start feeling the effects of climate change?	(Spence, Poortinga et al. 2012)
T2	Do you think climate change is an immediate threat?	(McDonald, Chai et al. 2015)
T3	I have personally experienced the effects of climate change?	(McDonald, Chai et al. 2015)
T4	Do you think future generations are more likely to face the effects of climate change?	(McDonald, Chai et al. 2015)
Uncertainty		
U1*	I am uncertain that climate change is really happening	(Spence, Poortinga et al. 2012)
U2*	The seriousness of climate change is exaggerated	(Spence, Poortinga et al. 2012)
U3	Most scientists agree that humans are causing climate change	(Spence, Poortinga et al. 2012)
U4*	It is uncertain what the effects of climate change will be	(Spence, Poortinga et al. 2012)
U5*	There is no unified opinion related to climate change among scientists.	(McDonald, Chai et al. 2015)

*** Inversed in scale.**

5.1 Psychological Distance to Climate Change

The psychological distance to climate change highly influences the behavior of people towards risk. Hence, the main five dimensions of psychological distance were considered based on the construal level theory, i.e., psychological (PS), geographic (G), social (S), temporal (T), and uncertainty (U). These dimensions were further divided into 16 indicators. Descriptive statistics across 4 communities of Muzaffargarh were analyzed, and comparisons were made. The chi-square test was performed to ascertain differences among the communities. The first aspect was assessed using three questions (PS1, PS2, PS3) where respondents from Rangpur were relatively less inclined towards that climate change is responsible for floods (PS1). In contrast, the chi-square ($\chi2$= 92.75, p=0.000) indicates that responses towards psychological dimensions were significantly different among the selected communities. Responses from Muradabad were relatively high compared to other communities for blaming human activities being the cause of floods (PS2). Results suggest that respondents were highly uncertain about climate change and its impacts. The chi-square value was ($\chi2$=36.69, p=0.000), indicating that blaming human activities varied across all communities. Regarding the quantification of climate change (PS3), respondents were inclined towards the middle value, which shows that the question remained unclear to most. Overall, respondents from all rural communities were uncertain about the psychological dimension (Table 5.2).

Table 5.2: Indicator wise analysis for psychological distance to climate change

Indicators*		Ghazi Ghat	Muradabad	Rangpur	Shareef Chajra	Chi-square	Overall
Psychological							
PS1	Mean SD	2.41 0.90	2.28 1.28	2.02 0.98	2.53 0.72	92.746 0.000	2.31 0.99
PS2	Mean SD	2.55 0.91	2.8 0.78	2.68 0.89	2.73 0.73	36.692 0.000	2.69 0.84
PS3	Mean SD	3.00 0.78	3.13 0.70	2.97 0.79	2.99 0.72	33.814 0.000	3.02 0.75
Geographic							
G1	Mean SD	2.73 1.67	2.14 1.08	2.61 1.78	2.21 1.73	94.111 0.000	2.43 1.62
G2	Mean SD	3.45 0.91	3.33 0.63	3.27 0.74	3.63 0.80	86.671 0.000	3.42 0.79
G3	Mean SD	2.76 0.90	3.65 1.22	3.42 1.22	2.51 0.97	93.745 0.000	3.09 1.17
Social							
S1	Mean SD	3.43 0.84	4.05 0.95	3.58 1.31	3.34 0.75	83.648 0.000	3.58 1.01
Temporal							
T1	Mean SD	3.55 0.83	3.83 0.82	3.60 0.73	3.70 0.65	33.102 0.005/1	3.66 0.76
T2	Mean SD	3.32 1.38	3.28 0.64	3.10 1.21	2.79 1.25	184.698 0.000	3.12 1.19

T3	Mean SD	3.38 1.01	2.57 1.43	2.49 1.33	3.68 0.88	102.924 0.000	3.06 1.27
T4	Mean SD	1.99 1.26	2.11 1.04	1.68 1.28	1.70 1.44	75.753 0.000	1.86 1.28
Uncertainty							
U1	Mean SD	2.61 0.69	2.83 0.61	3.05 0.73	2.39 0.70	90.558 0.000	2.86 0.73
U2	Mean SD	3.73 0.96	2.16 1.16	2.54 1.43	3.39 0.90	153.788 0.000	2.96 1.28
U3	Mean SD	2.38 0.91	3.21 0.80	2.85 1.02	2.21 0.60	147.685 0.000	2.6 0.93
U4	Mean SD	3.02 0.82	3.70 1.30	3.77 1.21	3.06 0.58	100.829 0.000	3.39 1.06
U5	Mean SD	3.28 1.16	1.85 0.88	2.45 1.38	3.96 0.72	192.397 0.000	2.89 1.33

