

SOCIAL CAPITAL, PLACE ATTACHMENT AND FLOOD RISK PERCEPTION: A STUDY OF KOSI RIVER BASIN IN BIHAR

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

BY

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GUWAHATI, INDIA

AUGUST 2022



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DECLARATION

I hereby declare that the thesis entitled “**Social Capital, Place Attachment and Flood Risk Perception: A Study of Kosi River Basin in Bihar**” is the result of investigation carried out by me at the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, under the supervision of Prof. Sambit Mallick and Dr. Mithilesh Kumar Jha. The work has not been submitted either in whole or in part to any other university/institution for a research degree.

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CERTIFICATE

This is to certify that Ms. Tulika has prepared the thesis entitled “**Social Capital, Place Attachment and Flood Risk Perception: A Study of Kosi River Basin in Bihar**” for the degree of Doctor of Philosophy at the Indian Institute of Technology Guwahati. The work was carried out under our supervision and in strict conformity with the rules laid down either in whole or in part to any other university/institution for the purpose. It is the result of her investigation and has not been submitted either in whole or in part to any other university/institution for a research degree.

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ACKNOWLEDGEMENTS

Now that my PhD journey is coming to an end, I have mixed feelings. My journey of PhD has been a roller coaster ride with many ups and downs, but it has taught me how to overcome most unfavorable situations patiently. This experience will help me in all walks of life.

I owe gratitude to my supervisor Prof. Sambit Mallick who not only supported me when I was on the verge of quitting PhD but also agreed to be my mentor. Without his guidance and immense support, this journey would not have been completed. He is like a father figure to me. I would like to take this opportunity to acknowledge his contribution and thank him for the support he provided to date. He is the best supervisor a student can ask for.

I would like to thank my co-supervisor Dr. Mithilesh Kumar Jha for all the help and support. I am grateful to Prof. Sawmya Ray, Dr. Dilwar Hussain and Dr. Ngamjahao Kipgen, members of the doctoral committee, for their guidance and valuable suggestions which shaped my understanding of the subject.

I acknowledge and thank the Indian Institute of Technology Guwahati for providing me with Research Fellowship that helped immensely during my fieldwork.

I wish to extend my gratitude to the government institutions and people of Supaul district for participating in my research. The data collection process would have not been completed smoothly without their support.

Since I have this opportunity, I would like to thank my father Mr. Birendra Kumar Sharma for always encouraging me to do better in my life. He taught me that nothing is impossible with hard work. I also want to thank my sister Priya for motivating me whenever I had doubts about my abilities and helping me in every best possible way.

The special mention here goes to my husband Dr. Avinash Kumar and my son Nirvaan Krishna. Nirvaan grew up with my Ph.D. and bore all the consequences with me. His playful activities always brought a smile to my face and cheered me up in adverse situations. I dedicate my academic success to both of them. Without their support, I would not have been able to complete my dissertation.

Tulika

ABSTRACT

Flood is a perennial problem in the state of Bihar, in general, and in the Kosi river basin, in particular. The Kosi river is the main cause of floods in Kosi region. River Kosi is known as the 'Sorrow of Bihar' inflicting a devastating impact on the people residing in the region. The provincial and central government has taken several measures over time to reduce the casualties and vulnerability of people caused by Kosi floods. Most of these measures were structural-based solutions such as the building of dams, embankments, and floodwalls. However, these structural measures have failed to control the flood problems in the Kosi river basin. Despite all past and current engineering solutions to control floods and increase flood safety, the plight remained unchanged and the suffering continues on account of massive human and physical loss.

Against this backdrop, the present study aims to examine the influence of sociodemographic characteristics, social capital, and place attachment on flood risk perception. Furthermore, a modest attempt is also made to capture the ground reality of flood control and management in Kosi Basin by eliciting the responses, views, beliefs, and perceptions of the affected communities and representatives of flood control institutions. The scope of the study is confined to the Supaul district of Bihar. The study employed a mixed-method approach to achieve its research objectives. A cross-sectional survey was conducted in the flood-affected areas of Supaul, Bihar. Simultaneously, in-depth personal interviews were conducted with the officials engaged in flood control in the Kosi region and community members of Supaul district. Multiple regression analysis was performed to analyze survey data and thematic analysis was carried out to analyze interview data. The findings show that perceived flood risk is distributed quite unequally along occupation, length of residence, gender, and caste of respondents. Importantly, the study also found a positive exchange between social capital, place attachment, and flood risk perception. Specifically, the components of social capital and place attachment have emerged as strong determinants of flood risk perception. Nevertheless, place attachment predominated social capital in terms of the degree of influence. This exhibits the dominance of place-specific factors over social-relational factors. Embracing the social, psychological, and place-specific approach to studying flood risk perception could be instrumental in developing integrated flood risk reduction strategies which could ultimately contribute significantly to the endeavour of protecting human and physical loss owing to natural disasters like floods.

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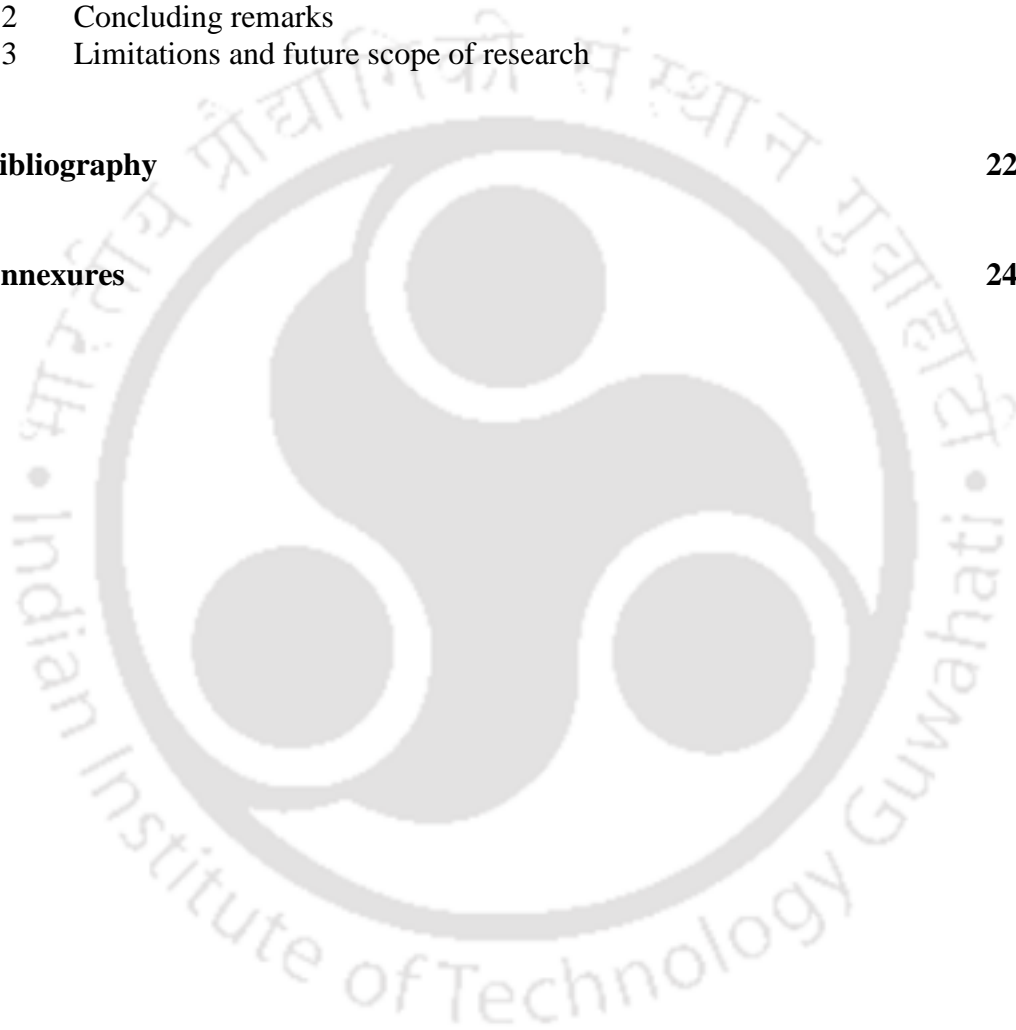
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LIST OF ABBREVIATIONS

AE	Assistant Engineer
ANOVA	Analysis of Variance
BDO	Block Development Officer
CE	Chief Engineer
CRED	Centre for Research on the Epidemiology of Disaster
CWC	Central Water Commission
DM	District Magistrate
DMD	Disaster Management Department
DO	Divisional Officer
EE	Executive Engineer
EM-DAT	Emergency Events Database
EOC	Emergency Operation Centre
FMISC	Flood Management Information System Cell
FYP	Five-Year Plan
GDP	Gross Domestic Product
GFCC	Ganga Flood Control Commission
GIS	Geographic Information System
GoB	Government of Bihar
GoI	Government of India
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
JE	Junior Engineer
JRY	Jawahar Rojgar Yojna
MHA	Million Hectare
NCF	National Commission of Floods
NDMA	National Disaster Management Authority
NIDM	National Institute of Disaster Management
PAR	Pressure and Release Model
PHC	Primary Health Centre
PMT	Protection Motivation Theory
PRI	Panchayat Raj Institutions

SAKY	Shatabdi Anna Kalash Yojna
SDMA	State Disaster Management Authority
SDO	Sub-Divisional Officer
SE	Superintended Engineer
UNDP	United Nations Development Programme
WALMI	Water and Land Management Institute
WMO	World Meteorological Organisation
WRD	Water Resources Department



Chapter I

Introduction

Flood hazards have emerged as one of the significant disasters in terms of human and physical losses. Among all the natural disasters, floods are the most severe and damaging in the world (Messner & Meyer 2006). It represents about one-third of all-natural disasters, including one-third financial losses due to natural hazards (White 2000). Unfortunately, floods are liable for more than half of the fatalities that occur due to disasters in the whole world (White 2000). Floods are a recurrent annual feature in India, particularly in the eastern and north-eastern regions. Flood damage statistics indicate that, on average, 7.17 million hectares of area in India are affected annually. Out of which, around 3.94 million hectares are cropped area. Floods have claimed an average 1654 human lives and 618248 livestock every year. Approximately 1.2 million houses are damaged fully or partially, and annual loss in monetary terms accounted for Rs 5649 (NITI Aayog 2021).

Bihar is one of the worst-hit states in India. Flood is the most common and regular annual phenomenon in Bihar, resulting in enormous loss of life and property. The total flood-prone area of the state is 68.80 lac hectares which accounts for 73.06% of its total geographical area and 17.2% of the total flood-prone area in the country (GoI 2013). As per data of the State Disaster Management Authority Bihar, from 1980 to 2020, on average, around 1.24 million hectares of the area were affected in Bihar due to floods. Out of which, the proportion of cropped area accounted for 0.54 million hectares. Floods in Bihar have been equally devastating in terms of human and livestock loss by claiming 250 human lives and 747 livestock annually. The annual loss in monetary terms is reckoned to be Rs 454.5 crores along with 158765 houses damaged fully or partially.

Proper understanding of the flood phenomenon and its consequences is essential for formulating flood control techniques, risk reduction, improved resilience, and flood risk management. According to Ulrich Beck, 'risk society is the result of modern society's industrial and scientific developments (Beck 1992). These transformations can be seen in terms of changing the order of the world, as well as in changing structures of the state, family, and labor class. However, these changes showed that societies could not overcome hazards using traditional procedures only. Specifically, it can be said that the instruments of modern societies could not succeed in controlling the consequences of globally emerging hazards, whose impacts and accountability are hard to anticipate (Beck 1999). Therefore, new approaches are required to deal with the contemporary crisis (Beck 1992). Across the time and globe, the focus has shifted from structural-induced risk reduction policies to non-structural-induced risk reduction policies to control floods. The method of risk analysis has undergone a paradigm shift. The traditional approaches to risk analysis were anchored on objective measures (Lechowska 2018). It was largely based on the external factors that affect the disaster communities. Little attention was paid to the subjective aspect of risk assessment, such as risk perception. Over time, risk perception has emerged as a crucial aspect of modern approaches to flood risk management. Knowledge of public risk perception is essential to improve the effectiveness of any risk reduction program (Kellens et al. 2011). It is important to take risk perception into account because it determines the attitude (preparedness level), possible behavior, and capability of flood-affected communities to react to natural disasters like floods (Lechowska 2018; Bradford 2012). Risk perception tends to be affected by social, spatial, economic, psychological, and regional conditions. The topic of risk perception is broadly situated within the scope and ambit of sociological sciences.

Sociologists conceptualize risk as a socio-cultural product connected with dynamics of social systems such as social organization, social institutions, culture, norms, beliefs, etc.

(Tierney 1999; Weichselgartner 2001). Nevertheless, the study of risk perception also perfectly fits with the scope of human geography and psychology. In recent years, social, spatial, economic, psychological, and regional conditions have emerged as the most important links to managing flood disasters at the community level. Without understanding how society perceives risk and its determinants, the possibilities of conducting effective flood risk management are reduced. Several scholars have acknowledged the importance of socio-psychological factors such as social capital and place attachments' role in determining risk at the different stages of natural disasters, particularly at the community level (Hudson, Hagedoorn & Bubeck 2020; Wind, Fordham, and Komproe 2011; Dzialek et al. 2013; Bird, Gisladottir & Dominey-Howes 2011; Gallina & Williams 2014; Bernardo 2013; Bonaiuto et al. 2011 and Bernardo 2013). However, the linkages of social capital and place attachment specific to the perceived flood risk still maintain the status of an under-researched topic, particularly in developing countries. In developing countries, it has been observed that most of the research and policies related to flood control focus on strengthening physical infrastructure by reinforcing the existing infrastructure through government spending, while social, psychological, and regional factors are ignored to a greater extent.

As mentioned previously, flood is a perennial problem in the state of Bihar, in general, and in the Kosi river basin, in particular. The Kosi river is the main cause of floods in the Kosi region. River Kosi is Known as the 'Sorrow of Bihar', inflicting a devastating impact on the people residing in the region. The provincial and central government has taken several measures over time to reduce the casualties and vulnerability of people caused by Kosi floods. Most of these measures were structural-based solutions such as the building of dams, embankments, and floodwalls. Structural measures were the cornerstone of any risk reduction policies or programs implemented in the Kosi region. However, these structural measures have failed to control the flood problems in the Kosi river basin. Despite all past and current engineering solutions to

control floods and increase flood safety, the plight remained unchanged, and the suffering continues on account of massive human and physical loss.

Against this backdrop, the present study aims to examine the influence of sociodemographic characteristics, social capital, and place attachment on flood risk perception. Furthermore, a modest attempt is also made to capture the ground reality of flood control and management in the Kosi river Basin by eliciting the responses, views, beliefs, and perceptions of the affected communities and representatives of flood control institutions. The scope of the study is confined to the Supaul district of Bihar.

1.1 Review of Literature

Water has played an instrumental role in the evolution of human society. The river waters were and are still providing opportunities for humankind to cultivate, produce and develop themselves. The traces of many great civilizations are found near water bodies mainly. This kind of settlement indicates that floods were inevitable to the existence of humankind. The knowledge about flood control techniques and the hydrological cycle of rivers were always essential for the overall development of society. The floodplain areas served many purposes for the population, e.g., availability of natural resources, expansion of industries, river transport, development of tourism, etc. But, all these created enormous pressure over the areas resulting in increased flood risk.

Among all the natural disasters, floods are the most severe and damaging in the world (Messner et al. 2006). It represents about one-third of all-natural disasters, including one-third of financial losses due to natural hazards (White 2000). As for environment-related risks, floods are most connected with climate change (Nirupama & Simonovic 2007). It's unfortunate that floods are liable for more than half of the fatalities that occur due to disasters in the whole world (White 2000). It does involve not only material, infrastructural, economic, and

environmental losses but also causes long-term impacts like psychological damages, physical injuries, and even loss of human lives. Proper understanding of the flood phenomenon and the consequences caused by it is essential for formulating flood control techniques, risk reduction, improved resilience, and flood risk management. The process of flood risk is very complex and involves both natural and human factors. It is characterized by the conjunction of the possibility of floods taking place and the consequences attached to them in the form of social, cultural, economic, human as well as environmental. These consequences can be reduced either by controlling the occurrence of the phenomena or by controlling the vulnerability of the exposed assets. In terms of river flooding, climatic conditions play an important role. When the weather is extreme, i.e., heavy rainfall, it leads to the accumulation of rainwater in different river canals, which afterward spreads to other flood plain areas and inundates them. For a successful flood management policy, understanding the flood hazard, knowledge about the vulnerability of a particular space, and quantifying the probability of risk is fundamental. In the current scenario, it is very important to adopt a systematic approach to dealing with these hazardous events, including the insecurities created by them. As new methods of flood risk mitigation are being explored, there is also gradual evolution in people's understanding of the idea of what exactly flood risk is and how to handle it. The most probable reason behind this growing awareness is to make the best estimation of the consequences of the disaster and to improve the social aspects of the community so that they can become more resilient.

According to Ulrich Beck, 'risk society' is the result of modern societies' industrial and scientific developments (Beck 1992). As per him, the development of ICTs has quickened the overall transformation of the industrial societies of the 19th century into a global risk society. These transformations can be seen in terms of changing the order of the world, as well as in changing structures of the state, family, and labor class. However, these changes showed that societies could not overcome hazards by means of traditional procedures only. In short, it can

be said that the instruments of modern societies could not succeed in controlling the consequences of globally emerging hazards, whose impacts and accountability are hard to anticipate (Beck 1999). Therefore, new approaches are required to deal with the contemporary crisis (Beck 1992). In the words of Beck, new institutions and 'reflexive modernization (progress through reorganization and reform) is the need of our globalized world (Beck 1992). The most commonly used method of flood protection to keep floods away from human settlements through the ages has been the use of structural measures such as embankments, dams, levees, dikes, etc. Although, it has been observed that they have created more destruction than before. Therefore, the central argument of flood risk management focuses on balancing flood mitigation measures, structural and non-structural. Although it seems tough to achieve a hundred percent balance, initiatives like land-use planning, the establishment of the early warning system, and early forecasting methods could help decrease the system gaps. The 20th century has observed drastic climate change globally because of human's overutilization of fossil fuels. The major environment-related problems like air pollution, forest degradation, and depletion of the ozone layer leading to global warming have taken the front row in most countries in the world (IPCC 2007).

The focus on disaster risk reduction from disaster response occurred in the 1990s. Before this shift, the focus was mainly on the response and recovery activities after the occurrence of any disaster. As per the notion of conventional approaches, natural disasters can be defined as unrestrained incidents faced by societies regularly (Balamir 2007). According to this perception, the disastrous consequences of any hazard are based on fate and are a part of a process. There are four steps in disaster management as per the conventional approach preparedness, risk reduction, crisis response, and recovery and rehabilitation. In conventional disaster management these steps complement each other as a unit. However, the conventional approach has been criticized by Balamir (2007) because it focuses on each phase separately

and does not include a comprehensive disaster management policy. It also does not take into account the participatory approach involving all stakeholders. The risk reduction process involves measures that can either reduce or minimize the impact of a disaster on societies. In addition, to minimize the effects of disaster, necessary steps should be taken by individuals, local communities, and institutions as a whole. Getting prepared for a disaster requires a proper plan in coordination with individuals, local communities, municipal corporations, organizations as well as national governments.

Floods are "temporary inundation of normally dry areas from the overflow of inland or tidal waters, or the unusual and rapid accumulation or runoff of surface waters from any source" (FEMA 1986). Flood hazard can also be explained as the likelihood of occurrence of detrimental events of flood hazard (Merz 2004). In the words of Schanze, potentially damaging floods refer to the components that are open to floods and could be but are not necessarily harmed (Schanze 2006). The vulnerability raised out of flood hazards involves three basic aspects, i.e., economic vulnerability, social and cultural vulnerability, and ecological vulnerability (ibid). While economic vulnerability reveals the losses direct or indirect due to potential harm to properties, materials and goods, the impact on health in terms of physical and mental injuries, stress and anxiety, the loss of lives and impact on cultural heritage is indicated by the different levels of socially and culturally produced vulnerability. Besides, ecological vulnerability deals with the problems of hydro, geo, and ecological damages.

There is a clear distinction between flood control and flood plain management in terms of the use of flood mitigation measures of structural and non-structural. As per the definition provided by FEMA, flood control is to "confine, limit or control the runoff characteristics of a watercourse through structural means such as dams and levees" (FEMA 2003). Whereas Floodplain management is to "identify and recognize hazard associated with the runoff characteristics of a watercourse and develop floodplain safely" (ibid). The flood protection

method that is used most widely to protect the settlements from floods is the use of structural measures such as the construction of embankments, levees, dams, etc. However, they are temporary solutions to the problem and further aggravate the situation because of their least or no maintenance. When the movement of water is restricted to a confined setting, it mostly has negative impacts. These interventions involving physical actions like structuring by or on top of a river are more severe because they ultimately increase the speed and height of the water level. In response to this structuring, the river tries to adjust itself, leading to more disastrous consequences and resulting in constant upgradation of the structure. In other words, structural measures may seem fruitful in the short run but are mostly catastrophic in the future. Therefore, it is the need of the hour to include human perception in the flood management approach.

Involvement of human behavior along with structural measures will give the flood management approach a societal point of view which is very important, particularly for the policy makers regarding the planning of non-structural measures. The non-structural measures are based on the concept that floods are inevitable and therefore focus mostly on the cost-effective measures to protect the communities from surges. In other words, it is a long-term approach that aims to reduce the loss of lives and properties by making people aware of and understanding the risk of flood hazards. Although there is a need for a balanced approach involving structural and non-structural measures, the government's central policy focuses mainly on using structural measures. It is the combination of both these measures that can help in protecting people in a risk-prone area. According to Pilon (2003), the flood management process involves schemes that aim to reduce the risk but do not remove it entirely.

In most cases, flood risk cannot be eliminated entirely. The journey of flood risk management involves multiple phases. The first phase is risk identification (the potential disaster followed by vulnerability), the second phase is based on risk assessment, the third

phase is all about developing strategies to reduce that risk and the final phase is about execution of all the plans and policies to make the strategies work (ibid).

The definition of risk perception states that an evaluation of the occurrence of a natural disaster and the likewise results are inherited by society that often has detrimental effects (Grothmann & Reusswig 2006; Bubeck et al. 2012; Becker et al. 2013). For Kellens et al. (2011), human emotions, their behavior, and consciousness towards any disaster form the base to investigate the question of how flood risks are perceived. They further state that, in general, objective measures are used for analyzing risk; however, risk perception, which is the subjective assessment of risk, has gained the first position in the context of flood risk management presently (ibid). When flood risk management is being conducted as an aspect of social context, it is emphasized to consider an individual's flood risk perception (Renn 2005; Brown & Damery 2002). Because it does not only ascertain their level of flood risk perception, but also their attitude, and the related behaviour when they encounter a flood. An insight into the public's risk perception helps to improve the risk management related to floods (Kellens et al. 2011). Understanding how societies perceive flood risk plays a vital role in finding the most suitable method to spread information regarding flooding, which will further enhance the society's trust in the government as well as increase the capability and resilience of the communities (Bradford et al. 2012). The main reason for various unsuccessful flood management policies is the lack of understanding on the part of authorities about the affected communities; therefore, people's risk perception must be at the center of all discussions (ibid).

In most cases, the society's perception of risk does not correspond with the expert's determining flood risk level. This problem can be solved after having an idea about the factors that influence the subjective flood risk perception. After knowing the factors, the habitants can be influenced to take the required actions to mitigate the desired effects of a flood that will further decrease the flood risk (Becker et al., 2013). When there is a difference in the perception

regarding flood risk, it becomes important to understand the elements causing differences in the risk perception related to floods. It will enable developing a strategy to communicate the incoming danger to the communities and eventually make them resilient to flood hazards (Bradford et al., 2012). Besides, the starting point of flood risk management politics needs to be based on the communication and perception regarding flood risk (Messner & Meyer 2006). There are three basic elements, preparedness, awareness, and worry, that characterise the flood risk (Raaijmakers et al. 2008). Awareness is linked with a person's understanding that the place where they are living comes under flood risk. Sharing of information and education are the two things that increase awareness among societies. The level of awareness also rises with the experience of a flood. A person who has faced a flood before will be more aware of any disastrous situation. It is also linked with demographic factors such as age, sex, education, gender, etc. (Bradford et al. 2012). According to Slovic (1998), if the level of the unknown threat is higher, the risk perceived will also be higher. Preparedness is connected with the actions taken before a flood and includes the execution of mitigating plans, flood coping capacity, and the chances of recovery afterward (Raaijmakers et al. 2008).

Several studies on flood risk suggest that the level of preparedness and preventive measures for any natural disasters are often based on the factors connected with the social and economic aspects of the community (Miceli et al. 2008). The frequent occurrence of a disaster increases the worry among people. It is further multiplied by the losses after it. However, the level of worry differs among individuals.

1.1.1 Risk perception, flood risk perception, and flood management interface

Flooding is becoming a worsening challenge day by day for many human societies. Since the 19th century, among all the natural disasters, floods count for more than one-third and account for almost half of the population getting adversely affected by it (Adikari & Yoshitani 2009).

Similarly, the prevalence, and severity caused by them, appear to be on the rise (Schanze 2006). The increasing frequency of flooding and the increase in the weather of the Northern Hemisphere results from rising greenhouse emissions and globally changing climatic conditions, as argued by recent researchers (Schiermeier 2011). Recent studies on floods have recognized that complete prevention and protection from the flood is almost impossible to attain, and that is why the attention has been shifted towards a more holistic approach, i.e., from prevention to management of flood risk (Schanze 2006). The holistic perspective focuses on understanding why and how the severity of disasters occur, who are the people affected, and what planning, interventions, and methods to overcome flood disasters are. These questions have further been linked with the recent progress in the research on understanding risk and the ways people live with uncertainty (Slovic 2010).

The definition of 'risk perception' draws from the various risk characteristics. Earlier, the risk was defined as 'measures of hazard' where the hazard was seen as 'dangerous to the population and their valuable belongings' (Kates & Kasperson 1983). These definitions have been supplemented by more aspects that see risk as a convergence of people and assets with exposure, vulnerability, and openness to a hazard (Crichton 1999). These three elements (hazard, exposure, and vulnerability) of risk advance the present understanding of it, covering a wide range, including natural disasters (Blakie et al. 1994). However, it also demonstrates the relationship between risk and behavior, i.e., how exposure and vulnerability to a particular hazard can be altered by certain behavior. These behavioral responses, including the weight of risk perceived, are forwarded by the human assessments (Slovic et al. 1974). These judgments based on human intuitions through which people evaluate and estimate the possible outcome of a particular hazardous event are generally termed as risk perceptions, based on which people choose best suited behavioral response (Slovic 1987). Risk perception has obtained particular mention in the contemporary literature on risk management. According to Burns and Slovic

(2012, pp.579), "more than their direct consequences, the political, social and economic impact of disasters may be amplified by risk perceptions and related behaviors". They also highlighted the importance of understanding the links between emotions, behavior, and risk perception in developing more effective policies of disaster management and risk communication. However, in the general literature of risk management, when there is a shift towards flood risk management from general risk, the character of risk perception seems to be not well developed or least developed. Historically, the traditional approaches of flood management that focused mainly on the prediction and monitoring or improvements of physical flood defenses have overlooked the social dimension of it, i.e., people's understanding and perception of the hazardous event (Brown & Damery 2002). However, flood risk perception has recently been considered an important aspect in the overall development of effective strategies for flood risk management. The judgment about any flood hazard and the actions taken to prepare, mitigate and respond to any flood event are shaped by the way people (individuals, households, government bodies, etc.) understand and perceive flood risk.

1.1.2 Theoretical developments of risk perception

There are two broad paradigms that undermine the different approaches to risk perception, the first paradigm is a rationalist paradigm, and the second paradigm is known as constructivist. The emphasis of the rationalist approach to risk perception is on the cognitive process of an individual. It states that when any hazard occurs, it will prompt the individual to quick judgment and take a 'rational' decision in adopting preventive and protective behavior as required. The studies based on the rationalist paradigm focus mainly on predicting, modeling, and characterizing behavioral outcomes after different hazards. However, the constructivist approach undermines risk as a contextual and socially constructed phenomenon. It assumes that the judgment an individual makes during hazards, and his decision-making process are influenced, constrained, and shaped by the social environment in which he lives (Drake 1992).

These social environments, including institutions, organizations, and cultures, sometimes dictate the behavioral option because of the power dynamics, control of resources, and access to knowledge (Slovic 2000). The distinction between rationalist and constructivist paradigms in the social sciences originated from the 'constructivist turn', and has gathered various debates around this distinction particularly from the political sciences (Fehl 2004).

1.1.2.1 Rationalist approaches – Revealed preferences and the psychometric paradigm

A comprehensive study based on how individuals perceive or weigh technological risks in opposition to their own profits was conducted in 1969 by an American engineer to assess the extent of being safe (Starr 1969). The study used the archival facts to undermine the opportunity cost of risk-benefit chosen by the authorities and society when they face uncertainty regarding cost and benefit analysis related to technological risks. The findings of this study suggest that voluntary people will take greater risks than involuntary people (Starr 1969). Slovic's research that there is a cognitive process behind every risk-taking behavior is primarily inspired by Starr's work (Slovic 2000). The research aimed to exhibit that risk could be explained psychometrically to reveal judgments in quantitative terms as it is a cognitive construct (De Marchi 2007). This approach of characterizing and analyzing risk perceptions quantitatively is generally referred as a psychometric paradigm. It has greatly influenced the different research on risk perceptions. According to Fischhoff et al. (1978), nine characteristics or dimensions of risk influence how an individual or society perceives the risk. These are voluntary or involuntary risk; the level of one's knowledge related to risk; the level of risk related to scientific knowledge; the immediacy effect; whether the risk is catastrophic or chronic; whether risk was dreaded or commonplace; the level of severity; the level of control over exposure to risk and the last one is the novelty of risk. The revealed preferences approach mainly analyses the extent of social cost considered acceptable for an individual or society within a cost-benefit

analysis of risk (technology) assessment. Whereas the psychometric paradigm is interested in how people differentiate between the type of risks and accordingly assess and rank them.

1.1.2.2 Prospect Theory- heuristics and judgment

The prospect theory explains how individuals, based on their calculation of probable gain and loss, make a decision under uncertainty (Kahneman et al. 1982). This concept also had an immense impact on financial decisions around economic theories (Kyle et al. 2006). By exploring the way people assess "the probability of an uncertain event or the value of an uncertain quantity," the researchers explain how an individual analyzes the occurrence of an event based on a set of heuristics (Kahneman et al. 1982). The heuristics & judgment approach argues that individuals often follow their mental guidelines while making judgments in terms of uncertain risk events (ibid). These judgments are based on one's access to personal and scientific information related to risk. A recent study investigated people's judgments when they came across hazard images and argues that people's mental representation of a hazard can carry an "affect tag" which means the positive or negative feelings related with hazard are 'tagged' with and can influence risk perception of people in terms of a hazardous event (Finucane et al. 2000). Slovic (2010) has comprehensively examined the impact of heuristics and factors like mood on risk perception. According to him, the rational behavior of an individual in terms of risk is a complex interrelationship between reason and emotion.

The rationalist approaches, however, have certain limitations. The contemporary critiques of this perspective explain that every individual's actions are personal, based on a particular context, and socially constructed. It is based on the universal rationality concept and cannot be limited to technological risks only. Studies on heuristics have explained that there can be manipulation of an individual's affective reactions through advertising or other methods which can further have an immense impact on his logical way of thinking and might lead to

unreasonable behavior (Slovic et al. 2004). Another critique of the rationalist approach comes from Jaeger et al. (2001), who also provided a minute distinction between the three stages of analysis of the rationalist perspective. He argues that the rationalist paradigm assumes that the behavior of every individual may be regarded as optimization problem variants, which is not valid. This critique has opened new doors for the development of other innovative approaches to understanding various aspects of risk management.

1.1.2.3 Constructive approaches – Social construction of risk

In the 70s and 80s, many anthropologists and sociologists started questioning the rationalist paradigm approaches and assumptions of risk and its perception (Douglas 1985, Johnson et al. 2004). Their argument was based on the fact that the rationalist paradigm did not undermine the social organizations and constructions within which risk perception developed (Tierney 1999). One of the counter-attacks to this argument was the implementation of the political ecology approach in risk perception research. The political ecology approach tends to evolve around society-hazard relationships by analyzing various contextual factors like economic and political forces, structural constraints resulting in unequal distribution of resources, and creating a different level of vulnerability among the marginalized category. With this line of approach, the risk research turned towards investigating the role of the contextual factors that shapes the risk perception of individuals (Mustafa 2002). The concept was linked with the evolution of constructivist thinking of risk perception, which disapproves in a larger sense of the idea of hazards being an objective phenomenon that is external to the social systems. Risk and hazards are socially constructed and have a complicated connection with the dynamics of the social system like social organizations, social institutions, culture, norms, beliefs, etc. (Tierney 1999, Weichselgartner 2001). Though the understanding of risk is context specific, in one social context, what can be termed as a hazard might serve in another social context as a resource (Weichselgartner 2001). An initial illustration of the constructivist approach brought

in focus the influence of media in shaping the social risk perception of an individual (Short 1984). The study provided a new dimension to the rational approach research pointing out the role of media coverage in producing biased risk judgments that show how risk perception is 'influenced' (Johnson & Tversky 1983). The authors of the constructivist approach maintained that to make new sensational stories, the media pays more attention to rare disastrous events than the day-to-day hazards, which results in people perceiving everyday hazard as less frightening and dangerous and could be solved easily. Therefore, people often underestimate the underlying risks of day-to-day hazards. This explains the critical role that media plays in the social construction of the perception of risk. With the development of the constructivist approach across other fields of study, some authors argued that this played an important role in the opening of a new line of inquiry, for example, understanding the power dynamics of the society and also the influence of interest groups organised for risk management policy which plays an important role in framing the debates around the perception of risk in the society (Clarke & Short 1993). Some authors have also argued that the social constructivist paradigm will benefit further research on risk perception as it highlights the factors that can transform the dynamics between risk management and perception of risk. These factors might be the social system through which social agents demarcate as what should be considered as a hazard; why and how a particular measure of risk perception is better than the other, the risk-related strategies adopted by the researchers, the private sector, the decision-makers and anyone who makes risk related claim (Tierney 1999).

1.1.2.4 Cultural theory of risk

The cultural theory of risk was the other major theory developed around the constructivist paradigm (Douglas & Wildavsky 1982). It argues that the social and organizational structures reinforce and endow risk perception in an individual (ibid). The approach rests on "the uniquely human capacity to classify experiences, encode such classifications symbolically, and teach

such abstractions to others" (Oltedal et al. 2004, pp.12). According to Mary Douglas, there is a clear difference between 'social relations,' i.e., the way interpersonal relationships work and cultural bias in terms of shared beliefs and values, and the individuals' way of living life' is a mixture of both; his relations and the influence of cultural beliefs (Douglas 1978). Therefore, the established 'way of life' is reproduced by the enculturation of the next generation (Oltedal et al. 2004). In the same line, four categories of 'way of life' proposed by Douglas and Wildavsky (1982) generally explain one's actions and attitudes towards risk. These categories are individualistic, egalitarian, hierarchical, and fatalistic.