*** Refer to table 1 for indicator details**

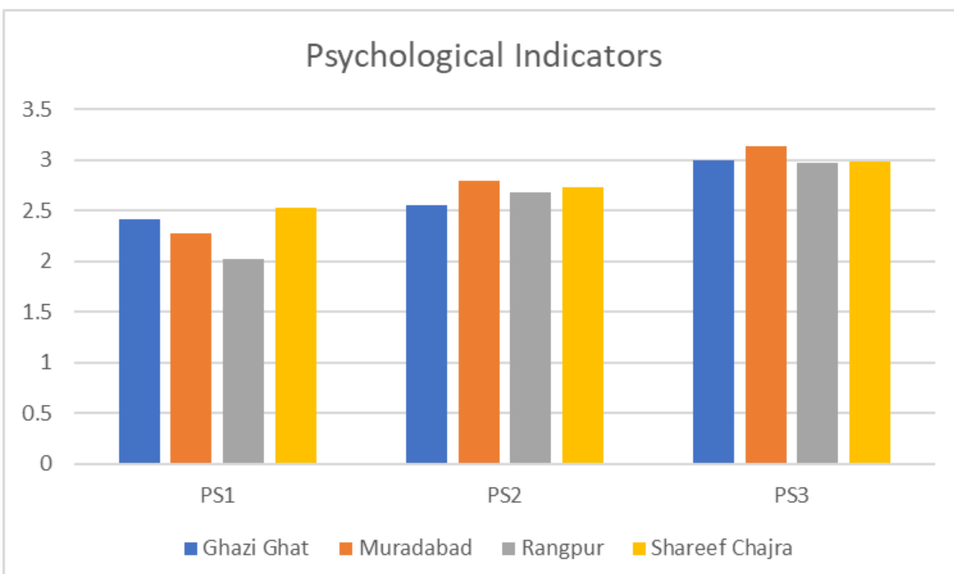

Figure 5.1: Psychological Indicators

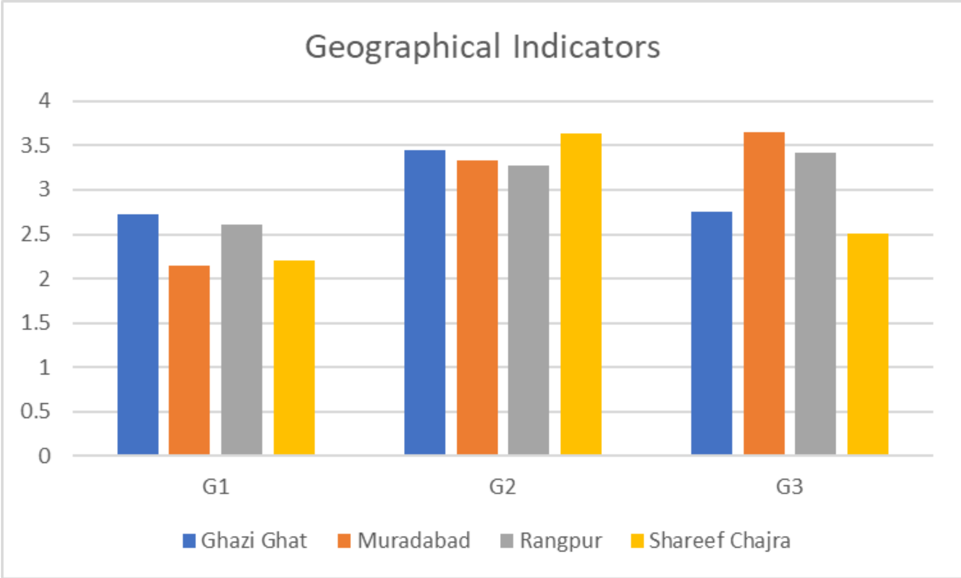

Figure 5.2: Geographical Indicators

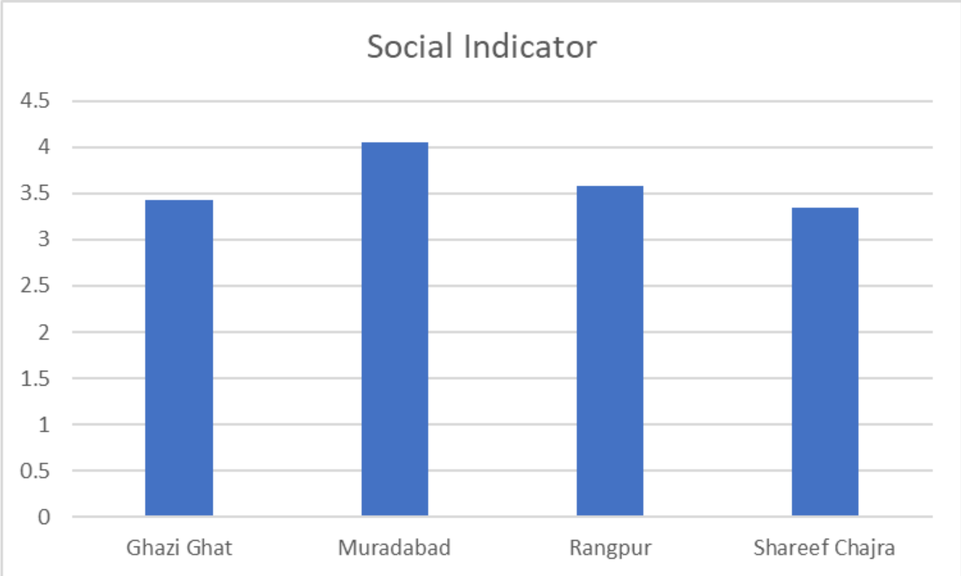

Figure 5.3: Social Indicator

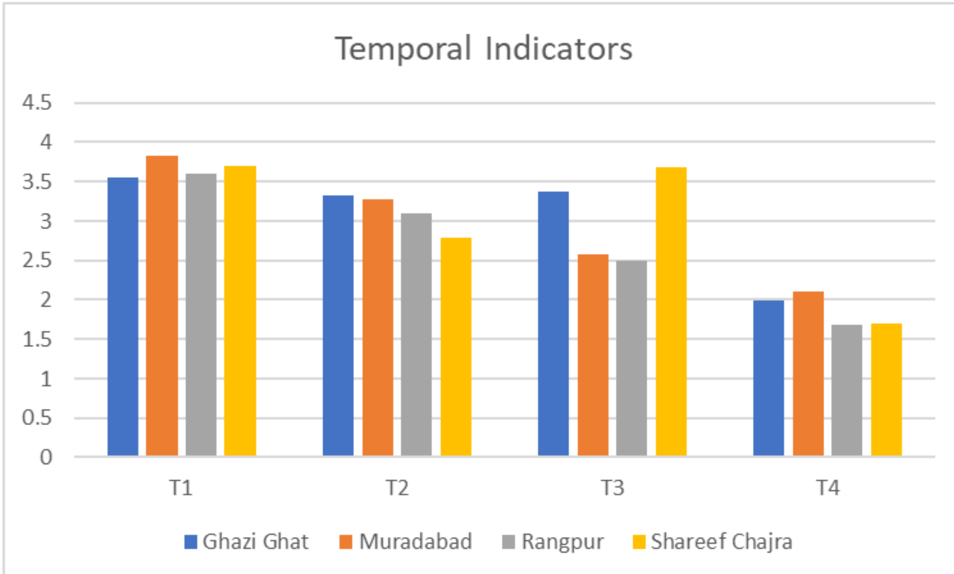

Figure 5.4: Temporal Indicators

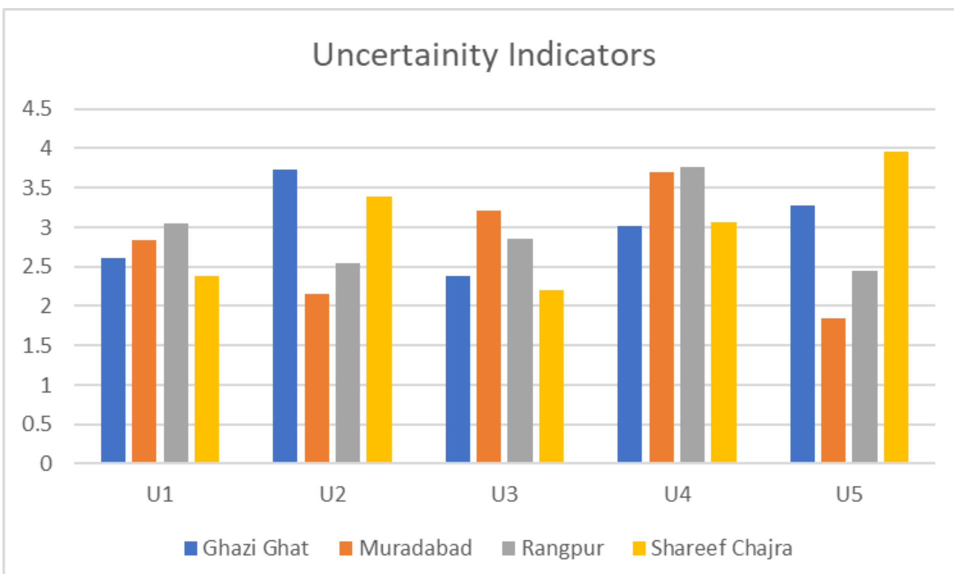

Figure 5.5: Uncertainty Indicators

The second aspect, perceived geographic distance, was determined using three key indicators: climate change affecting the local area (G1), climate change affecting developing countries (G2), and the impact of climate change on distant locations (G3). Responses from all rural communities reflected that people agreed that climate change was affecting their area. The chi-square value was ($\chi2$=94.11, p=0.000), indicating that responses for G1 were spatially different. Among all rural communities, individuals from Shareef Chajra were more inclined towards disagreement that climate change is affecting developing countries. In contrast, responses from other rural communities also disagreed to some extent (Table 5.2). The chi-square value was ($\chi2$=86.67, p=0.000), which shows that responses for G2 were statistically different among communities. Regarding climate change affecting distant locations, overall responses from rural communities infer that respondents were uncertain that climate change would affect distant locations. The chi-square value was ($\chi2$=93.75, p=0.000), indicating that responses for G3 were spatially different among communities.

There was one indicator covering the social dimension: climate change will affect people similar to themselves (S1). Respondents from Muradabad disagreed, whereas responses from other rural communities reflected an inclination towards the question (Table 5.2).

The temporal distance was assessed using four key questions: The extent to which Pakistan is facing the impacts of climate change (T1), climate change is an immediate threat (T2), personal experience of climate change (T3), and the likelihood of future generations facing climate change (T4). All the rural communities showed similar responses that Pakistan would start feeling the effects of climate change during the next 25-50 years (T1). Chi-square value was ($\chi2$=33.10, p=0.005). Responses from all rural communities indicated that they agreed to some extent that climate change is an immediate threat (T2). Chi-square value was ($\chi2$=184.70, p=0.000). Similar results were observed for the question about personally experiencing the effects of climate change (T3). Respondents from all rural communities strongly agreed that future generations would likely face the effects of climate change (T4). Chi-square value was ($\chi2$=75.75, p=0.000). Chi-square values for all four indicators prove that responses for temporal dimension were statistically different among communities (Table 5.2).

Five indicators were assessed to analyze the uncertainty about climate change. For the first question, overall responses from rural communities infer that people are uncertain that climate change is happening (U1). Chi-square value was ($\chi2$=90.56, p=0.000). Similar responses were observed where all rural communities, except Ghazi Ghat, agreed to some extent that the seriousness of climate change is exaggerated (U2). The Chi-square value for this indicator was ($\chi2$=153.79, p=0.000). Moreover, they were also uncertain that most scientists blame humans for causing climate change (U3). Similar responses were observed about the uncertainty of climate change effects (U4). Chi-square value for was ($\chi2$=100.83, p=0.000). Responses for "no unified opinion related to climate change among scientists" (U5) infer that all rural communities were uncertain with the given statement except Muradabad, where individuals were inclined towards disagreement. (Table 5.2).

Table 5.3: Dimension wise analysis of psychological distance to climate change

Dimensions		Ghazi Ghat	Muradabad	Rangpur	Shareef Chajra	ANOVA	Overall
Psychological	Mean SD	2.65 0.56	2.74 0.49	2.56 0.45	2.75 0.42	F = 3.115 p-value= 0.026	2.67
Geographic	Mean SD	2.98 0.70	3.04 0.43	3.10 0.58	2.78 0.77	F = 4.301 p-value= 0.005	2.98
Social	Mean SD	3.43 0.84	4.05 0.95	3.58 1.31	3.34 0.75	F = 8.788 p-value= 0.000	3.60
Temporal	Mean SD	3.06 0.66	2.95 0.68	2.71 0.64	2.97 0.45	F = 5.382 p-value=0.001	2.92
Uncertainty	Mean SD	3.00 0.41	2.75 0.29	2.93 0.44	3.00 0.37	F = 8.098 p-value=0.000	2.92
Overall psychological distance to climate change	Mean SD	3.03 0.38	3.11 0.20	2.98 0.33	2.97 0.30	F = 3.458 p-value=0.017	3.02

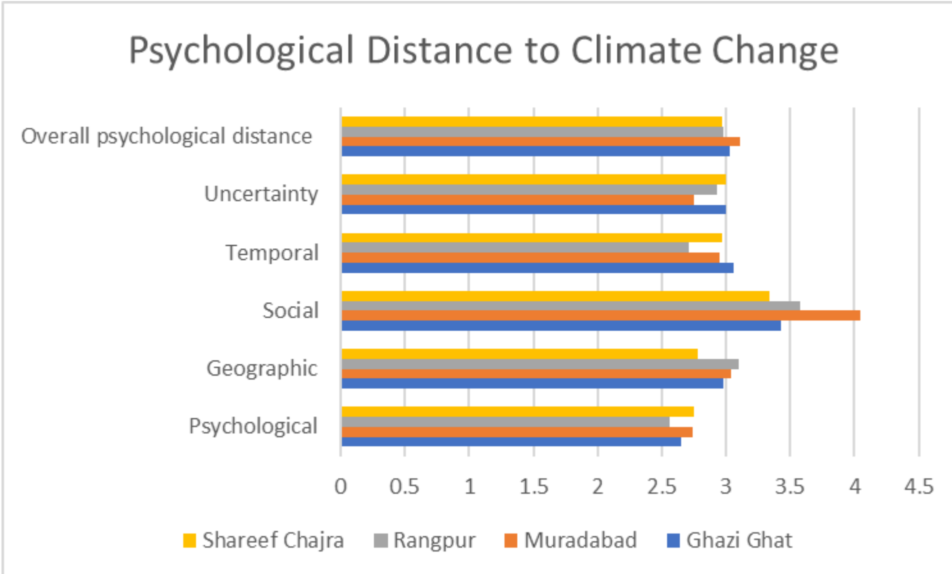

Figure 5.6: Dimension wise analysis of psychological distance to climate change

Descriptive statistics along with a one-way ANOVA test were applied for all five dimensions (Table 5.3). Overall responses from rural communities indicated that the psychological distance was moderate in the study area. ANOVA value was (F=3.115, p=0.026), which shows that difference was apparent among the communities. A low value of F showed that means of all rural communities are more clustered together than within community variability. Moreover, the distance between the means is small as compared to a random error within each rural community. Hence, it cannot be concluded that all these rural communities are different at a population level. Regarding geographic distance, similar responses were observed. However, the ANOVA value was high (F=4.301, p=0.005), which indicates that the difference among communities was evident. Responses for social distance inferred that individual from all rural communities, especially Muradabad, reflected a socially distant behavior. Temporally, respondents perceived some of the impacts of climate change to be far away, while a high agreement was assessed with regards to uncertainty related to climate change effects. ANOVA value was observed to be high in all dimensions, indicating that responses for other dimensions were statistically different across all communities.

5.2 Flood Risk Perception

Table 5.4: Indicators and dimensions for assessing flood risk perception

Dimensions	Questions asked	Empirical Evidence
Preparedness		
P1	To what extent, do you think you are prepared for a flood hazard?	(Zaalberg, Midden et al. 2009)
P2	To what extent, have you discussed flood disaster preparedness with your family members?	(Becker 2007)
P3	How much are you willing in the future to seek information about flood risk?	(Becker 2007)
P4	What do you think about your capability to cope without external support?	(Terpstra and Gutteling 2008)
P5	What is your likelihood of insuring yourself, your family, and your assets?	(Becker 2007)
P6	What is the likelihood of flood-proofing your house?	(Becker 2007)
P7	How much are you willing to participate in flood training programs?	(Becker 2007)
P8	How much do you understand about the early warning and its protocols?	(King 2000)
P9	What is your level of trust in the government?	(Yu, Wang et al. 2013, Rana, Jamshed et al. 2020)
P10	What is your level of trust in media?	(Yu, Wang et al. 2013)
P11	How much are you willing to undertake flood preparedness measures in your house?	(Becker 2007)
Worry		
W1	How much are you afraid of floods?	(Ho, Shaw et al. 2008, Miceli, Sotgiu et al. 2008, Qasim, Khan et al. 2015)
W2	If a flood occurs, what are the chances of loss of lives in your area?	(Ho, Shaw et al. 2008, Miceli, Sotgiu et al. 2008)
W3	How much damage can flood cause to your personnel health?	(Siegrist and Gutscher 2006, Miceli, Sotgiu et al. 2008)
W4	How much damage can flood cause to the social environment (disruption of schools, transportation, and communication)?	(MEHTA , Smith 2013)
W5	To what extent, can flood damaged houses (sweeping away of belongings, wet floor, damaged walls)?	(Terpstra and Gutteling 2008, Qasim, Khan et al. 2015)
W6	To what extent can food security be disturbed by floods (disruption of food supply, loss of livestock, famine)?	(Miceli, Sotgiu et al. 2008, Rana, Jamshed et al. 2020)

W7	What are the chances of utility services being damaged by floods (water supply and sanitation)?	(Takao, Motoyoshi et al. 2004, Miceli, Sotgiu et al. 2008)
W8	What are the chances that a flood will change your lifestyle?	(Armaş and Avram 2009, Rana, Jamshed et al. 2020)
Awareness and Experience		
A1	How much are you aware of evacuation routes in your area?	(Wisner, Blaikie et al. 2004, Rana and Routray 2016)
A2	What is your level of knowledge about emergency protocols?	(Wisner, Blaikie et al. 2004, Hosseini, Hosseini et al. 2014, Rana and Routray 2016)
A3	How much do you think you can understand flood forecasting and warning?	(Ahsan and Warner 2014)
A4	How much are you aware of unusual weather patterns (high temperatures than usual, changes in rainfall pattern)?	(Bichard and Kazmierczak 2012, Działek, Biernacki et al. 2014)
A5	What is the likelihood of flood occurrence in your area?	(Ho, Shaw et al. 2008, Terpstra and Gutteling 2008)

Risk perception is normally categorized into three main components: preparedness, worry, and awareness. These components were further divided into 24 indicators to assess the flood risk perception of four rural communities of Muzaffargarh. Preparedness highly influences the precautionary measures, mitigation actions, coping capacity, and the recovery time after the flood occurs. 11 indicators (P1-P11) were utilized to analyze the preparedness of the study area. Respondents from four rural communities were asked about their perception of their flood preparedness, and the results indicated that they perceived themselves to be prepared to some extent. According to the respondents, they had discussed flood preparedness measures with their family members. In comparison to other communities, respondents from Shareef Chajra were more interested in seeking flood risk information in the future. Individuals from this community were also certain about their coping capacity without any external support and anticipated a high likelihood of getting insurance (Table 5.4). Furthermore, participants from all four rural communities were almost certain about floodproofing their houses and indicated a possibility of participating in flood training programs in the future. According to them, they were also able to understand the early warning system and its protocols to some extent. It was obvious from the responses that people have more trust in the media than in the government. Among all rural communities, people from Shareef Chajra indicated a high likelihood of undertaking flood preparedness measures in their houses.

Table 5.5: Indicator wise analysis for flood risk perception

Indicators*		Ghazi Ghat	Muradabad	Rangpur	Shareef Chajra	Chi-square	Overall
Preparedness							
P1	Mean	3.00	3.43	3.12	3.14	84.711	3.16
	SD	0.78	0.61	0.53	0.45	0.000	0.62
P2	Mean	3.79	3.59	4.07	3.97	59.149	3.86
	SD	0.52	0.54	0.49	0.34	0.000	0.51
P3	Mean	3.94	3.40	4.05	4.16	72.237	3.91
	SD	0.96	0.79	0.75	0.53	0.000	0.82
P4	Mean	3.28	4.12	3.66	4.33	96.701	3.83
	SD	1.59	0.95	1.73	1.42	0.000	1.52
P5	Mean	3.83	2.88	3.79	4.75	190.262	3.85
	SD	1.10	0.66	0.86	0.54	0.000	1.05
P6	Mean	3.30	3.47	3.80	3.83	60.824	3.60
	SD	0.93	0.76	0.67	0.45	0.000	0.76
P7	Mean	2.64	2.41	2.14	2.27	131.914	2.37
	SD	1.11	1.27	1.25	0.76	0.000	1.12
P8	Mean	2.91	3.68	3.49	2.40	136.186	3.09
	SD	1.21	1.31	1.39	0.88	0.000	1.30
P9	Mean	2.17	2.42	2.05	1.41	78.507	1.20
	SD	1.18	1.29	1.20	0.83	0.000	1.19
P10	Mean	3.13	3.85	3.95	3.11	85.842	3.49
	SD	0.79	1.12	0.96	0.82	0.000	0.10
P11	Mean	3.78	2.99	3.97	4.67	84.711	3.88
	SD	1.09	0.77	0.91	0.81	0.000	1.08
Worry							
W1	Mean	4.32	3.01	4.05	4.89	164.773	4.11
	SD	1.17	0.89	1.13	0.50	0.000	1.16
W2	Mean	4.05	3.14	3.91	4.76	187.037	4.00
	SD	0.96	0.61	0.87	0.52	0.000	0.95
W3	Mean	4.21	2.89	3.39	4.11	121.588	3.69
	SD	0.74	1.05	1.27	0.60	0.000	1.08
W4	Mean	3.90	3.79	4.34	4.09	116.897	4.04
	SD	0.72	1.20	0.80	0.50	0.000	0.85
W5	Mean	4.46	2.57	3.47	4.92	171.264	3.92
	SD	0.90	1.45	1.73	0.35	0.000	1.50
W6	Mean	4.12	2.40	3.13	4.84	195.085	3.68
	SD	1.14	1.29	1.73	0.53	0.000	1.54
W7	Mean	3.86	3.28	3.73	3.54	66.791	3.62
	SD	1.03	0.75	0.90	0.95	0.000	0.94

W8	Mean SD	4.18 1.11	3.94 1.10	4.32 1.37	4.82 0.54	98.797 0.000	4.33 1.11
Awareness and experience							
A1	Mean SD	4.31 1.24	3.53 1.08	3.24 1.39	4.53 1.19	144.367 0.000	3.93 1.34
A2	Mean SD	2.40 1.12	2.06 1.09	1.92 1.21	1.90 1.33	48.412 0.000	2.08 1.21
A3	Mean SD	3.57 0.88	3.16 0.68	2.79 0.96	3.12 0.89	64.648 0.000	3.17 0.90
A4	Mean SD	2.19 1.07	3.58 1.25	2.99 1.62	1.84 1.32	135.904 0.000	2.60 1.48
A5	Mean SD	4.11 0.90	2.46 1.32	3.10 1.56	3.98 0.86	128.485 0.000	3.46 1.35