1.1.3 Theoretical constructs of flood risk perception

1.1.3.1 Bounded rationality

The early research works on risk perceptions about natural hazards mainly focused on flood-oriented risk, where the scientists tried to explore that, despite having a constant flooding threat, why people still choose to stay in floodplains and what are the adjustments that they make to cope with these (White 1945; Burton et al. 1968). These research works provided a new base for reconceptualizing the problem by viewing risk perception at the juncture of natural and social structure (Burton et al. 1968). The underlying argument of these researches stated, "floodplain occupancy represents an interaction between the requirements of a human system with its economic, social and geographical relationships, and a hydrological system marked by strong elements of uncertainty" (White 1945, pp.436). The question of why someone chooses to stay in flood-prone risky areas is based on the belief that the alternatives people choose for their habitation are based on the act of balancing between two opposite situations, i.e., the relationship between the advantage of residing at a certain place and the associated hazard outcome (White 1972). While these arguments were strongly inherent in the rationalist approach, these researchers soon understood that the cost-benefit analysis of the conventional

rationalist approach is insufficient in capturing the human responses to any natural hazard. Therefore, in search of other better conceptual models, they turned or shifted towards the bounded rationality concept (Kates 1997). The idea of bounded rationality states that "cognitive limitations of decision makers force them to construct a simplified model of the world to deal with it" (Slovic et al. 1974, pp.5). Regarding natural hazards, when it comes to choices, the individual decision maker has to pick from a large number of possible responses. However, the choices of the decision-makers are limited, as they choose according to their perception of viable alternatives available (White 1972). The decision-makers, including both community as well as the government officials within risk-prone areas, are influenced by the characteristics of both; the social system and the biological and physical system and are therefore assumed to express their ratings and perception about risk based on their descriptions, their actual behavior as well as their articulation of the outcomes (White 1972). This branch of research had a strong influence on cognitive psychology, and the efforts were directed towards developing a comprehensive understanding of choices of adjustments by linking these two schools of thought. This collaboration is one of the first efforts which tried to combine the research of natural hazards with general theories of risk and also demonstrated the importance of cross-disciplinary research (Slovic et al. 1974). There are four variables that play an important role in shaping bounded rationality when it comes to the choices made related to natural hazard adjustments. These variables are; denial of uncertainty, misperception of risks, the orientation of crisis, tiff between collective versus individual management, and the existence of limited alternatives (Slovic et al. 1974).

1.1.3.2 Protection Motivation Theory

According to Protection Motivation Theory (PMT), the behavior of self-protection is inspired by the following factors: the occurrence probability perception, the threat severity perception, the response effectiveness perception, and the perceived ability of response implementation.

The theory aimed to understand how individuals deal with disaster threats and fear (Roger 1975). Grothmann & Reusswig (2006) conducted a study on the German people to explore the factors responsible for taking protective measures from floods. They found that an individual's decision to adopt protective measures is determined by four different processes similar to the elements of PMT. They are threat and coping appraisal, administrative measures appraisal, and threat experience appraisal. These processes, as per the author's findings, can interact in different ways to impact the behavioral responses of individuals in adopting flood protection.

1.1.3.3 Vulnerability, adaptive capacity, and resilience

Over recent decades, the studies around flood risk management have shifted their focus from engineering-based structural defenses and have turned their base to a more holistic approach that focuses on the impacts and drivers of flood risk involving individuals and communities. The concept of vulnerability has gained a particular place within natural disasters and hazard-related studies. The researchers use it as an analytical tool to analyze how social contexts, particularly natural disasters like flood events, shape individuals' risk perception. For example, the definition of vulnerability can be stated as "a persons' or a group's characteristics in terms of their capacity to anticipate, resist, cope and recover from the impact of a natural or man-made disaster, noting that there are various political-institutional, economic and socio-cultural factors behind the construction of vulnerability" (Schneiderbauer & Ehrlich 2004, pp.12). Similarly, the PAR (Pressure-and-release) model of disaster management explains that vulnerability is produced socially. The PAR model demonstrates that the 'progression of vulnerability' is the root cause, and the dynamic pressure resulting from rapid population growth with high inequality promotes unsafe localized conditions, and in these conditions, if any natural hazard takes place, it results in disaster (Blaikie et al. 1994). The three components of vulnerability are exposure to hazards, capacity to adapt, and susceptibility to harm (Messner & Meyer 2006). One of the key components of vulnerability assessment is risk perception. For

example, risk perception is shown as one aspect of 'social fabric' given in place specific hazard model by the cutter, which creates 'place vulnerability' after interacting with the geographical context (Cutter et al. 2012). Similarly, in terms of flood vulnerability, 'crisis perception' is seen as an aspect of society's cultural arrangements that play an important role in its capability to cope with the flood disaster (Few 2003). However, many studies acknowledge risk perception as a major determinant of vulnerability but do not explain flood risk perception adequately (Messner and Meyer 2006). It may be argued that flood vulnerability is contested and experienced at the interaction of flood risk management and perception.

Generally, adaptive capacity refers to a persons' or community's ability to bounce back from any disastrous events. Although, in recent studies, it has been extended to becoming more effective and enhancing the ability to adjust more while dealing with any natural hazard (Smit & Wandel 2006; Lopez-Marrero 2010). This shows the relative shift from recovery to adaptation, where recovery implies returning to the status quo, while adaptation implies being more efficient in handling a hazardous situation and shifting beyond the status quo. The studies on flood risk perception and adaptive capacity suggest that some cognitive factors act as a barrier in adapting protective actions at the household level. These factors include a perception regarding precipitation frequency and assuming a decrease in flood events or perceiving that the structural measures are sufficient to handle the flood events.

Recently, community resilience as a major mechanism of disaster risk reduction has gained the focus of risk researchers across the globe (Schelfaut et al. 2011). Vulnerability, resilience, and adaptive capacity are all interrelated. Broadly speaking, a resilient system or community refers to those who can reorganize themselves after disturbing events (Folke 2006). In flood risk management, a resilient strategy would always provide flexible and continual adaptation in a changing environment.

1.1.4 Dimensions of Social capital

Social capital has been utilized in literature in many senses. It has several dimensions. To achieve a common target, it's always easier to work with a group with mutual cooperation, coordination, and trust than to work alone. Human beings, when working as a group, are capable of achieving synergy in their work and by virtue of their coordinated actions, able to produce amazing results (Leonard & Onyx 2004). This phenomenon is a part of social structure and is a valuable resource to the 'social actors,' which they can mobilize to achieve their interests and is commonly known as 'social capital' (Dynes 2002). The different aspects of social capital have always been there in society, even before it was termed as 'social capital' by sociologists. It has historical links with authors like Durkheim, Simmel, Webber, and Marx, among many others, and is also related to psychological theories (Claridge 2004). However, contemporary authors argued that the term 'social capital' was first mentioned by Hanifan in 1916. He referred to it as "goodwill, fellowship, mutual sympathy, and social intercourse among a group of individuals and families" (Hanifan 1916, pp.130). Researchers who popularized the modern concept of social capital are James Coleman, Pierre Bourdieu, and Robert Putnam. The term social capital has been used in literature in many senses. It has several dimensions. In simple terms, social capital is broadly defined as "a stock of relationships, social norms, values, beliefs, trusts, obligations, networks, friends, memberships, civic engagement, information flows, and institutions that inculcate cooperation and collective actions for mutual benefits and contributes to economic and social development" (Bhandari & Yasunobu 2009, pp.480). According to Portes (2000), the family, friends, and colleagues of an individual are the important assets whom he can ask for help when he is in any problem or crisis. However, if we delve into the body of literature on social capital, we find that it was Pierre Bourdieu who popularized the phrase social capital. With reference to social power hierarchies, Bourdieu (2011) has suggested four forms of capital- economic, social, cultural, and symbolic. Bourdieu

defined social capital "as the sum of actual or potential resources which are linked to the possession of durable network of the more or less institutionalized relationship of mutual acquaintance and recognition, in other words, to membership in a group" (Bourdieu 1986, pp.248). It emphasizes the benefits of social networks available to the person if he is a member of a group or community in the form of opportunities and advantages. Bourdieu (1986) postulated that every individual's existence in the social space is not only defined by his social class but also by the kind of capital he has gathered through social relations, including social networks. Corresponding to the same perspective, Coleman (1988) conceived social capital as the resources gathered through the relationships among people. He defines social capital "by its function as it is not a single entity, but a combination of different entities having two characteristics in common: it is an aspect of a social structure, and it facilitates certain actions of individuals who are within that structure. The entities include obligations, expectations, trust, and information flows" (Coleman 1990, pp.302). Robert Putnam is recognized as another leading scholar to bring social capital into broad mainstream study. Putnam (1993, pp.167) defined social capital as "features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions." Social capital refers to "connections among individuals—social networks and the norms of reciprocity and trustworthiness that arise from them" (Putnam 2000, pp.18-19). In his interpretation of social capital, Putnam (2000) distinguished social capital into bridging and bonding, where bridging social capital is associated with what network researchers refer to as 'weak ties.' Bridging social capital refers to more distant ties of like persons, such as loose friendships and workmates. Often people in bridging networks differ on key personal characteristics. Bridging is more outward-looking, civically engaged, narrows the gap between different communities and exercising open membership, and is, therefore, crucial to organizing solidarity and pursuing common goals (Van Oorschot et al., 2006). On the other hand, bonding social capital exists

between individuals in strong ties, primarily in closed emotional relationships, such as family, friends, and close acquaintances. Often people in bonding networks are alike on key personal characteristics (e.g., class, race, ethnicity, education, age, religion, gender, and political affiliation). It is more inward-looking, protective, and exercising close membership, and therefore good for undergirding specific reciprocity and mobilizing informal solidarity (Van Oorschot et al., 2006). Bonding promotes communication and relationships necessary to pursue common goals. Individuals can engage in both bridging and bonding simultaneously, but typically they tend to favor one over the other (Putnam, 2000). It has been recognized by World Bank as the 'missing link' in development (Grootaert 1998). According to Peeling and High (2005, pp.317), "social capital offers ways to understanding the role of fundamental social attributes that contribute towards building capacity for social collectives and individuals to respond to climate change."

1.1.4.1 Social capital and Flood Risk perception

Recently, the world has observed a rise in the number and frequency of severe weather-related events like floods, earthquakes, drought, storms, etc. (IPCC 2012). These events, when they severely impact livelihoods and takes a toll on human lives, become natural disasters (Beniston & Stephenson 2004). When the adverse effects of any hazard are not handled well, they become a disaster (Abarquez & Murshed 2004). Thereafter creates a big challenge for the government worldwide, particularly in developing countries, to recover from post-disaster effects (Aldrich 2012a). In spite of frequent dialogues, several discussions, and enormous investments in the disaster management area in the last decade, there has been a continuous rise in losses (Shaw & Sharma 2011). The most cited reasons behind this increase in natural disasters are climate change due to global warming and blindfold development. Worldwide this blindfolded development has pushed people to reside in disaster-prone areas by exposing them to several natural hazards and afterward increasing their vulnerability, and to survive, they may be forced

to further degrade the environment (Wisner et al. 2004). Natural hazards like floods occur suddenly. Although there are sometimes warning, the time span is usually much less. The water moves very fast, and by the time people realize it, it has already entered their lives and becomes uncontrollable. In areas where flood occurs because of rivers, mud and silt deposition is also a big challenge. As a consequence, there is enormous direct and indirect damages to the livestock, crops, properties and also to various intangible assets making it difficult to cope and recover from the disaster (Chan 2015a). Worldwide several measures have been taken by the government to reduce the casualties and vulnerability of people through various risk reduction programs, but the situation remained almost the same. With time it has come into existence that there is more to risk reduction programs than the use of only structural measures. The traditional approaches have focused only on the external factors that affect the disaster communities. Still, little attention has been paid to social relations, which is crucial in the process of rebuilding of the communities. According to White (1942), there is a lot of action required to adjust human behaviors to limit floods rather than just controlling water. At present, to manage disasters at a community level, the social aspect has emerged as one of the most important links. Several studies on disaster risk management have emphasized social capital's role in managing risk at the different stages of natural disasters, particularly at the community level, where mobilization of social capital has proved to be beneficial for the whole community (Koh & Cadigan 2008). Until recently, disaster research mostly focused on the physical and human aspects of hazards. The social capital aspect is a less researched topic. Although social capital's role in disaster risk reduction and making the community resilient is understood by people, it is often overlooked. According to Aldrich and Meyer (2015), almost every research and policy related to flood disaster management mainly focuses on the physical infrastructure by improving the existing infrastructure by spending government money even when it is

apparent that social factors are crucial for community resilience. The author suggests that communities cannot be made disaster resilient by only strengthening the social infrastructure.

1.1.5 Place attachment and risk perception

The current situation in which human society is standing now needs a detailed understanding of reasons and measures for coping with disaster risk. The importance of an individual's special fondness for places has been recognized long back (Altman & Low 1992, Relph 1976). Place attachment is a major social-psychological element of human-environmental transactions (Bonnes, Lee & Bonaiuto, 2003). It has been defined as a "cognitive or emotional connection to a particular setting" (Low 1992, pp.256), "emotional involvement with places" (Low 1992, pp.165), and affective bonds toward places that often include some aspect of individual and collective identity (Lewicka 2008), emotions and affective responses towards a place that gives a sense of stability and connectivity (Twigger-Ross & Uzzell 1996), multidimensional concepts, involving an individual (the actor), psychological process (affect and cognitive behavior), and physical setting (place characteristics) (Scannell & Gifford 2010), overall bonds, thoughts, feelings, and behavioral intentions towards social-physical milieu (Perkins 1992), and emotional and affective responses toward the places that define identities and give life meaning (Giuliani 2003). For place attachment, multiple concepts have been used in the literature, such as sense of place and rootedness, place identity, and place dependence (Stedman 2002). Despite using different terms, a majority of researchers conclude that place attachment comprises physical, psychological, socio-cultural, and symbolic aspects of a particular place (Relph 1996). In the present study, however, we consider place attachment as an emotional entity that involves bonding among individuals, groups, or communities in relation to their physical environment. In the words of Fried, when people are forcefully relocated from their living places, they experience severe grief similar to what they have experienced from losing a close person (Fried 1963). There are three main aspects of place attachment as per Scannell

and Gifford which are interrelated to each other, namely the person (individual or collective), the psychological processes involving the conscious intellectual activities, and the place, such as the physical environment, whether natural or constructed, its symbolic meaning as well as the social environment (Scannell & Gifford 2010). This framework provides a better understanding of place attachment as a term and its influence on the behavior of an individual related to a particular place. The impact of place attachment on risk perception can be determined by its relationship with it, which can either be negative, or positive, or there might be a lack of relationship between these two. The following section will address these relationships in detail.

1.1.5.1 Positive exchange between place attachment and perceived risk

Across the globe, several scholars have found a positive connection between place attachment and perceived risk with reference to a natural disaster. Bird, Gisladdottir & Dominey-Howes (2011) in their study, which was conducted on volcanic eruption risk in Iceland, have found that place attachment and risk perception are positively related. The study included both rural as well as urban residents as its sample. It examines the knowledge and perception of the respondents (rural and urban communities) about the Katla volcano and the emergency response processes adopted by them. It shows that there is a clear difference in the understanding of emergency response plans between rural and urban communities and the rural communities are more resilient to the volcanic hazard. Another study conducted in the U.S. on the prospects of hurricanes has shown similar results. The study found that the higher the awareness and perception of a hurricane disaster among the respondents, the higher the place attachment. The study was based on the residents of Louisiana staying in the high probability hurricane area and suffering from coastal land loss (Burley et al. 2007).

Stain et al. (2011) have found a similar positive connection between environmental risk and place attachment with regard to drought risk. The findings of the study suggested that the Australian people's exposure to long-term drought was positively related to place attachment. Although the study did not include comparisons in terms of high and low levels of attachment, it showed that people with a higher sense of place were reportedly more worried and aware of the drought.

Gallina & Williams (2014) analyzed the impact of place attachment on participants' perseverance of environmental risk. The study was conducted in Northeast Hamilton, Ontario, Canada. It takes into account the environmental stress and coping framework to know about people's perception of air quality among the local as well as immigrant women. A mixed method was used to achieve the objectives. The results of the quantitative survey showed that there was a higher sense of place attachment among the local inhabitants than those of immigrants. While the focus group discussion (qualitative) method showed that in comparison to immigrant women, Canadian women are more aware, conscious, and more worried regarding the larger air quality issues. The result of both methods used, i.e., qualitative and quantitative suggested that the association is positive between environmental risk and place attachment. If the sense of place is greater, the concern regarding air quality is also greater.

Bonaiuto, De Dominics, Ganucci Cancellieri, & Mosco (2011) conducted the same line of study to examine the role of place attachment with regard to environmental risks. The study aimed to assess the relationship between neighborhood attachment, i.e., one's own sense of place in the neighborhood, and participants' flood risk perception, their concern, their attitude toward flood-related behavior as well as their flood coping strategies by taking into account two different specific risk areas which comes under different risk levels. The findings suggest that participants have a high sense of place attachment but living in low-risk areas perceived high flood risk (vs. areas where risk magnitude is high although the frequency is less).

Bernardo (2013) tried to find the connection between environmental risk perception and place attachment in the Portuguese context, involving one hundred fifty-seven participants between 18-79 years of age group. The analysis revealed that place attachment has a significant role and contributes to amplifying high probability risks such as global warming while weakening the perspective about less frequent disasters such as war, terrorism, and earthquake. In other words, those risks whose probability is high are more frequent but less dangerous; for them, place attachment increases the risk perception.

Another study that compared the same risk but in the context of flood disaster occurrence at two different places with risk occurrence also at different levels (high/low) was conducted by Bonaiuto et al. (2011) and Bernardo (2013). Bernardo (2013) compared various risks in one place, i.e., Portugal, by categorizing the risks into different levels based on their chances of occurrence. Both studies revealed that if the risk is frequently occurring but is less dangerous, the participants having a stronger sense of place attachment perceived higher risk. The result also exhibits that when the risk was more dangerous in nature but less frequent in occurrence, there was no positive relationship.

1.1.5.2 Negative exchange between place attachment and environmental risk Perception

The results of several studies have shown an adverse connection between people's sense of place and their risk perception related to the environment. These studies showed that if a person has higher place attachment, then his risk perception and risk consciousness will be lower.

Armas (2006) tried to understand the connection linking place attachment and natural environment-related risk by conducting a study in Romania. His focus was to analyze how the people of Bucharest perceive exposure to seismic risk in relation to place attachment. The study took place attachment as feelings and affective bonds towards places. The findings suggest that safety and security are the main reasons behind participants' association with their residential

area, which comes as a result of a strong affective bond with a certain place. The interviewed respondents showed ignorance and somehow denied the seismic risk by saying that this would not affect their families much, and even if it did, the effect would not be severe. In other words, their sense of place was high, but environmental risk perception was low.

The same kind of adverse connection was also found between place attachment and environment-related risk perception by Donovan et al. (2012) when they conducted a study on volcanic risk in Central Java, Indonesia. The connection to the Volcanic area was analyzed in terms of 'cultural intensity,' i.e., people's attachment to the symbolic power of the volcano, their operation of hazard-related rituals, their reliance on supernatural powers, as well as their trust in dharma gurus. The study examined the impact of various sub-cultures on the action of local communities associated with volcanic activities. The major findings suggest that participants' low hazard perception was related to their attachment to the volcanic area. It also revealed that the relevance that volcanic culture possess determines the respondent's attachment to place and their risk experience. GIS-coded maps were used by the authors to explore the sub-divisions of their cultural intensity and various geological patterns. The study revealed that those respondents living in the rural areas had robust belief systems towards animism and were against evacuation in comparison to respondents living in other parts of the country. They had a strong belief that their areas could not be affected by hazards (therefore showing the adverse connection between place attachment and environmental risk perception).

Bonaiuto et al. (1996) analyzed the connection between place attachment and risk perception by focusing on beach pollution threats in the context of the UK. He analyzed the influence of identity (whether they belong to the place or are migrated from other countries) on the perception of respondents regarding beach pollution. The result showed that those respondents having a close connection to their town or country tend to perceive their beaches

as less polluted, which means at both local and national levels, strong place attachment is connected with low perceived pollution risk.

1.2 Research Gap

Research on the interplay of social capital, place attachments, and risk perception in the state of Bihar, in general, and the Kosi river basin, in particular, is non-existent. Most of the studies have been conducted either examining the effectiveness of structural measures in controlling floods and mitigating flood damages or analyzing flood situations in the region. One can hardly find any studies focusing on the role of non-structural factors in controlling floods with specific reference to social, economic, spatial, and psychological aspects. Undoubtedly, at the global level, the influence of social capital on risk perception has been fairly explored by scholars. However, the results are mixed owing to the importance of local context. A few scholars found a positive impact of social capital on risk perception, and a few have found an unfavorable exchange between the two. A considerable amount of ambivalence persists in the relationships between social capital and risk perception. Concerning place attachment, the literature mentioned above highlights that the relationship between place attachment and risk perception is still equivocal because of contradictory results. Furthermore, the literature on the correlation between place attachment and flood risk perception is scarce. Therefore, the association between place attachment and flood risk perception is unclear. Overall, most of the studies focusing on the effects of social capital and place attachment on risk perception have been carried out in the context of developed countries. Relatively, very little is known about developing countries. Therefore, there is a need to test the generalizability of these studies' findings in the context of developing countries like India in general and poor states like Bihar, where flood is a perennial issue inflicting massive human and psychological loss. The present study aims to fill these downsides of literature by achieving its research objective

1.3 Objectives of the Study

- a) To examine the impact of sociodemographic characteristics on flood risk perception.
- b) To investigate the influence of social capital on flood risk perception.
- c) To assess the influence of place attachment on flood risk perception.
- d) To capture the institutional and community perspectives and values of flood control and management in the Kosi region.

1.4 Research Questions

- 1) Does the sociodemographic characteristics of households influence their flood risk perception?
- 2) Does the stock of bonding and bridging social capital increase the flood risk perception of the households?
- 3) Does the level of place attachment enhance the flood risk perception of the households?
- 4) What are the perspectives of institutions and communities on flood control and management in the Kosi basin?

1.5 Study area

In North Bihar, the Supaul district is a part of the Kosi division. It covers an area of 2,425 sq. km, including an urban area of 36sq km and a rural area of 2389sq km¹. It has been divided into 11 blocks, one municipal corporation, 11 circles, and four sub-divisions with 556 villages and 181 Gram panchayats. According to the 2011 census, the total population of Supaul is 360,198, where 187,813 are males and 172,385 are female². The literacy rate of the district is 59.65%. The sex ratio in the rural areas of the district is 931 females per 1000 males and 945 girls per 1000 boys in urban areas. The district is dominated by the Hindu religion (80.77 %).

¹ https://www.indiagrowing.com/Bihar/Supaul_District (accessed on 5th January 2022).

² <https://www.censusindia.co.in/subdistrict/supaul-block-bihar-1109> (accesses on 5th January 2022).

The district has Nepal in the North, Saharsa in the South, Araria in the East, and Madhubani in the West. Since the Vedic period, the Supaul district of Bihar has been a part of Mithilanchal. In Hindu mythology, its reference is given as the fishery area. It is situated on the lower plains of the river Ganga. The main occupation for the residents of Supaul district is Agriculture. The cropping pattern in the region includes four agricultural seasons Bhadai, Aghani, Rabi, and Garma³. The gross cropped area of the district is 254.1 ha, and the net sown area is 146.6 ha⁴. The main crops of the district are Paddy, Wheat, Mustard, Gram, Jawar etc. The river Kosi, known as the 'sorrow of Bihar', flows through the district and is the primary reason behind flood destruction in the region. Despite being jacketed within the embankments; the river brings hardship to the lives of its population. Among 38 districts in Bihar, Supaul is one of the highest flooded districts. Flooding due to the Kosi river is an annual phenomenon here. The river is habituated to changing its course and shifting to new areas. In the devastating floods of 2008, which resulted from an embankment breach on the Kosi river, almost 90 percent of the entire district was affected. Out of 11 blocks, eight blocks of the Supaul district is vulnerable to floods which makes it one of the most flood-prone districts in India.

1.6 Methodology

The study adopted a mixed-method approach to investigate research questions. It combines quantitative and qualitative research methodologies to reach a better and more comprehensive understanding of the research topic. "Mixed-method research is the type of research design in which a research or team of researchers combines elements of quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" (Johnson et al. 2007, pp 123). Mixed method research captures a complete picture of the

³ http://cgwb.gov.in/District_Profile/Bihar/Supaul.pdf (accessed on 5th January 2022).

⁴ http://www.nicra-icar.in/nicrarevised/images/statewiseplans/Bihar/BR35_Supaul_28.12.2013.pdf (accessed on 5th January 2022).

research topic by adopting qualitative and quantitative methods simultaneously or iteratively vis-à-vis either method individually. It fetches stronger research outcomes by equipping researchers to explore more complex aspects and nuances of human and social world relationships (Malina, Nooreklit, and Selto 2010). Nevertheless, the selection of method in research should be contingent upon the nature of the study, purpose, likely accuracy of descriptions, and resources available rather than an ideological commitment to one or another methodological paradigm (Hammersley 1992). The selection of research methods should be based on which method offers better chances to obtain useful answers to the research questions of the study (Johnson and Owegbuzie 2004). There are two primary reasons for selecting a mixed-method approach for the present study. First, the existing literature suggests that the dimension of disaster risk in general and flood disaster risk, in particular, has been studied using standalone methods, i.e., quantitative or qualitative. The dimensions of risk have been studied either through statistical models or detailed narratives of disasters collected through personal interviews, case studies, observations, focused group discussions, and other qualitative paradigms. Both sets of methods (quantitative or qualitative) have their advantages and downsides. Therefore, keeping these methodological conundrums in mind, an attempt was made to have a mixed-method research design for the study. Second, the nature of the research questions that the study investigates calls for a mixed-method approach. For instance, the research questions investigating the influence of socio-demographic characteristics, social capital, and place attachments on flood risk perception can be effectively captured by inferential statistics (quantitative methods), whereas the research questions related to institutional and community perspective on flood control and management can be encapsulated by in-depth personal interviews (qualitative methods). The mixed-method design used in the study combines quantitative and qualitative methodologies to achieve its research objectives.

The quantitative method attempts to establish the relationship between key variables, whereas the qualitative part expands the study by providing a deeper understanding of the topic.

1.6.1 Quantitative method

This section details the data collection procedure, sampling method, questionnaire preparation, measures, and data analysis technique used to analyze quantitative data.

1.6.1.1 Data collection procedure

The study involves both primary and secondary data collection. To collect primary data, a cross-sectional survey was conducted in the flood-affected areas of Supaul, Bihar. The multistage random sampling method was adopted to choose the sample for this study. We have used multistage random sampling because our study involved the selection of samples at multiple stages. Since there are no statistical/mathematical formulae or a formulaic way to combine different methods of sampling (used at more than one stage), we adhered to the multistage sampling method to collect primary data. The body of literature suggests that there is no strict or concrete definition of a multistage random sampling method. In the multistage random selection method, samples are selected randomly at all stages. Moreover, the multistage random sampling method is cost and time effective, and most importantly, it retains two important features of any robust sampling method: i) randomness and ii) sufficient sample size. In the first stage, we employed the random sampling method to identify blocks. Supaul district has 11 blocks, out of which five blocks were selected for the study. In the second stage, we randomly selected villages and households from each flood-affected block. In total, 25 villages were included in the study. These villages are either trapped within Kosi embankments or bisected by them. Consequently, these villages are severely affected by the flood. In every village, 20 households were approached to participate in the survey. In total, 445 households participated in the survey.

Table 1.1 illustrates the block-wise distribution of households. It is important to note that the principal aim of the sampling procedure was not to simply attain a statistically representative sample of the population. But also, we equally strived for sufficient variations on a set of socio-demographic characteristics for a reliable analysis of flood risk perception between the various social groups. The survey questionnaire was administered through face-to-face interviews with the heads of the household. A pilot study was also carried out on randomly selected samples of 30 respondents to test the reliability and validity of items and improve the survey questionnaire. The primary data for the study were collected from 459 households. Finally, 380 questionnaires were found to be complete after eliminating the incomplete and thus, were retained for statistical analysis. The time of the interview was recorded to be 35 minutes, which we consider a reasonable response rate. The primary data collection was carried out in two phases. Phase I was conducted in the month of January – March 2020. Phase II was carried out in the month of January – March 2021. As mentioned previously, flooding is a perennial issue in the Supaul region. The region is mostly submerged during monsoon. It takes almost the whole autumn for the water-logging to subside. Moreover, the primary data collection process was also disrupted owing to pandemic Covid 19. These were the primary reasons for bifurcating the primary data collection into two phases.

Furthermore, the study also involves secondary data collection. Secondary data was collected from journals, books, reports, newspapers, surveys, and online sources. Notably, the study used the data archived by the National Institute of Disaster Management (NIDM) and the Disaster Management Department, Government of Bihar, to analyze the extent of flood damage at the state level and district level (Supaul).

Table 1.1 Distribution of households across blocks

Block	Village	Number of the households approached	Number of households responded
Supaul	Karnapatti	20	18
	Balwa	20	16
	Narahia	20	20
	Piprakhurd	20	20
	Bairiya	20	20
Saraigarh-Bhaptiyahi	Harpur	20	13
	Laukaha	20	20
	Bahuarawa	20	17
	Ugripatti	20	20
	Siyani	20	19
Marauna	Sisauni	20	18
	Rasuar	20	11
	Dhabghat	20	20
	Kadmaha	20	20
	Gotarahi	20	19
Kishanpur	Kalimugara	20	20
	Dinajpur	20	20
	Lachhminia	20	15
	Khakhai	20	19
	Shivpuri	20	18
Basantpur	Bhim Nagar	20	20
	Dubiyahi	20	20
	Madhura	20	17
	Raniganj	20	19
	Piparahi Patti	20	20
Total		500	459

1.6.1.2 Preparation of questionnaire

A survey questionnaire was designed to collect empirical data for quantitative analysis. A semi-structured questionnaire with close-ended questions was prepared contingent on the research questions. The questionnaire was divided into five sections: Section I – the cover page, Section II—socio-demographic information, Section III—flood risk perceptions, Section IV— social capital, and Section V— place attachments. The questions and scales used to measure flood risk perception, social capital, and place attachments have been described extensively in a later section—Measures. The responses to perception questions related to flood risk, social capital, and place attachments were measured using a five-point Likert scale (1 = strongly agree to 5 =

strongly disagree). A five-point Likert scale makes it easier for interviewees to read the list of scale descriptors (Dawes 2008). It reduces the respondents' frustration level, increasing the response rate and quality (Sachdeva and Verma 2004). Finally, the averaging method was used to calculate the Likert scale score of flood risk perception, social capital, and place attachments.

1.6.1.3 Data analysis

To analyze the survey data, we have relied on the following statistical analysis: i) descriptive statistics were employed to capture the features of the sociodemographic characteristics of the households and the other key independent and dependent variables (social capital, place attachment, and flood risk perception). ii) To compare the group means, we have used independent samples t-test and one-way analysis of variance (ANOVA). Independent t-test was used to locate differences in group means when there is one dependent variable and two independent variables, whereas ANOVA is applied to identify the differences in group means when there are more than two independent variables and one dependent variable. The formula used to compute the t-test is mentioned below:

$$t = (\bar{x}_1 - \bar{x}_2) / \sqrt{[(S^2_1 / n_1) + (s^2_2 / n_2)]}$$

Where,

\bar{x}_1 = Observed Mean of 1st Sample

\bar{x}_2 = Observed Mean of 2nd Sample

s_1 = Standard Deviation of 1st Sample

s_2 = Standard Deviation of 2nd Sample

n_1 = Size of 1st Sample

n_2 = Size of 2nd Sample

Simultaneously, the following formula was used to compute ANOVA:

$$F = MST/MSE$$

$$MST = SST/P-1$$

$$MSE = SSE/N-p$$

Where,

F denotes ANOVA coefficient

MSB = mean sum of squares between the groups

MSW = Mean sum of squares within the groups

MSE = Mean sum of squares due to error (within groups, residual mean square)

MST = Mean sum of squares due to treatment/groups (between groups)

SST = total Sum of squares

p = total number of populations

n = total number of samples in a population

SSW = Sum of squares within the groups

SSB = Sum of squares between the groups

SSE = Sum of the squares to error

ANOVA results indicate that at least one group differs from the other. However, it does not estimate which groups differ and by how much. In other words, the ANOVA test does not detect the pattern of differences existing between the group means. To surmount this lacuna, we conducted multiple mean comparison analysis by using the most frequently used multiple mean comparison technique (also known as Post hoc test) viz. Tukey test. Tukey test provides accurate information and locates which are the groups where significant differences exist. The formula to carry out multiple mean comparisons analysis by using the Tukey test is mentioned below.

Notation

\bar{y} = sample mean for the i^{th} factor level

N_i = number of observations in level i

r = number of factor levels

s = pooled standard deviation or sqrt (MSE)

n_t = total number of observations

α = probability of making a Type 1 error

$$\bar{y}_i - \bar{y}_j \pm \frac{Q(1 - \alpha; r, n_T - r)}{\sqrt{2}} s \sqrt{\frac{1}{n_i} + \frac{1}{n_j}}$$

Where,

$Q = (1 - \alpha)$ percentile of studentized range distribution with r number of factor level and $n_i - r$ degrees of freedom $- \alpha$ p.

Furthermore, to measure the effect size of ANOVA models we have used Eta-squared techniques. It measures the variance proportion associated with one or more than one main effect, errors, or interaction in ANOVA models. Following is the formula to compute Eta-squared:

$$\text{Eta squared} = \frac{SS_{\text{effect}}}{SS_{\text{total}}}$$

where,

SS_{effect} denotes the sum of squares of an effect for one variable

SS_{total} denotes the sum of squares in the ANOVA model

It is important to note that t-tests, ANOVA, Tukey test, and Eta-squared were conducted to examine the impact of socio-demographic characteristics on the components of the social capital and place attachment. iii) Multiple Ordinary least square (OLS) regression was performed to examine the influence of socio-demographic characteristics and components of social capital and place attachment on flood risk perception of households. OLS is a commonly used linear modeling technique that describes the relationship between one or more explanatory variables and one dependent variable. OLS regression is a powerful inferential statistic that is easy to implement and assess assumptions such as linearity, variance, constant, and outlier effects in the model (Hutcheson and Sofroniou 1999). Following is the formula to compute multivariate OLS regression:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + e$$

Where,

Y is the dependent variable, α denotes intercept, β is the slope of line, X denotes explanatory variables, and e is the random error with expectation 0 and variance σ^2 . Each β parameter shows the average change in Y with a unit change in X .

To measure the reliability of various multi-item constructs/ scales, Cronbach's Alpha was calculated for each scale, i.e., for various aspects of capital, the intensity of Facebook use, self-

esteem, and life satisfaction. It may be noted here that Cronbach's Alpha is basically a measure of the internal consistency of scale items. In the past, Alpha has been used for scale development to measure attitudes and other multi-item constructs (Taber 2018) in different disciplines. Although a liberal minimum requirement for scale reliability is considered to be 0.60 (Peter 1979), some accept 0.70 as the minimum requirement (Nunnally & Bernstein 1994). However, a few scholars also consider values between 0.58 and 0.97 to show the reliability of the scale when the number of items in a construct is less than ten, as the Alpha values depend heavily on the number of items on the scale. As the number of items increases the value of Alpha tends to increase. We have resorted to IBM SPSS Statistics Version 28 for analyzing the quantitative data.

1.6.1.4 Measures

The primary purpose of employing the quantitative method was to analyze the relationship between one dependent variable, i.e., flood risk perception, and three sets of key independent variables, i.e., sociodemographic characteristics, social capital, and place attachments. The following section details the frequency, percentage, and descriptive statistics of the above mentioned variables.

1.6.1.4.1 Sociodemographic characteristics

Table 1.2 displays the socio-demographic profile of the 380 households. The distribution of households as per their marital status accounted for 66.8% Married, 1.8% Unmarried, and 1.3% Widows. A majority of households belong to a joint family system (61.8%), while 38.2% belong to the nuclear family system. Over one-third (33.5%) of households attained High school and over one-fourth (27.1%) Middle school. As a source of livelihood, a majority of households (57%) are dependent on farming activities. However, 18% were fishermen, 10.5%

were engaged in government services, and 8.2% had their own business. Over half (50%) of households have resided in their locality/villages for more than 30 years. Nevertheless, over one-fourth (27.6%) of households have stayed in their villages for more than 20 years and less than 30 years, 18.3% for 10-20 years, and 3.4% for 5-10 years. Over three-fourths (79.05%) of the total households were male, and 20% were female. In total households, 92.1% were Hindus, and 7.9% were Muslims. Regarding caste, Other Backward Class accounted for 48%, Scheduled caste 29.2%, General 18.2%, and Scheduled Tribes 3.9%. In our entire selected samples, a majority of households (52.6%) belong to the 41-50 age group, followed by 27.1% to the 31-40 years, 14.2% to more than 50 years group, and only 6.1 to the 20-30 years. As far as the distribution of households as per monthly income is concerned, 52.63% accounted for 11000-15000 income category, 24.47% for the 5000-10000 income group, 11.84% for the more than 20000, and 11.05% for 16000-20000 income group.

Table 1.2 Socio-demographic characteristics of respondents

Socio-demographic characteristics	Count	%	Mean	SD
Marital status*				
Unmarried	7	1.8		
Married	368	96.8		
Widow	5	1.3		
Family type*				
Nuclear family	145	38.2		
Joint family	235	61.8		
Education				
			2.88	1.25
1. Illiterate	87	22.9		
2. Primary school	42	11.1		
3. Middle school	103	27.1		
4. High school	127	33.4		
5. Higher Secondary	21	5.5		
Occupation*				
Cultivation	218	57.4		
Fishing	70	18.4		
Service	40	10.5		
Business	31	8.2		
Length of residence				
			1.77	0.90
1. More than 30 years	190	50.0		
2. 20-30 years	105	27.6		
3. 10-20 years	70	18.4		
4. 5-10 years	13	3.4		

5. Less than 5 years	2	0.5		
Gender*				
Male	302	79.05		
Female	78	20.5		
Religion*				
Hindu	350	92.1		
Muslim	30	7.9		
Caste*				
Other Backward Caste (OBC)	183	48.2		
Scheduled Caste (SC)	111	29.2		
General	71	18.7		
Scheduled Tribe (ST)	15	3.9		
Age			2.75	0.77
1. 20-30	23	6.1		
2. 31-40	103	27.1		
3. 41-50	200	52.6		
4. >51	54	14.2		
Income			2.01	0.86
1. 5000-10000	93	24.47		
2. 11000-15000	200	52.63		
3. 16000-20000	42	11.05		
4. >20,000	45	11.84		

Note: * denotes dummy variables

1.6.1.4.2 Flood risk perception

Flood risk perception was measured by adopting the scales proposed by Babcock and Seebauer (2017) and Hudson, Hagedoorn, and Bubeck (2020). The scales of Babcock and Seebauer (2017) and Hudson, Hagedoorn, and Bubeck (2020) are premised on Grothmann and Reusswig's (2006) approach to measuring flood risk perception. Grothmann and Reusswig's (2006) measures consisted of two components: 1) perceived probability, i.e., the likelihood of future flooding, and 2) perceived severity, i.e. the impact of the flood on life quality and possessions. The third component used in the study to measure flood risk perception was the affective component used by Babcock and Seebauer (2017) and Hudson, Hagedoorn, and Bubeck (2020). It 'captures emotional states such as fear and worry associated with a potential flooding' (Babcock and Seebauer 2017, pp. 1026). To measure flood risk perception, we have asked respondents how much they agree ('1' = strongly disagree to '5' = strongly agree) on

mentioned items/statements in Table 1.3. Figure 1.1 exhibits the overall frequency and percentage of responses for flood risk perception. The item/statement: 'A potential flood intimidates me (Risk6)' received the highest responses, with 74.5 of households moderately agreeing (56.6%) and strongly agreeing (17.9%) to it. The item: 'A potential flood worries me (Risk5)' was second in terms of responses, with 70.8 of households moderately agreeing (53.4%) and strongly agreeing (17.4%) to it. Ultimately, the six items were averaged to create the score of flood risk perception ($M=3.64$; $SD=.0.86$; Cronbach's $\alpha=0.71$). The reliability (Cronbach's α) score for flood risk perception was found to be satisfactory, i.e., >0.70 .

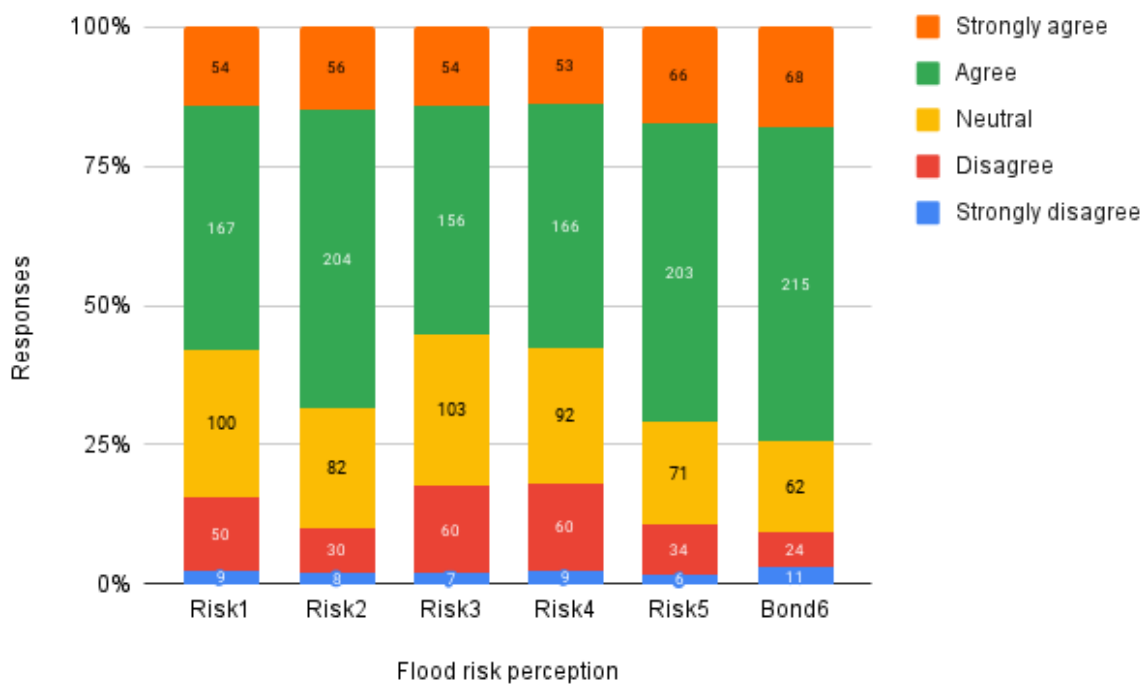


Figure 1.1: Frequency and response percentage for flood risk perception

Table 1.3 Descriptive statistics for flood risk perception

Individual Items and Scales ¹	N	Mean	SD	Min	Max
Flood risk perception scale (Cronbach's $\alpha = 0.72$)	380	3.64	0.86	1	5
A potential flood affects my health (Risk1)	380	3.54	0.97	1	5

A potential flood damages my possession (Risk2)	380	3.71	0.89	1	5
On an average, flood come every year (Risk3)	380	3.50	0.98	1	5
A potential flood affects my quality of life (Risk4)	380	3.51	0.99	1	5
A potential flood worries me (Risk5)	380	3.76	0.90	1	5
A potential flood intimidates me (Risk6)	380	3.80	0.90	1	5

Notes: ¹ The response categories ranged from 1 = strongly disagree to 5 = strongly agree. The scales were constructed by taking the mean of items

1.6.1.4.3 Social capital

Bonding social capital was measured by adopting the scale of Hudson, Hagedoorn, and Bubeck (2020). For bonding social capital, we have asked respondents how much they agree ('1' = strongly disagree to '5' = strongly agree) on mentioned items/statements in Table 1.4. Figure 1.2 and Figure 1.3 exhibit the overall frequency and percentage of responses for bonding and bridging social capital, respectively. Concerning bonding social capital, the following item/statements: 'My family members often participate in community/village activities (Bond1)' with more than 82% of households moderately agreeing (61.6) and strongly agreeing (20.8%) it. The frequency of responses for the items: 'My family members actively participate in a local management committee (Bond2)', 'Me and my family members regularly interact with other members of my village/community (Bond3)', and 'Most of the people in my village/community can be trusted (Bond4)' were found to be high with around 73% of households moderately agreeing or strongly agreeing to each of the items. These eight items were averaged to create the score of bonding social capital (M = 3.70, SD = 0.80, Cronbach's alpha= .71). Bridging social capital was measured by the respondent's self-stated number of social networks: 'In how many groups and associations at the community level, you are involved with' (cooperative society, farmer association, self-help groups, religious trust, etc.) (M = 3.75; SD = .92). The frequency of responses indicates that a majority of household (49.47) are associated with four groups/associations. The reliability (Cronbach's alpha) score for the

bonding social capital scale was found to be satisfactory, i.e., > 0.70. The reliability score for the bridging social capital scale is not applicable because it consists single item.

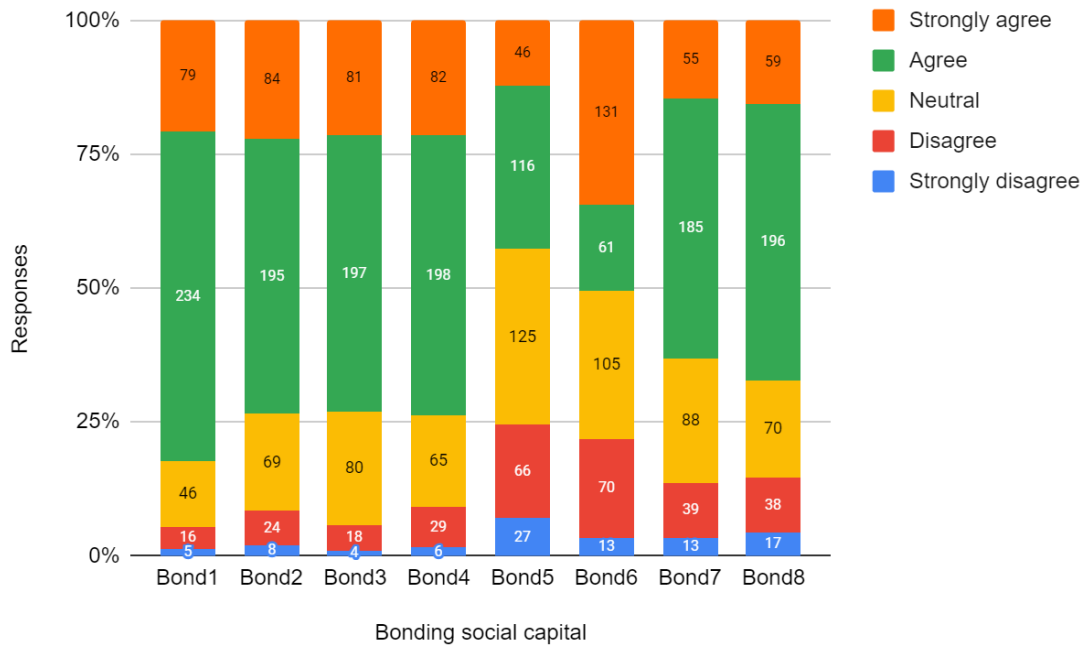


Figure 1.2: Frequency and response percentage for bonding social capital

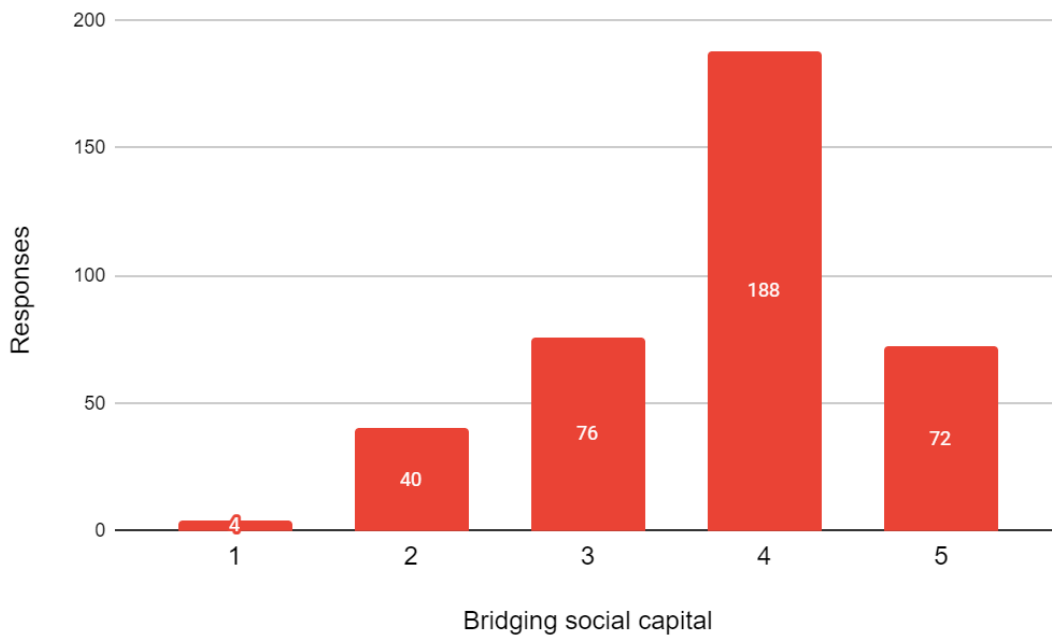


Figure 1.3: Frequency and response percentage for bridging social capital

Table 1.4 Descriptive statistics for bonding and bridging social capital

Individual Items and Scales ¹	N	Mean	SD	Min	Max
Bonding social capital scale (Cronbach's alpha = 0.71)	380	3.70	0.80	1	5
My family members often participate in community/village activities (Bond1)	380	3.96	0.78	1	5
My family members actively participate in a local management committee (Bond2)	380	3.85	0.91	1	5
Me and my family members regularly interact with other members of my village/community (Bond3)	380	3.88	0.83	1	5
Most of the people in my village/community can be trusted (Bond4)	380	3.84	0.90	1	5
I am confident that my village/community members will help us in a time of need (Bond5)	380	3.23	1.09	1	5
I help other families when they need help (Bond6)	380	3.60	1.23	1	5
My village/community is united (Bond7)	380	3.61	0.97	1	5
In my community, I feel accepted and at home (Bond8)	380	3.64	1.01	1	5
Bridging social capital scale²					
Number of groups/associations in which the respondents are involved	380	3.75	0.92	1	5

Notes: ¹The response categories ranged from 1 = strongly disagree to 5 = strongly agree. The scales were constructed by taking the mean of items. ²Cronbach's alpha for the bridging social capital scale is not applicable because it consists of only one item

1.6.1.4.4 Place attachment

Place attachment was measured one a two-component construct, i.e., economic and genealogical, based on the scale developed by Mishra et al. (2010). Using a five-point Likert scale ('1' = strongly disagree, '5' = strongly agree), respondents were asked to what extent they agree or disagree with the items/propositions mentioned in Table 1.5. Figure 1.4 and Figure 1.5 exhibit the overall frequency and percentage of responses for economic and genealogical place attachment, respectively. For economic place attachment, the proposition: 'I cannot think of a place other than this because I have fertile land here (Ecopa6)' has remarkable responses,

with more than three-fourths (85.8%) of households moderately agreeing (49.6%) and strongly agreeing (36.3%) to it. Likewise, 'This place provides me with bread and butter (Ecopa4)' has overwhelming responses, with over three-fourths (85.6%) of households moderately agreeing (53.2%) and strongly agreeing (32.4%) with it. For genealogical place attachment, the item: 'I find the memory of my parents/grandparents in every piece and corner of this place (Geneapa3)' obtained maximum responses (75.8%) with 57.9% of households moderately agreeing and 17.9% strongly agreeing to it. This was followed by 'This place is important to me because my ancestors/forefathers stayed here (Geneapa4)' with 52.4% of households moderately agreeing and 22.9% strongly agreeing it. Finally, economic place attachment scale was formed by averaging all the above mentioned six items (Mean = 3.85; SD= 0.89; Cronbach's alpha= 0.79). The same process was followed to compute the score of the genealogical place attachment (Mean = 3.83; SD= 0.93; Cronbach's alpha= 0.71). The reliability (Cronbach's alpha) scores for both scales were found to be satisfactory, i.e., > 0.70.

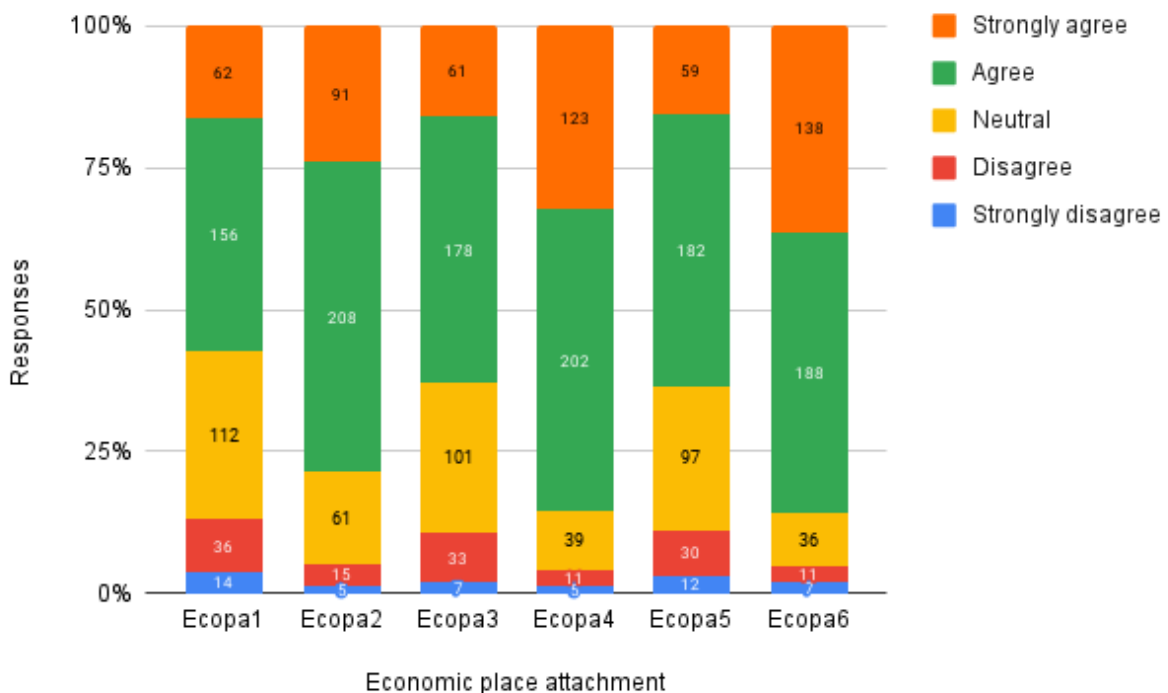


Figure 1.4: Frequency and response percentage for economic place attachment

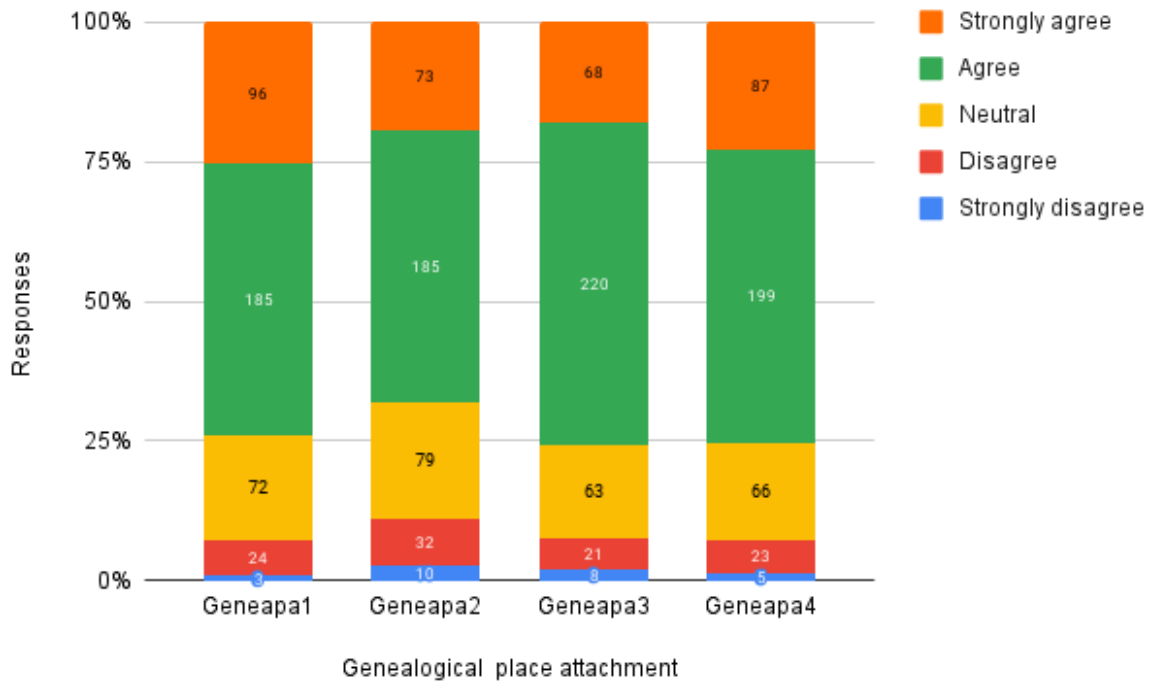


Figure 1.5: Frequency and response percentage for genealogical place attachment

Table 1.5 Descriptive statistics for economic and genealogical place attachment

Individual Items and Scales ¹	N	Mean	SD	Min	Max
Economic place attachment (Cronbach's alpha = 0.79)	380	3.85	0.89	1	5
This place is good for business (Ecopa1)	380	3.57	0.99	1	5
At this place, I have friends who can provide me with financial support during any crisis (Ecopa2)	380	3.96	0.82	1	5
At this place, I can get a loan easily (Ecopa3)	380	3.67	0.91	1	5
This place provides me with bread and butter (Ecopa4)	380	4.12	0.80	1	5
This place provides me livelihood opportunities that no other place can offer (Ecopa5)	380	3.65	0.94	1	5
I cannot think of a place other than this because I have fertile land here (Ecopa6)	380	4.16	0.85	1	5
Genealogical place attachment (Cronbach's alpha = .70)	380	3.83	0.93	1	5
I get inspiration by seeing the used places of my ancestors (Geneapa1)	380	3.91	0.87	1	5

I get all kinds of support here because of my ancestral place (Geneapa2)	380	3.69	1.28	1	5
I find the memory of my parents/grandparents in every piece and corner of this place (Geneapa3)	380	3.84	0.86	1	5
This place is important to me because my ancestors/forefathers stayed here (Geneapa4)	380	3.89	0.87	1	5

Note: The response categories ranged from 1 = strongly disagree to 5 = strongly agree. The scales were constructed by taking the mean of items

1.6.2 Qualitative Methods

In the present study, the qualitative method included in-depth personal interviews with the officials engaged in flood control in the Kosi region and community members of the Supaul district. The study elicits the responses of officials engaged in flood control and management in the Kosi region coming under the aegis of included the Water Resource Department (WRD); Flood Management Information System Cell (FMISC); Water and Land Management Institute (WALMI); and Disaster Management Authority, Government of Bihar (State Disaster Management Authority (SDMA). The rationale behind the selection of these four institutional setups is that flood control and management activities in the Kosi region are commanded by these four institutes. These institutes are extensively engaged in developing as well as implementing measures and policies to curb the problems of flooding in the Kosi region. The overarching objective of interviewing experts was to holistically understand the functional capabilities of the above-mentioned institutions. Furthermore, community members were also interviewed to get an insight into the ground reality of the flood situation in the Supaul district. The purpose of these interviews and discussions was primarily to assess the experience and knowledge held by flood-affected communities, as well as the level of awareness and their perspectives on the role and functions of the institutions related to flood mitigation in the Kosi Basin. The study employed the purposive sampling method to select the potential respondents from the above-mentioned four institutes. Only those representatives/officials were invited to

participate in the interview who are extensively and intensively engaged in flood control and management in Kosi Basin. In the contrast, the random sampling method was used to select potential community members of the Supaul district.

Table 1.6 Demographic profiles of interviewees

Demographic profile of Officials	Count	Demographic profile of Community members	Count
Affiliation		Village	
Water Resources Department (WRD)	7	Karnapatti	05
Flood Management Information System Cell (FMISC)	4	Laukaha	03
Water and Land Management Institute (WALMI)	3	Sisauni	02
State Disaster Management Authority, Bihar (SDMA)	3	Shivpuri	05
Professional status		Bhim Nagar	04
Director	01	Occupation	
Chief Engineer	05	Cultivation	10
Professor	01	Fishing	02
Reader	01	Service	02
Assistant Professor	01	Business	01
Assistant Engineer	04	Labour	04
Junior Engineer	03		
Retired Engineer	01		
Age group		Age group	
31-40	02	31-40	03
41-50	09	41-50	12
51-60	05	51-60	04
>61	01	>61	00
Gender		Gender	
Male	17	Male	18
Female	00	Female	01

Interviews were conducted using open-ended questions, which allows freedom for the informants to express their views on the topic under investigation. The interview guide was developed before going into the field for the data collection. It included the key themes and

questions. An interview schedule containing open-ended questions was prepared to have an in-depth insight into the grassroots problems encountered by the flood-affected communities of the region, as well as their views and opinions on the measures provided to control the flood. Questions were mainly formulated according to the research objectives and actors, i.e., officials and community members. Questions were refined throughout the data collection process.

Officials of the institutions engaged in flood control in the Kosi region were contacted by email and telephone with a brief introduction of the project. However, informants (community members) in the field were contacted in-personal. The interviews were conducted during the Phase I - January – March 2020. The four institutes selected for the study are located in Patna, the Capital city of Bihar. Consequently, a lot of time was invested in traveling. In general, each interview was around 40-50 minutes; however, in some cases, it was more than one hour and some 15 minutes. Most of the interviews were recorded using a digital recorder with the permission of the interviewees. However, some respondents refused permission to record the conversation. In those cases, their responses were noted down.

Thematic analysis was used to analyze the interview transcripts. It is a method of analyzing qualitative data. It is used to analyze a set of text such as interviews and transcripts. It enables researchers to identify underlying themes, patterns, ideas, and topics by closely observing the texts. The analyses of interview data started first with the transcription, i.e., the written translation of a recorded interview. All interviews were transcribed. Although it was a laborious and time-consuming task, nevertheless, the exercise helped to identify key themes and analyze the narratives of participants. Initially, the interviews were conducted, and then interview data was transcribed manually.

Ethical issues in research are an important aspect that is explicitly related to the integrity of any research. Therefore, it is essential to ensure informed consent, anonymity, privacy, and

confidentiality of the participants. This project was designed as per the Indian Institute of Technology Guwahati ethical guidelines, and after approval from the institute, fieldwork was conducted. Empirical data were collected using surveys and face-to-face interviews. Written consent was sought from survey and interview participants. Moreover, permission was sought from participants to record the conversation. Permission was also taken to use the quotations taken from their answers for the reproduction in the thesis and any subsequent publications derived from the thesis. In addition, participants were assured that their responses would be kept confidential, and also their identifications were anonymized. Participants were informed of their right to withdraw from the study at any time without giving an explanation.

1.7 Structure of the Study

The thesis is divided into six chapters. The first chapter introduces various facets of the thesis attempting to capture the review of literature, research gaps, the rationale for the topic, research questions, objectives of the study, method of analysis, structure of the study, and so forth.

The second chapter provided a socio-historical analysis of the nature and extent of flood damage in the state of Bihar in general, for the period of 1980-2020, and in Supaul district in particular, for the period of 2000-2020. The chapter also sheds light on the morphology, flooding aspect, and changing the course of the river Kosi including a brief history of the embankment around it. By providing a brief record of the flood policies adopted by the government of India, and the state of Bihar, it reflects the strategies planned by them for the mitigation and control of flood disasters. It also brings forth the details of the government institutions engaged in water resources and flood control and management in the state of Bihar. This chapter is qualitative in nature and banks on the secondary data source of books, journal articles, newspapers, surveys, and internet sources for its analysis.

The third chapter, under a broad canvas, captures the influence of two forms of social capital, i.e., bonding and bridging, on flood risk perception of the communities. The first objective of the third chapter is to examine the impact of sociodemographic characteristics on flood risk perception. The second objective of the chapter is to capture the influence of social capital on flood risk perception. The chapter further focuses on how bonding and bridging social capital strengthens the coping abilities of the households. The chapter addresses the first and second research questions. This chapter employs the mixed method for data analysis and rests on primary data.

The fourth chapter is a modest attempt to examine the influence of place attachment on the flood risk perception of the households of the Supaul district. The primary objective of the chapter is to assess the impact of economic and genealogical place attachment on flood risk perception. By highlighting the relationship between place attachment and flood risk perception, the chapter focuses on individuals' attachment to a particular place that affects their risk apprehensions and related coping measures, which ultimately influences their anticipation and perception of risk and also their coping abilities. The fourth chapter addresses the third research question. The chapter employs a mixed method for data analysis and rests on primary data.

The fifth chapter sheds light on the beliefs, norms, values, and actions of the four government institutions, WRD, FMISC, WALMI, and SDMA, involved in flood control and management in the Kosi region of Bihar. It also reflects the views, beliefs, and perceptions of the affected communities on flood management in the Kosi basin. It provides in-depth insight into the grassroots problems faced by the flood-affected communities of the region, as well as their views and opinions on the measures provided by the institutions in the name of flood management and control. The fifth chapter addresses the fourth research question. The chapter is qualitative in nature and rests on primary data.

The sixth and final chapter summarizes the findings of the study. Based on the findings, the chapter makes concluding remarks in relation to the argument presented earlier. The concluding section is followed by the limitations of the present study and points out the need for future research in the field.



Chapter II

Nature, Extent, and Severity of Flood Hazards in Bihar

Introduction

Across the globe, the frequency and severity of natural hazards are increasing daily, and so is the affected population, which has already reached an average of 231 million people annually (EM-DAT 2012). Among other natural disasters, one of the significant contributors to both losses of lives and economic loss are floods, and the intensity is expected to increase in the near future (IPCC 2012). Apart from the loss of tangible and intangible assets, floods also generate a sense of fear among people that is often more than the actual loss. Floods also have a severe impact on the agriculture and economy of the country. In general terms, the flow of water exceeding the capacity of any stream or channel and flowing out of the flood-plain can be defined as a flood. As per the definition provided by the World Meteorological Organisation (WMO), floods can be defined as a rise in the water level, usually brief, in the stream to a peak from where the water recedes at a slower rate, and relatively high flow and rising tide as measured by stage height or discharges (WMO 2011). According to the National Institute of Disaster, management floods can be defined, as access to water, due to heavy rainfall and followed by the rivers' inadequacy to control the water within its confined area (NIDM 2015). Therefore, the overflow of water, either from a river or other water bodies, beyond its natural confine because of severe rainfall or other water inputs can be defined as a flood (Chow 1956). Floods can be fluvial, i.e., riverine, coastal, flash, estuarine, ice, and debris-jam (WMO 2011). The magnitude and probability of flood occurrence depend on any region's climatic condition and river catchment characteristics.

Floods have become an annual phenomenon in India, mainly in the Eastern and North-Eastern regions, leading to massive loss of lives and severe or complete damage to property,

infrastructure, livelihood, health system, and public utilities. As per the statistics provided by National Disaster Management Authority (NDMA), the Government of India, out of the entire area of 329 million hectares (mha), around 40 mha comes under the severe flood-prone zone, and this trend is increasing as new areas are coming under threat every year (GoI 2008). During the last decade (1996-2005), the average flood damage was Rs 4745 crore annually compared to the average damage caused during the previous 53 years, which was Rs 1805 crore (ibid). As per the data provided by UNDP (2004), on average, 1595 lives and 94722 live stocks, including 1.2 million fully or partially damaged houses, have been claimed by floods annually. The primary reasons behind this include continuous population increase, rapid urbanization, blind construction, lack of drainage system, economic activities in the name of development in flood plain areas, and global warming. The flood plains in India are affected mainly by riverine floods primarily because of monsoon rains and thus termed monsoon floods, as there is excessive rainfall during the monsoon season, which results in the overflow of river water leading to inundation of large areas. Other flooding reasons include heavy rainfall, an outburst of glacial lakes, cloud bursting, tsunamis, etc. However, river floods have more impact than other factors (Munich Re 2000). Almost every year, the varying magnitude of floods affects different parts of the country. The frequency and severity differ across regions because of other climatic conditions and rainfall patterns. In India, the most flood-prone areas come under the Brahmaputra, Ganga, and Mahananda basin of the North and Northeast region of the country and the coastal areas of Eastern and Western coastal regions (Dasgupta 1986). The primary reason behind river floods is the accumulation of water from different river tributaries, which carries huge sand and silt and deposits it on the river's bed. This silt deposition leads to a rise in the river bed, obstructing the normal flow of water. As a result, water expands horizontally, and the nearby habitats are submerged.

As per the data provided by CRED (Centre for Research on the Epidemiology of Disaster 2015), floods have claimed an average of 1000 lives per year during 1965-1975, which increased to 1700 lives per year during 2005-2015. Also, in the last decade, from 2005-2015, the cumulative financial loss caused by the flood was around 2 percent of the current GDP of India (EM-DAT 2015). This shows a steep rise in the country's financial burden caused by flood disasters. Despite this, there is no separate institutional setup created by the Indian Government to tackle flood disasters, and all the flood-related works are carried out by the Disaster Management Cell of the Indian Government.

In India, Bihar tops the list of flood-prone states, with 76 per cent of its population under continuous flood threat. The climatic condition of Bihar is tropical; Monsoon oriented, having intense heat, and average to high rain. Out of the entire geographic region of about 94160 sq. km, around 68800 sq. km (73.06 %) of the whole area is affected by the flood. Most of the Bihar rivers originate outside India (either in Nepal or Tibet, China). Also, 65 per cent catchment area of these rivers is in Nepal, while 35 per cent area falls in Bihar. Bihar's east border is shared with West Bengal, the west border is shared with Uttar Pradesh, the southern border is shared with Jharkhand, and the northern border is shared with Nepal. There are two physiographic units in Bihar, namely plains and Plateaus. According to the Annual Action Plan of Bihar State Horticulture Mission (2010-11), North Bihar's topography comprises mainly the plains that bend towards the south and are mainly inundated by the Ganga Gandak and Kosi rivers. This topography, along with heavy rainfall in the plains, is the primary reason behind the flooding of Bihar. The state's population is 103.8 million, with 1102 persons living per sq. km and a decadal growth of 25.1 per cent (Economic Survey 2012-13, GOB). Most of the population (around 90 %) resides in rural areas and has agriculture as their primary occupation (Bihar Kosi Flood Need Assessment Report 2008). Against this backdrop, this chapter discusses the morphology of the Kosi river, its changing course, and various aspects of the Kosi

flood and related planning and management in the Supaul district. It also focuses on the extent of damages due to floods in Bihar in general and Supaul district in particular. Further, it sheds light on the problems raised due to embankment construction on the Kosi river and the flood policies adopted by the country and the state of Bihar. The present chapter is qualitative in nature and based on secondary literature such as journal articles, reports, web sources, and so forth.

2.1 The river system in Bihar

North Bihar's plains are divided into eight different river basins: The Gandak, the Burhi-Gandak, the Ghaghra, the Bagmati, and the Adhwara group of rivers the Kosi, the Kamla, and the Mahananda (Sinha et al. 2012). And each river basin is shared either with Nepal and Tibet or with other Indian states. The rivers of south Bihar, namely the Punpun, Kiul, Sone, Karmanasa, Badua, and Chandranare, originate in the Chhotanagpur, Vindhyachal, and Rajmahal hills. Most of the Northern Bihar river's catchment area lies in the glacial region of the Himalayas and generally has low flow, but with Monsoon, there is a 50 to 90 percent increase in the flow of these rivers, causing severe floods in the plains. However, the southern rivers mainly depend on the rains and usually carry very little flow during the non-monsoon period.

2.2 Major flood events in Bihar

During the last three to four decades, the highest number of floods have been recorded on the plains of North Bihar. After independence, the major flood events occurred in 1954, 1974, 1987, and 2004. Apart from this, high magnitude floods have been witnessed by the people of Bihar in the years 1978, 1998, 2007, and 2008. With each passing year, the total severity has increased. The 2004 floods were the result of an embankment breach in the Kamla, Bagmati, and Adhwara group of rivers leading to the loss of the lives of 800 people. However, the 2008

flood is counted as the worst in the last 20 year's history of Bihar. It occurred because of an embankment breach in the Eastern Kosi river and affected more than five districts of North Bihar. Almost 3000 people lost their lives, and 7000,000 became homeless. The flood damages are on the increase despite the increase in government spending from "1.3 lakhs in the First Five-Year Plan (1951-56) to 106 billion in the Tenth Five-Year Plan (2002-07)" (Sinha et al. 2012). During the years 2010-11, only the total expenditure on flood protection works was more than 159 Billion, as reported by the Water Resource Department of the Government of Bihar (ibid).