*** Refer to table 2 for indicator details**

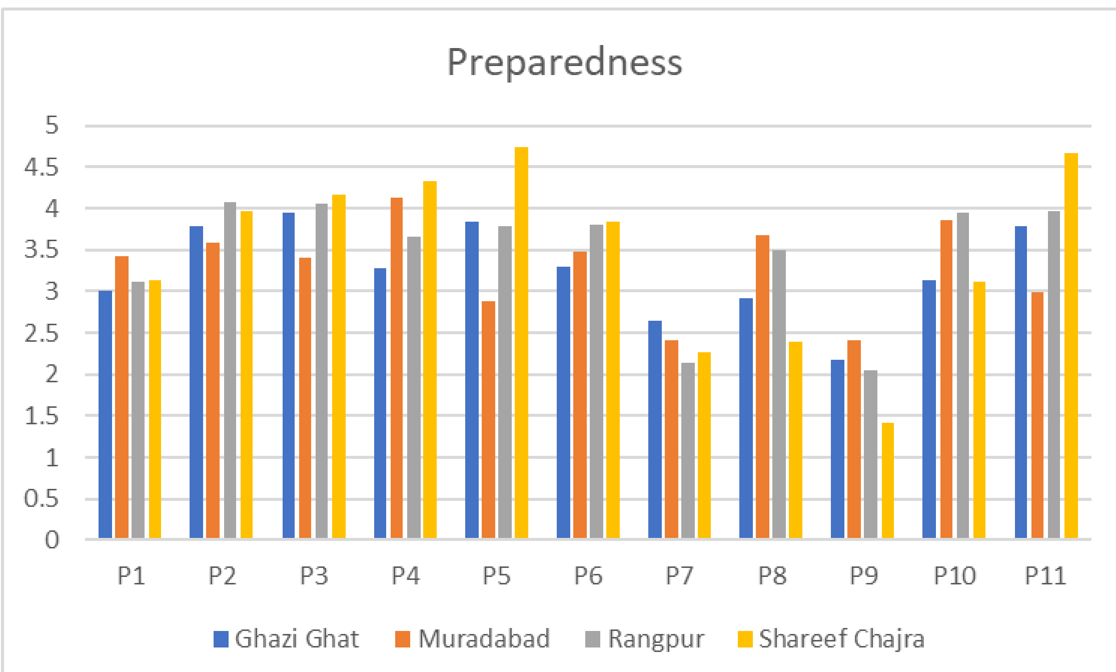

Figure 5.7: Preparedness Indicators

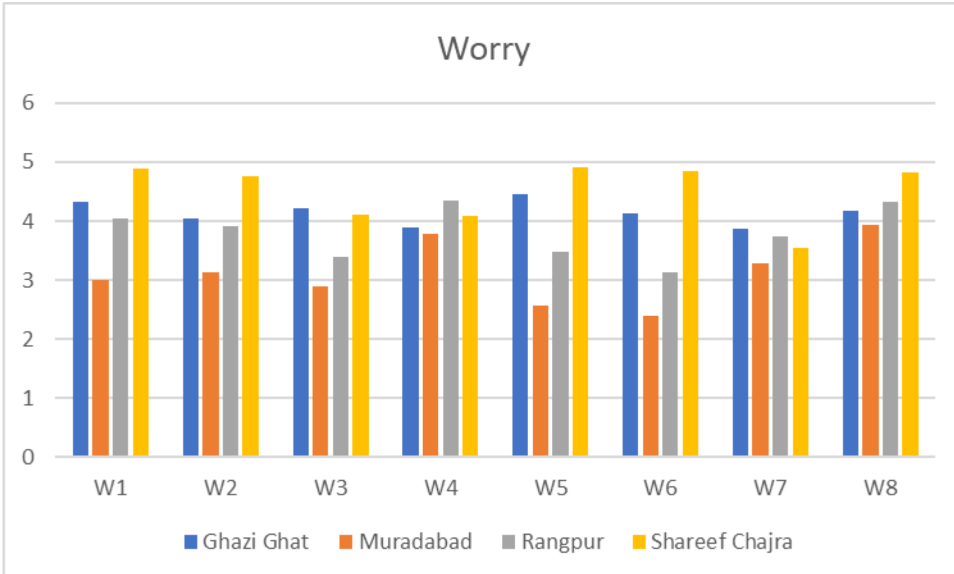

Figure 5.8: Worry Indicators

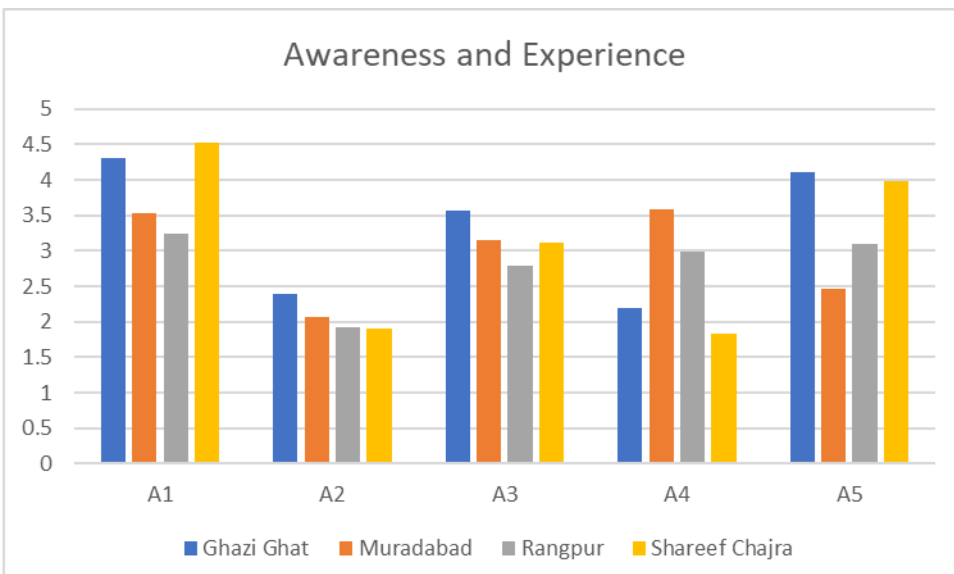

Figure 5.9: Awareness and Experience Indicators

Literature suggests a positive correlation between worry and flood mitigation measures. In this study, the dimension of worry was divided into 8 indicators to analyze how much people of respective rural communities are worried about the flood situation in their area. Respondents from all rural communities were highly afraid of floods except individuals from Muradabad, where people were relatively less frightened. Similar responses were observed for the chances of loss of lives in their respective areas in case of flood occurrence. Damage to the social environment was perceived to be higher than flood damage to personnel health across all rural communities (Table 5.5). Respondents from Shareef Chajra indicated that floods could highly damage houses and disturb food security. Overall, responses from rural communities inferred that there is a high chance of flood affecting utility services in their areas and a change in their lifestyles.

Awareness and knowledge of people play a vital role in influencing their flood risk perception. This component was further divided into five indicators (A1-A5). Respondents from all four Rural communities were aware of evacuation routes in their areas but had little knowledge about emergency protocols. People from Ghazi Ghat had a relatively high understanding of flood forecasting and warning as compare to other Rural communities. Moreover, the awareness of unusual weather patterns was relatively high in Muradabad. Overall responses from Rural communities indicated that people were not certain about the likelihood of flood occurrence in their area, while people from Muradabad were more inclined towards the unlikelihood (Table 5.5).

Table 5.6: Dimension wise analysis for flood risk perception

Dimensions		**Ghazi Ghat**	**Murada-bad**	**Rangpur**	**Shareef Chajra**	**ANOVA**	**Overall**
Preparedness	Mean SD	3.25 0.25	3.29 0.27	3.46 0.25	3.46 0.20	F= 19.529 p-value= 0.000	3.37
Worry	Mean SD	4.14 0.66	3.13 0.44	3.79 0.78	4.50 0.27	F=84.648 p-value= 0.000	3.89
Awareness and knowledge	Mean SD	3.32 0.53	2.96 0.43	2.81 0.71	3.08 0.64	F= 12.509 p-value= 0.000	3.04
Overall flood risk perception	Mean SD	3.57 0.33	3.13 0.22	3.35 0.36	3.68 0.27	F= 57.933 p-value= 0.000	3.43

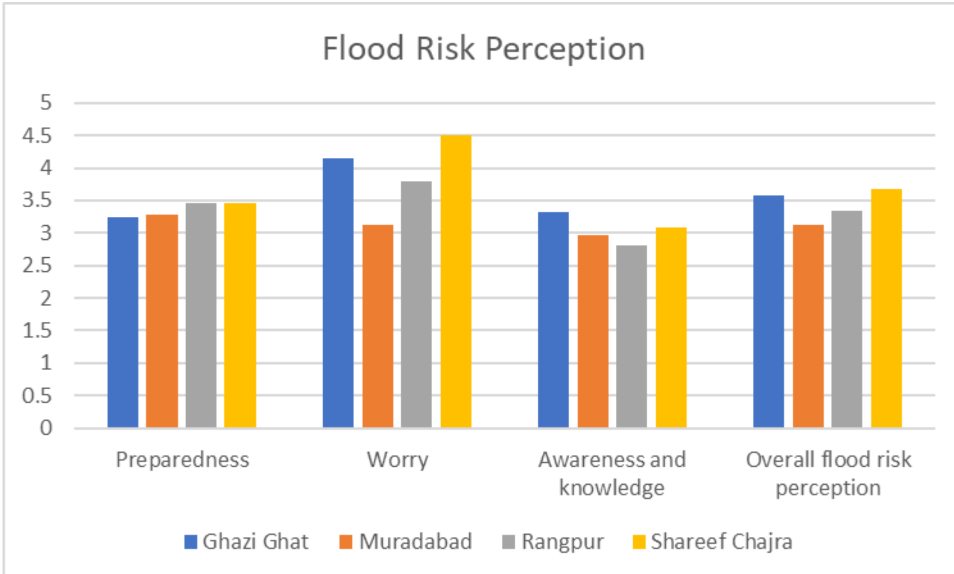

Figure 5.10: Dimension wise analysis for flood risk perception

In this section, descriptive statistics along with ANOVA test were applied to all three components of flood risk perception: preparedness, worry and awareness. Overall responses from rural communities indicated that people from Rangpur and Shareef Chajra perceived themselves to be more prepared than the other two rural communities. Furthermore, respondents from rural communities located alongside Indus River, Ghazi Ghat and Shareef Chajra, were found to be more worried. With regards to the awareness factor, individuals from all rural communities were moderately aware of the flood risk situation in their respective areas. These results indicated that Rural communities near the Indus River had a relatively higher flood risk perception than those located near the Chenab River. ANOVA value for worry was relatively higher and significance value was similar for all dimensions which showed that outcomes were statistically significant.