Despite the increasing investment in flood disaster management, both flood-prone areas and flood damages are increasing in Bihar (Mishra 1997). There are a number of programs run by the Central Government and the state government to manage and control the damages of floods. However, most of the programs initiate only after the occurrence of floods. Despite having a five-decade-long history of managing Kosi floods in Bihar, the river continues to bring hardship to the people living along its bank and nearby areas. Efforts have been made to reduce the vulnerability of the flood-affected people, as claimed by the Government, but the uncountable human, material, as well as social loss, is continued to date. A large part of fertile lands has been laid waste because of the shifting nature of the Kosi river. The overbank flooding has caused extensive damage and long-term inundation in various regions of Bihar. Owing to this, it is known as the 'Sorrow of Bihar' (Sinha et al. 2008). In Bihar, the Supaul district comes under the category of severely flood-affected, but the flood management planning and facilities are inadequate. There are 11 blocks in the district, where five blocks are worst hit by flood every year. It has been affected by floods since 1934 (Mishra 1997). Different scholars, departments, and institutions have conducted various studies on the dynamic nature of the river Kosi, and this number has increased significantly after the 2008 flood devastation. However, detailed research at both macro and micro levels is required.

2.3 The Kosi River System

The river Kosi in Sanskrit books is known as 'Kaushiki' and is among the most ancient rivers in India. It originates in the Himalayas (Chinese region), travels through the east of Kathmandu in Nepal, and then comes to India, where it joins the Ganges by flowing through the plains of North Bihar. It has seven tributaries within the Himalayas; the Sun, the Tamba, the Tama, the Indravati, the Dudh, the Likhu, the Tamur, and the Arun. At Harkapur (Nepalese village) the Sun Kosi joins the Dudh Kosi. At about 10 km upstream of Barakhshetra, also called 'Triveni,' three tributaries, namely the Sun, Tamar, and Arun, join together and are called the Sapta Kosi. From there, it comes down from the mountains and is called only Kosi. These tributaries of the Kosi river circles Mount Everest from all sides and are fed by its glaciers. After entering the plains, the river widens its bed and spreads over 6 to 10 km. From there, it enters into the plains of North Bihar near Bhim Nagar after flowing for about 58 km in Nepal and takes another flow of 260 km to mingle into the Ganges near Kursela. The entire area covered by Kosi is 74,030 sq. km. from which 11,410 sq. km. rests in India while the other 62,620 sq. km. lies in Nepal or Tibet (Sinha et al. 2012).

Geddes (1960) was the first person to analyze the flat topography of the plains and used the term 'cone' to explain the Kosi river's morphology. These cones are very large and have flat sediment accumulation, supplied with water from Mount Everest and the mountains of Nepal. However, the term 'cone' is later replaced by 'fan' and 'megafan' (Gohain 1990). In 1966, Gole and Chitale used the term 'inland delta' made of large sediment flux to describe the Kosi system and also attributed this sediment flux to be the primary reason behind extensive flooding and westward shifting of the Kosi river (Gole & Chitale 1966). The Kosi mega fan has formed on a vast plain which is steeper (55-75 cm/km) in the north, flatter (6 cm/km) in the south and has North to South and West to East slopes. Therefore, the entire surface of the Kosi megafan is mostly flat and is dissected by various small channels popularly called '*dhars*', and these small

channels represent the palaeochannels of the river Kosi. Some of these channels are completely dry, while some are muddy and vegetated because of monsoon water. However, there is extensive cultivation in the alluvial plains. The river also forms numerous depressions called '*chaurs*' which are mostly submerged for almost the entire year. Few of these submerged places in the lower reaches and near the embankments occupies huge area owing to either seepage along the embankments or overbank flooding of flood water (Sinha et al. 2008). In short, the Kosi river's topographic condition may be summarised as; a large catchment in the hills but small in the plains, from where water is drained steep in the north but flat in the lower reaches, and incessant discharge of water making the shifting of river course more active in the plains (Das 1968). The Kosi river resembles the Huang Ho river (China) as both carry high sediment-laden water. However, the Huang Ho river carries mostly fine silt while the Kosi river carries mostly fine to coarse silt (Sinha 2008).

Table 2.1: Characteristics of the Kosi basin

1	Total drainage area	74030
2	Drainage area in Bihar	11410 sq.km
3	Population in Bihar	1041 lakh
4	Water resources	52219 MCM
5	Average annual rainfall	1456 mm
6	Total length of the main river in Bihar	260 km
7	Cropped area in Bihar	8694 sq. km
8	Tributaries: Baghmata (R), Kamala Balan (R), Tiljuga (R), Bhuthi Balan (R), Fariani dhar (L), Dhemama dhar (L)	

Source: Water Resource Department, (GoB 2002)

2.4 Changing course of Kosi

In North Bihar Plains, the Kosi river is one of the main contributors to severe flood events and is considered a problematic river because of its changing course. It often begins to meander and shifts its course. The river has shifted in a westerly direction in the last two centuries. As per the records, around 200 years ago, Kosi flowed about 160km east of where it is today. In the late eighteenth century, it flowed east of Purnea, and now it is flowing near Nirmali in Supaul (Mishra 2008). This movement has been avulsive (sudden change in the course of the river) nature (Wells & Dorr 1987). The river Kosi carries a very high load of sediments. As per the Irrigation Commission of Bihar (1994), the annual sediment load at Barahkshetra in Kosi is estimated to be 92.5 million cubic meters (GOB 1994). The innovative movement of the river Kosi has resulted in extreme destruction in the past, especially in the downstream areas of India and Nepal, leading to not only current losses of property and lives but also long-term losses like soil erosion and land loss (Dixit et al. 2008). As per the records, 85 percent of the land (16 % of total area) of North Bihar, which is about one million hectares, is waterlogged (GOB 2009).

2.5 Aspects of Kosi Floods

In the Supaul district of Bihar, major devastation has been caused by Kosi floods in the last 50 years. In Asia, Kosi comes among the highest sediments carrying river (around 80 million m³ per year) because of either Monsoon, landslide in the Himalayas, mass wasting, or sudden cloudburst (Kale 2008). The river carries sands when it comes down from the hills and spreads over the plain surfaces, often choking the wells and destroying the productive capacity of fertile lands, "changing the whole face of the country from a fruitful landscape to a wilderness of sand and swamp" (O' Malley 1911, pp.6).

The duration of floods is directly related to the onset of the Monsoon when heavy rainfall occurs in the catchment area and causes floods in the region. In this region monsoon typically starts in mid-June and lasts in September. However, this period often extends for a month or two. In the Kosi basin, the normal flood period begins from early July until September. But, recent cases of early floods have increased. Usually, in this region, people have faced two to three low floods, three to four normal and one to two severe floods per decade. However, there is no pertinent data regarding the flood duration. It might take a few hours to several months, depending upon the frequency of occurrence.

2.6 The Extent of flood damage in Bihar

Floods in Bihar cause severe devastation on an annual basis. It not only puts a question mark on the survival of millions of its population but also challenges the Government in terms of mitigation and control. Flood damage covers every aspect of harm caused by the flood disaster. It could be harmful impacts on human health, lives, belongings, heritage, impact on public infrastructure, ecological aspects, and so forth. This section focuses on the annual loss of crops, the total area affected, the total cropped area affected, the total population affected, the total damage to houses, and the total loss of public properties due to flood disasters in the last four decades, i.e., 1980-2020 in the state of Bihar. The data from the State Disaster Management Authority (SDMA) was used to capture the extent of flood damage in Bihar.

2.6.1 Total area affected

The total area of Bihar is 93.60 lakh hectares⁵. Figure 2.1 represents the total area affected (in a million hectares) by the flood disaster in the state of Bihar from 1980-2020. The year 1987

⁵ <https://www.mapsofindia.com/bihar/bihar-at-a-glance/area.html> (accessed on 15th November 2021)

occupies the first place with 4.16 mha of the area affected. After that, the year 2014 is positioned in second place with 3.9 mha of the area affected. This is followed by the years 1984, 1998, 2004, and 2002 with the highest affected areas of 3.05, 2.51, 2.7, and 1.97mha respectively. If we observe the decadal average, the decade of the 1980s finds first place with 1.58 mha of the area affected due to flood disaster.

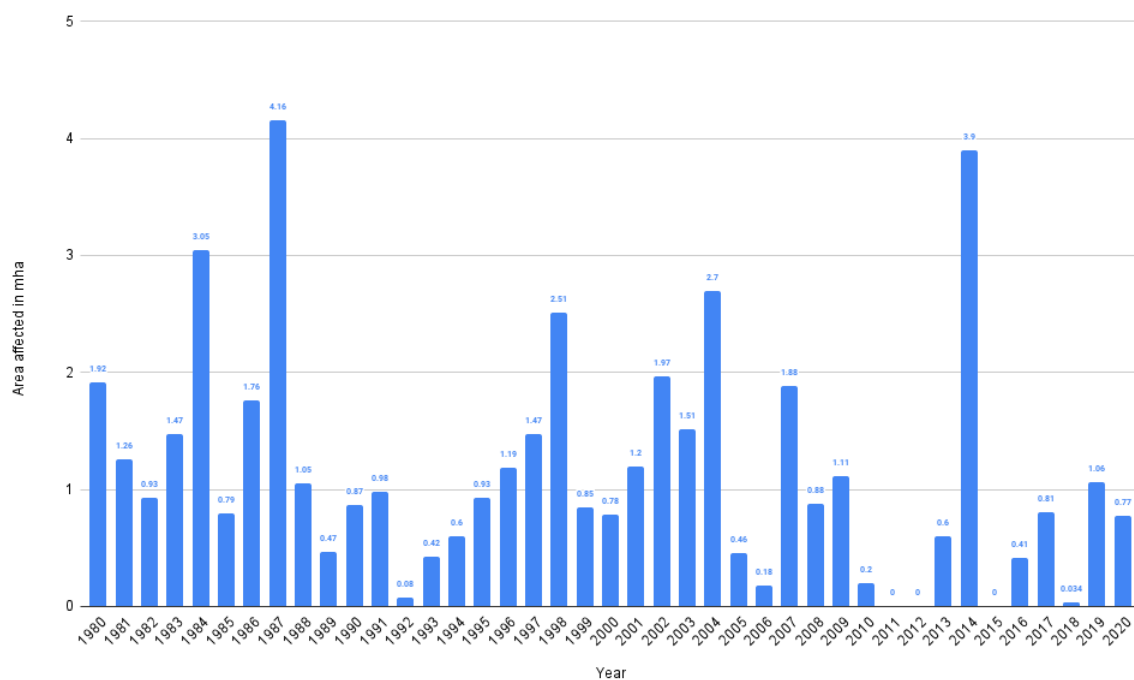


Figure 2.1: Year wise total area affected (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 1.581 mha (1981-1990), 0.981 mha (1991-2000), 1.209 mha (2001-2010), and 0.758 mha (2011-2020)

2.6.2 Total Cropped area affected

Out of the total geographical area of 93.60 lakh hectares of Bihar, 5.638 lakh hectares is the net area sown, while 79.46 lakh hectares is the gross cultivated area⁶. Since agriculture is one of the mainstays of the economy of Bihar, damage to crops leads to severe consequences as the

⁶ <https://dbtagriculture.bihar.gov.in/krishimis/WebPortal/AboutUs.aspx> (accessed on 18th November 2021)

rural population depends on it for their survival. Figure 2.2 depicts the total cropped area affected (in a million hectares.) due to flood disaster for the period 1980-2020 in the state of Bihar. It is evident from the data that in the last four decades, in the year 1987 the highest cropped area of 2.24 mha was affected by floods. This was followed by the year 1984, which accounted for 1.59 mha of the cropped area affected. Furthermore, 2004, 1998, 2007, and 2017 with cropped area coverage of 1.4, 1.28, 1.06, and 0.81 mha are the years where the substantial cropped area was affected owing to flood. However, the decadal average of the cropped area affected showed the decade of the 1980s as the most disastrous, with 0.73 mha of the cropped area affected by floods.

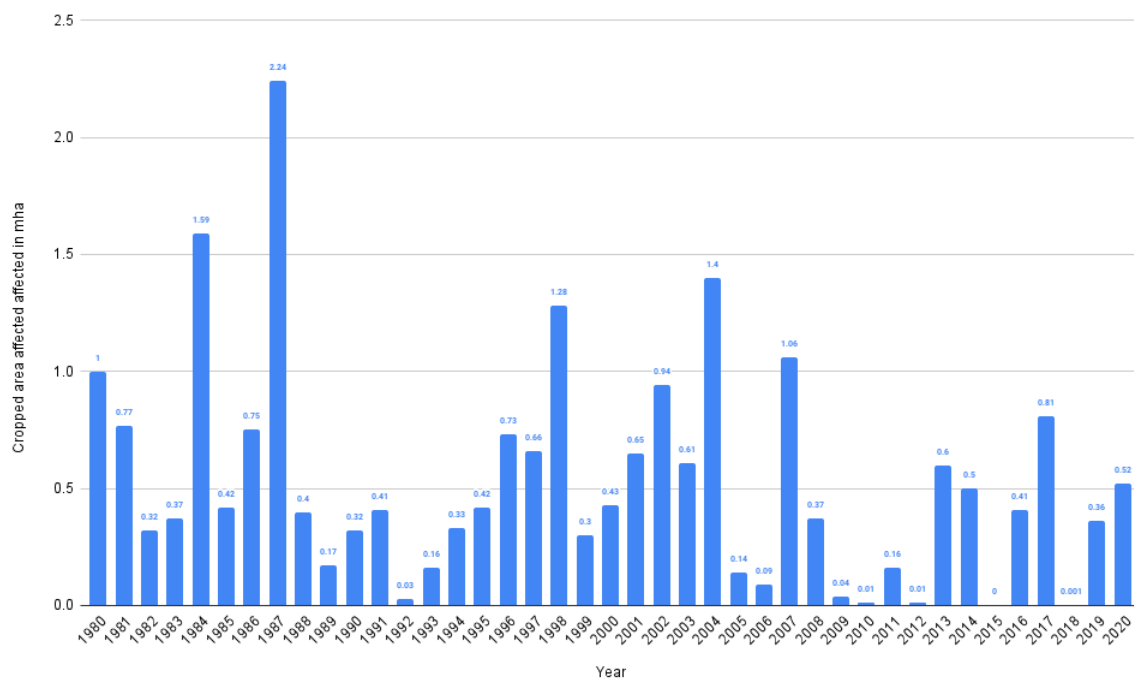


Figure 2.2: Year wise total cropped area affected (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 0.735 mha (1981-1990), 0.475 mha (1991-2000), 0.531 mha (2001-2010), and 0.337 mha (2011-2020)

2.6.3 Total Population affected

According to the 2011 census, the total population of Bihar is 10.41 Crores⁷. Figure 2.3 illustrates the total number of population affected owing to flood disasters in the last four decades from 1980-2020. Figure 2.3 suggests that almost every year, millions of the population have been severely affected by flood disasters, but the year 2004 finds the first position among all of them with 29.99 million affected populations. Furthermore, the year 1987 with 24.49 million affected population occupies the second position. Moreover, 2017, 2002, 2019, and 1998 are the significant years with 17.16, 16.02, 14.94, and 13.47 million affected populations, respectively, by flood disasters. The decadal average divulges that in the last four decades, the highest population of 8 million was affected in the decade of the 2000s.

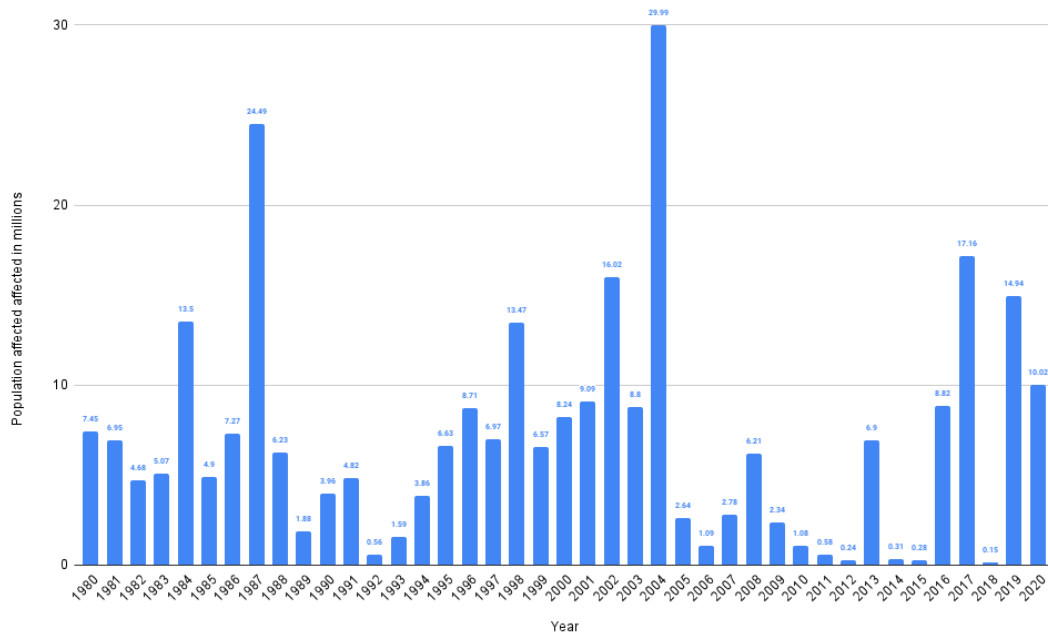


Figure 2.3: Year wise total population affected (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 7.893 million (1981-1990), 6.142 million (1991-2000), 8.004 million (2001-2010), and 5.94 million (2011-2020)

⁷ <https://www.census2011.co.in/census/state/bihar.html> (accessed on 18th November 2021)

2.6.4 Damage to crops

Agriculture plays a significant role in Bihar's economy, with a share of 23 percent of total GDP, where crops represent a 12.23 percent share in agriculture⁸. It is also one of the prominent livelihood sources for the state's population. Figure 2.4 illustrates the total crop damage (in crores) from the flood disaster in Bihar from 1980-2020. It reveals that damages to crops have been caused annually for the last four decades, but 2007 marks the most devastating, with the highest crop damage worth 768.38 crores. The second most affected year of crop damage is 2020, with a loss of 727.9 crores. Furthermore, severe damages have also been caused in the years 2004, 2002, 1987, 2019, and 2016 with a loss of 522.06, 511.5, 501.32, 446.6, and 443.53 crores, respectively. If we calculate the decadal average, we can observe that the decade of the 2000s is the period that accounts for the highest crop damage of 220.96 crores by flood disaster.

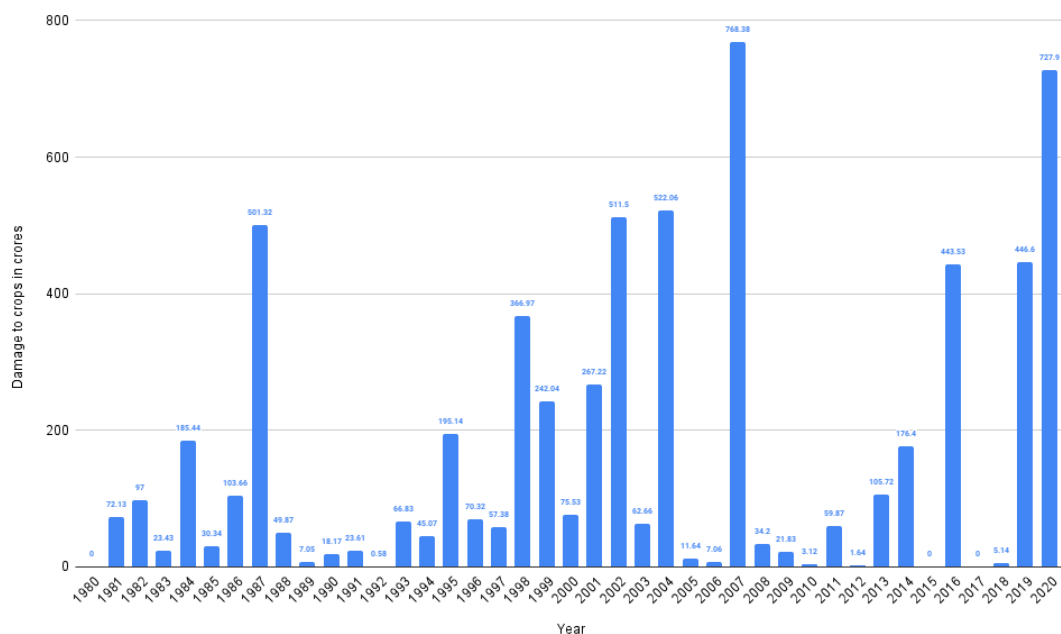


Figure 2.4: Year wise damage to crops (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 108.841 crores (1981-1990), 114.347 crores (1991-2000), 220.967 crores (2001-2010), and 196.68 crores (2011-2020).

⁸ <https://statisticstimes.com/economy/india/bihar-economy.php> (accessed on 15th November 2021)

2.6.5 Damage to houses

Figure 2.5 exhibits the total value of damaged houses due to floods for the period of 1980-2020. The data indicate that the maximum value of damaged houses occurred in the year 2007 with a valuation of 831.45 crores. The next position is occupied by 2004 with the damaged house's value of 758.1 crores. The year 2002, 1987, 2001, and 2000 are other major years with damage valuations of 526.22, 217.74, 173.58, and 148.56 crores, respectively. The average decadal calculation shows that the maximum value of house damage worth 242.26 crores occurred in the decade of the 2000s.

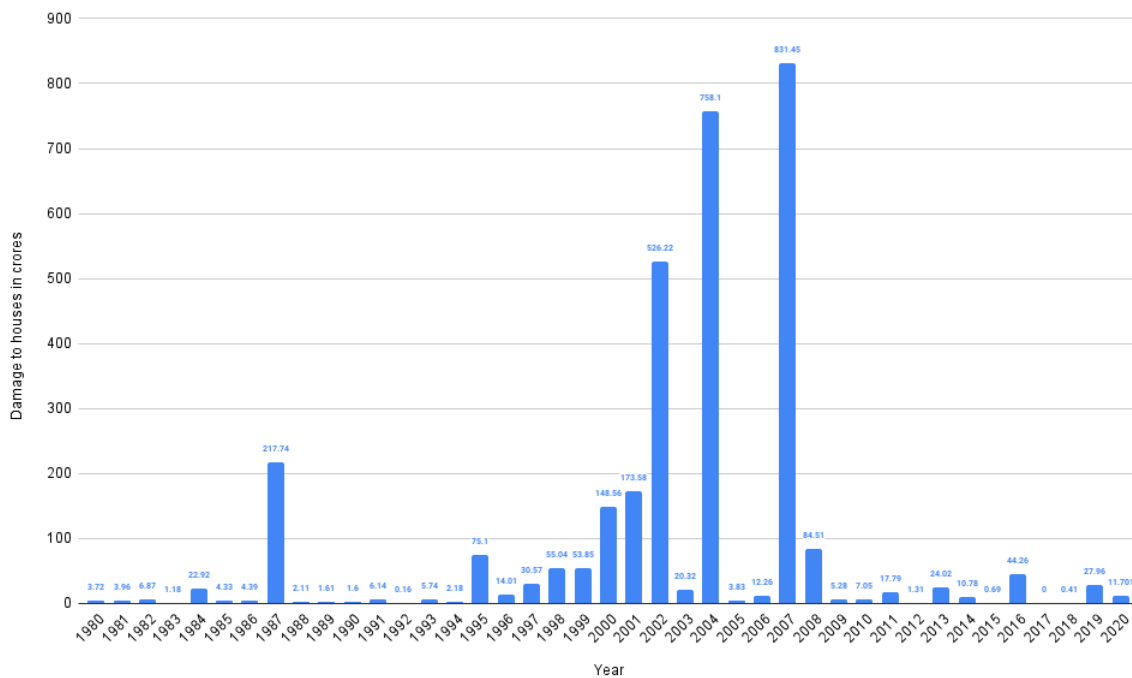


Figure 2.5: Year wise damage to houses (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 26.671 crores (1981-1990), 39.135 crores (1991-2000), 242.26 crores (2001-2010), and 13.892 crores (2011-2020).

2.6.6 Damage to public property/utility

Whenever any disaster occurs, it pushes the country ten years back in terms of development because it affects the rail, road, hospitals, and other development infrastructures that have been built for decades. Figure 2.6 displays the total value of public property damage (in crores) for the period 1980-2020. It highlights that the maximum public property damage occurred in the year 2020 with a value of 3281.87 crores. Moreover, another major damage of 1035.1 crores was recorded in the year 2003. This was followed by major damages of and 1030.5 crores in the years 2004. Apart from this, the major damage of 642.42 and 490.55 crores occurred in the year of 2007 and 1987. However, the decadal average calculation accentuates that the decade of 2010s has proved to be most disastrous with 360.17 crores loss of public properties.

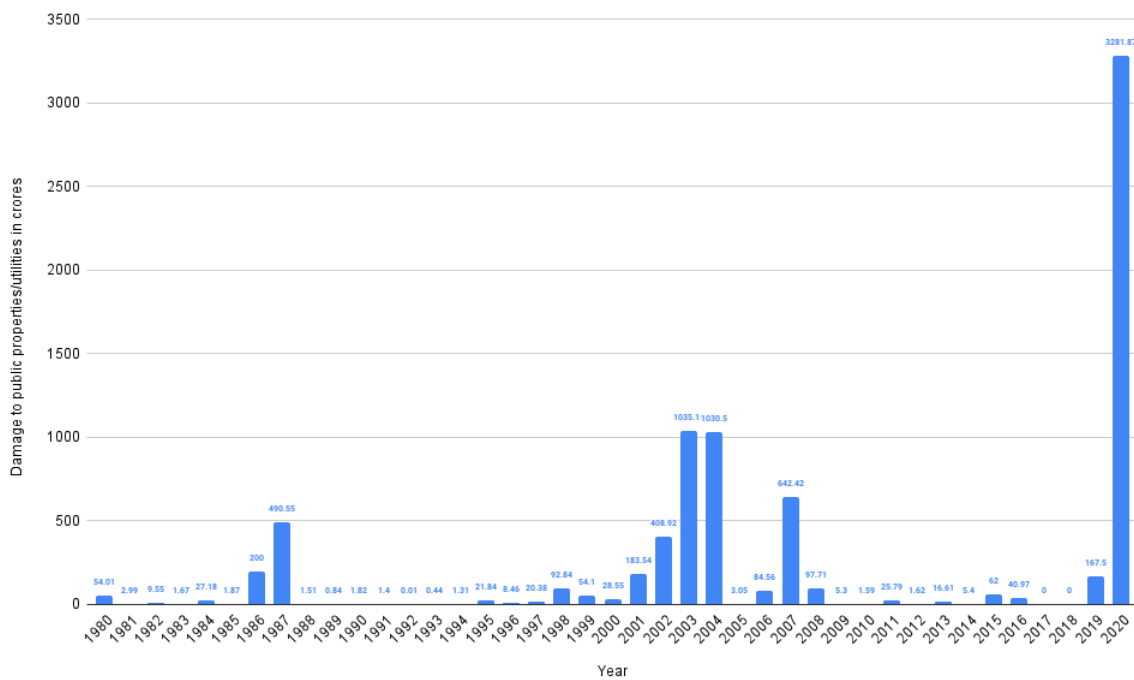


Figure 2.6: Year wise damage to public utilities (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 73.79 crores (1981-1990), 22.93 crores (1991-2000), 349.27 crores (2001-2010), and 360.17 crores (2011-2020).

2.6.7 Total damage

Figure 2.7 represents the total amount of damage (in crores) that occurred to crops, houses, and public utilities due to uncontrolled floods in the state of Bihar. It is evident from Figure 7 that 2020 is the year when maximum damage is worth 4021.47 crore occurred. The year 2004 finds the second position with regard to maximum damage to crops, houses, and public utilities with a loss of 2310.66 crores. Other than that, the loss of 2242.25, 1446.64, and 1209.61 crores was reported in the years 2007, 2002, and 1987 respectively. The decadal average suggests that the decade of the 2010s marks the highest damage with 812.49 crores. All these structural and non-structural losses not only make the lives of its population measurable but also pushes the country and state's growth and development activities decades back.

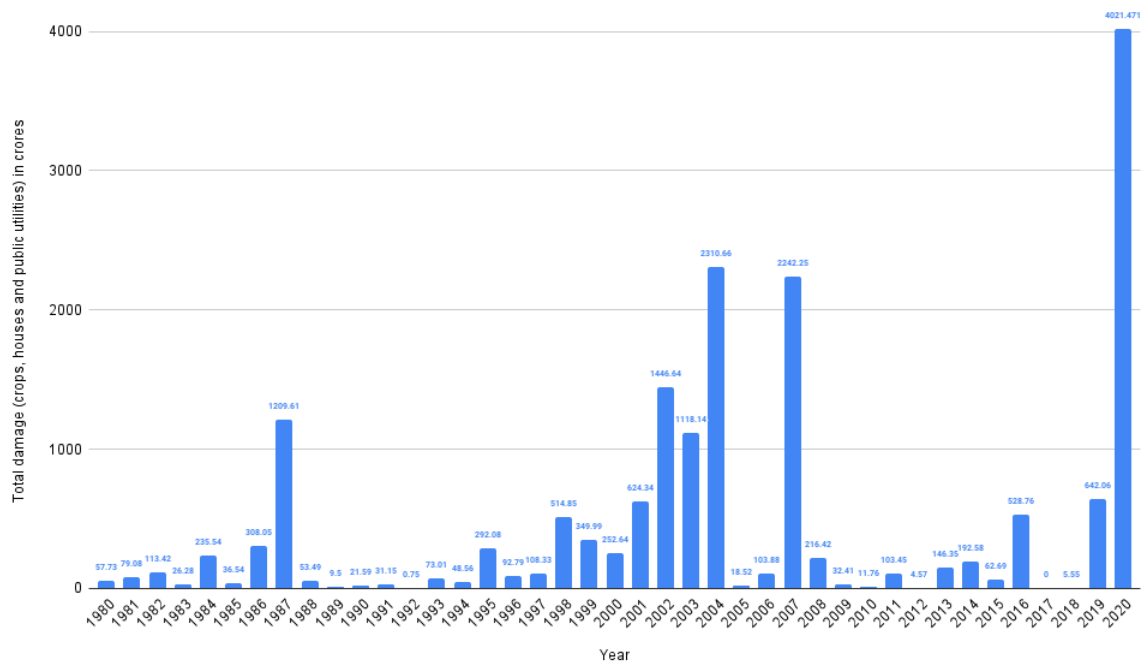


Figure 2.7: Year wise total damage (Source: data compiled from SDMA, accessed on 20th October 2021)

Note: Decadal average – 209.31 crores (1981-1990), 176.41 crores (1991-2000), 812.49 crores (2001-2010), and 570.74 crores (2011-2020).

2.7 The extent of flood damage in Supaul

In North Bihar, 76.63 percent of the entire area is considered flood-prone⁹. Among 38 districts in Bihar, 28 districts are affected by floods on an annual basis, but 15 districts are worst affected in terms of human lives lost and economic loss¹⁰. Supaul district comes under those 15 districts which are worst hit by floods on an annual basis and make it one of the most flooded districts not only in Bihar but in India. There are 11 blocks in the district, and eight among them are under constant flood threats. The main reason for the flood in this area is the presence of the Kosi river, which brings annual hardship to the lives of its population. This section is focused on analyzing the extent of flood damage in the Supaul district of Bihar for the period 2000-2020. The data of the Disaster Management Department, Government of Bihar, was used to analyze the extent of flood damage in the Supaul region.

2.7.1 Total area affected in Supaul

The total area covered by Supaul district is 2425sq km including the urban area of 36sq km and rural area of 2389sq km¹¹. Figure 2.8 shows the total area affected annually due to floods in the last two decades of 2000-2020 in the Supaul district. The data reflects that the maximum total areas of 2 ha were affected in the year 2013, and then 1.93 ha were affected in the year 2002. This was followed by 1.78 ha areas affected in the year of 2004 floods. These two years mark the highest area affected in the last two decades of 2000-2020. Besides, the year of 2008 and 2017 with area coverage of 0.84 and 0.23ha, were reported to be more disastrous. The decadal average shows that the decade of the 2000s (0.52 ha.) was more disastrous vis-à-vis the 2010s (0.2962 ha.)

⁹ <http://bsdma.org/Know-Your-Risk.aspx?id=3> (accessed on 5th January 2022).

¹⁰ <http://bsdma.org/Know-Your-Risk.aspx?id=3> (accessed on 5th January 2022).

¹¹ https://www.indiagrowing.com/Bihar/Supaul_District (accessed on 5th January 2022).

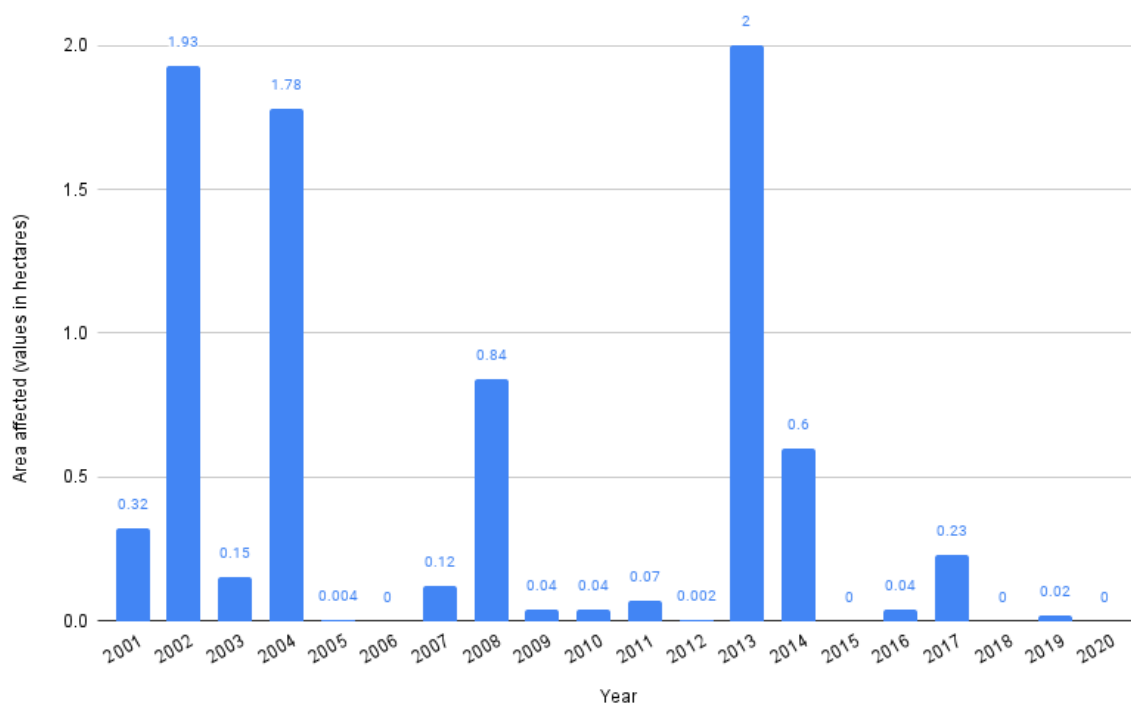


Figure 2.8: Year wise area affected in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 0.5224 hectares (2001-2010) and 0.2962 hectares (2011-2020). The value 0 denotes either data is not available or not reported.

2.7.2 Total cropped area affected in Supaul

The gross cropped area of the Supaul district is 254.1ha, and the net sown area is 146.6 ha¹².

Figure 2.9 reflects the annual damage to cropped areas due to flood disasters for the period of 2000-2020 in the Supaul district. The data indicate that 2012 was the most wasted year, with 3.86 ha of the cropped area affected in the Supaul region. Thereafter, 2013 was another year with the most affected cropped area (1.3 ha) by floods. Moreover, 2004, 2002, and 2008 were other years has proved disastrous for the population of Supaul district, with affected cropped areas of 0.47, 0.44, and 0.43 ha, respectively. The decadal average reveals that the decade of the 2010s was more disastrous, with cropped area coverage of 0.527 ha.

¹² http://www.nicra-icar.in/nicarevised/images/statewisepans/Bihar/BR35_Supaul_28.12.2013.pdf (accessed on 5th January 2022).

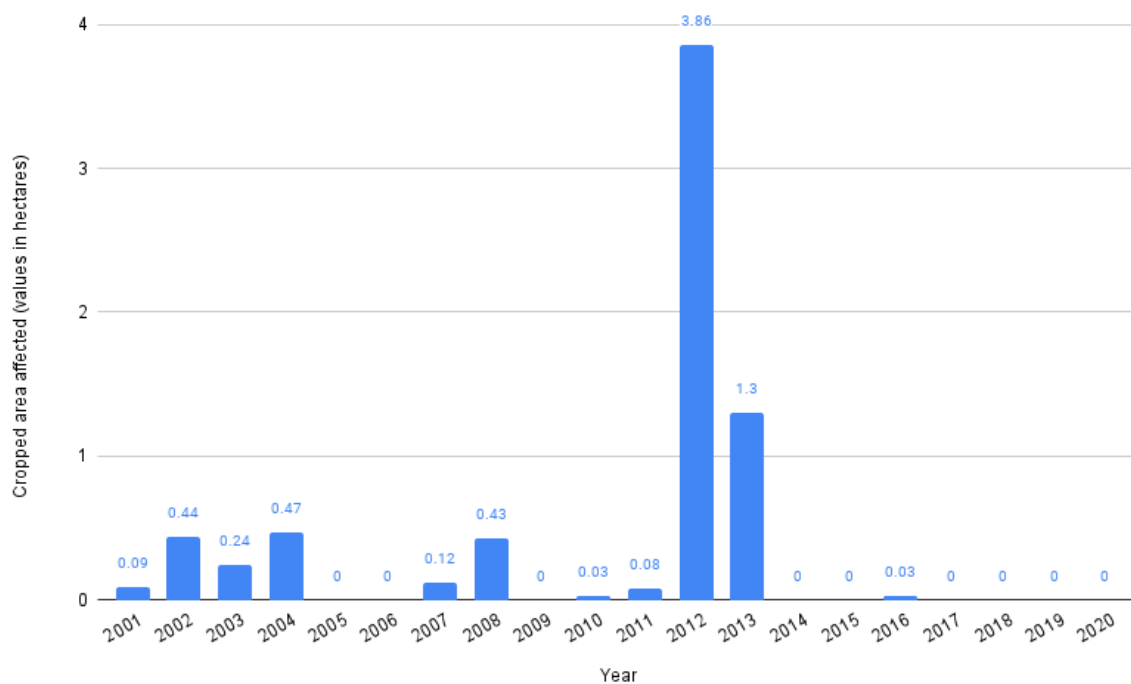


Figure 2.9: Year wise total cropped area affected in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 0.2022 hectares (2001-2010) and 0.527 hectares (2011-2020). The value 0 denotes either data is not available or not reported.

2.7.3 Total population affected in Supaul

According to the 2011 census, the total population of Supaul district is 2,229,076, where the male population is 1,155,283, and the female population is 1073793¹³. Figure 2.10 suggests the total number of population affected by the flood disaster in the period of 2000-2020 in the Supaul district. It is evident that the most people, i.e., 7.5 lakhs including five blocks, 86 panchayats, and 247 villages, were affected by floods in the year 2008, which records as one of the most disastrous floods in the flood history of Bihar. After 2008 the second devastating year in terms of population affected was 2003, with 4.5 lakh people in 6 blocks, 47 panchayats,

¹³ https://www.indiagrowing.com/Bihar/Supaul_District (accessed on 8th January).

and 86 villages. Other than that, 2017, 2004, and 2002 were severe years with 4.15, 4.21, and 3.02 lakhs affected population. The decadal average showed that the decade of the 2000s was reported to be more damaging than the 2010s (1.427 lakhs), with 2.574 lakhs population affected.

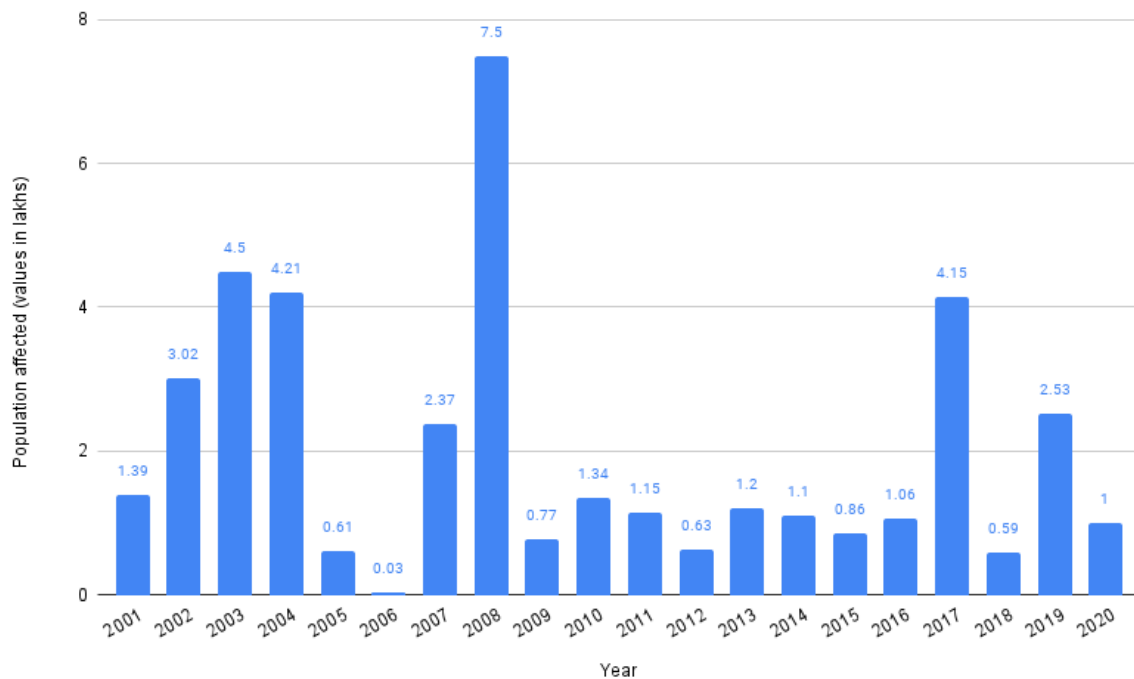


Figure 2.10: Year wise total population affected in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 2.574 lakhs (2001-2010) and 1.427 lakhs (2011-2020).

2.7.4 Damage to crops in Supaul

The main occupation for the residents of Supaul district is agriculture. The cropping pattern in the region includes four agricultural seasons Bhadai, Aghani, Rabi, and Garma¹⁴. The main crops of the district are Paddy, Wheat, Mustard, Gram, Jawar, etc. Besides, vegetable farming is also practiced in the district because of its climatic condition. Cauliflower, cabbage, long beans, potato, garlic, and onion are some of the main vegetables grown by the farmers in the

¹⁴ http://cgwb.gov.in/District_Profile/Bihar/Supaul.pdf (accessed on 5th January 2022).

district. However, when the flood comes, it destroys all the hard work done by the farmers. Figure 2.11 reflects the trend of annual crop damage (in lakhs) in the Supaul district of Bihar for the period 2001-2020. It is evident from the data that in the last two decades, the most devastating year in terms of crop damage was 2008, with crop loss worth 2691.19 lakhs. The 2008 flood was one of those which marked a red dot in the history of Bihar. It affected all the 11 blocks of the Supaul district, but five blocks were submerged. The flood occurred due to embankment breaches in the Kosi barrage and inundated the new areas with no flood history in the last decade. Lakhs of people and livestock were swept away in the flow of water. After 2008, the year 2017 reported the highest damage to crops worth 2220.41 lakhs in the district. The decadal average shows that the decade of the 2000s (507.424 lakhs) was more disastrous than the 2010s (289.218) with regard to crop damage.

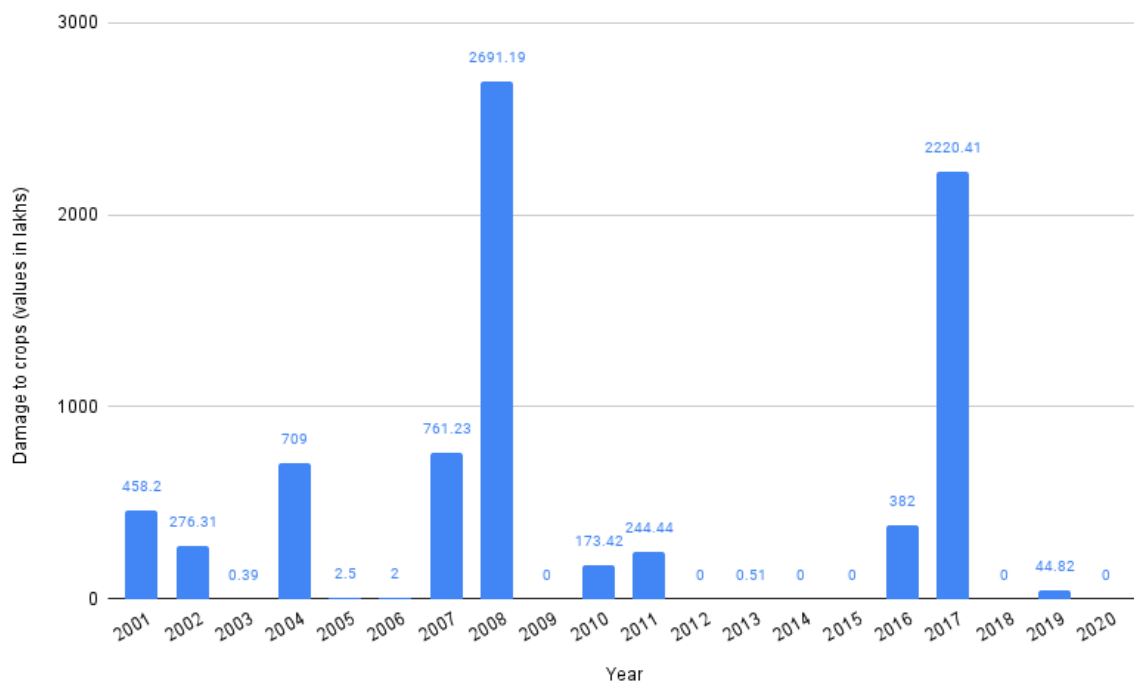


Figure 2.11: Year wise damage to crops in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 507.424 lakhs (2001-2010) and 289.218 lakhs (2011-2020). The value 0 denotes either data is not available or not reported.

2.7.5 Damage to houses in Supaul

Figure 2.12 represents the total value of houses damaged in the entire Supaul district within a time frame of 2000-2020 due to the flood disasters. It is apparent from the data that the maximum value of house damage occurred in the floods of 2008, which was worth 16644.36 lakhs. The second major year in which maximum damage to houses occurred was 2007, when a value worth 2313.86 lakh houses was damaged from 6 blocks, 61 panchayats, and 145 villages. The third major year of house damage worth 1669.15 lakhs was 2004. The 2004 flood was the result of heavy rainfall in Nepal, leading to the increased water level in the Kosi river and causing floods in North Bihar. In 2004, 9 blocks, 68 panchayats, and 189 villages were trapped in the flood water and making lakhs of people homeless. Apart from that, the 2017 and 2010 floods worth 481.54 and 410.35 lakh damaged houses were disastrous in other years. However, the data for 2020 is not available. The decadal average of house damage shows that the decade of 2000 was more damaging in making people homeless with an average value of 4830.8 lakhs.

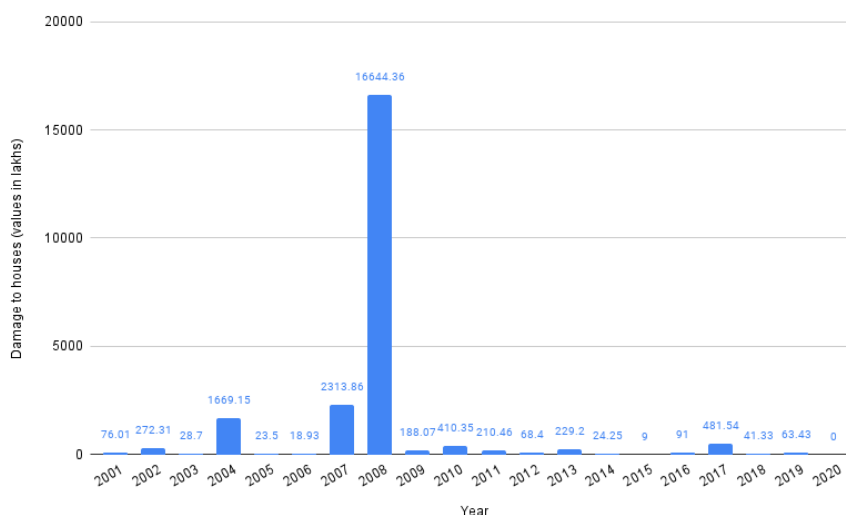


Figure 2.12: Year wise damage to houses in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 4830.8 lakhs (2001-2010) and 1768 lakhs (2011-2020). The value 0 denotes either data is not available or not reported.

2.7.6 Damage to public properties/utilities in Supaul

When a flood hits any region, it affects the basic amenities of the population means not only their bread, butter, and house but their health and education are also affected. Figure 2.13 depicts the total annual public property damage that occurred in the period 2000-2020. The data reflects that the maximum damage to public properties worth 11813.36 lakhs occurred in the year 2020 due to the flood disaster in the district. Damage to public properties means no functioning of facilities like health, transport, education, etc., which further increases the intensity of existing problems. After 2020, 2008 remains in the second position with a major loss of public properties worth 11222.31 lakhs, affecting the district's total population of 1.39 lakhs. Apart from these two, the years 2004, 2014, and 2002 were the worst hit by floods with damage to public properties worth 527.01, 375.88, and 224.78 lakhs, respectively. The average decadal loss reveals that the 2020s was the worst decade, with a loss of 1220.32 lakhs.

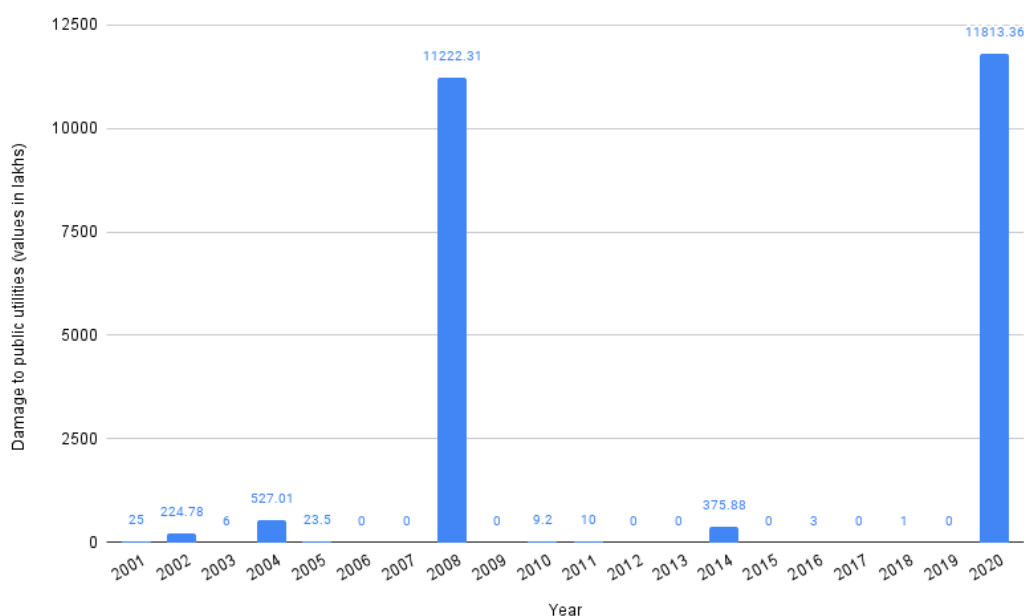


Figure 2.13: Year wise damage to public utilities in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 1203.78 lakhs (2001-2010) and 1220.324 lakhs (2011-2020). The value 0 denotes either data is not available or not reported.

2.7.7 Total damage in Supaul

Figure 2.14 shows the value of total loss of crops, houses damaged, and the loss of public properties in the Supaul district of Bihar from 2000 to 2010. The loss of crops not only destroys the farmers' hard labor but also burdens the economy of the country/state in the long run. Although significant losses have occurred on an annual basis, in the last two decades, 2001 was the most disastrous year with a total loss of 19360.55 lakhs, which means millions of people not only remained hungry but became homeless and also deprived of basic amenities. 2020 was another year that stands in the second position with a loss of 11813.36 lakhs. Apart from that, a significant loss of 11677.21 lakhs occurred in 2008. As per average decadal loss, the decade of the 2000s remained in the top position with a loss of 4250.91 lakhs.

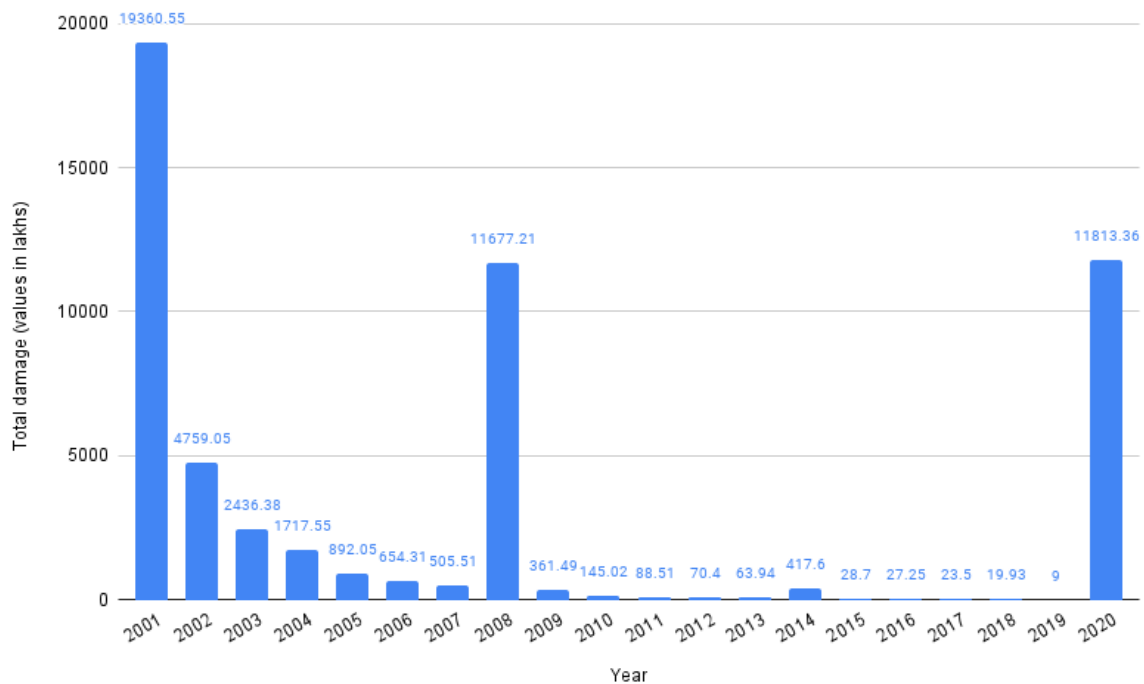


Figure 2.14: Year wise total damage in Supaul (Source: data compiled from Disaster Management Department, Government of Bihar, accessed on 20th October 2021)

Note: Decadal average – 1256.219 lakhs (2001-2010) and 4250.912 lakhs (2011-2020).

The following section focuses on the history of embankment on the Kosi river as a means of flood control, followed by the flood policies adopted by the Government of India. And the final section gives a brief idea about the government organizations working in flood management at both district and state levels.

2.8 The Embankment system around the Kosi river and the Kosi Barrage

The first attempt to control the rivers was the construction of an embankment on the Kosi river in the 12th century AD by King Lakshmana II (Mishra 1997). This embankment was 32 km long along the western bank and is called the 'Bir Bund.' However, Bir Bund failed to provide the expected relief to the people. Another attempt in 1756 to control the rivers and floods was made with the construction of a 158 km long embankment on the Gandak river. After this construction, the East India Company took over India (Chaudhary 1960). Although the British did not give attention to the Gandak embankment initially, in 1797, for the first time, they sanctioned the amount of Rs 36,000 for its maintenance. They later recovered this amount from the local 'Zamindars' (Landlords) as it was their responsibility, not the public work (Chaudhary 1960). In 1855, the British Government took responsibility for the Damodar embankment. However, they had to demolish an area of 32 km of the embankment in 1859 to reduce the flood level (ibid).

In 1869 and 1870, severe floods occurred in the Kosi basin, which majorly hit Purnia resulting in considerable crop and cattle damage. This flood aroused the expectation of flood protection from rivers. In 1891, the construction of an embankment on the Kosi basin was started by the British but could not be completed due to heavy rains. In The Calcutta Flood Conference 1897, the British and Nepali governments agreed on constructing short-length embankments in some parts of Nepal and some parts of North Bihar. This conference made

way for embankment construction all over the country. After India gained independence in 1947, the debate on flood protection increased.

After many discussions and debates regarding river embankment, Kosi fell prey to the embankment builders. On January 14th 1955, the Kosi project's foundation stone was laid by Dr. Shrikrishna Sinha near Bhutaha village in the Saharsa district. Also, the same year, on March 22nd, Dr. Rajendra Prasad laid the foundation stone for the eastern embankment near Bairia village near the Supaul district (Mishra 2008). The Kosi Barrage was built between 1959-1963 at the Indo-Nepal border and is also called Bhimnagar Barrage as it is situated in Bhimnagar. It was made under a bilateral agreement between India and Nepal with a prime focus on hydropower generation, flood control, and irrigation in both countries. However, India only took care of the entire cost of embankment construction. At the Barrage site in Nepal, the catchment area of river Kosi is 61,788 km. The discharge capacity of the Eastern canal of the barrage is 455 cubic meters per sec to cover irrigation of 6,125 sq. km. (1,514,000 acres) of land, and the discharge capacity of the Western canal is 210 cubic meters per second for irrigation of 3,566.1 sq. km. (881,200 acres) land (Mishra 2003). On the Eastern canal, a hydropower plant has been built to generate 20MW electricity. Sixty-two thousand acres of land in Nepal depend on the western Kosi canal for irrigation. In 1976, Nepal took over the project and renovated it with the help of IDA. With the help of earth dams, afflux bunds across the river, and the above and below embankments, the Kosi barrage traps the river's flow within the embankment. The length of embankments on both sides of the barrage is 246 km. It is built to protect approx.—2800 km of land in both Nepal and North Bihar. To solve the silt problem, a distance of about 12 to 16 km have given between embankments. Although the embankments have checked the lateral movements of Kosi, the objective of flood control is not fulfilled by the Kosi Embankment Project. In addition, the rise of the level of the river bed, permanent

water logging, and drainage congestion is some of the adverse effects of the Kosi project, which are not taken care of by the Government (Mishra 2003).

2.9 Flood Control Policies in India and Bihar

In India, a two-tier system, a state-level mechanism, and a central-level mechanism exist regarding flood control and management. At the state level, flood management includes agencies like State Technical Advisory Committee, Water Resources Departments, and Flood Control Boards. Also, in some states, flood matters are looked after by the Irrigation and Public Works department. At the center level, organizations like 'Central Water Commission (CWC), 'Brahmaputra Board,' 'Ganga Flood Control Commission,' 'Farakka Barrage Project Authority,' and 'National Disaster Management Authority (NDMA) deal with flood management (Sinha et al. 2012). India relies mainly on structural measures like dams, embankments, reservoirs, drainage channels, anti-erosion works, etc., for flood control and management. However, non-engineering solutions like flood forecasting, flood plain management, etc., have gained importance lately.

The first Flood Control Policy of the Government of India came on September 3rd, 1954. In independent India, this document was the first of its kind after the disastrous floods of 1953 and 1954 (Mishra 1997). The policy was supposed to be implemented in three stages; immediate, short-term, and long-term. The immediate phase covering a period of two years was devoted to the investigation and data collection of the flood disaster. During this period, designs, plans, and a rough estimate for short-term flood protection measures were also prepared. In selected sites, immediate construction of spurs, embankments, and revetments were proposed to be applied. The second stage, called the short-term phase, would include flood control measures like embankment construction, channel improvement, etc. They were supposed to protect a considerable portion of the flood-prone areas within two to seven years.

The third stage, i.e., the long-term phase, was considered to undertake measures like constructing additional embankments and storage reservoirs on different rivers and their tributaries if necessary. The time frame for this was seven to twelve years. After this policy, it was expected that the floods could be controlled for fourteen to fifteen years, starting from 1954. In the First (1951-1956) and the Second Five-Year Plan (1957-1962), the focus of the Government of India was on large multipurpose dams that could generate electricity, contain water, and help the population with irrigation.

Meanwhile, the massive flood of 1954 caused severe damage in West Bengal, Bihar, UP, and Assam. And, very soon, it was realized that this was a dream that could never come true (GOI Second Five-Year Plan). However, during the Third Five-Year Plan (1961-1966), new embankments of 6900 km, drainage channels of 9200 km, anti-water logging, and drainage work to save the villages were done by the Government (GOI Fourth Five-Year Plan). In the fourth (1969-1974) five-year plan and the fifth (1974-1979), strengthening the already existing measures of flood control was done (Roy 2000). In addition, the National Flood Commission (Rashtriya Barh Ayog) 1980 came up with a comprehensive report with 207 recommendations focusing on the formation of a national council of disaster mitigation. The commission and the need for structural measures stressed the importance of measures like flood forecasting and early warnings (Non-structural). It also emphasized the importance of flood plain management with the help of flood plain zoning, varied cropping pattern, construction of embankments, and raising the level of villages for flood protection. With all these flood control initiatives, 'Jawahar Rojgar Yojana (JRY), an employment generation program, was introduced in the Eighth Five-Year Plan (1992-1997). The aim was to generate income for the affected population of the flood-prone areas. Further non-structural measures like a supply of drinking water, raised platforms from the flood level, post-flood reliefs, etc., were included to encourage the rural communities to cope with floods (GOI 2002). In the Ninth Five Year Plan (1997-

2001), terms like early warning system and flood forecasting were introduced formally and were important (Ibid). During the Tenth (2002-2007) and Eleventh (2007-2012) Five Year Plan, flood mitigation with developmental initiatives for the capacity development of the most vulnerable section at all levels like preparation, monitoring, and proper implementation of a plan, relief material distribution, etc. was given importance. In the Twelfth Five Year Plan (2012-2017), Bihar was given special consideration as one of the most flood-vulnerable states, and 1676 km of embankment construction to protect an additional area of 2.668 mha was proposed. Apart from this, the National Water Policy of 1987, 2002, and 2012 are some of the major policy initiatives taken by the Indian Government with prime concern on managing the floods rather than controlling them.

In the state of Bihar, the Ganga Flood Control Commission (GFCC) (1972) was constituted to prepare a comprehensive plan including various river systems for planning regarding soil erosion and flood management in the sub-basins of Ganga and Farakka Barrage. The commission formulated the SOP (Standard Operating Procedure) of schemes like 'Emergency Operation Centre' (EOC) and 'Shatabdi Anna Kalash Yojna' (SAKY) in terms of immediate action, flood preparedness, relief material distribution, and rescue and rehabilitation of the affected population from flood and other disasters. To regulate flood control, irrigation projects, and drainage works, The Flood Management and Drainage Rules (2003) were passed by the Government of Bihar (Sharma, Dutta & Ghose 2012). However, lack of proper planning, execution, relief materials, community participation, and improper distribution of resources led to the failure of such initiatives.

When it comes to controlling the flood disaster, Bihar extensively relied on the engineering methods of flood protection. However, it increased the problem rather than solving it. Even the Water Resources Department of Bihar's annual report of 1999 maintained that those rivers habituated to changing their course; taming them with the help of embankments can be

a short-term help but cannot be helpful in the long run. It further stated that from 1951 to 1998, the total expenditure on the engineering methods of flood protection included Rs. 530794.10 million; still, there is very less protection provided (GOB 1999). Because it is pretty impossible to control the floods, at best, the losses can be reduced to a certain extent. Predicting the exact place and magnitude of river erosion is impossible besides embankment breaches that could occur at any point on the river. Therefore, even the so-called protected areas also are not 100 percent flood-proof. It is visible from the fact that during the years 1885-86, out of Rs. 240 million, only 48.3 million was spent on the construction of new embankments; the rest of the amount was spent on works like raising the height of levees, embankments and anti-erosion works (GOB 1999). Similarly, in 1990-91, only ten crores out of 405 million were spent on constructing new embankments; the rest was spent on strengthening the existing ones (Ibid).

This gives a picture of the existing flood control policies adopted by the state so far. Some modification in flood planning and strategy is needed to control floods. Experts are of the view that if some measures like flood-plain zoning, change in agricultural practices, land uses regulation, flood-proof housing, clear drainage system, real-time rainfall data, early forecasting and warning system, etc., can be included while planning for flood management; the result can be different. It will help in reducing the damages to a major extent. Apart from this, the affected communities must be made aware of the possible preparation and survival measures. This will help them recover from the major losses.

2.10 Active institutions in flood management in Bihar

This section will briefly discuss the background details and functioning of key institutions involved in water resource and flood management at both district and state levels. There are four to five organizations in Bihar that plan, execute, finance, and manage every detail related

to water resources and flood disaster management in Bihar. WRD stands at the top with supreme power and authority among all the organizations.

2.10.1 The Water Resources Department of the Government of Bihar

The process, activities, and participants working in the field of flood management in the state of Bihar have given space in the "Flood Management Rules" in the "Bihar Irrigation, Flood Management, and Drainage Rules" (Sinha et al. 2012). Following these rules, Water Resources Department (WRD) deals primarily with medium and major irrigation schemes and projects, drainage and water management, flood management, and command area development in Bihar. It undertakes projects in constructing reservoirs, developing irrigation schemes (Major and minor), anti-erosion works, construction of dikes, levees, and other flood protection structures, irrigation management at the micro and macro level, development of drainage systems, development of information systems related to flood control, the building of various channels and other concerned areas.

The field apparatus of WRD is divided into different Zones, Circles, Divisions, and Sub-Divisions. Every zone has one Chief Engineer (CE) who handles all the Circles of his zone. Each Circle is headed by a Superintended Engineer (SE) whose work is related to planning, drainage, waterways, flood and canal management, etc., in his Circle. A Circle has different divisions. Each division is headed by an Executive Engineer (EE), also called Divisional Officer (DO). There are typically four to five Sub-Divisions come under a Division. The Sub-Divisions are headed by SDO (Sub-Divisional Officer) and an Assistant Engineer (AE). Apart from this, four Junior Engineers (JE) are placed in every Sub-Divisions who report to the AE about their work.

For proper functioning of Flood Management, every Circle's field office has been made liable to supervise 'Flood protection structures' and 'anti-erosion work'; they also guide the

decision-makers and experts about the affected areas, ongoing anti-erosion works, and approved maintenance works. The flood management operations conducted by WRD are based on an annual calendar. In WRD terminology, June 15th to October 15th is called the 'flood fighting' period when high alert flood monitoring is done. During this period, all the staff of the departments is deputed in different basins to monitor high flood risk areas. In addition, at each kilometer, home guards and night watchmen are deployed to inspect the high-alert areas. October 16th to December is called the 'flood anti-erosion period' when the post-flood situation is being inspected. During this period, rivers flow in their usual flow, and flood risk is relatively low. Thus, the engineers conduct anti-erosion work. January to June 15th is marked for implementing major flood protection works as recommended by the decision-making committees.

2.10.2 Flood Management Information Systems Cell (FMISC)

Another important institution in Bihar managing flood disasters is FMISC. The FMISC (Flood Management Information System Cell) was constituted in 2007 with the order of the Government of Bihar. In January 2006, the World Bank and the Government of Bihar agreed on a partnership in the water sector and related action plans. The setup of FMISC was the result of that agreement. The primary goal was the introduction of modern information technologies in the state to make the working institutions more technically efficient in managing flood disasters.

FMISC aims to generate customized information and disseminate it timely to other flood management agencies so that they can back up the ongoing operations of managing flood disasters in their areas effectively and move from disaster response to disaster preparedness. It was understood that modern technologies could have compelling benefits in improving decision-making processes before and after floods. The FMISC has a 'Joint Director,' two

'Deputy Directors,' one 'additional Director' (on deputation), and six 'Assistant Directors' (Sinha et al. 2012). Apart from this, four Engineers and one JE with seven contractual staff specializing in web and IT management, GIS, remote sensing, and disaster management are employed in the Cell (ibid). In addition, fourteen support staff is also working there.

The major areas that FMISC deals with are long-term and reliable rainfall forecast, improved hydrologic observations, prediction of inundation using mathematical models, enhanced flood forecasting, real-time mapping of inundation and river during flood using radar, dissemination of real-time flood data, flood-plain geomorphology mapping, maintenance of database of embankments, and the upgraded flow of ICT providing flood warning and flood risk assessment with community outreach and participation programs.

World Bank supports FMISC and trains its staff with some selected employees of WRD. The training involves aspects of asset management with particular emphasis on flood forecasting, planning for embankments, and management of water resources. In addition, FMISC hosts annual training for the engineers of WRD who work in the area of hydrology, meteorology, mathematical modeling, and flood management in the Cell. It is jointly conducted by the personnel of the 'Water and Land Management Institute' (WALMI) and 'FMISC,' which could deal with hydrological and mathematical modeling aspects.

FMISC is nodal in charge of the World Bank-funded Kosi project (Bihar Kosi Flood Recovery Project). Additionally, using satellite images helps WRD in decision-making during flood-fighting works, finalizing anti-erosion works, and also assists in monitoring the critical locations in Bihar. With the help of inundation maps, it helps the Disaster Management Department in rescue and relief operations in North Bihar.

2.10.3 Water and Land Management Institute

Under the purview of WRD, the 'Water and Land Management Institute' (WALMI) of Bihar was established in 1983. It became an autonomous institution in 1999. Its primary objectives are multidisciplinary training for WRD and Agriculture Department engineers, developing land and water management solutions around existing irrigation systems, establishing linkage and collaborating with other foreign institutions working on similar research topics, and offering training in computer and water resources management.

WALMI depends on WRD for its operations as 95 percent of its annual grant is sanctioned by WRD. It (WRD) also simultaneously deposes readers and assistant professors of AE AND EE rank officials and professors (SE rank officers) for research and teaching work in WALMI. All these people report to the Director (head of WALMI).

In flood management, WALMI has both roles; strategic and operational. It is responsible for information dissemination within WRD and developing institutional linkages for research at the strategic level. On the other hand, at the operational level, it offers training to the AE and JE for managing floods.

2.10.4 State Disaster Management Authority

The 'State Disaster Management Authority of Bihar was created under the provisions of the Disaster Management Act 2005 for the state. SDMA follows and interprets NDMA suggestions, policies, and recommendations and develops new schemes and plans specifically for Bihar Disaster Management. The Chief Minister of Bihar heads the SDMA. However, the day-to-day activities are handled by the vice-chairman. SDMA is not a specialized body for flood disaster management but covers all types and forms of disaster. However, it supports flood disaster preparedness by publishing and disseminating related information. Similarly,

they disseminate flood preparedness information among the community members and prepare them for flood hazards.

2.10.5 Disaster Management Department

The Disaster Management Department (DMD) of Bihar is the coordinating agency whose main aim is to provide disaster information, disaster relief, disaster rescue, and rehabilitation to the people in affected areas within the state. When any disaster occurs, DMD coordinates with other departments to ensure immediate relief and rescue action is taken or not. For smooth operation of the department, a disaster control room operates in Patna and other districts. DMD has also developed a flood disaster-specific operation manual that provides pre-disaster preparation and coordination mechanism guidelines. It also has an operating book about relief and rescue operations during and after a disaster.