5.3 Relationship between Flood Risk Perception and Psychological Distance to Climate Change

Results indicate people with less knowledge about climate change (high psychological distance) tend to perceive that climate change will not impact their personnel health (low social distance). Moreover, respondents seem to believe that climate change is affecting their areas as well as developing countries indicate that they perceive climate change to be a global issue and will affect everyone (Table 5.7). Therefore, when climate change is not considered a geographically distant phenomenon, people are more likely to be aware of the unusual weather patterns and the emergency protocols required during and after floods (high awareness). In addition, a moderate correlation was also found between social distance and worry. People perceiving themselves to be highly affected by climate change would tend to worry more about flood damages. Regarding the relation between temporal distance and awareness, a moderate negative correlation (-0.302) was found. Respondents who perceive climate change threats as imminent or ongoing (low temporal distance) are more likely to be aware of the flood risk situation in their respective areas. Furthermore, individuals uncertain about climate change are likely to worry less about flood risk, as suggested by a negative correlation of -0.392. Regarding preparedness, people who perceive themselves to be better prepared in case of flood occurrence would be more over-confident and hence may be less aware of their surrounding environment.

Table 5.7: Correlation between psychological distance to climate change and flood risk perception

	Psychological	**Geographic**	**Social**	**Temporal**	**Uncertainty**	**Preparedness**	**Worry**	**Awareness**
Psychological	—	-0.080	-0.316**	0.288**	-0.077	0.097	-0.059	0.169**
Geographic	-0.080	—	0.212**	0.223**	0.249**	0.107*	0.038	-0.451**
Social	-0.316**	0.212**	—	-0.164**	-0.012	-0.037	0.307**	-0.170**
Temporal	0.288**	0.223**	-0.164**	—	0.200**	0.088	-0.086	-0.302**
Uncertainty	-0.077	0.249**	-0.012	0.200**	—	-0.020	-0.392**	-0.269**
Preparedness	0.097	0.107*	-0.037	0.088	-0.020	—	0.165**	-0.323**
Worry	-0.059	0.038	0.307**	-0.086	-0.392**	0.165**	—	0.220**
Awareness	0.169**	-0.451**	-0.170**	-0.302**	-0.269**	-0.323**	0.220**	—

* correlation significant at 5%

** correlation significant at 1%

CHAPTER 6

PERCEIVED SPATIAL EXTENT OF FLOOD 2010

6.1 Ghazi Ghat

a. Age

Figure 6.1 represents the spatial extent of the 2010 flood as perceived by different age groups of Ghazi Ghat. Age was classified into three main groups: < 30 years, 31-40 years, and > 41 years. The sample size for each age interval was around 30. The maps were generated based on the level of agreement by the locals. The green area indicates that very few people agreed that flood occurred in the specific bastis (village). In contrast, red represents the majority of the population agreed that flood-hit the particular areas. In Figures a and b, a high level of agreement was observed in the center. According to all respondents, the 2010 flood occurred in the north-eastern side of Ghazi Ghat. The spatial extent perceived by age group greater than 41 is relatively greater than the other two age categories. It can be concluded that the perceived spatial extent of flood enhances as age increases.

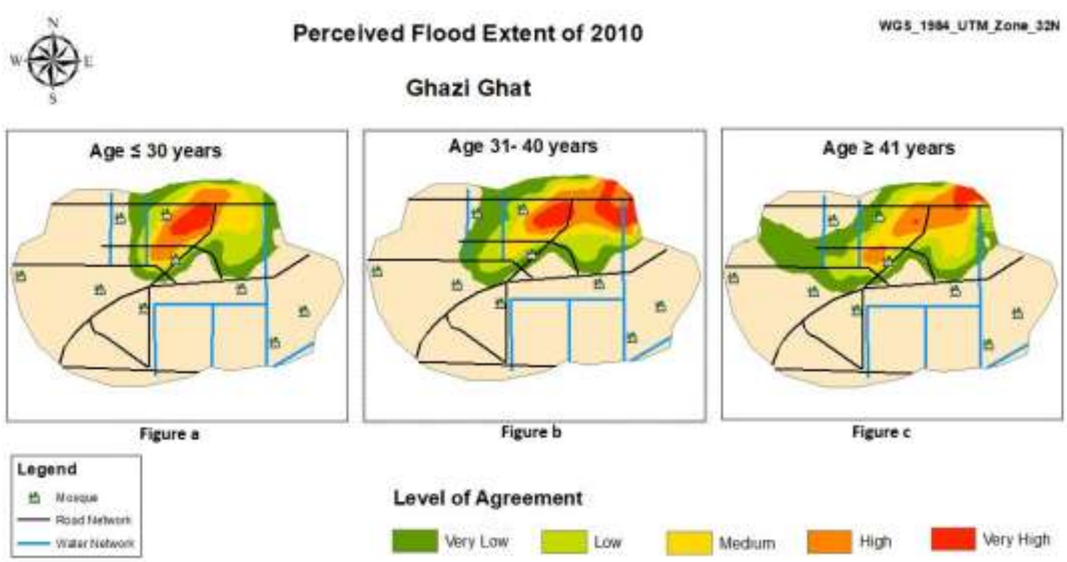

Figure 6.1: Age (Ghazi Ghat)

b. Distance to nearest River

Proximity to river is one of the significant factors affecting the flood risk perception. In this research, cognitive maps were designed using the aforementioned indicator. Distance to nearest river was classified into two main categories: distance < 5km and distance > 5km. Figure 6.2 shows that spatial extent marked by residents living nearby river is more focused whereas those residing at a distance perceived a larger spatial extent stretching towards the western side of Ghazi Ghat.

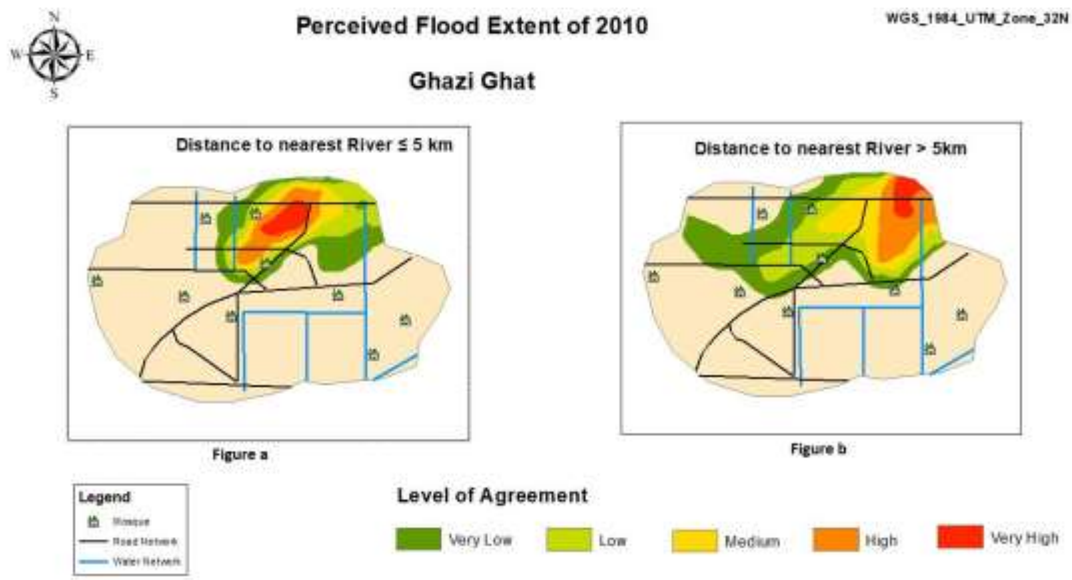

Figure 6.2: Distance to Nearest River (Ghazi Ghat)

6.2 Muradabad

a. Age

Figure 6.3 represents the spatial extent of flood 2010 as perceived by different age groups of Muradabad. The flooded area marked by individuals from all three age groups is near the River of Chenab. However, flood extent perceived by age group less than 30 and 31-40 is relatively greater and stretched more towards the south. Most of the area in figure 1 lies in the red zone-, indicating a high level of agreement on area flooded in 2010 among younger people.

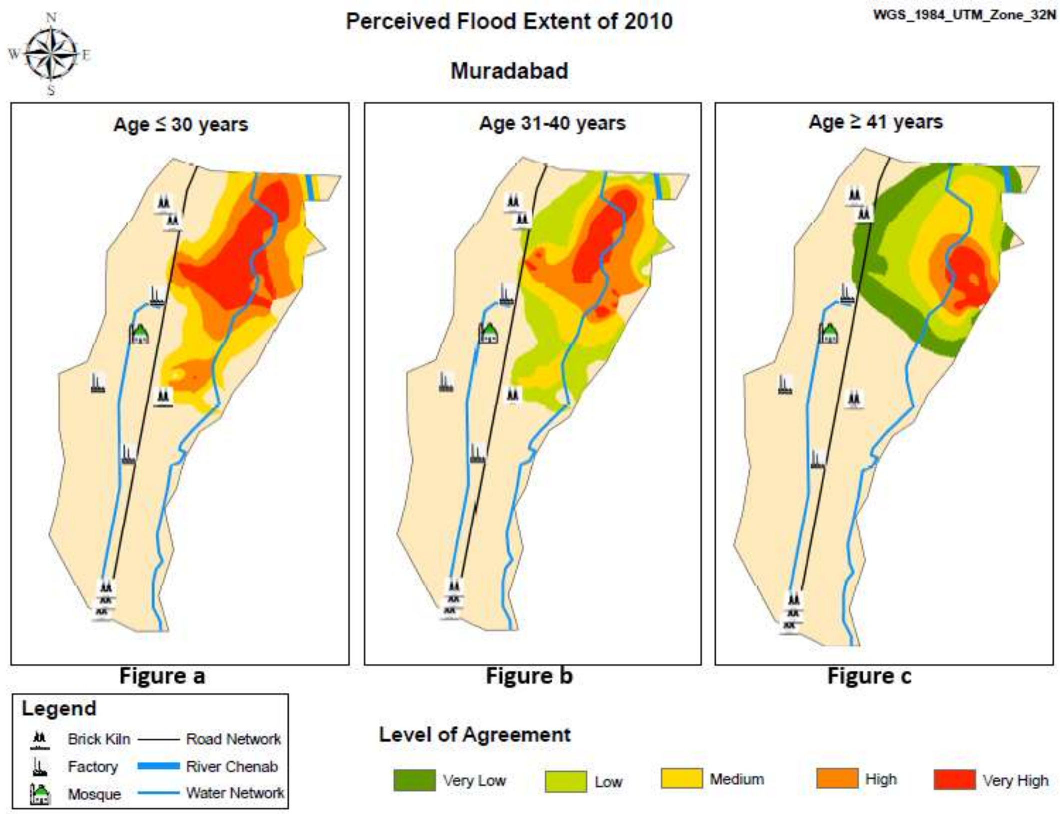

Figure 6.3: Age (Muradabad)

b. Distance to nearest River

Muradabad lies on the west of River Chenab and hence is one of the most flood-prone areas of Muzaffargarh. Figure 6.4 represents two maps showing flood extent perceived by those who live in close proximity to the river (distance < 5km) and those who reside far away (distance > 5km). There is a high level of agreement regarding the flooded area near River Chenab and highlighted water network in both maps. As shown in Figure a, the level of agreement of exposed residents living close to the river ranged from medium to very high. Therefore, it can be deduced that most of the population living close to the river distinctly remembered the areas flooded in 2010. Furthermore, these two maps indicate that flood memory becomes vague as the distance to the river increases.