2.10.6 District Magistrates Office

The primary function of DM (District Magistrate) and BDO (Block Development Officer) involved in the work of flood control and management is to communicate and inform the communities regarding flood situations, media interaction and briefing, being alert for the rescue of the affected population, and staying alert for relief and rehabilitation operations. In addition, they supervise the preparedness level of the affected areas through different development projects such as the construction of village roads, Primary Health Centres (PHC), government schools, and installation of hand pumps, etc., which ensures both, i.e., Flood preparedness as well as post-flood recovery operations at the community level. The Flood Division and Circle offices of WRD are in direct contact with the DM to provide information on rainfall, vulnerabilities, and waterfall. The three major roles assigned to the DM office include protection of embankments, continuous patrolling and being on alert during floods, and clearing the encroachment on the embankments for further maintenance work.

Apart from the District Magistrate Office, Local Police Stations also play an essential role in flood management at the community level. They ensure the safety of flood protection structures such as embankments and levees. They also play an active role during rescue and relief operations carried out by the Government to avoid any chaos and maintain law and order at the local level.

2.10.7 Panchayati Raj Institutions (PRIs)

Although the PRIs are not formally engaged in the setup of flood management, they play an essential role in pressurizing the Government for all the flood mitigation work to be carried out timely, such as informing the BDO office regarding embankment breach anti-erosion piece, construction of schools, etc. They also actively participate in any development work carried out at the local village level, and the officials contact them before starting any operation in the areas.

This describes how government organizations engaged in flood control and management in Bihar operate. Although, it is expected to have a collaboration among all the departments to successfully implement the flood mitigation programs as no separate department could be capable enough to handle the work solely.

Conclusion

This chapter traces the history of the river system and major flood events in Bihar with reference to the historical evolution, morphology, changing course, and construction of barriers around the river Kosi. In the next section, the chapter focused on the damages in terms of loss of crops, houses, area affected, the population involved, and the loss of public utilities in the last four decades, i.e., 1980-2020 in the state of Bihar in general, and the damages occurred in the district of Supaul from 2000 to 2020 in particular. Further, the chapter sheds light on the details of the government organizations engaged in flood mitigation and control activities at

state and district levels. The findings suggest that since its first flood control policy in 1954, the Government of India has always relied on structural means of flood control. However, time and again, this means of flood control has not only failed to protect the population but has also increased the severity of the flood disaster. The increasing intensity of human and economic loss are significant examples of the failure of the structural means of flood control. This depicts the need to shift towards non-structural measures of flood control to make the society/community more flood resilient so that they can cope well with the disaster. In light of this, the next chapter attempts to capture the role of social capital in flood risk perception and coping ability of the flood-affected community in the Supaul district.



Chapter III

Influence of Social Capital on Flood Risk Perception

Introduction

One way through which stakeholders can control flood impacts is via structural measures. Structural measures involve engineered solutions such as building dams, embankments, and floodwalls and designing or redesigning other physical barriers to minimize flood damage. However, structural measures have fallen short of addressing the problem of floods in the long run. Another way can be community-based measures such as collective adaption (Reid 2016; Hagedoorn et al. 2019). Community-based adaptation calls for adjustments in the behavior and action of individuals living in the flood-risk zone. People's response to disaster is not an isolated activity, and it's a collective action involving members from overlapping social affiliations (Elliott & Pais 2006). For the adaptation process, institutions and actors' relationships are essential to determine peoples' ability to collective action during a natural disaster (Adger 2003). Trust and public participation are the two essential elements of social capital required to underpin adaptation at a single and aggregate level (Gamper & Turcanu 2009; Norris et al. 2009). Besides shaping adaptation, social capital is essential to achieving collective goals through shared norms, trust, and reciprocity (Putnam 1995; Pretty 2003; Ostrom & Ahn 2009). Together these studies highlight the importance of social relationships in the adaptation process. Against this pretext, this chapter aims to empirically analyze how bonding and bridging social capital influence the flood risk perception in households. It also analyses the impact of social capital on the coping abilities of flood-affected households.

Perceived risk and coping abilities are arguably determined subjectively (Aven & Kristensen 2005). They might be influenced through social relationships that households accumulate

across the time within and outside the community measured via their bonding and bridging social capital stock. Adaptation is likely to occur when risk perception and coping appraisals are perceived higher by households (Bubeck et al. 2012; Bamberg et al. 2017; Valkengoed & Steg 2019; Grothmann and Reusswig 2006). Therefore, to analyze the role of social capital in adaptation, it is of paramount significance to examine the potential effect of bonding and bridging social capital on risk perception. To achieve the aforementioned objective, the primary data were collected from 380 households in five blocks, namely, Supaul, Saraigarh-Bhaptiyahi, Triveniganj, Pipra, and Raghopur of the Supaul district. Regression analysis was performed to analyze the empirically collected data. This chapter starts by analyzing whether the stock of bonding and bridging social capital varies as per socio-demographic profiles of the households. Then, in the next section, we have assessed the impact of the two forms of social capital, i.e., bonding and bridging, on flood risk perception. Finally, we conclude by highlighting the major findings of the chapter.

3.1 Socio-demographic characteristics and social capital

Social capital is related to every aspect of human existence. It is deeply rooted in the centurial evolution of cultures (Fukuyama 1995; Putnam et al. 1993). The formation and accumulation of social capital do not follow a linear trend. Neither is stable and consistent. It varies across societies, communities, and individuals. It is likely to be influenced by individuals' socio-cultural, political, economic, and demographic milieu. Simultaneously, the positions and values of individuals in terms of gender, marital status, education, occupation, age, income, and so forth are not evenly distributed in a social system, which causes inequalities in their stock of social capital. Therefore, before we analyze the influence of social capital on the perceived risk of households, it is imperative to assess the distribution of both forms of social capital (bonding and bridging) across various socio-demographic variables.

3.1.1 Relationship between marital status and social capital

Table 3.1 demonstrates the distribution of bonding and bridging social capital levels in unmarried, married, and widow households. ANOVA results do not find any statistically significant difference in the mean value of both forms of social capital across different marital status categories. Therefore, the marital status of the households is found not to be contributing to variations in their levels of bonding and bridging social capital.

Table 3.1: Marital status and social capital of the households

Marital status	Bonding		Bridging	
	Mean	SD	Mean	SD
Unmarried	3.88	0.85	4.00	0.83
Married	3.70	0.80	3.74	0.92
Widow	3.83	0.92	4.00	1.00
ANOVA result	F value = .464 Degree of Freedom = 2 P value = .629		F value = .395 Degree of Freedom = 2 P value = .527	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.2 Relationship between family type and social capital

Table 3.2 depicts the distribution of the amount of social capital as per family type. T-test analysis exhibits no significant differences in the mean value of both forms of social capital possessed by households of different family types. Therefore, the family type is not associated with the household's bonding and bridging social capital stock.

Table 3.2: Family type and social capital of the households

Family Type	Bonding		Bridging	
	Mean	SD	Mean	SD
Nuclear family	3.73	0.79	3.82	0.98
Joint family	3.68	0.81	3.70	0.88
t-test result	t = .889 Degree of Freedom = 378 F value = .055 P value = .815		t = 1.223 Degree of Freedom = 378 F value = .996 P value = .319	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.3 Relationship between education and social capital

Table 3.3 exhibits the spread of levels of bonding and bridging as per different education levels of households. ANOVA results do not show any statistically significant difference in the mean value of both forms of social capital across different education categories. Therefore, heterogeneity in the households' education level does appear to be contributing to heterogeneity in their stocks of bonding and bridging social capital.

Table 3.3: Education attainment and social capital of the households

Education	Bonding		Bridging	
	Mean	SD	Mean	SD
Illiterate	3.73	0.76	3.76	0.95
Primary school	3.71	0.89	3.83	0.99
Middle school	3.72	0.80	3.82	0.81
High school	3.65	0.81	3.65	0.93
Higher secondary	3.74	0.83	3.71	1.10
ANOVA result	F value = .402 Degree of Freedom = 4 P value = .807		F value = .616 Degree of Freedom = 4 P value = .615	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.4 Relationship between occupation and social capital

Table 3.4 illustrates the distribution of the levels of social capital across households' types of occupation. ANOVA result shows a marginal statistically significant difference ($p < 1$) in the mean values of bonding social capital across different kinds of households' occupations. This indicates that bonding social capital is slightly unevenly distributed across the different occupation categories. Hence, the nature of occupations in which households are engaged somewhat determines their stock of bonding social capital, i.e., the closeness of the households towards their family, kinships, neighbors, and close friends. Furthermore, we have also computed Eta-squared to explore the effect size of occupation on bonding social capital. The result indicated a small effect of 0.009. On the contrary, there is no significant difference in the mean values across different categories of households' occupations with reference to bridging

social capital. Therefore, the result suggests that occupations of the household shape their stock of bonding social capital but not bridging social capital.

Table 3.4: Occupation and social capital of the households

Occupation	Bonding		Bridging	
	Mean	SD	Mean	SD
Cultivation	3.65	0.82	3.67	0.95
Fishing	3.69	0.85	3.87	0.81
Service	3.71	0.78	3.80	1.04
Business	3.91	0.69	3.84	0.73
Labour	3.93	0.73	3.86	0.91
ANOVA result	F value = 2.309 Degree of Freedom = 4 P value = .058*		F value = .847 Degree of Freedom = 4 P value = .496	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.5 Relationship between the length of residence and social capital

Table 3.5 exhibits the relationship between the length of residence of households and their amount of bonding and bridging social capital. ANOVA results show a significant difference in the mean value of bonding and bridging social capital for different lengths of residence. The result establishes explicit linkages between the socio-spatial pattern of households and their levels of bonding and bridging social capital. An additional pair of analyses viz. post hoc test was carried out to assess the specific pair of means which are significantly different. In other words, the mean values of which groups significantly differ. We have subscribed to the Tukey test for the same. Tukey test for bonding social capital revealed that group 1 (more than 30 years) significantly differs from groups 3 (10-20 years) and 4 (5-10 years) with a mean difference of 0.42 and 0.63 at a significance level of 0.000 and 0.001 respectively. Also, the mean value of group 2 (20-30 years) from groups 3 (10-20 years) and 4 (5-10 years) with a mean difference of 0.26 and 0.46 at a significance level of 0.02 and 0.03 respectively. The value of Eta-squared indicated a medium effect of the length of residence on bonding social capital with 0.10. On a different note, the Tukey test for bridging social capital showed that group 1 (more than 30 years) significantly differs from group 5 (less than 5 years) with a mean

difference of 1.80 at a significance level of 0.04. Also, the mean value of group 2 (20-30 years) significantly differs from 5 (less than 5 years) with a mean difference of 1.78 at a significance level of 0.05. The effect size of the length of residence on bridging social capital was small with an Eta-squared of .025. Finally, the mobility pattern of households appears to determine their amount of social capital. However, the magnitude of the effect was found to be stronger in terms of bonding social capital ($p < 0.00$) vis-à-vis bridging social capital ($p < 0.05$).

Table 3.5: Length of residence and social capital of the households

Length of residence	Bonding		Bridging	
	Mean	SD	Mean	SD
More than 30 years	3.85	0.76	3.80	0.92
20-30 years	3.68	0.73	3.78	0.85
10-20 years	3.43	0.97	3.61	0.98
5-10 years	3.22	1.19	3.69	0.95
Less than 5 years	3.50	0.001	2.00	0.001
ANOVA result	F value = .616 Degree of Freedom = 4 P value = .000***		F value = 2.41 Degree of Freedom = 4 P value = .047*	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.6 Relationship between caste and social capital

Table 3.6 depicts the distribution of the quantum of bonding and bridging social based on their caste. ANOVA results do not suggest any significant differences in the mean value of both forms of social capital possessed by households of different social groups. This means there is no effect of the caste factor on both components of social capital. Therefore, the caste affiliation of the households does not determine their stock of bridging and bonding social capital.

Table 3.6: Caste and social capital of the households

Caste	Bonding		Bridging	
	Mean	SD	Mean	SD
OBC	3.72	0.82	3.76	0.92
SC	3.73	0.78	3.71	0.92
General	3.62	0.81	3.73	0.94
ST	3.58	0.74	3.93	0.88
ANOVA result	F value = 2.41 Degree of Freedom = 3		F value = .276 Degree of Freedom = 3	

	P value = .436	P value = .843
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Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.7 Relationship between religion and social capital

Table 3.7 depicts the spread of the level of bonding and bridging social capital across households' religious affiliations. An independent t-test was carried out to determine the influence of religion on social capital. The result shows no significant differences in the mean value of bridging and bonding social capital owned by households belonging to the Hindu and Muslim religions. Therefore, levels of social capital do not seem to be driven by the religious affiliation of the households.

Table 3.7: Religion and social capital of the households

Religion	Bonding		Bridging	
	Mean	SD	Mean	SD
Hindu	3.70	0.81	3.76	0.91
Muslim	3.72	0.74	3.63	1.03
t-test result	t = .203 Degree of Freedom = 378 F value = 1.841 P value = .176		t = .708 Degree of Freedom = 378 F value = .312 P value = .577	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.8 Relationship between gender and social capital

Table 3.8 shows variations in the level of bonding and bridging social capital for men and women households. An independent t-test was performed to capture the impact of gender on social capital. Interestingly, the result indicates no statistically significant difference in the mean value of bonding and bridging social capital commanded by male and female households. Gender has not emerged as a determinant of bridging and bonding social capital.

Table 3.8: Gender and social capital of the households

Gender	Bonding		Bridging	
	Mean	SD	Mean	SD
Female	3.74	0.81	3.94	0.93
Male	3.69	0.80	3.70	0.91
t-test result	t = .637		t = 1.784	

	Degree of Freedom = 378 F value = .014 P value = .905	Degree of Freedom = 378 F value = 2.042 P value = .182
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Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.9 Relationship between age and social capital

Table 3.9 depicts the amount of bonding and bridging social capital distribution across different age groups. ANOVA results indicate no statistically significant relationship between age categories and bonding social capital. Conversely, the distribution of bridging social capital is not consistent across all age groups ($p < 0.02$). Furthermore, the Tukey test divulges that social group 2 (31-40 years) significantly differs from group 3 (41-50 years) with a mean difference of 0.29 at the significance level of 0.05. The value of Eta-squared indicated a medium effect of the length of residence on bridging social capital with 0.027. Hence, older households are more likely to attract more bridging social capital vis-à-vis younger households. Therefore, the distant ties of households were found to be structured by their age.

Table 3.9: Age and social capital of the households

Age	Bonding		Bridging	
	Mean	SD	Mean	SD
20-30	3.81	0.69	3.52	0.99
31-40	3.73	0.83	3.98	0.86
41-50	3.66	0.80	3.69	0.90
>51	3.75	0.84	3.59	0.94
ANOVA result	F value = .879 Degree of Freedom = 3 P value = .452		F value = 3.470 Degree of Freedom = 3 P value = .016*	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.1.10 Relationship between income and social capital

Table 3.10 displays the amount of bonding and bridging social capital distribution across different income groups. ANOVA analysis shows no significant difference in the amount of both forms of social capital across different income groups. This means that households' level of social capital does not depend on their class structure. Therefore, the economic status of the households does not determine their stock of bridging and bonding social capital.

Table 3.10: Income and social capital of the households

Income	Bonding		Bridging	
	Mean	SD	Mean	SD
5000-10000	3.71	0.69	3.73	0.98
10000-15000	3.67	0.83	3.72	0.89
15000-20000	3.74	0.80	3.79	0.84
Above 20,000	3.81	0.84	3.91	1.00
ANOVA result	F value = .664 Degree of Freedom = 3 P value = .575		F value = .456 Degree of Freedom = 3 P value = .713	

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.2 Correlation between social capital and risk perception

Table 3.11 illustrates the correlations between key variables used in the chapter to estimate the effects of bonding and bridging social capital on flood risk perception. The findings reveal that bonding and bridging social capital positively correlate with perceived risk. However, the correlation coefficient of bonding social capital was estimated to be the highest with both dependent variables perceived risk perception vis-à-vis bridging social capital. Furthermore, the result showed a low correlation coefficient (.350) between the two key independent variables – bonding and bridging social capital.

Table 3.11 Correlation matrix showing inter correlations between key variables

Variables	Perceived risk	Bonding	Bridging
Perceived risk	1		
Bonding	.511**	1	
Bridging	.390**	.350**	1

Notes: ** implies the correlation coefficient is at the 0.01 level (two-tailed test)

3.3 Impacts of social capital on flood risk perception

We have used multiple linear regression analysis to capture the relationship between forms of social capital and perceived risk. We have used 12 independent variables and one dependent variable to establish this relationship. Our independent variables consisted of 10 socio-demographic characteristics of households: marital status, family type, education, occupation, length of residence, gender, caste, religion, age, and income. Apart from this, two key independent variables, i.e., bonding and bridging social capital, were used to capture the influence of social capital on perceived risk. Finally, this set of independent variables was used to predict our one dependent variable, i.e., flood risk perception of the household. Two separate regression analyses were carried out to capture the effect of social capital after controlling the impacts of socio-demographic variables on flood risk perception. Our regression analysis included the following testing procedure: i) Model 1 examined the effects of socio-demographic characteristics on flood risk perception of the households, and ii) Model 2, after controlling the effects of socio-demographic variables, examined the impacts of bonding and bridging social capital on perceived flood risk of the households. It is important to mention that a few socio-demographic variables were converted to dummy variables before performing regression. The variable 'marital status' was converted to Married and Non-married (unmarried+widow), and the variable 'occupation' was converted to Cultivation and Non-cultivation activities (fishing+ service+business+none). Likewise, 'Caste' was transformed into General and Non -general (OBC+SC+ST). Table 3.12 summarizes the results of the regression analysis.

3.3.1 Relationship between socio-demographic characteristics and flood risk perception

The existing literature confirms that individuals' risk perception is unique and is most likely to be influenced by socio-personal characteristics of individuals (Duzi et al. 2014). Since subjective risk assessment of individuals forms the basis of risk perception, socio-demographic

characteristics play a significant role in shaping risk perception. Model 1 (Table 3.12) tested the impact of socio-demographic variables on perceived risk perception. In our result, the intercept estimate of Model 1 is positive and significant ($B = 3.94$ p -value < 0.00). The intercept is the predicted y value when all the x predictors are equal to 0. Therefore, the positive and significant intercept value implies that flood risk perception for socio-demographic characteristics differs significantly from 0. Furthermore, the result suggests that the performance of Model 1 was relatively low, with socio-demographic variables explaining only 6% of the variation in flood risk perception.

Among socio-demographic characteristics, occupation, length of residence, gender, and caste were found to be significantly associated with risk perception. Household occupation showed a negative and significant relationship with risk perception at a 10% significance level (p -value < 0.05). Therefore, households dependent on cultivation for their livelihood tend to perceive more risk of flood vis-à-vis households of other occupations. Another one of the study's interesting findings was the significant relationship between the length of residence and flood risk perception. The length of residence of the households demonstrated a 10% significance level (p -value < 0.05). The negative and significant beta coefficient of the length of residence indicates that the more a household has lived in the study region, the more likely they perceive flood risk. This means that the length of residence or the time a household spends in the region explains their higher degree of flood risk perception. Therefore, the residential mobility of households determines their amount of flood risk perception. Concerning gender, the beta coefficient was once again found to be negative and significant. Notably, among all the four significant socio-demographic variables, gender has emerged as the strongest predictor of risk perception with a p -value of less than 0.01 (5% significance level). The negative and significant beta coefficient gender suggests that male households perceive more flood risk vis-

à-vis female households. This unequal distribution of risk perception may worsen females' disadvantages who are already vulnerable to floods.

Moreover, unequal distribution of risk perception may facilitate further inequalities. A substantial amount of risk research suggests that women report higher levels of risk than men. (Flynn et al. 1994; Finucane et al. 2013; Brown, Largey, & McMullan, 2021). Women perceive greater risk because they are more vulnerable, have less control, and benefit less from it (Flynn et al. 1994). However, the result of the present study contradicts the findings of these studies. One plausible reason can be differences in research design, study context, the socio-political milieu of the research area, and risk type. It is difficult to draw or arrive at concrete conclusions regarding the relationship between gender and flood risk perception because the impact of gender factors on flood risk perception may vary depending on the risk type studied in a country (Brown, Largey, & McMullan, 2021). Finally, the social group of households was also found to be significantly linked with their level of risk perception. The result of the study finds the caste of the households to be negatively associated with flood risk perception at a 10% significance level ($p\text{-value} < 0.05$). This suggests that households belonging to a non-general social group (OBC, SC, and ST) are more likely to perceive risk vis-à-vis the household belonging to a general category or social group. In contrast to these statistically significant socio-demographic variables, other variables such as marital status, family type, education, religion, and income indicated p -values greater than 0.5. Therefore, these variables seem to have no influence on the risk perception of the households.

3.3.2 Impact of bonding and bridging social capital on flood risk perception

Model 2 examined the impacts of bonding and bridging social capital on the perceived flood risk of the households after controlling the effects of socio-demographic variables (Table 3.12).

The intercept value of Model 2 is positive and significant ($B = 1.26, p < 0.00$). It implies that

flood risk perception for bonding, and bridging social capital are significantly different from 0. However, the value of intercept has decreased in Model 2 vis-à-vis Model 1. This change occurs because of adding new predictors, i.e., bonding and bridging social capital to the model. New predictors can impact the intercept values to increase or decrease, by pretty much any amount, based on the mean of the x independent variables and the size/direction of its corresponding coefficient.

The total variation in risk perception improved substantially, accounting for 34% (Model 2) after the social capital variables – bonding and bridging were added to Model 1. The regression results demonstrate that bonding and bridging social capital are positively and significantly related to households' risk perception. Indeed, both bonding and bridging social capital remain highly significant at 1% of the significance level ($p < 0.001$). However, a comparison of standardized betas shows that the impact of bonding social capital ($\beta = 0.43$) on risk perception is higher than that of bridging social capital ($\beta = 0.24$). Therefore, from the given result, it may be inferred that both forms of social capital increase the flood risk perception of the households. The likelihood of flood and severity of its consequences are perceived more by the households with a higher level of bonding and bridging social than those with a lower amount of bonding and bridging social capital.

Now, returning to the impact of bonding social capital on flood risk perception. The results indicate an affirmative and significant association between social capital and flood risk perception. Bonding social capital has emerged as the strongest predictor of flood risk perception. This implies that if individuals share a strong connection with their family, neighbors, and close friends, they tend to perceive risk as higher than those who are weakly or loosely connected with their family and close associates. This is because, primarily by living in the flood-prone area across time, they have directly or indirectly experienced the flood's brutal face. Through these self or empathetic experiences, they can sense how a flood can be

destructive to their family members and close associates in terms of physical harm and property damage. In a bonding network, people are emotionally attached. These tightly-knit social connections increase the perceived subjective or reinforce emotional impact of flooding (Terpstra et al. 2009; Hudson, Hagedorn & Bubeck 2020; Hudson et al. 2019).

Furthermore, the favorable exchange between bonding social capital and flood risk perception may also be due to adequate information flow and the cross-generational transmission of past flood memories in a dense local network (Scolobig et al. 2012; Dzialek et al. 2013). The three major components used in the study to capture the bonding social capital of households are norms, trust, and reciprocity. The social norms reinforce trust and reciprocity, which makes the respondents believe that within their community, they can rely on other members for help. This further fosters the adaptation process to flood risks. These strong ties further increase the perceived subjective effect of floods. Hudson et al. (2019) found a negative impact on the well-being of respondents who had not been impacted by flooding, however, their neighbors had. This shows how tightly-knit connections reinforce subjective impact through indirect experiences (Terpstra et al. 2009). Therefore, the primary reason behind the positive association between bonding social capital and risk perceptions is the formerly narrated subjective effects of floods through close connections. Flood in the Supaul district has proved to be detrimental in terms of human and property loss. This leads to an increase in the threat's tangibility and perception. This corresponds with the findings of Dzialek et al. (2013), who discovered that social capital helps in strengthening the flood events memory. This is similar to what Soane et al. (2010) argued for traumatic events. However, the result of the study seems to oppose the result of previous research, arguing a negative relationship between social capital and flood risk perception (Babicky & Seebauer 2017). One of the primary reasons behind these contradictory findings can be local factors. Risk perceptions are place-based, and risk communication is heavily influenced by the cultural and demographic makeup of

individuals experiencing it (Kasperson et al. 1988; Harrington & Elliott 2015). This means that the risk perceptions are more likely to vary between and within locations based on the cultural and demographic profile of individuals experiencing the risk. Babicky & Seebauer's (2017) study was conducted in the Austrian context, which is quite different from the Indian context in terms of social, cultural, and physical milieu.

With regard to the second dimension of social capital viz. bridging, the study finds a highly statistically significant relationship and a positive correlation between bridging social capital and flood risk perception. In weak ties, people access new and unique information (Granovetter 1973). In a bridging network, information transmits and ultimately reaches many people. Bridging social capital enhances individuals' knowledge and perspectives about the severity of a flood by accessing information from their bridging network or distant ties. Bridging social capital can effectively generate awareness about the severity of floods in the locality. During a disaster crisis, people keep their social and personal differences aside, unify as a single community and support each other. They exchange information, thoughts, ideas, and best practices through a bridging network. Two neighboring villages rely heavily on each other, especially for exchanging information pertaining to the severity of the flood. An individual from a village or community may inform their distant relative or friend in another village regarding the penetration of floodwater in their area and its severity. Bridging social capital can play an essential role in risk communication and flood education strategies (McEwen & Jones 2012). Pertinently, the primary source of comparison is the findings of Hudson et al. (2020). Our analysis found the overall positive relationship between bridging social capital and flood risk perception. Hudson et al. (2020) found an unfavorable exchange between bridging and risk perception in Vietnam.

Nonetheless, given the importance of local conditions, the link between bridging social capital and flood risk perception may vary across research contexts. To put it succinctly, the

impact of bridging social capital on flood risk perception may differ in different social, cultural, political, temporal, and environmental contexts. However, the effect size of bridging social capital ($\beta = 0.24$) is lower than the bonding social capital ($\beta = 0.44$). One of the reasons behind the low effect size might be the unknown quality of bridging networks, making it difficult to assess their usefulness. In our household survey, we have captured the only number of groups and associations with which households were associated. The magnitude of participation in these associations was not examined in the study.

Table 3.12 Regression model predicting the amount of perceived risk

Independent Variables	Model 1					Model 2				
	B	SE	β	T	P-value	B	SE	β	t	P-value
Intercept	3.942	.422		9.343	.000***	1.255	.416		3.015	.003**
Marital Status	.101	.174	.030	.581	.562	.139	.147	.041	.943	.346
Family type	-.004	.070	-.003	-.054	.957	.002	.059	.001	.029	.977
Education	.016	.025	.033	.640	.523	.022	.021	.045	1.050	.294
Occupation	.049	.025	.100	1.947	.052#	.020	.022	.040	.914	.361
Length of residence	-.080	.034	-.120	-2.345	.020*	.023	.030	.034	.751	.453
Gender	-.243	.087	-.163	-2.805	.005**	-.156	.073	-.105	-2.136	.033
Caste	-.081	.039	-.119	-2.112	.035*	-.053	.033	-.078	-1.631	.104
Religion	.036	.122	.016	.300	.765	.028	.102	.013	.274	.784
Age	.028	.041	.036	.695	.487	.041	.034	.052	1.177	.240
Income	-.016	.037	-.023	-.441	.660	-.040	.031	-.057	-1.288	.199
Bonding						.456	.051	.429	8.919	.000***
Bridging						1.255	.416		3.015	.003**
R-square	0.06					0.34				
Adjusted R-square	0.04					0.31				
F value	2.20				0.02	15.45				0.000

Notes: # implies $p \leq 0.1$, * implies $p \leq 0.05$, ** implies $p \leq .01$, *** implies $p \leq .001$.

3.4 Does social capital enhance the coping abilities of households?

Flood has become a menace to people and society as a whole. To protect themselves from the scourge of the flood disaster, individuals should strengthen their coping abilities and overall resilience of their community. Coping abilities are those actions or activities that an individual carries out to reduce the potential negative consequence (Floyd et al. 2000). Importantly, an individual's engagement in preventive steps is based on the judgment (subjective) that he/she makes about risks and various alternatives of coping. The Protection Motivation Theory (Rogers 1975) states that every individual (at risk) assesses the threat (risk perception) and his abilities to cope with that threat (including self-efficacy) separately. There is a separate evaluation of threat and coping abilities at the individual level. This process of cognitive evaluation either leads to very high protection motivation or very low protection motivation, which might or might not intimidate the person into seeking protective action based on actual barriers (Bubeck et al. 2013). Risk perception and coping abilities also have a combined effect in determining an individual's choice of protective or non-protective action (Floyd, Dunn & Rogers 2000). According to Grothmann and Reusswig (2006), if the households have to be prompt in taking protective actions, they need to have both high perception of the risk and perceived coping ability. However, if a person's risk perception is high but his/her perceived ability to cope is lower, then, he/she is probably to choose non-protective actions like denial, wishful thinking, or fatalism (Rippetoe & Rogers 1987). Thus, coping abilities helps individuals and the community to take protective action. The success of flood preparedness, mitigation, and recovery largely depend on the coping abilities of individuals and the community. One individual or community with higher coping abilities can lessen the adverse conditions inflicted by the flood. Social capital as an indicator of coping appraisal has an important role, especially for households in flood-prone areas such as the Supaul district of Bihar. Therefore, it is essential to have knowledge of the nature and the scope of social capital

in enhancing the coping abilities of the households. The strong association between bonding social capital and coping abilities was evident in the interviews with the households. As per households, mutual support came through the crucial network of bonding social capital during stressful times. Individuals having more access to the stock of bonding social capital like family and kinship networks have more self-efficacy, i.e., coping abilities. Such networks play an essential role in adaptation to floods because of the benefits of financial support that these bonding networks can generate. Family and friendship networks can extend financial assistance without any interest charge and responsibility to reciprocate in the same way. These networks act as a buffer for people in a state of crisis. Family members, close friends, and neighbors help people fight flood disasters by providing physical or financial support. As one of the interviewees explained:

One of our neighbors has built his house in a high place. When the flood comes, I shift with my family to his home. He has livestock, and I help him care for them as it's challenging to find human resources during the flood. He helps me resettle and reconstruct my house when the situation gets normal. Sometimes, if I am out of the village for earning purposes, he takes care of my family and lends money to them if needed without charging any interest rate. After returning to the village, I pay the money back to him. That's how we lived here for decades fighting the flood.

The significance of bonding social capital in helping people sustain a disastrous situation is evident. Some people have greater access to their family networks which help them survive to a greater extent. To make it more clear, another respondent revealed:

Flood is inevitable. It comes every year, but that does not mean we should leave this place. My whole family is here, and we help each other in every up and down. My sister is married to an elite family in a nearby village; she sends essential food items like rice, flour, ghee, jaggery etc., when we need them. Sometimes, she also sends us

money if we ask her, and that too without any interest charge. In our village, 4-5 percent interest rate is charged by the lenders and sometimes even after paying the required rate, people do not give money. Because our financial condition is not good and we cannot offer anything for a mortgage.

The above proposition demonstrates how bonding social capital is nourished by reproducing economic wealth and enhances their coping abilities to combat floods. Although the evidence of bonding social capital as an essential source of coping is visible, this does not mean that it leads to a positive outcome every time. The analysis of interview transcripts indicates that almost 70 percent of the villagers have access to family and friends networks who can come up with large financial assistance without interest charges and commitment to reciprocate the same in the future. However, there are situations, especially in poor households, where it is impossible for them to access financial support from their family networks on their terms. In such cases, they borrow a small amount of money from their neighbors without any obligation, as they have access to the network of exchange and reciprocity. The interest rate charges depend on the duration of the loan. For example, if the loan amount is taken for a brief period like one week, there will be no interest rate charged, and if it exceeds the period from one to three or four weeks, a very less interest rate is charged. While this kind of financial association acts as a primary coping mechanism for the poor and helps them resettle after any disaster, it does not work in the long run because these financial exchanges are for a shorter period. As one respondent asserted:

There are people who give a small loan amount for a short time and don't charge any interest rate if they are sure to get the money back on time. This time frame of without interest charges varies from one to four weeks. But I don't take money from any person

because I will not be able to give it back in a short period. I am not in that economic condition.

Furthermore, the access to bonding social capital networks like family and kinship can provide economic assistance depending on mutual trust, based on a person's capability to repay the loan and reciprocate exchanges when required. In such a scenario, trust is built on financial capital. For instance, a family with an extreme poverty level might not be able to convince the lender that the amount will be returned on time and, consequently, will not get the loan. In such a situation, the financial status of other family members generates confidence in the lenders that their loan amount will be repaid. According to a respondent:

Our situation is terrible; if we go to ask for some money from our village money lender, they demand some guarantee that their loan will be repaid. As we are destitute, we don't have anything to exchange, so they do not lend money to us. Because of our financial condition, they do not trust that we will repay their amount.

This shows how fragile social networks are when providing mutual support in hard times. The internal money lending and exchange systems are insufficient to offer secured benefits to poor households; i.e., it does not generate a wholesome environment that can strengthen the self-efficacy of the poor people to cope with stressful situations. Additionally, these strategies have limited potential to create benefits in the long run for the poorest section of the community owing to no or little assets to repay the loan amount, and they are not included in the family, kinship, and community-based mutual support networks. Furthermore, the scope of the internal exchange system is limited in providing mutual support in disastrous situations like a flood because almost everyone is affected simultaneously. However, this might differ depending on the kind of covariate risk. For instance, compared to a slow onset disaster like drought, the internal exchange network appears to be ineffective, particularly in the case of a disaster like a sudden onset disaster that destroys the livelihoods and severely affects a large population.

When a family's economic capital deteriorates, it becomes more difficult for them to provide resources to their kinship networks for mutual support. As one of the respondents explains:

When a flood comes, only water is visible as far as one can see. In those situations, everyone tries to save themselves, so who will help others? That's why I also look for the safety of my family first, and only then something else. The rise in flood water happens so fast that there is no time to think about anything else. But, in any other situation, we help each other wholeheartedly.

Therefore, due to the lack of assistance offered by the family and kinship networks, it becomes an obligation for the poor to borrow money from village moneylenders. However, those with access to this informal credit system may sometimes have to face exploitation due to the very high exploitive interest rates (10-15 %) charged by the money lenders per month. This situation might be interpreted as negative reciprocity that is wholly based on a person's paying ability. Moreover, incentives to meet obligations such as repaying a loan might involve intimidation and harassment of that person resulting in physical violence in some cases. As per one respondent,

I owned a small shop in the village. Last year, when the flood came, it washed away all my belongings, so I had to borrow money from one of my relatives despite a high-interest rate. I was giving interest every month. Due to some health emergency, I could not pay the interest for one month. I told him about my problem, but he asked me to pay then and there. After that, he started coming to my house every day for money. One day he even brought some goons to beat me up. I somehow saved my life by running away. Later I returned the money by selling my shop.

These practices raise questions on the trustworthiness of informal money lending networks to provide support during stressful times. This emphasizes the need to focus not only on the

positive aspect of financial support provided by close networks but also considering the impact of receiving such support on an individual's psychological, mental, and emotional health, especially on the most vulnerable.

Furthermore, occasionally, some moneylenders take advantage of the information shared within the network (particularly in bonding social capital) to gain personal benefits, which is carried out through exploitative practices. This demonstrates the negative aspect of social capital. The informal moneylenders use the details/information shared within the group to understand the borrower's financial situation better and then impose higher interest rates when the person asks for a loan as they know how desperate the person is for money.

One respondent shared:

The bigger the problem is, the higher interest rates will be. Sometimes this interest rate is increased to more than 100% the usual. If they know that we are in major problem, they will ask for more money. After any natural disaster, there is an automatic increase in the interest rates. So, we have no option left.

The disadvantage of borrowing money from close networks is illustrated by the fact that the moneylender from outside the community usually lends money at comparatively lower interest rates. This shows the benefits of bridging social capital. This happens because the outsider moneylender does not know the exact economic condition of the borrower like the insiders, which saves the borrower from further exploitation. However, accessing this kind of facility is not possible for every village inhabitant because some people lack the assets required to produce as a guarantee of repayment. As shared by one respondent:

One of my friends borrowed money from his distant relative at a very low-interest rate in comparison to our village lenders. I asked him for the same but could not manage

to get that because I do not own any assets to guarantee. Also, the lender stays very far from our village, and I do not have that much money to frequently pay him a visit.

Another primary source of accessing financial support is Self-help groups (SHGs). The SHGs-based microfinance networks are formed with the idea of collective actions and are usually characterized by bonding and bridging social capital. These organizations provide loans to poor people. The interest rates charged for these loans vary as per the amount. Here, most of the loans are provided at the rate of 5-10% of interest, which is way lower than the moneylenders' rate (10-20 % per month), as shared by the respondents. Therefore, accessing financial support from SHGs-led networks helps the poor overcome the exploitative relationship with the money lenders. However, the main aim of microfinance networks is not limited to responding to climate stress only. For instance, it creates diverse economic opportunities for people independent of weather and climatic conditions. This helps the poor in two ways. First, it decreases the direct consequence of disaster on the household's livelihood. Second, it increases the coping ability of the household to deal with the aftermath of flood hazards. Occasionally, if a person loses his property (used as a guarantee in taking a loan) in any hazardous situation, and is also bound to repay the amount, there also he gets some relief in the form of extended time period and interest rest waive off. As one respondent shared,

I had a grocery shop in the village, which I started after taking a loan from SHG. Last year when the flood came, it swept away the entire village. I lost my house and shop. Somehow I managed to take out some items from the shop but selling those was not sufficient. So I requested the members to give me some time for repayment. They agreed after knowing my situation and gave me six more months to repay the loan.

This shows the effectiveness of social capital in dealing with natural hazard crises. In its absence, some community members are left with no option but to sell their properties at low prices to meet the repayment requirement. Furthermore, when needed, SHGs-led institutions

suspend the repayments for some periods, i.e., introducing a repayment system to people severely affected by floods and helping them combat stressful situations. During the flood, the overall flow of cash declines while the requirement for economic capital increases. In such cases, even small financial help provided by family and friends proves to be very helpful in overcoming the stress. It saves people from forced borrowing from money lenders, who usually increases their interest rates during these periods. Therefore, bonding social capital provides a safety net for flood-affected people by reinforcing their coping abilities, which further enhances the affected communities' resilience capacity. Otherwise, people often get trapped and become prey to the exploitation of moneylenders. As per one respondent:

My grandfather owned big farmland. By mortgaging them to the informal lender, he opened a shop. But when the flood came, everything was washed away. There was nothing left to eat, then from where could the installment be paid? He requested the lender to give him some time for repayment, but they did not listen and took away the land instead. Since then, we have been living as laborers. Some years back, one of my friends helped me to get a loan through SHGs. With that money, I opened a grocery shop. I run my family with that shop's income and have also repaid the loan. He would not have to sell his land had this facility been there during my grandfather's time.

Therefore, it can be inferred that network-based institutions like SHGs play a pivotal role in creating and maintaining the coping abilities of flood-affected people. Other than financial exchanges, other opportunities and advantages of bonding social capital also play a vital role in survival during stress. For instance, borrowing food from the neighborhood. These food-based exchange strategies are life saviors for many who lost everything in the disastrous flood. One respondent shared:

There are eight members in my family, two sons, two daughters-in-law, and four grandchildren. My wife died many years back. I am a daily wage laborer. During

floods, my family does not provide food to me because my earnings stop. They say they only have for themselves. First, they feed the kids and then to themselves. If some leftover is there, then only it is given to me. I have starved for more than two days sometimes. In that situation, I ask my neighbors for food. And most of the time, I survive on that only.

When there are limited resources, it changes the family dynamics, and priorities are given to certain house members. These priorities are based on an individual's capability to handle multiple stresses, and those who have greater capacity (mostly male members) are fed first, while females like elderly widows are chosen to starve sometimes depending on the availability of food. As shared by one female respondent:

I am a widow. I am staying with my brother's family. There are six members in his family. My brother works at a construction site. Whenever he is sick and does not go to work, I don't get anything to eat. Because the food falls short enough for him and his family members, then from where they will give me, in that situation, I ask my neighbors for food. Sometimes they give, but that is also for one time. I have spent many days without food.

The above statement shows the quantum of trust and reciprocity that bonding social networks provide during stressful times. There are also incidents of collective action during floods. Some households procure food items from their house and share them with needy people. However, it is mainly limited to their family and kinship networks. Although minor, this action helps people survive (a short-term coping mechanism) until government relief reaches them. These collective actions are voluntary based on food availability, and accessing them depends on a person's bond of trust and his stock of social capital. According to Pelling (2012), these forms of collective actions respond to a particular need that, in this context, is a lack of food. Although not much beneficial in the long run, but enhances the reactive

resilience of the affected communities. This form of social capital helps to retain people in its place and prevents local mobilization. These collective responses are provided mainly by family, community-based, and kinship networks. When a person lacks financial capital and is in acute stress, these exchange and reciprocity relationships provide the basis for survival. It reaches the needy people before any other governmental helps and therefore enhances their coping behavior.

Conclusion

This chapter focused on the influence of socio-demographic characteristics, bonding, and bridging social capital on flood risk perception of households located in the Supaul region. The regression results suggest that socio-demographic variables, viz. occupation, length of residence, gender, and caste, influence flood risk perception. Households in cultivation perceive flood risk as higher vis-à-vis households engaged in non-cultivation activities. Likewise, the more a household has lived in the Supaul region, the more likely they perceive flood risk. Males are more likely to perceive flood compared to females. Interestingly, the social affiliation (caste) of the households was also found to be significantly related to flood risk perception. Importantly, the findings support the proposition that accesses to bonding and bridging social capital increases the risk perception of households. However, in terms of effect size, the impact of bonding social capital on risk perception is higher vis-à-vis bridging social capital. Finally, thematic analysis of qualitative data suggests that the two forms of social capital, i.e., bonding and bridging strengthen the coping abilities of the households.

Cognitive ties with a particular place are important to understanding the relationship between humans and a disaster. They have been conceptualized by scholars as place attachment, place identity, sense of place, and so forth. Place attachment encompasses

individual, psychological, social, and cultural factors affecting people’s risk perception and their ability to cope with these risks. In the light of this, Chapter IV dwells upon the influence of place attachment on flood risk perception of households in the Supaul region.



Chapter IV

Influence of Place Attachment on Flood Risk Perception

Introduction

Over the time, households develop a certain understanding of a place. Despite continuous flooding followed by disastrous outcomes, they do not move to safer places or relocate themselves. They use their internal resources and adapt different resilient measures to effectively deal with the crisis. This attachment to a particular place works as a catalyst in adapting various measures that help them to deal with the crisis at that place only (Landau & Weaver 2006). Residents' attachment to a certain place influences their risk apprehensions and risk avoidance measures which later on affect their anticipation and perception of risk and also their coping abilities. It is because of households' risk perception and coping ability that they continue to live and survive in flood-prone areas. Households' risk perception motivates them to adopt various coping measures before the onset of any disaster (Dovers & Handmer 1992). Households who have high flood risk perception adopt various coping measures to survive the disaster so that they do not have to leave the place. The majority of areas of the Supaul district are at a high risk of flooding. However, in response to the flood events, various flood management strategies with the aim of reducing flood-related risks have been put in place by the government. Flood risk adaptation will also likely involve changes to places, either by applying some soft engineering methods or by using some hard permanent methods. According to Brown and Perkins (1992), people's value of a place might change after any significant, destabilizing event. This also indicates that perceptions about a place might play a different role either in evaluating what needs to be protected or in choices for adaptation. Keeping these aspects in mind, household surveys were conducted in the five blocks of the Supaul district, focusing on how people relate to their surroundings, the area they stay in, their living space,

their perceptions of flood risk, and their willingness as well as capacity to cope with flood disaster. In particular, this chapter attempts to explore the impact of place attachment on the flood risk perception of the households located in the Supaul region. Regression analysis was used to analyze the collected empirical data.

4.1 Socio-demographic characteristics and place attachment

Physical space attracts people for multiple reasons. Some people may be tempted to a place due to social connections, a serene environment, genealogical roots, and religious artefacts. Others may be pulled due to the source of livelihood that the area offers. Place attachment may be physically, socially, culturally, and economically constructed. Various scholars have concurred that the formation of place attachment occurs when people develop a strong bond based on social, cultural, and demographic factors apparent in a particular geographic space (Wang and Chen, 2015; Murphya, Lorenzoni, and Clarkea, 2018). The attachments or bonds towards a place are not the outcome of a single factor but the combination of factors, which depends on other externally determined factors (Nientied et al. 2019). Moreover, the human-environment relationship is varied and complex. Therefore, it is important to examine the relationships between socio-demographic characteristics of the households and components of place attachment before we assess the influence of place attachment on the risk perception of the households dwelling in the Supaul region.

4.1.1 Relationship between marital status and place attachment

Table 4.1 manifests the distribution of economic and genealogical place attachment levels in unmarried, married, and widow households. ANOVA results do not find any statistically significant difference ($p > 0.05$) in the mean value of the economic component of place attachment across different marital status categories. On the contrary, genealogical place attachment is found to be significantly associated ($p < 0.01$) with the marital status of the

households. Furthermore, the Tukey test indicates that group 2 (married) significantly differs from group 1 (unmarried), with a mean difference of 0.81 at the significance level of 0.008. The value of Eta-squared indicated a small effect of the marital status on genealogical place attachment with 0.023. Therefore, the marital status of the households is found to be contributing to variations in their level of geological place attachment.

Table 4.1: Marital status and place attachment of the households

Marital status	Economic		Genealogical	
	Mean	SD	Mean	SD
Unmarried	3.76	.71	3.04	2.05
Married	3.86	.63	3.85	.67
Widow	3.80	.79	3.90	.65
ANOVA result	F value = .107 Degree of Freedom = 2 P value = .898		F value = 4.497 Degree of Freedom = 2 P value = .012*	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.2 Relationship between family type and place attachment

Table 4.2 illustrates the distribution of economic and genealogical place attachment as per family type. T-test analysis shows no statistically significant differences in the mean value of economic place attachment ($p > 0.05$) possessed by nuclear and joint family households. However, in contrast, households belonging to a nuclear family ($p < 0.05$) are found to be more genealogically attached to place vis-à-vis households belonging to a joint family. The value of Eta-squared indicated a minute effect of the family type on genealogical place attachment with 0.003. Therefore, the study finds the family type to be linked to the households' genealogical place attachment levels.

Table 4.2: Family type and place attachment of the households

Family Type	Economic		Genealogical	
	Mean	SD	Mean	SD
Nuclear family	3.87	.71	3.89	.83
Joint family	3.85	.58	3.80	.64
T-test result	t = .394 Degree of Freedom =378 F value = 1.755 P value = .186		t = 1.123 Degree of Freedom =378 F value = 4.885 P value = .028*	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.3 Relationship between education and place attachment

Table 4.3 displays the distribution of levels of economic and genealogical place attachment as per different education levels of households. Interestingly, the ANOVA results do not show any statistically significant difference ($p > 0.05$) in the mean value of any of the components of place attachment across different education categories. Therefore, households' education level does not appear to be contributing to their levels of economic and genealogical place attachment.

Table 4.3: Education attainment and place attachment of the households

Education attainment	Economic		Genealogical	
	Mean	SD	Mean	SD
Illiterate	3.89	.66	3.90	.69
Primary school	3.88	.59	3.98	.56
Middle school	3.86	.68	3.83	.67
High school	3.87	.57	3.76	.77
Higher secondary	3.62	.85	3.74	.97
ANOVA result	F value = .850 Degree of Freedom = 4 P value = .49		F value = 1.043 Degree of Freedom = 4 P value = .385	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.4 Relationship between occupation and place attachment

Table 4.4 demonstrates the distribution of the levels of economic and genealogical place attachment across households' types of occupation. ANOVA result shows statistically significant differences ($p > 0.05$) in the mean values of genealogical place attachment across different kinds of households' occupations. The levels of genealogical place attachment is unevenly distributed across the different occupation categories. The Tukey test shows that group 1 (cultivation) significantly differs from group 4 (business), with a mean difference of -.49 at the significance level of 0.023. The value of Eta-squared accounted for 0.033, indicating a small effect of the occupation on genealogical place attachment. Hence, the occupation in which households are engaged determines their genealogical attachment to a place. On the contrary, there is no significant difference in the mean values across different categories of households' occupations with reference to economic place attachment ($p > 0.05$). Therefore, the result suggests that occupations of the household shape their amount of genealogical place attachment but not economic place attachment.

Table 4.4: Occupation and place attachment of the households

Occupation	Economic		Genealogical	
	Mean	SD	Mean	SD
Cultivation	3.81	.65	3.76	.77
Fishing	3.86	.52	3.82	.62
Service	3.89	.61	4.03	.63
Business	4.09	.55	3.85	.66
Labour	3.91	.83	4.25	.54
ANOVA result	F value = 1.358 Degree of Freedom = 4 P value = .248		F value = 3.173 Degree of Freedom = 4 P value = .014*	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.5 Relationship between the length of residence and place attachment

Table 4.5 shows the relationship between the length of residence of households and their levels of economic and genealogical place attachment. ANOVA results show a statistically significant difference in the mean values of both economic and genealogical place attachment for different lengths of residence with $p < 0.001$ and $p < 0.023$, respectively. Tukey test for economic place attachment revealed that group 1 (more than 30 years) significantly differs from groups 3 (10-20 years) and 5 (Less than five years) with a mean difference of 0.27 and 1.26 at a significance level of 0.014 and 0.034 respectively. Also, the mean value of group 2 (20-30 years) from group 5 (Less than five years) with a mean difference of 1.21 at a significance level of 0.49. The value of Eta-squared indicated a small effect of the length of residence on the economic place attachment with 0.046. On a different note, the Tukey test for genealogical place attachment showed that group 1 (more than 30 years) marginally differs from group 3 (10-20 years) with a mean difference of 0.27 at a significance level of 0.056. The effect size of the length of residence on genealogical place attachment was small with an Eta-squared of .030. Hence, the ANOVA result manifests explicit linkages between the socio-spatial pattern of households and their levels of economic and genealogical place attachment. Finally, from the above results, it can be inferred that the mobility pattern of households appears to determine their amount of place attachment. However, the study finds the magnitude of the effect to be stronger in the context of economic place attachment ($p < 0.01$) vis-à-vis genealogical place attachment ($p < 0.05$).

Table 4.5: Length of residence and place attachment of the households

Length of residence	Economic		Genealogical	
	Mean	SD	Mean	SD
More than 30years	3.93	.59	3.91	.69
20-30 years	3.88	.66	3.85	.75
10-20 years	3.65	.59	3.65	.73
5-10 years	3.95	.52	3.69	.61

Less than 5 years	2.67	1.89	2.88	.53
ANOVA result	F value = 4.485 Degree of Freedom = 4 P value = .001**		F value = 2.874 Degree of Freedom = 4 P value = .023*	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.6 Relationship between caste and place attachment

Table 4.6 depicts the distribution of the quantum of economic and genealogical place attachment based on their caste. ANOVA results suggest a marginal statistically significant difference in the mean value of economic place attachment ($p > 0.1$) perceived by households of different social groups. The value of Eta-squared accounted for .017, demonstrating a small size effect of caste on genealogical place attachment. However, the caste factor has no effect on genealogical components ($p > 0.05$). Therefore, the caste affiliation of the households contributes marginally to their levels of economic place attachment.

Table 4.6: Caste and place attachment of the households

Caste	Economic		Genealogical	
	Mean	SD	Mean	SD
OBC	3.89	.63	3.81	.76
SC	3.89	.65	3.86	.71
General	3.81	.57	3.88	.67
ST	3.49	.63	3.73	.52
ANOVA result	F value = 2.156 Degree of Freedom = 3 P value = .093#		F value = .329 Degree of Freedom = 3 P value = .805	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.7 Relationship between gender and place attachment

Table 4.7 shows variations in the levels of economic and genealogical place attachment for men and women households. An independent t-test was performed to capture the impact of

gender on social capital. Interestingly, the result indicates a statistically significant difference in the mean value of economic place attachment commanded by male and female households. Male households ($p > 0.05$) tend to be more attracted to a place vis-à-vis women for economic reasons. Interestingly, the effect size of gender on genealogical place attachment was not found to be small, with an Eta-squared of 0.005. Conversely, geological place attachment ($p > 0.05$) is found to be equally distributed among male and female households. Gender has emerged as an important determinant for economic place attachment.

Table 4.7: Gender and place attachment of the households

Gender	Economic		Genealogical	
	Mean	SD	Mean	SD
Female	3.77	.79	4.03	.71
Male	3.88	.77	3.78	.71
T-test result	t = -1.393 Degree of Freedom =378 F value = 9.419 P value = .002**		t = 2.717 Degree of Freedom =378 F value = .005 P value = .942	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.8 Relationship between Religion and place attachment

Table 4.8 reveals the distribution of economic and genealogical place attachment across households' religious affiliations. An independent t-test was carried out to assess the influence of religion on social capital. The result shows no significant differences in the mean value of economic ($p < 0.05$) and genealogical ($p < 0.05$) place attachment owned by households belonging to the Hindu and Muslim religions. Therefore, the religious faith of households does not drive their attachment to a place.

Table 4.8: Religion and place attachment of the households

Religion	Economic		Genealogical	
	Mean	SD	Mean	SD
Hindu	3.85	.64	3.83	.72
Muslim	3.92	.54	3.88	.70

T-test result	t = -.578 Degree of Freedom =378 F value = 2.158 P value = .143	t = -.329 Degree of Freedom =378 F value = .331 P value = .566
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Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.9 Relationship between age and place attachment

Table 4.9 divulges the distribution of economic and genealogical place attachment across different age groups. ANOVA results indicate no statistically significant relationship between age categories and both components of place attachment. The distribution of both components of place attachment is consistent across all age groups ($p > 0.05$). Older and younger households are equally attached to their physical space for economic and genealogical values. Therefore, the place attachment levels of households were not found to be structured by age.

Table 4.9: Age and place attachment of the households

Age	Economic		Genealogical	
	Mean	SD	Mean	SD
20-30	3.96	.56	3.75	.78
31-40	3.84	.65	3.88	.81
41-50	3.85	.64	3.82	.68
>51	3.90	.60	3.85	.65
ANOVA result	Sum of Square = 3.71 Degree of Freedom = 3 F value = .311 P value = .817		Sum of Square = .426 Degree of Freedom = 3 F value = .274 P value = .844	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.1.10 Relationship between income and place attachment

Table 4.10 unfolds the relationship between levels of income and place attachment of the households. ANOVA analysis shows no statistically significant difference in the amount of both components of place attachment across different income groups. The p values of both forms of place attachment are greater than 0.05. This means that households' level of place

attachment does not depend on their class structure. Therefore, the economic status of the households does not determine their levels of place attachment.

Table 4.10: Income and place attachment of the households

Income	Economic		Genealogical	
	Mean	SD	Mean	SD
5000-10000	3.86	.64	3.86	.71
10000-15000	3.85	.64	3.81	.74
15000-20000	3.95	.52	3.89	.67
Above 20,000	3.81	.65	3.82	.70
ANOVA result	Sum of Square = .467 Degree of Freedom = 3 F value = .392 P value = .759		Sum of Square = .331 Degree of Freedom = 3 F value = .21 P value = .888	

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$, ** denotes $p \leq 0.01$, and *** $p \leq 0.001$

4.2 Correlation between place attachment and risk perception

Table 4.11 illustrates the correlations between key variables: economic place attachment, genealogical place attachment, and perceived risk perception. The results indicate that economic and genealogical place attachment positively correlates with perceived risk. A strong correlation between the two components of place attachment and flood risk perception shows an increase in inhabitants' level of place attachment increases their level of flood risk perception. However, the correlation coefficient of genealogical place attachment was estimated to be the highest with both dependent variables perceived risk perception (.561) vis-à-vis economic place attachment. Furthermore, the result showed no correlation coefficient higher than .561, indicating the absence of multi-collinearity among the key variables used to assess the influence of place attachments on households' risk perception and coping abilities.

Table 4.11 Correlation matrix showing inter correlations between key variables

Variables	Economic place attachment	Genealogical place attachment	Perceived risk
Economic place attachment	1		
Genealogical place attachment	.388**	1	
Perceived risk	.402**	.561**	1

Notes: ** denotes correlation coefficient is significant at the 0.01 level (two-tailed)

4.3 Relationship between components of place attachment and flood risk perception

We have used multiple regression analysis to assess the impact of place attachments on flood risk perception of the households. Our hierarchical analysis included the following testing procedure: i) Model 1 tested for the effects of socio-demographic characteristics of households on risk perception, and ii) Model 2 tested for the effects of economic and genealogical place attachment on perceived flood risk. It is important to note that we have converted a few socio-demographic variables to dummy variables before performing regression (kindly refer to Chapter III, Section 3.3, pp. 101–107). Table 4.12 represents the results of the two models used in the study. The performance of Model 1 was relatively low, explaining only around 2% of the variation in risk perception. The intercept estimate of Model 1 is positive and significant ($B = 3.83$ p -value < 0.00). Among the control variables i.e., socio-demographic characteristics, occupation, gender, and caste were found to be positively associated with risk perception at $p < .05$. Among the significant variables, gender has emerged as the strongest predictor of flood risk perception at a 0.005 significance level. In contrast to these statistically significant socio-demographic variables, other variables such as marital status, family type, education, religion,

and income indicated p-values greater than 0.5. Therefore, these variables seem to have no influence on the risk perception of the households.

4.3.1 Influence of economic and genealogical place attachment on flood risk perception

Model 2 examined the impacts of economic and genealogical place attachment on the perceived flood risk of the households after controlling the effects of socio-demographic variables (Table 4.12). The intercept value of Model 2 is positive and significant ($B = 1.87, p < 0.00$). It implies that flood risk perception for economic and genealogical place attachment is significantly different from 0. However, the value of intercept has decreased in Model 2 vis-à-vis Model 1. This change occurs because of adding new predictors, i.e., economic and genealogical place attachment, to the model. The total variation in risk perception improved substantially to 37% (Model 2, Table 4.12) after the place attachment variables – economic and genealogical were added to Model 1. The Model 2 results indicate that economic and genealogical place attachment is positively and significantly related to households' risk perception. Indeed, both economic and genealogical place attachment was found to be significant at 1% of the significance level ($p < 0.001$). However, a comparison of standardized betas shows that the impact of economic place attachment ($\beta = 0.195$) on risk perception is higher than that of genealogical place attachment ($\beta = 0.485$). One of the major findings of the study is that place attachment affects flood risk perception (Model 2, Table 4.3.1). The positive association between these two components of place attachments and flood risk perception indicates that people firmly attached to their place or locale tend to perceive the flood risk as higher. These findings are congruent with findings of the previous studies focusing on the interface between place attachment and environmental risks in general (Gisladdottir & Dominey-Howes, 2011; Donovan et al., 2012; Groulx et al., 2014; Aramas, 2006) and flood risk perception in particular (Bonaiuto et al., 2011). Our survey questionnaire included mainly two dimensions of place

attachment, viz. i) economic and ii) genealogical. To have a nuanced understanding of the relationships shared between place attachment and flood risk perception, a finer analysis of these two components is imperative. The results divulge that genealogical and economic components enhance flood risk perception for residents living in flood-prone areas of Supaul.

With regard to economic components, farming, cattle rearing, and fish catching (fishing) are the three occupations that provide an essential economic mainstay to the people residing in the Supaul area. Kosi river is the main reason for floods in the Supaul region. It causes erosion of land, sand casting, and waterlogging in the area. The sediment load of the river Kosi is relatively high and creates many problems, especially for agriculture (Mishra, 2008). During the floods, the Kosi river meanders and deposits fertile lands with dunes of sand, destroying the productive power of soil and making farming very difficult. Every year thousands of acres of arable land get submerged or waterlogged, inflicting tremendous crop loss. Even irrigation facilities are likely to suffer in the area due to damage caused by excessive water. Likewise, cattle rearing also suffers due to regular floods in the area. There is a high risk of cattle getting swept away by floodwater.

Moreover, due to sand casting, erosion, and waterlogging, these cattle grazing grounds either shrink or disappear, resulting in severe fodder scarcity. Constant waterlogging also exposes these cattle to the risk of disease because, in the absence of dry land, the cattle have to stand in the water for many days. Besides, fish-catching is also an important source of livelihood for many communities in the Supaul region. However, floods inflict unrecoverable damage to fishing communities. During floods, fishing becomes almost impossible due to the increase in the river level.

Moreover, when flood water enters villages, it damages public and private ponds partially or fully. Furthermore, floods submerge or cause waterlogging in the fields. In the

waterlogging condition, there is a high risk of fish disease due to dirty water and chemical used in farming. Importantly, the construction of embankments has sabotaged the natural seasonal movement of fish, affecting the fish population in the Kosi river. Therefore, the vulnerability of economic mainstay activities, i.e., agriculture, cattle rearing, and fishing, to recurring floods lead inhabitants to perceive flood risk as high.

Returning now to the genealogical place attachment, the Supaul region is dominated by multiple communities. They are tied to each other through kinship, marriage, and common ancestors. They have a deep reverence for their ancestors and their belongings. Specifically, they are emotionally attached to their ancestral homes and valuables. This infuses a feeling of genealogical rootedness to the place and makes them perceive flood risk as higher because they are aware of the extent to which a flood can be detrimental to their ancestral artefacts. This further illustrates that the flood risk perception of individuals depends on the extent to which their ancestral artefacts are exposed to a flood. Therefore, the genealogical component of place attachment contributes significantly to the flood risk perceptions of individuals.

Table 4.12 Regression model predicting the amount of risk perception

Independent Variables	Model 1					Model 2				
	B	SE	B	T	P-value	B	SE	B	t	P-value
Intercept	3.942	.422		9.343	.000***	1.877	.383		4.907	.000***
Marital Status	.101	.174	.030	.581	.562	-.117	.144	-.035	-.817	.414
Family type	-.004	.070	-.003	-.054	.957	.009	.057	.007	.155	.877
Education	.016	.025	.033	.640	.523	.036	.020	.075	1.785	.075 [#]
Occupation	.049	.025	.100	1.947	.048*	.010	.021	.019	.456	.648

Length of residence	-.080	.034	-.120	-2.345	.020*	-.014	.028	-.021	-.493	.622
Gender	-.243	.087	-.163	-2.805	.005**	-.157	.072	-.105	-2.191	.029*
Caste	-.081	.039	-.119	-2.112	.035*	-.054	.032	-.080	-1.719	.086
Religion	.036	.122	.016	.300	.765	-.016	.099	-.007	-.166	.868
Age	.028	.041	.036	.695	.487	.008	.033	.010	.232	.817
Income	-.016	.037	-.023	-.441	.660	-.011	.030	-.016	-.378	.706
Economic place attachment						.187	.044	.195	4.252	.000***
Genealogical place attachment						.407	.039	.485	10.390	.000***
R-square	0.06					0.37				
Adjusted R-square	0.03					0.35				
F value	2.20				0.02*	18.56				0.000***

Note: # denotes $p \leq 0.1$, * denotes $p \leq 0.05$ (10%), ** denotes $p \leq 0.01$ (5%), and *** $p \leq 0.001$ (1%).

4.4 Place representation, flood events, and risk perception

To understand residents' perceptions about their places, they were first asked to describe the characteristics of their local areas (as used before by Devine-Wright and Howes 2010). The most frequent characteristics mentioned by the residents are 'heritage', 'emotion', 'friendliness', 'lovely', 'nice', 'less expensive' and 'companionship'. Apart from this, some aesthetic characteristics like 'open space', 'greenery', 'village feel' are also mentioned by them. Overall,

the residents provided a positive picture of their area with mostly positive descriptions. This indicates that the flood does not seem to have turned peoples' thinking completely negatively about the place they belong. The residents were also asked the reason behind staying in the flooded area. For the majority of people, the reason was that it is their ancestral place where he was born and brought up, for some people, either their ancestral property or family commitment was the reason, and for others, it's either their job or they have shifted because they are local and have stayed before at the place. These descriptions indicate that this place is a desirable location for people and has good quality of life as people prefer to stay or come back there.

To understand the residents' feelings about being constantly flooded, an open question was asked to them as to what ways floods have impacted their lives. The most cited responses are that; floods have always been beneficial in terms of agriculture for them, it has made them economically and financially sound; also, the flood has brought them closer together with their communities and it has increased their companionship. However, some people also expressed their distress towards the unwanted changes brought by the flood to their fields and villages, following which the place didn't remain the same, and their progress has also become slow. By mentioning 'coming closer to the communities and companionship,' residents refer to a positive social aspect of the flood. It indicates that although their daily routine and living arrangements have been altered by the flood, it has also led to an addition in their social capital. This is to the literature on place attachment which suggests that following a flood event, people become more conscious of the social aspects of a place (Chamlee-Wright and Storr 2009). The results highlight place-related meaning. The changes in residents' experiences of a place not only impact their present well-being but also shape their future place-related behavior and interactions.

4.5 Place attachment, living space, and flood risk perception

Another question asked from the residents was related to their feelings about their houses/living spaces. The aim was to understand if and how their experience of place has been affected by constant flooding. In other words, the aim was to explore what kind of impact flooding has left on their attachment to their living spaces. The majority of the responses were positive, revealing that they see their houses as more precious because of flooding. These type of responses points to the ways the recovery process has made more prominent or increased the respondent's attachment to their houses.

As one of the respondents mentioned:

Well, if you want me to choose between negative and positive impacts, I would choose positive. I love my house more every time I reconstruct it because it is a part of me. I have invested my toil and blood in it. It belongs to me, and I belong to this place. It is my ancestral property. Besides me, my whole family is emotionally and financially attached to this. I cannot imagine leaving my house, even in my dreams, no matter what comes my way.

Another respondent explained:

I feel my attachment with my house has increased because, last year, when we returned to our place after the floodwater subsided, my house was standing there. Although I had to repair it, it was there; it didn't vanish in the floodwater. When I saw that, I started crying. I felt as if it was saying, do not worry, I am there to protect you. It is the first house that I built with my savings. It will always be special for me. I always want to come to my home at night, no matter where I spend my day.

All these responses indicate the emotional connection people feel towards their place, particularly their house/living space. People associate themselves with the place to the level

that they find their purpose of life attached to it, and this in the literature on place attachment is called place identity which is defined as, “the symbolic importance of a place as a repository for emotions and relationships that give meaning and purpose to life” (Williams & Vaske 2003). As reflected by another respondent;

I got my house completed only weeks before the sudden flood last year. I had invested all my money in that, and it gave me a return as well. When the level of flood water increased we went on the roof of our house and spent four-five days there. Some of my neighbors whose houses were either destroyed or submerged due to flood also stayed with us. By god's grace, my house was not much affected. When the water level decreased, we came down. I always feel that my house is especially blessed by god. I am a spiritual person and have faith in worship. I firmly believe that Kosi Mother has saved our life.

This is similar to what Relph (1976) said: peoples' attachment with their living spaces may only become visible during hardships and losses, and experiencing those hardships could further strengthen the place attachment. Apart from these positive responses, some people felt that their connection has either lost with their houses or decreased to a certain extent. As mentioned by Harries (2008), a flood event could be anticipated to negatively impact peoples feeling of security. Because in any flood event, normal life which was earlier stable suddenly becomes insecure and, in many cases, leads to a permanent shift or change in one's feeling towards their house/place.

As shared by a respondent:

It's just a concrete structure now. Earlier it was my home where I spent my entire childhood. I could see the entire village from the roof of my house. I used to live in a room built on the roof. I got it constructed and decorated as per my own liking. For me,

it was not only a room but my companion in every struggle that I faced before getting a job. But my old room vanished because of the flood. Now I have a new room with better design and structure, but I don't feel that connection. I feel as if I have lost a friend. It is just a house now earlier, it was my home.

Authors like Shumaker & Taylor (1983) revealed that people show attachment to their residential environment, and this attachment creates a sense of comfort and a feeling of security. However, this feeling sometimes changes due to the effects of natural hazards like floods. From the responses, Safety issues within residential spaces emerged as another common response where some residents revealed that they do not feel safe in their living spaces/houses. The most cited reasons behind this are heavy rainfall, sudden onset of the flood, continuous waterlogging, and a flood with heavy rains. All these factors sometimes prove to be fatal and life-threatening for the residents.

According to a respondent:

Flooding becomes more frightening for poor people like us who do not have a well-built structure in the name of the house. We stayed in the kutcha houses and could not afford to do maintenance on an annual basis. Last year my brother's house collapsed in the early morning due to heavy rain. Although his family narrowly escaped the accident because they were outside, all his household items, including rations, bed, and cattle, got buried under the debris. Five to ten cases of such types, including death, happen here every monsoon.

Another respondent shared:

It is very painful to see your entire deposit in ruins before your eyes. I live in Punjab; I work there. Last year when I came to my house; I had thought that in some time, I would get the house repaired. In the meantime, it started raining heavily. One night when I

was sitting at my friend's house, I suddenly heard the loud noise of crying. When I came outside, I saw that my house was falling. All my family members ran out, but my grandmother was left inside. She was sick and could not come on her own. I started shouting and calling more people for help. People did come, but it took a long time to get grandmother out of the rubble, and I could not save her. After that, my family had to suffer a lot for months. I would never want to remember that time. Since then, my desire to build a house is over, and we are living in a temporary shelter only.

These responses reveal how the feeling of not being safe in one's own space led to a change in attachment to their house or living space. However, for some respondents, the flood also gave them a new, better view of appreciation as it led to materialistic improvements in their houses. As explained by one respondent:

Now my house has become even more beautiful than before. We have fully reconstructed it. The back part of our house was broken due to rain, so we had to do it. Although we had been thinking about this for a long time, the rain made our work easier. We also got the interior decoration done well and purchased many new items because now our house is strong, and there is no fear of falling off of the house. Now we don't need to be afraid of heavy rain. Although I miss my old house, I have started liking my new modern house.

These variations in responses reveal that floods do not have an evenly or entirely negative impact on people's feelings related to their houses/living spaces. In fact, it shows that floods made residents more aware of their house attachment and made them value their living spaces more. This is in line with what Brown et al. (2003) said: the longer time someone spends or stays in a place, they are likely to be more attached to it. However, in some cases, floods have

also shaken and questioned previous assumptions regarding the security of a house, and when these expectations are challenged, there might be an inclination toward feelings of insecurity.

4.6 River attachment and flood risk perception

The three main aspects of place attachment, as per Scannell and Gifford (2010), which are interrelated to each other are the person (individual or collective), the psychological processes involving the conscious intellectual activities, and the place, such as the physical environment whether natural or constructed, its symbolic meaning as well as social environment. This framework provides a better understanding of place attachment as a term and its influence on the behavior of an individual related to a particular place. The various research on place attachment suggests that the physical aspect of a place should be paid more attention to, and it shouldn't be concluded that the quantitative measures of place attachment reflect a homogenous level of attachment to every aspect of a place. To gain a deeper understanding of how residents connect to certain aspects of their area, they were asked how they value the river situated in their area. In other words, since this chapter focuses on place attachment, fluvial flood risk, and related possible coping measures, this section is an attempt to understand whether there is a difference between the way people relate to their surroundings in general and the way they connect to their local rivers in particular. As the focal point of flood management is mostly based on the rivers in the form of engineering methods, these insights could probably explain in detail the preference of residents regarding flood management if rivers hold particular meaning. The questions focused on understanding how the rivers were valued were included in the questionnaire. These questions included different attributes like aesthetics, utility, contribution to well-being, the spiritual, cultural, emotional, and financial aspect, historical importance as well as heritage value of the river (adapted from Brown and Raymond 2007) to make the respondents more aware of the values they associate to the Kosi river. In the present study, river attachment is taken as an important aspect of the wider concept

of place attachment and is understood as an emotional connection established through day-to-day activities and experiences. The term river attachment, according to Lindemann (2008), refers to an affective bond with a particular river. As per him, there are three categories of river attachment: physical, symbolic, and socio-cultural. There are various factors that play an important role in the formation of river attachment. For some authors, significant life experiences have a huge impact on individuals' relationships with the river (Chawla 1998). Early memories and experiences of childhood have a vital role in the development of river attachment (Altman & Low 2012). When asked about their connection with the river, most of the respondents revealed their strong bonding with the river and also highlighted its importance. However, for them, river attachment is an aspect of place attachment in a broader context. For them, the Kosi river is an integral part of the landscape. One of the respondents recollected his childhood memories and explained his emotion towards the river Kosi. As per him:

From childhood, I have seen how important this river is for us. We are not only emotionally or economically connected with it, but it is the base of our spiritual existence. My grandfather was an active member of the Save Kosi Movement (Kosi Bachao Aandolan). He was entirely against the embanking of rivers. He would take other children of the village and me to the bank of the Kosi and tell us many mythical stories related to the river. He made us understand how this river is historically important. He used to say it is in their nature to flow freely; if you will confine them, they will confine you. It seems he was right; when the river was free, floods were boon. After embankment construction, floods have become a curse. Mostly it has affected the agriculture sector. I feel there are many other ways of dealing with floods rather than just embanking them. We live here and have an idea about the extent of flooding. Over

time we have learned how to live with it and save ourselves as we know there is no one to save us.