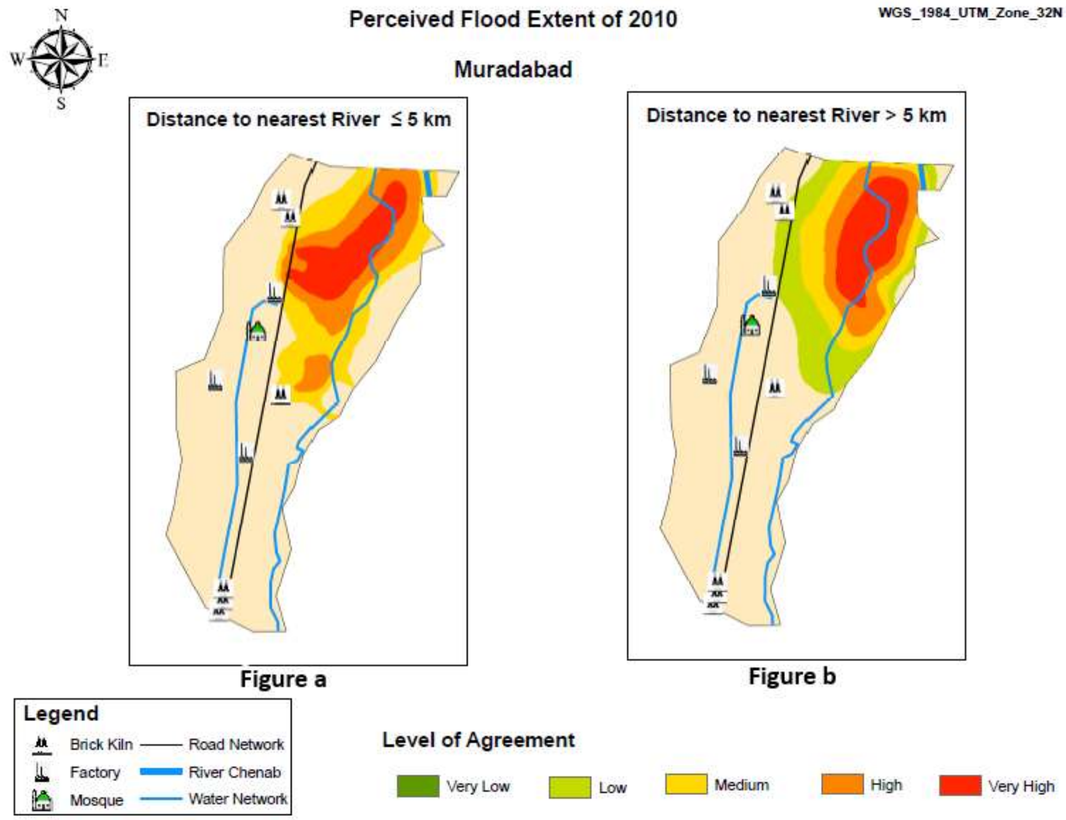

Figure 6.4: Distance to nearest River (Muradabad)

6.3 Rangpur

a. Age

The map below illustrates the impact of age on perceived flood extent where respondents of Rangpur with three different age categories were analyzed. The river of Chenab passes through the Union Council and is considered at high risk of flooding. According to all respondents, the stretch of the flood was from south to north around the river. The flooded areas with a high level of agreement were low in all three maps. In figure a, a high level of agreement was observed in the center and on the south-east of River Chenab, whereas in figure b, it was more concentrated in the center. Respondents with age above 41 years had a high level of agreement that some of the area surrounding the river in the south was flooded in 2010.

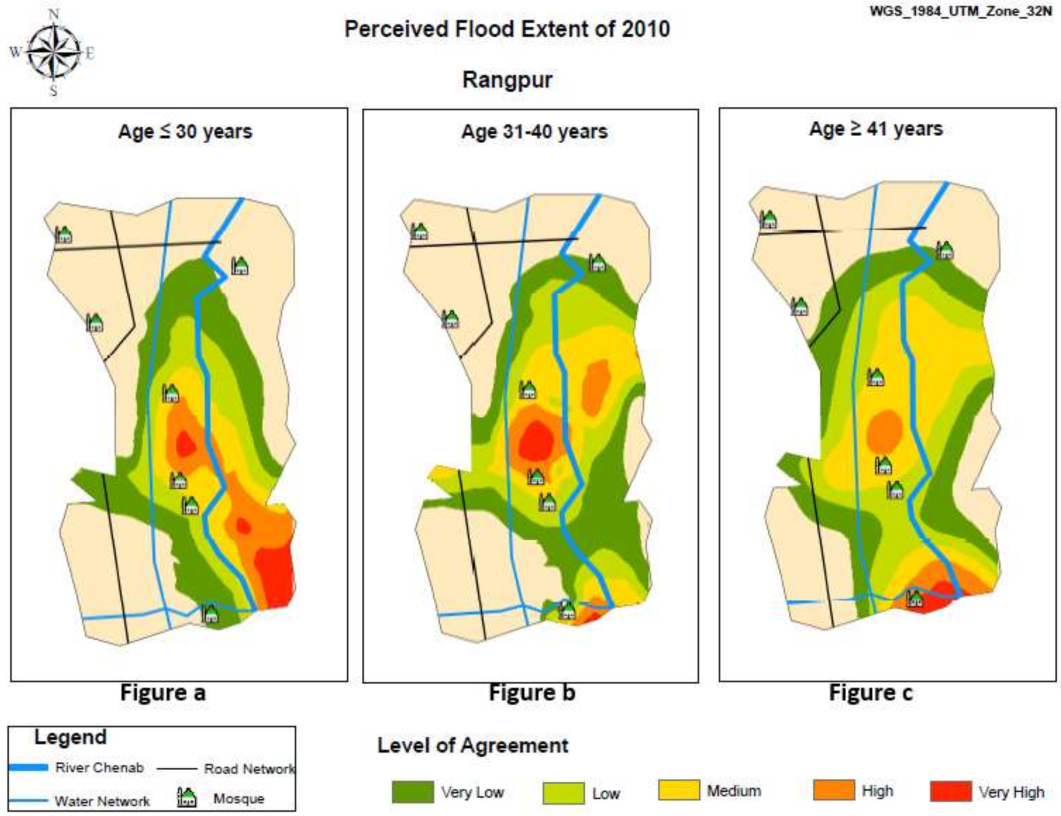

Figure 6.5: Age (Rangpur)

b. Distance to nearest River

In past research, correlations have been observed between proximity to hazard and flood risk perception. Figure 6.6 demonstrates how the flood memory changes as the distance to the nearest river increases. The spatial extent outlined by all respondents of Rangpur was similar. However, individuals who resided in close proximity to the river (< 5km) had a high level of agreement about the flooded area in the center, whereas those who live far away (> 5km) strongly agreed that flood occurred in the south of Rangpur near Chenab River.

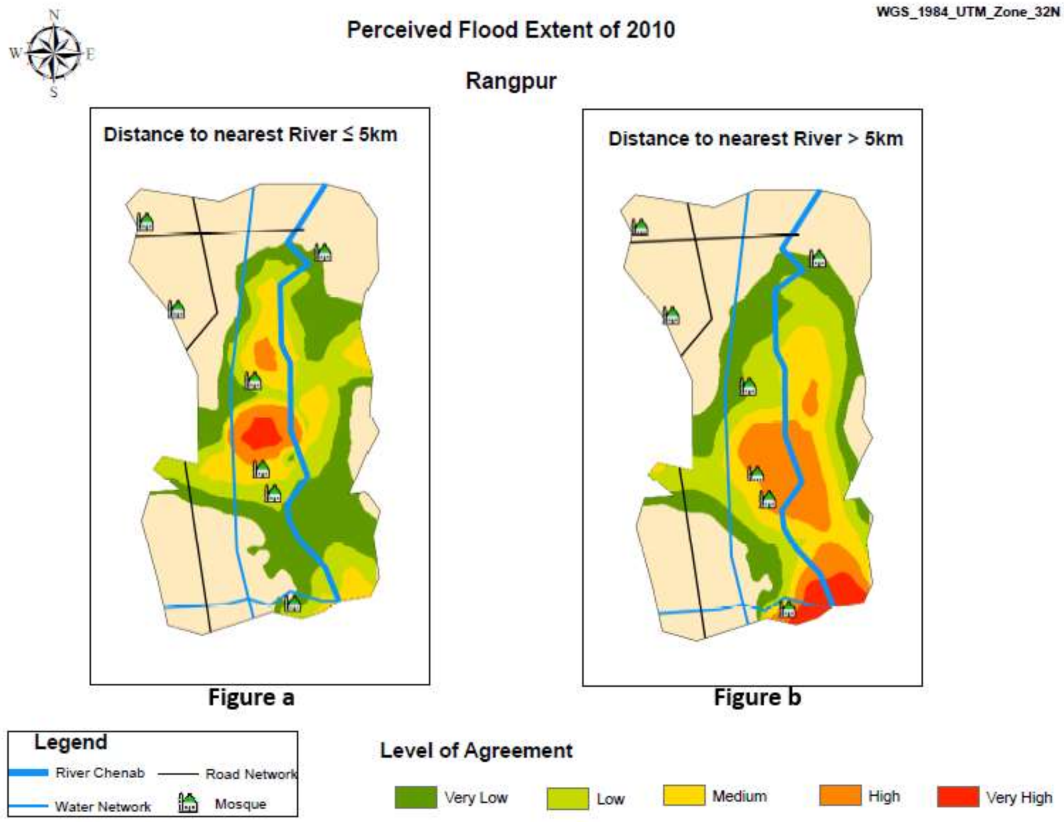

Figure 6.6: Distance to nearest River (Muradabad)

6.4 Shareef Chajra

a. Age

Shareef Chajra lies west of River Indus and is mainly responsible for past floods in the area. It is a highly flood-prone area and has experienced many floods in the past. Therefore, cognitive maps were generated, and age-wise comparisons were made. The perceived flood extent in figure a and figure b are indifferent, whereas a larger extent can be observed in figure c. Therefore, it can be inferred that the perceived spatial extent of senior inhabitants is relatively greater than the other two age categories. Overall, the high level of agreement lies in the same areas of all three figures.

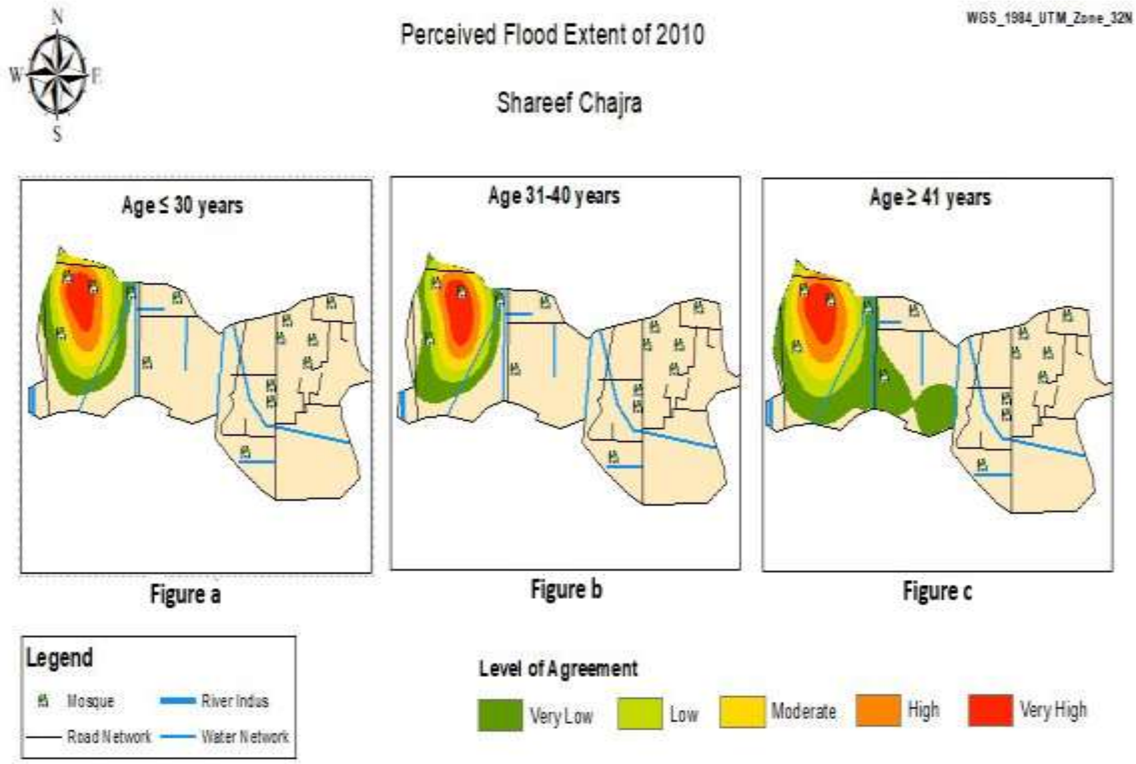

Figure 6.7: Age (Shareef Chajra)

b. Distance to nearest River

Figure 6.8 illustrates that all respondents of Shareef Chajra, irrespective of their distance from the river, were certain about the flooded areas in 2010. The stretch outlined by the respondents in both figures is similar. Figure a and figure b demonstrate the 2010 flood-affected north-western side of Shareef Chajra and areas located near the Indus River. In comparison, among respondents living close to the river majority outlined the same spatial extent.

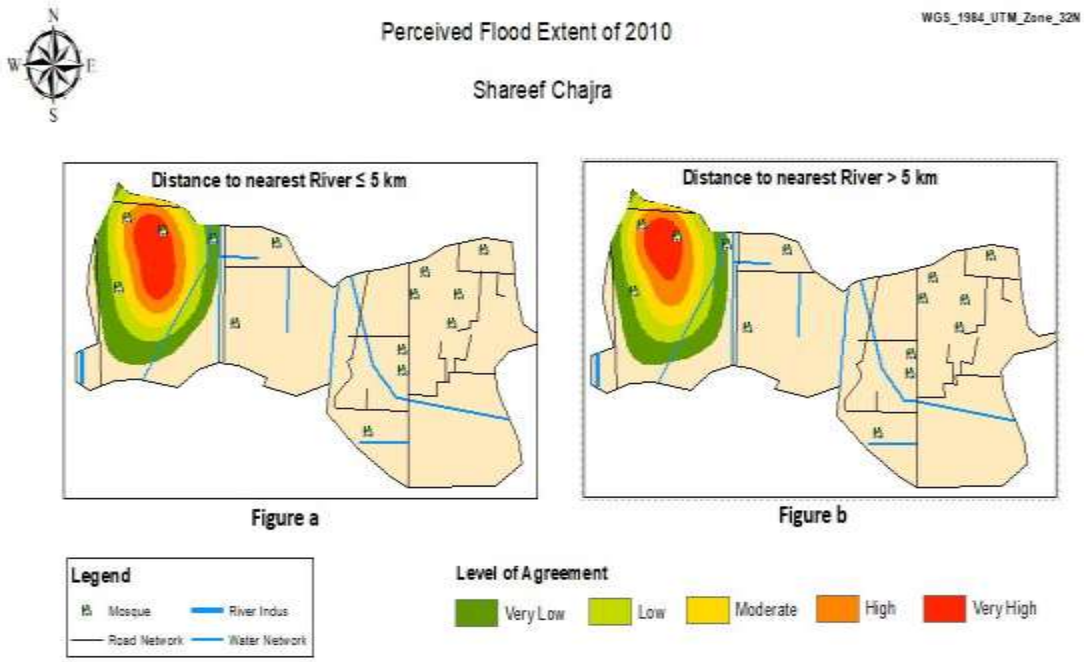

Figure 6.8: Distance to nearest River (Shareef Chajra)

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Flood risk management strategies have become increasingly significant due to observed changes in the climate. These strategies must integrate not only the physical factor but also the social components; hence, flood risk perception plays a vital role in designing effective strategies. A lack of understanding by authorities may lead to the failure of flood management plans. The findings of this study provide an intriguing insight into flood risk perception and psychological distance to climate change. Results reveal that social distance was relatively higher than other factors of psychological distance to climate change. Regarding flood risk perception, respondents were observed to be more afraid than preparedness and awareness. Overall flood risk perception was higher among rural communities located near the Indus River. According to literature, more floods have occurred in the Indus River, and hence residents living near-by perceive flood risk to be high. A strong negative correlation was observed between uncertainty and worry. Respondents skeptical about climate change were more worried, which supports the theory of "fear of unknown."

This study also explores the perceived spatial extent of the 2010 flood in Muzaffargarh based on two main indicators: age and distance to the nearest river. Previous literature suggests that proximity to hazard is important in determining risk perception and affects the cognitive component. Results reveal that a high level of agreement is observed among young respondents, which indicates that the flood memory of these individuals is relatively strong. The majority is certain about the flooded area in 2010. Furthermore, the stretch outlined by senior residents is greater, which highlights that the spatial extent of flood enhances as the age increases. The maps also illustrate that spatial extent becomes more focused as the distance to the nearest river decreases inferring a negative correlation between the two variables.

The comprehensive methodology and practical findings of this study can facilitate the disaster management authorities in designing integrated flood risk management plans. Moreover, risk communication strategies need to be revised to reduce psychological distance and enable people to understand climate change better, leading to more sustainable behavior. However, the methodological limitations of this research must be acknowledged. Firstly, respondents who refused to participate in the survey might have some informative reasons for the refusal, and this nonresponse may lead to biasness. Secondly, the study was restricted to only four rural communities in Muzaffargarh and cannot be generalized to other rural areas. This study involves paper-based cognitive maps, which were then digitized and processed, consuming time and resources. Lastly, the majority of the respondents were males due to religious and cultural factors. However, the role of females in disaster risk management cannot be neglected, and results cannot be generalized to other genders. Despite its limitations, this study provides a clear methodology that can be operationalized in the urban context and other rural areas of Pakistan and can be applied to analyze the link between other disasters and climate change. Considering the limited studies analyzing the spatial component of flood risk, this research contributes in the field of flood risk management by exploring the flood risk perception based on cognitive maps. It is suggested that the relevant authorities incorporate modern tools and web apps that can perform similar functions faster. This information can then be disseminated to vulnerable individuals and, therefore, enhances the risk communication. It is also suggested to study the role of gender in assessing the psychological distance to climate change in the future. The implementation of preventive measures is difficult without raising awareness among the general public. Therefore, this research recommends that government should introduce content-specific risk awareness programs at the local level.

7.2 Recommendations

1. Flood plains act as natural buffers and therefore, needs to be preserved. Integrated water resource and river basin management must be acknowledged.
2. Water sensitive design needs to be incorporated in urban planning where it reduces the flow of water cycle from developed areas and facilitate the integration of urban planning into water cycle management.

3. Development is based on the perception that future climate will be no different from the current patterns. Local authorities need to understand the impacts of climate change in order to design sustainable infrastructure keeping in mind the future impacts of climate change.
4. Disadvantaged groups are often settled in flood prone areas and the impact of floods are more severe on the poor and vulnerable population. Strategy development must integrate the capacity and requirements of the community. Moreover, steps must be taken to improve the living conditions of the vulnerable population.
5. Combination of real-time observations and global datasets ensures effective flood forecasting.
6. Risk communication can be enhanced by introducing people centered early warning system where alerts are disseminated to the population at risk. These warnings must be made according to the language and culture of the community.
7. In every community, at least one place must be marked as shelter in the time of crisis. Based on the religious and culture factors, these shelters must have areas allocated for women only.
8. Local authorities must incorporate the use of GIS and Remote Sensing data to identify flood prone areas and design efficient urban emergency response systems based on network analysis.
9. Integration of community-based management strategies into socio-economic development ensures effective flood risk management policies. The perception of people is imperative in order to understand their behavior and preparedness. Participatory approach must be considered at local level and community must be included in planning and designing the flood maps of their areas and evacuation strategies.
10. The role of NGOs must not be neglected as they can play a significant part in reducing vulnerability and risk of communities.

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QUESTIONNAIRE

Respected Sir /Madam,

This questionnaire is a part of my MS thesis research titled “Cognitive Mapping for Flood Risk Management”. We would appreciate your taking the time to complete the following survey. It should take few minutes of your time. Your responses are voluntary and will be confidential. All responses will be compiled together and analyzed as a group. Please note there is only one answer required for each question. I shall be very grateful for your co-operation and help.

Note: Kindly choose only one option.

Section 1: Household information

1) Age: ___________

2) Gender

   ○ Female ○ Male ○ Other

3) Marital Status

   ○ Married ○ Unmarried ○ Widowed

   ○ Divorced ○ Separated

4) Head Education Level

   ○ Primary school and below ○ Middle school ○ High school

   ○ Bachelors ○ Masters and above

5) Household size: ___________

6) No of children under 18 in your house: __________

7) No of adults above 60: ___________

8) No of females in your house: ________

9) No of people with special needs in your house: _________

10) No of people with chronic illness in your house: _________

11) No of educated family members: _________

12) Length of residency (in years): __________

SECTION 2: Economic

13) Head's employment

- ○ Full time
- ○ Part time
- ○ Unemployed
- ○ Retired

14) No of people employed in the household: _________

15) No of household members employed outside the district: ___________

16) Monthly Income: ________

17) Monthly savings: ________

18) Livelihood options

- ○ Agriculture and Livestock
- ○ Retail and trade of commerce
- ○ Services
- ○ Private
- ○ Industry
- ○ Others (please specify)

~~20)~~19) Type of home ownership

- Owned outright
- Owned with mortgage
- Renting privately
- Social housing

~~21)~~20) Have you taken insurance? If yes, mention the type.

- Yes (specify)
- No

~~22)~~21) Have you borrowed loan in past few years?

- Yes
- No

~~23)~~22) Have you gone to local government in past 12 months?

- Yes
- No

SECTION 3: INFRASTRUCTURE

~~24)~~23) Distance to nearest medical facility (in km): ___________

~~25)~~24) Distance to nearest river (in km): __________
~~26)~~25) No of floors: ___________

~~27)~~26) Construction material?

- Pakka (brick, cement)
- Katcha (mud)

~~28)~~27) Building age (in years): ______________

~~29)~~28) Housing type

- Terraced
- Detached
- Semi-detached
- Apartment

~~30)~~29) Presence of basement

- Yes
- No

SECTION 4: UTILITY SERVICES

30-35) Access to

Utilities	Yes	No
Electricity		
Sanitation		
Drinking water		
Gas supply		
Means of communication (TV, radio, mobile)		
Means of private transportation		

SECTION 5: FLOOD RELATED INFORMATION

36) Has your residence flooded previously?

- ○ Yes
- ○ No

37) In case of No, what was your source of indirect experience?

- ○ TV
- ○ Newspaper
- ○ Phone
- ○ Radio
- ○ Relatives/ friends
- ○ Social Media (Facebook, twitter)

38) How many times have you experienced flood? ___________

39) When was the last time, your house was flooded? ______________

40) On a scale of 1-5, what was the severity of previous flood?

	1	2	3	4	5	
very low	○	○	○	○	○	Very severe

41) Height of flood measured inside your house (in meters): _________

42) Have you or your family members suffered from any disease as a result of flood?

○ Yes (please specify) ○ No

43) Do you have any knowledge about first aid?

○ Yes ○ No

44) Frequency of drills or awareness programs attended by your family? __________

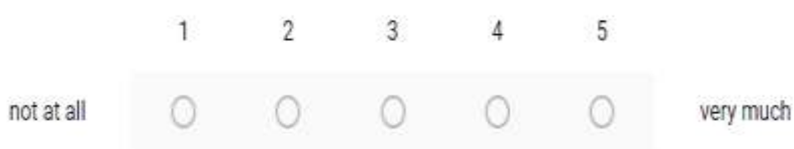
45) Reasons for staying in flood prone area? __________

44) How do you think we ca control floods? ________________

45) Whose responsibility do you think it is to provide protection against floods? _________

SECTION 6: HAZARD INFORMATION

46) How much do you rely on traditional information?



47) Whom do you prefer to contact in order to get information related to floods? _________

48) Who would you contact for information during a flood?

○ Government ○ Community ○ Army ○ Flood Management experts

49) What was your source of information during previous floods? ____________

SECTION 7: Rescue and Relief

50) Did you evacuate successfully during previous flood?

○ Yes ○ No

51) Duration of evacuation as a result of flooding in your area? __________

52) Who provided relief aid during the past flood? __________

SECTION 8: Risk Perception (Preparedness)

53) To what extent, do you think you are prepared for a flood hazard?

	1	2	3	4	5	
not at all	○	○	○	○	○	very well-prepared

54) To what extent, have you discussed flood disaster preparedness with your family members?

	1	2	3	4	5	
Not at all	○	○	○	○	○	To a great extent

55) How much are you willing in future to seek information about flood risk?

	1	2	3	4	5	
not interested	○	○	○	○	○	highly interested

56) What do you think about your capability to cope without external support?

	1	2	3	4	5	
not sure	○	○	○	○	○	to a large extent

57) What is your likelihood of insuring yourself, family and your assets?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

58) What is the likelihood of flood proofing your house?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

59) How much are you willing to undertake flood preparedness measures in your house?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

60) How much are you willing to participate in flood training programs?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

61) How much do you understand about early warning and its protocols?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

62) What is your level of trust in the government?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

63) What is your level of trust in media?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

SECTION 9: RISK PERCEPTION (WORRY)

64) How much are you afraid of floods?

	1	2	3	4	5	
not worried at all	○	○	○	○	○	greatly worried

65) If a flood occurs, what are the chances of loss of lives in your area?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

66) How much damage floods can cause to your personnel health?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

67) How much damage floods can cause to social environment (disruption of schools, transportation, communication)?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

68) To what extent, floods can damage houses (sweeping away of belongings, wet floor, damaged walls)?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

69) To what extent can food security be disturbed by floods (disruption of food supply, loss of livestock, famine)?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

70) What are the chances of utility services being damaged by floods (water supply, sanitation)?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

71) What are the chances that flood will change your lifestyle?

	1	2	3	4	5	
not likely	○	○	○	○	○	very likely

SECTION 10: RISK PERCEPTION (AWARENESS AND EXPERIENCE)

72) How much are you aware of evacuation routes in your area?

	1	2	3	4	5	
not at all	○	○	○	○	○	highly aware

73) What is your level of knowledge about emergency protocols?

	1	2	3	4	5	
no information	○	○	○	○	○	know very well

74) How much do you think you can understand flood forecasting and warning?

	1	2	3	4	5	
no understanding	○	○	○	○	○	completely understands

75) How much are you aware of unusual weather patterns (high temperatures than usual, changes in rainfall pattern)?

	1	2	3	4	5	
not at all aware	○	○	○	○	○	extremely aware

76) What is the likelihood of flood occurrence in your area?

	1	2	3	4	5	
extremely unlikely	○	○	○	○	○	extremely likely

SECTION 11: PSYCHOLOGICAL

77) To what extent, do you think climate change is responsible for floods?

	1	2	3	4	5	
not at all responsible	○	○	○	○	○	completely responsible

78) To what extent, do you blame human activities for causing floods?

	1	2	3	4	5	
not at all responsible	○	○	○	○	○	completely responsible

79) It is possible to quantify climate change?

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

SECTION 12: GEOGRAPHIC

80) My local area is likely to be affected by climate change.

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

81) Climate change will mostly affect developing countries

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

83) Climate change will mostly affect areas that are far away from here

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

SECTION 13: SOCIAL

84) Climate change is likely to have a big impact on people like me

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

SECTION 14: TEMPORAL

85) When, if at all, do you think Pakistan will start feeling the effects of climate change?

- ○ We are already feeling the effects
- ○ In the next 10 years
- ○ In the next 25 years
- ○ In the next 50 years
- ○ In the next 100 years
- ○ Beyond the next 100 years

86) Do you think climate change is an immediate threat?

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

87) I have personally experienced the effects of climate change?

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

88) Do you think future generations are more likely to face effects of climate change?

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

SECTION 15: UNCERTAINITY

89) I am uncertain that climate change is really happening

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

90) The seriousness of climate change is exaggerated

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

91) Most scientists agree that humans are causing climate change

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

92) It is uncertain what the effects of climate change will be

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

93) There is no unified opinion related to climate change among scientists.

	1	2	3	4	5	
strongly agree	○	○	○	○	○	strongly disagree

94) Any suggestions/ Comments