Past experiences, beliefs, and cultural exposure have an influence on the place-related perception of an individual (Rapoport 1977). Cultural exposure here refers to a cluster of characteristics such as the customs, norms, perceptions, values as well as traditions that has a huge impact on a person's mind (Altman & Low 1992). This explains how culturally affective activities and meanings associated with a place derived from historical, social, political, and cultural sources are involved in place attachment.

As per one respondent:

When I was a kid, I always thought that I owned a River. My grandfather owned several acres of land nearby the river, where he used to grow paddy, green gram mustard, and other items. Before sowing any new seed in the field, he would take the blessings of mother Kosi. He also owned an orchard with guava, mango, and plum trees. These were the source of earnings for my family. I always liked to play on the bank of the Kosi river. Sometimes I would carry my books along with the sac and would spend the entire day sitting there. This had shaped my imagination in a way that when I grew up, I went to several places for my work but could not stay there for a longer period. I have always missed that peace. Finally, I returned here and started working in my fields. And I still spend my time on the riverside once in a while. It gives me new energy and always inspires me to do better in my life. I also take my kids there. I cannot imagine my life beyond this place.

All of these responses mostly revolve around first frequent contacts, childhood memories and experiences, and then their past and significant life experiences, as mentioned by Chawla (1998), to explain their bonding and attachment. The findings revealed that people have an

affective, deep, emotional bonding with the river. This kind of river bonding is similar to what Manzo (2005) has called “experience-in-place,” where the meaning of place develops from a wide range of emotions and experiences, which can be both negative and positive. The above findings refer to the bonding with the Kosi river as a physical entity based on various experiences and direct contact, which provides a basis for leisure activities (Lindemann 2008). The overall attachment to a particular place increases and becomes stronger when contact with that place is made frequently and regularly maintained, building “experience-use history,” as mentioned by Kyle et al. (2003). According to him, the attachment level is a part of experience-use history as frequent contacts emerge from the bond to that place and also enhances the attachment formation process. The respondents who showed a deep connection with the river perceived flood risk as high. When asked about risk perception, almost every respondent shared their various stories of flood events. They also discussed the frequency in detail. Most of them think of themselves as survivors because they handle floods on their own with the help of certain techniques developed by them. While sharing their narratives, many older respondents focused on their past flood memories, which they experienced as a kid or teenagers. One of the respondents’ recalled:

There is a big difference between the floods of our time and the floods of today. Earlier floods were not so severe. The faster the flood waters rose, the quicker they went down. We even learned to swim in the flood water. Our agriculture was also dependent on floods. But now everything has changed. Now, year after year, the frequency and severity of floods are increasing. Farming has all been ruined. But we have changed our cropping pattern accordingly, so it does not affect much.

The flood stories shared by people are ‘lived’ memories, i.e., why it appears to be detailed and lively. This is a reflection of how to survive in an adverse situation.

One of the respondents' mentioned:

My house is on the highest point of the village, so I don't face many problems when there is a flood. But in other places, many difficulties have to be faced. Last year the bridge in our neighborhood village broke due to an embankment breach, and they lost all their connectivity. But they did not give up and built a temporary bamboo bridge. This is one of the examples of our fighting spirit. When the flood comes, we all help each other to survive. We keep extra ration so that we can help the needy persons. As disaster does not discriminate among us, so do we. We keep only one thing in mind i.e., to survive.

The place also has a cultural significance that gives meaning to the lives of its inhabitants. It imbibes one's emotions, their sense of being, feelings as well as their pride that defines their existence in a particular flood-affected area (Stedman 2003). By combining their efforts and resources, the communities fight the disaster and eventually adapt to the best-suited strategies for their survival. People of the Supaul region consider river Kosi as their 'mother', and apart from physical and economical attachment they possess very strong emotional connect with it. They even see flood devastation as the result of their deeds (Karma). One respondent spoke in length about what the river Kosi means for the local inhabitants. As per him:

Our village is an extension of the resettlement site. There was a shield of a thick bamboo plantation and an orchard between the embankment and our village. In the last flood of 2012, when there was a breach, all of us gathered at the courtyard of goddess Bhagwati temple and promised her that if we will be saved we will offer sacrifice ('bali') of goat in the name of Kosi maa. Our village was somehow less affected because all the debris got stuck in the bamboo clumps and the orchard. The walls and roofs of the houses, wood, tools, and equipment of the flour mill, cows, buffalos, and goats all

got stuck in the trees. Before the water could attack us, it got diverted towards the south. Only filtered water through the orchard fencing reached us and that too very slowly. We were saved, and this was all because of the blessings of River Kosi. After the water settled, we performed 'bali' for her. Where can one find such life protection other than this place?

Adding to this, another respondent shared:

If a mother punishes her child, it is for their welfare, and this does not mean the child will leave his mother alone. It is the result of our bad deeds and bad karma that our mother has become angry and punished us. But even after getting angry, we are alive. If this is not her love for us, then what it is? I have spent my entire life here and will live the last breath of my life in her lap.

The findings of the study suggest that river attachment as an aspect of place attachment refers to an affective bond with a particular place (here, river) that evolves over a period of time and is related to activities, memories, and experiences (Chawla 1998). This also indicates that people have an inherited place attachment and relationship with the Kosi river in the form of the collective memory of floods. Most of the residents have a strong belief that no matter what happens, their Kosi mother will save them. This is visible in their responses and also in many folk stories that prevailed in the region. For people of the Supaul region river, Kosi is the pillar of their strength; it is their identity that reflects 'symbolic' attachment as mentioned by Lindeman (2008). The respondents' flood risk perception is high and is primarily based on past flood events as they face floods on an annual basis. Their perceived flood risk has an important role to play in their formation of river attachment.

4.7 Components of place attachment and related flood risk perception

This section will discuss the type of emotional connections, attachments, and ties that people have with their places (here, flood-prone areas) and how these connections consequently impact their flood risk perception. According to Low (1992), the various components of place attachment are genealogy, economics, cosmology, narrative, and pilgrimage. Here, for our study we will explore the effect of the first two components of place attachment on the risk perception of flood-prone households. Around the world, people inhabit the same place for many generations, and this, as per Low (1992), may lead to long-term place ties. This practice is very common in several parts of India, and Supaul is no exception. Here people mainly rely on their ancestral properties, especially on their house, land, and other physical possessions. As shared by one respondent:

My grandfather was a freedom fighter and is well-known in this area. He lived a very respectable life. My family is very reputed in this area because of him. He was the one who constructed our house and it is known by his name. After my grandfather's demise, my father is called for settlements in family disputes by the villagers. Apart from this, his opinion matters in any social issues related to our village. He also participates in flood-fighting works and discussions. I work as a teacher in a government school. Compared to my colleagues, my opinion is taken in any important matter related to school because they know I belong to a good family. In any critical situation, people think of us before themselves. This status gives me unparalleled happiness and satisfaction and infuses me with a sense of pride. My identity is because of my family; I am nothing without it.

Taking the story forward, another respondent shared:

This place is our homeland. We belong to this land. It gives meaning to our lives. All of our ancestral property is here, which feeds us. My friends and relatives are here who

support me financially in my time of need. Kosi is not a mere river; it is our 'Dharohar' (Heritage) which we have inherited from our forefathers and will pass to our coming generations. I agree that sometimes the river takes wild form and causes huge discomfort and losses to our properties, but this is our fate. We manage here because we have the emotional support of family and friends. If I go to stay at an unknown place, no matter how much I earn, but if something happens to me, there is no one to take care of. Staying with your family is always a blessing.

This aspect of place attachment is also called place dependency by some researchers, which indicates trust in a particular place that could provide features, properties, and support to achieve desired goals (Schreyer, Jacob & White 1981). There can be many reasons behind people's attachment to a particular place, where along with emotional attachment, land, property, ancestral heritage, and artefacts play an important role. They bind the people with that place. As per one respondent:

I am a vegetable vendor. I roam around the streets and sell vegetables. Earlier I used to cultivate paddy. The harvest was good, and the earnings were also fine. But ever since the floods' frequency increased, the destruction of my crops also increased, and my income kept on ending. Then one day, a friend of mine who also sells vegetables gave me the idea to cultivate vegetables. I have enough land around my house so I started planting vegetables on them. There is less effort and more profit because vegetables are the things everyone eats. In fact, during floods, the price of vegetables becomes very high. Even when the fields are submerged, this vegetable business of mine continues as my house is at some height. It is also a very convenient job for me. If someday I don't feel like going, I don't go, unlike other people who have to report on their job every day. I leave the vegetables in the tree itself then there is no fear of getting rotted. In this way, I take care of my family too and also earn a respectable living.

Another respondent added:

Though floods create a lot of difficulties in our everyday life but still being in our place is better than living anywhere else. I previously lived in Punjab and worked in a mill there. Once there was a severe flood in Punjab, and the mill was closed. Slowly all my money was exhausted, and there was a situation of starvation. Somehow I managed to come here. Here one gets some work even when there is a flood because people know you. I work as a rickshaw driver. During floods, when the roads are submerged, and the vehicles cannot run, I work as domestic labor at others' houses and take care of their cattle and other household works. In lieu of my work, I get food for my family and myself. Sometimes I also stay in refugee camps with my family. These facilities are not easily available outside this place.

The economic dimension of place attachment refers to the economic value associated with the place. Talking about the economic and financial aspects of the place.

One respondent states:

Since my childhood, neither I nor my family members have slept empty stomach and this is all because of the blessings of the Kosi river. Apart from cropping, fishing gives us the required profit. I have made three concrete houses with the blessings of the Kosi river. I still remember how I used to go fishing on a daily basis when my father was alive and taking care of our land. I used to sell those fish in the local 'haat' (Market). Because of its freshness, it has always been in demand, and I have always earned good profit from no hard labor. This has helped me in getting my two sisters married. And I always believe only a mother can have this much concern for their children. As a son, I cannot leave my mother alone.

Adding to the economic aspect, another respondent asserted:

I own ten bighas of land, which is completely submerged now. But I am paying the land revenue every year. I hope that if not me, my children will get the possession someday because the river is habituated to changing its course. The water will be settled in some year, and I will get my land back, but if I leave the place, someone else will occupy it. How will my children survive then? Also, where will I get the money to buy that large holding of land?

For the people living in the flood zone livelihood, scarcity is one of the major devastating impacts of floods. Floods wash the livelihood structure that is created after hard work in no time. However, households, as per their capacity with past experiences and knowledge, and with the support of their friends, family, government, and other organizations, adopt strategies to rebuild their livelihood structure.

As per one respondent

I run a grocery store. My grandfather opened it. This is a very famous shop here. Earlier I had two shops which I had opened by taking a loan from the bank. My income was very good, and I had also bought land in the city. But in the 2015 floods, everything was ruined. That year our entire village was suddenly flooded due to the embankment breach. Both my shops were also completely flooded. All the grains kept in the shop got rotten. Somehow I took out the goods from one shop but could not clear the other shop. My condition had become very bad. I did not have money to give to the bank. Somehow by selling that city land, I gave money to the bankers. After that, I borrowed money from my friend to start my shop again. Till now, I am paying his money but slowly, my life is getting back on track, and I am thankful to my friend for that.

Taking about the economic dimension of place attachment, another respondent points:

I used to work as an auto Rickshaw driver in Delhi fifteen years back. After saving some money, I had planned to buy my taxi. I tried there but failed as I was not having any guarantor. Then I returned to my village and asked one of my friends to be my guarantor. I got the loan quickly as I had all documents. Now, I have more than ten vehicles. I have also stopped many fellow villagers from going to other states and given them jobs as I know how difficult it is to survive in other states where you are strangers and have no connections. They are all very happy and living a good life here with their families.

These responses suggest that people develop an emotional bonding with a particular specific place over a period of time that is based on their past experiences and frequent encounters/contacts with the place. It's not only confined to a particular place but is linked with their identity and sense of being. And as discussed by O'Brien (2009), what adaptation options are desirable and which options should be prioritized are shaped by the individual's values.

Conclusion

This chapter captured the impact of economic and genealogical place attachment on flood risk perception of households. The regression results illustrate statistically significant relationships between the two components of place attachment (economic and genealogical) and flood risk perception. The households who are firmly attached to their place tend to perceive flood risk as high vis-à-vis the households who are loosely attached to their place. The economic and genealogical place attachments have emerged as two important predictors of flood risk perception. Therefore, it can be inferred that in the Supaul region, the households' flood risk level largely depends on the extent to which they are attached to their place for economic and genealogical reasons. However, in terms of effect size, genealogical reasons for place attachment were found to be more affecting the households' sense of flood risk vis-à-vis

economic reasons. To put it succinctly, the study finds a positive correlation between flood risk perception and people-place relationships. Furthermore, thematic analysis explicates how people located in the Supaul region are emotionally attached to the Kosi river and how their sense of living space is linked with their sense of flood risks. To have a holistic understanding of flood control and management issues in Kosi river basin, it is important to examine the community and institutional perspectives. Chapter V provides in-depth insights into the problems confronted by the communities and their views on measures provided by the institutions engaged in flood disaster management in Bihar.



Chapter V

Institutional and Communities Values, Norms and Perceptions of Flood Management

Introduction

Over the years, there has been dispute on this notion that natural hazards are independent of human activities (Blaikie et al. 1994; Mileti, 1999). This shows how human's perception and behaviour related to floods is responsible for damages and grief of the flood-affected population.

In light of this, Yodmani (2001) investigated natural hazards in the context of developing world and advocated for the concept of community based flood hazard management. He maintained that risk reduction policies and programmes are primarily designed for the people of disaster prone areas. And mitigating any disaster through institutional or government interventions only could not address the dynamics, perceptions, priorities, needs as well as the requirement of at risk communities. It is thus, community-based management of disasters should be at the centre point of any flood management policy. Further, any risk reduction programme or policy must include various stakeholders starting from individual, family, organization as well as public service (Yodmani 2001).

Similarly, Pearce (1997) in her study on Hazard Risk Vulnerability emphasized that for the effective implementation of any disaster management programme public participation is required as it plays a pivotal role in the successful execution of it. However, researchers working on disasters often seek to describe any event with a prime focus on the behaviour of an institution (Tierney et al. 2001).

In this context, to understand the functioning of an institution, it is important to explore its structure, beliefs, norms, values as well as actions involved in responding to flood hazards. Also it is equally important to understand the views, perceptions as well as various coping strategies adopted by the flood-affected communities, who are the real stakeholders in this entire process and whose safety and livelihood needs need to be addressed by the policymakers. Therefore, the primary objective of this chapter is to investigate community and institutional perspectives, beliefs and values of flood control and management, as well as the challenges which are hindering their optimal performance from addressing the problems of flood vulnerability.

This chapter is divided into two sections. The first section is focused on the flood-related perspectives and values that institutions involved in flood fighting works have. It also analyzes the role that these institutions play in reducing the flood vulnerability of the affected communities. The main focus is on 4 government institutions namely, WRD, FMISC, WALMI, and DMD with mandates concerning floodplain management and dealing with flood-related concerns at the community level. The second section deals with the flood management perspectives and values of the flood-affected communities of 5 blocks of Supaul district. This discusses in detail the different vulnerability levels that arose due to floods and the various measures adopted by the individuals of at-risk communities to meet their requirements. In addition to this, it also sheds light on their priorities in making coping strategies as well as major issues and challenges of decision making regarding flood disaster management and also their perception about different flood preparedness and mitigation operations run by the government institutions.

According to Rokeach (1979), the main role of 'institution' is the dissemination and execution of a certain set of principles, values and norms concerning their areas of responsibility. The Institutions "function like a prefabricated set of instructions on how to do

things" (Nash & Calonico 1993 p.12). The Institutions ensure that idea will be implemented. In a society, there are different socially created institutions with varied responsibilities like religious observance, education, livelihood, maintaining law and order, water management etc. Therefore, when it comes to flood disaster management in the Kosi region, there are four to five government institutions that play an important role in responding to the needs of the flood-affected communities. According to Thompson et al. (1990), within a society, it is not necessary that every group present will have a common point of view on every issue. He further suggests that shared values are most commonly observed at an individual rather than a collective level.

This chapter discusses the key perspectives, norms and values of flood disaster management found within government institutions and the perception of risk communities regarding flood disaster, coping mechanism and views on the working of institutions. In-depth personal interviews with the key informants were conducted to explore the role of institutions engaged in flood fighting works. The institutional analysis is done through in-depth personal interviews using a semi-structured questionnaire. The officials were asked open-ended questions regarding their perception of flood misery in the Kosi basin and their strategies to deal with the issues. However, in a society, there can also be conflict in the values and principles of the institutions.

5.1 Institutional Perspective

This section focuses on the response of officials working in the four government organisations engaged in flood control and management in the Kosi basin, namely, Water Resources Department, Flood Management Information Systems Cell, Water and Land Management Institute, and Disaster Management Department. The details regarding the functioning,

procedure, plans and mitigation activities carried out by them are discussed in the following sections.

5.1.1 Institutional authority and working system

The informants were firstly asked to explain the nature of work assigned to their institute and to what extent they are indulged in floodplain management, including the organizational mandate. There was also discussion regarding the strategies, if any, that they use with local communities to fight flood disasters. It came out clearly that the role of an institution related to flood issues is majorly defined by the power and extent of authorities assigned to them. The institutional mandates are fully backed by the legislation as per them. Based on these legislative requirements, these Organizations work with the local communities. They take the help of the local leaders to reach out to the affected communities. In terms of flood mitigation activities, their stress is mainly on structural measures. Inputs from key informants suggest that Water Resource Department (WRD) dominates other agencies in terms of infrastructure, responsibilities, manpower, authorities, decision making and so forth.

An informant from SDMA affirms:

WRD is the apex body and an important role player in the area of flood disaster management. With a broader ambit, robust infrastructure, technical expertise and sufficient budget allocation, it is controlled directly by The Ministry of Water. These all directly contribute to their level of authority vis-a-vis other agencies active in the same field. In a nutshell, WRD forms the core of flood management structure in Bihar and others are the shell. Currently, all the flood controlling activities are commanded by WRD, and no work is possible without its participation.

WRD is the main institution among all others engaged in flood fighting works, and decision making. Therefore, it can be said that WRD is a chief body and presides over other agencies

involved in flood control in Bihar. The major working areas of WRD include irrigation projects, flood, drainage, and water management, and command area development. The key projects of WRD is to develop irrigation schemes, to construct water reservoir, to construct new as well as maintain the existing structure for flood protection, to take care of the anti-erosion works, to construct new and maintain the old drainage systems for free flow of water, to develop information system of flood management, to construct new waterways and so on. Further, other government apparatuses such as the 'Flood Management Information System Cell' (FMISC), 'Water and Land Management Institute' (WALMI) and 'State Disaster Management Authority' (SDMA) also supported WRD across time to control and manage flood situations in Bihar. However, the role and authority of these agencies are limited vis-a-vis WRD. For instance, the role of FMISC is limited to the production and dissemination of customized information to flood management agencies to help in flood-fighting works. Likewise, WALMI'S role is limited to multidisciplinary training for engineers from WRD and other agriculture departments. WALMI is a constituent body of WRD and is running primarily by annual grants (95%) provided by it. The Bihar State Disaster Management Authority (SDMA) is an operational body at the state level constituted under the framework of the National Disaster Management Authority (NDMA). On the one hand, SDMA follows and ensures appropriate implementation of NDMA guidelines and policies in the state and, on the other hand, develops specific strategies and initiatives of disaster management for the betterment of the state. Formal mandates supported by provincial and central legislation binds the functioning of bureaucrats, engineers and so forth, which are also subject to change depending on needs and priorities at a particular point in time.

An engineer from WRD stated:

When I joined the institute, the primary mandates of the institute were irrigation and groundwater management. We used to look after only these two things primarily,

whereas flood management was taken along with other responsibilities. But, over the time, by considering the gravity and urgency of the situation, flood management was prioritized and hence included in the primary mandates of the institute. Now, our main aim is to protect communities as far as possible from flood disaster management.

However, all such promises of protecting the communities have been restricted to the use of structural measures.

5.1.2 Major obstacles in flood control and management

Another question asked from the respondents was, what are the biggest hurdles, as per them, in the management of floodplains, and how would they deal with them. Most of the respondents were consistent regarding lack of economic capital as one of the major obstacles to increasing sustainability in floodplain management.

One of the informants from FMISC perceives it as:

All these flood-related losses are the result of a lack of futuristic vision and long term funding on the part of the state government. The short-sightedness of the government has led to the present disastrous condition of the affected communities.

Additionally, time was another important factor cited by informants in flood-plain management as they said that, they also have to be involved in other works assigned by the government which sometimes is more important than the flood related works.

To elaborate on this, more than one person from SDMA affirms:

One of the barriers to sustainable flood management in Bihar is that engineers often work under both financial and political pressure to find the best solutions to flooding. They have to find a solution within budgetary constraints and also have to handle the

politics related to flood issues. For example, it often happens that they are working on a particular flood site and in between gets a call from a powerful leader to join another site which is of immense importance to them owing to the election, and the engineer has to leave the work unfinished and join another site immediately. So while on paper the work is done, in reality, it is still unfinished. These constraints lead to delay in quick and prompt response from them required at a particular point in time and hence causes serious damages in terms of loss of lives and damages.

The other major challenge as they mentioned was the absence of a proper comprehensive plan with inclusive attitude to handle water related problems such as faulty drainage system, false expectations, and weak cooperation at the local level etc. It was quite evident from the responses that planning needs to be done at multiple levels by increasing the involvement of the civil society as well as the local public.

One of the respondents from SDMA asserts that,

The biggest challenge that we face comes in the form of unrealistic expectations. People have false hope that no matter what happens, they will be saved by the government. They make irrational decisions based on their personal choices rather than the guidelines provided to them. Most often, there is an underestimation of flood risk, which leads to major losses.

For sustainable flood management solutions, it was advised that there is a need for a comprehensive goal-oriented plan, which will require reorganization of the entire process, improved communication, focused decision making and coming together of multiple agencies engaged in flood fighting works for a common goal of flood disaster management. Other suggestive measures include more and more involvement of the local population as well as the

use of different approaches like groundwater management water storage spaces on the landscape.

As per one respondent of WALMI:

The comprehensive goal-oriented plan needs not only details but also to be sent effectively to members of parliament and the concerned ministers at the higher level, revealing that someone or some organization need to take on that particular role or action.

It indicates that there is a need for restructuring the entire current flood management system if the government wants to reduce the impact of flood disasters.

5.1.3 Groundwork Challenges of sustainable flood plain management

The next question was asked from the informants about the challenges that they are facing in flood control and management in the Kosi basin. In this context, the first challenge highlighted by a majority of respondents is the non-accuracy of rainfall forecasting data. Similarly, the other major challenges include silt management and water discharge from Nepal. Nevertheless, almost all participants pointed out that the biggest challenge comes in the form of an embankment breach. The kind of embankment breaches that takes place in the basin is mainly for two reasons i.e. the first reason is the high level of water that comes from Nepal, and the second reason is the different cuts or wholes made by the communities themselves. It is very often the case that for irrigating their lands and to make them fertile, the farmers make cuts to the embankments. Secondly, when the water level starts going beyond the danger level, the local communities, to protect their areas, breach the other side of the embankment so that water flow can be turned to other areas by saving theirs. Describing the embankment breach situation that arose due to a high level of water, one of the respondents from WRD shared:

One of the biggest challenges is a breach in various parts of an embankment due to the high level of water. This is either because of heavy rains or because of water released by Nepal. In both situations, there is a very high sudden increase in the level of water. Once this happens, the local communities become aggressive, leading to obstruction in any kind of repairing work. They even don't let the labourers participate in the work and also throws the repairing materials like sandbags, sacs etc., and if we somehow convince some of them to help, they demand exceptionally high wages quoting threats to their lives. Sometimes we carry outside labourers to avoid these situations, but the locals don't allow and threaten them as well. Many times they have to face manhandling as well.

Another biggest challenge for them is the deposition of silt by the Kosi river. As per one respondent from FMISC:

Silt deposition is a major growing concern for the government. With the speed with which silt is getting deposited, it will hardly take a maximum period of ten years to fail most of the embankments in the region. And the resulting situation will be beyond our imagination. Because building a new dam or increasing the height of the existing ones are both costly as well as time taking and still cannot guarantee safety from the flood disaster. So, it is high time to look for some other alternative solutions. Most of the respondents were of the view that the proportion by which silt deposition is increasing in the embankments, very soon the need to either increase the height or build a new embankment will emerge. This silt deposition is also one of the major reasons behind the shifting of the river's course. It is the call of the hour to look for alternative solutions beyond the structural measures.

5.1.4 Flood Mitigation decision-making

In light of the above, the respondents were asked about the process of mitigation decision making, and a few respondents repeatedly used common points. Though, their statements reflected their perspectives, such as 'flood is an event-driven process'; political influence plays a major role'; no one is above law when it comes to decision making'. It is clear that, the change in government leads to change in their political agenda, and also a distinct barrier to collaborative decision making. Most of the informants were of the view that the current process of decision making is 'disconnected and incoherent' followed by agency wise rules and principles.

One of the respondents of WALMI summarised this as:

What gets done is a single objective by a single agency. There are two main reasons behind this. First is that the institute will get complete information on what needs to be done, and second, it can report to its superiors that action was taken on that problem. This is required to secure a budget for the next financial year. But, it acts as a barrier in collaboration with other agencies working on the same issue. We might think of some creative solution to the problem if we work together, but because of norms, we are unable to do so.

This shows that they have generated a tendency of showing themselves vulnerable in solving the flood-related problems of the communities because of government mandates. There is also a feeling of competition among organizations with similar or overlapping authorities. In a similar way, Rokeach (1979), defined the character of an institute which do not let them collaborate with other agencies working in similar areas. When the respondents were asked who are the people involved in decision making regarding flood mitigation, the interviewees from WRD stated that it was their agency that was proactive and, in a marginal way, other

government agencies. Almost every respondent stated that it's the Department of Water Resources that is the flag bearer of flood-related issues in Bihar and in Supaul in particular. However, one respondent from WALMI felt differently, and said that:

Involvement depends on where danger is perceived. It is connected with risk perception. It is the perception of risk which is tied to involvement of participants rather than focusing on capacity to be involved.

The lack of active participation of local governing institutions such as 'Panchayati Raj' Institutions at village level and municipal bodies at city level is a primary concern of several informants.

5.1.5 Overview of community priorities

Similarly, the other question asked from the respondents was aimed to gain an insight of their views regarding priorities of flood-affected communities. The next part of the question dwell upon the ways through which they came to understand these priorities. From the responses, it became clear that the priorities as per them could be organized in several sub-themes such as saving lives, protecting properties, the well-being of the community (health, education and livelihood), expectation from the government to be proactive, relief camps for protection from the disaster, maintenance of dikes and embankments etc. One of the respondents from WRD noted that people assume that government will save their lives no matter what. The utmost priority for the communities is saving their lives at any cost and after that saving the property, i.e. they want their houses and livestock to be protected from flood disaster. Then comes health, education and livelihood. They are very much concerned about what they will eat and how they will survive once the floodwater is settled. They expect the running government quickly release the funds for their relief and compensation. Some respondents felt that the arrangements of relief camps during the disaster are the main priority for them as they lose access to food and

shelter because of the flood, so survival becomes the most important thing for them. Then comes the maintenance of the structural measures like dikes, embankments, levees etc.

Later, the respondents were asked about their ways of understanding the community priorities. For instance, how they came to know what the affected communities exactly want from them. They mentioned that their source of knowledge regarding the communities comes from the experiences that they have gained over the years while working with them. The comments from respondents highlighted that personal knowledge gained through spending time during discussions with the residents is a major key for them to understand their problems and priorities.

One of the respondents from SDMA asserts:

It is very important to listen to the people without any preconceived notions. It gives a kind of reality check of what needs to be done on a priority basis or what is overlooked. My personal experience says that people can 'walk over fire' if they have to, in order to save their lives. So, survival is the most important thing for them.

However, a few respondents also acknowledged some secondary sources such as newspapers, reports, surveys, and also minute details given by the local leaders as major sources of information regarding the affected communities.

5.1.6 Perceptions of community vulnerability

Further, the next question was based on the perception of the respondents about the vulnerability of flood-affected communities and how they deal with it. Though during communication all the respondents were very much cautious, and almost seventy percent stated that the situation has improved and the Kosi basin is less vulnerable than in earlier years. A few respondents were very optimistic and positive about the situation, and as per them, there is improvement in the condition of the flood-affected people living in the Kosi basin. However,

these claims of respondents do not correspond with the secondary data. Several institutions such as Barh Mukti Abhiyan and others conducted studies on the topic and suggested that the flood situation in the Kosi basin has been worsening over the years. Though, the respondents rejected this proposition by giving the reason that one may not have all the necessary information as well as correct data to make such claims.

An informant from FMISC confirms:

The issue of flood vulnerability in the Kosi region is no doubt diminishing. However, it will take some time to reach the desired level. But, it is very difficult for us to convince people that the trend is progressive and is showing positive improvements. This is what our analysis indicates. We are committed to reducing vulnerability, and this is what we have been doing for the last decades, without bothering what others have to say and what their results depict.

Some of the respondents were of observation that the kind of social relations within a community also determines their level of vulnerability. What is the most important thing to be done during an emergency situation and whose opinions should be taken as a leader is directly or indirectly influenced by their social relations.

As per one respondent of WRD:

There are many villages where people do not adhere to the statutory warnings given by the government because their elders have told them that the village is flood-proof. As a result, they would not take the threat seriously despite several warnings, leading to dire consequences. This was the case in many villages in the 2008 flood, where most new areas were swept away by the Kosi river.

Hence, it shows that relying on past experiences of the flood only cannot result in better decision making for the affected communities. Some of the respondents also claimed that

incorrect assumptions and expectations of the communities, for example, if there will be loss of life and property, they will quickly get compensation and relief aid from the government, let them put themselves in the riskier situations. A similar kind of statement can be seen in Beatley (1999), where he stated that the resident's behaviours are often influenced by their perception that whatever losses have incurred will be covered by the government. This entire thought process, as per him, is problematic. Lack of education and transfer of misleading information also play a major role in increasing the vulnerability of the communities, as per many respondents.

As per one respondent from WALMI:

There is a lack of flood education among people to understand the basic things of flood management, which makes them dependent on the government. This is a major problem in the basin. When the people are asked to take part in the various training programmes of flood mitigation and management arranged by the government, they either do not take part and if they, then will complain of not understanding the things. Sometimes they assume different meanings leading to sharing of misleading information.

The respondents also verified some other variables that are making the people more vulnerable. For instance, the absence of an accurate forecasting system of the flood, and second, the inability to implement more creative solutions because of budget constraints as well as legislative bindings.

As one of the respondents from WALMI inferred:

We need to find the best alternative solution for the basin, but we always have to go for the cheapest solution owing to the budgetary issues. Actually, the problem is increasing, but the fund is decreasing. It's the need of the hour to go for the best solution, not the cheapest yet; the second one is given priority. Therefore, we do as instructed by our

seniors. This is the primary cause behind the failure of many flood mitigation works in the basin.

However, based on the above mentioned comments it can be said that there are various factors contributing to the vulnerability of the communities in the Kosi basin. Though, the respondent's points were mainly revolving around the allocation of funds, political constraints, as well as people's choice of priorities and their perseverance or estimation of the flood risk.

5.1.7 Steps to reduce vulnerability

The question was focused to know how the organization or institute decides whether a particular plan to reduce vulnerability should be taken to the next level. It was evident from the responses that the most important thing they take into consideration while formalizing a plan is the cost-benefit analysis. However, it has certain limitations, like there might be some emergency work that increases the cost of the project as per the respondents.

One of the respondents from SDMA opines that:

The cost-benefit assessments done by the committees are not capable enough to handle the intricacies of a project's expenses and benefits. The decision regarding what plans to be undertaken is completely a political matter depending on the political leader's motivations and desire to resolve a particular community risk on a priority basis.

To elaborate on this point, one person from FMISC affirms:

What mitigation action is suitable in a particular context is determined through engineering analysis of vulnerability reduction. These analyses are then reported to the concerned authority. However, the final decision is always taken by the elected officials. The cost-benefit tool is used to increase the effect of a particular project, but

actions like building a new dam or maintaining the existing embankments are done if they are feasible.

The details about the process of decision making as described by a respondent from WRD is:

The government consultants are asked to produce the necessary information; the local committee takes into consideration first the political impact that a particular proposal will have by reaching out to influential local groups who may approach them with concerns, if any. And, the final consideration is given to the influence that it will have on all floodplain as well as outside floodplain communities.

5.1.8 Involvement with local communities

There was also a motive to understand the pattern of partnership, collaboration and association that government agencies/institutions have- with the local communities. The majority of respondents stated that, in the process of selecting flood protection schemes, local villagers are contacted, and elderly people are given priority to express their views and suggestions regarding flood protection techniques based on their past experiences. Although, some of the respondents said, they mostly contact the head of the Gram Panchayat, i.e. 'Mukhiya', to gain information about the ground level problems and to know about the best-suited site where the work needs to be done. Besides this, occasionally, pilot surveys are conducted to make the communities understand the work to be done. However, more than 80% of the respondent were of the view that the communities do not show any interest in knowing about the ongoing projects. The agencies are also instructed to complete the anti-erosion work within the stipulated period. Therefore, they have to take help from the local people to get their work done on time. For this purpose, frequent meetings are conducted with the 'Mukhiya' and 'Sarpanch' of the village to get help regarding the work, as they can make the villagers understand the

importance of various projects run by governments. Sharing their experiences from public meetings, one of the officials from SDMA recalls:

Sometimes back, we had a meeting with the villagers of the Saharsa district of Kosi region to seek a solution to water congestion in their area. The area used to remain submerged for almost 9-10 months in a year, causing huge economic loss. Earlier it was not the case. So, we contacted the 'Mukhiya' and asked him to organize a meeting with the villagers. In the meeting, we asked some elderly people to share their views, experience as well as knowledge regarding the problem, and according to their advice, the alignment of the drainage channel was fixed. However, that did not go well with some people present there. They became aggressive and started shouting and blaming the government because their undue demands were not fulfilled. They did not want to fix the problem. Rather they wished to continue it so that they could demand compensation every year.

It shows the gap in communication between government officials and the local residents, which is a major reason for dissatisfaction among the affected communities. Hence, to fill this gap, there is a need to conduct more and more interactive sessions and meetings with the communities so that they can understand the message that officials want to convey.

5.1.9 Maintenance of embankments

This theme focuses on the process of maintaining flood embankments. Therefore, the questions focused on the process of maintenance adopted by the government agencies such as how often the embankments are repaired or maintained and the problems they face in doing so. The empirical data made available by the officials suggested that the flood embankment maintenance work is done before and after the flood. Anti-erosion works are carried out before

flood on the identified vulnerable sites for the safety of embankments. Besides, strengthening of spurs and revetment works are carried out to mitigate the pressure of high discharge in the river and keep the embankment safe. The responsibility or task of embankment maintenance is handled by WRD. It releases funds to different flood control divisions, prepare the work schedule (which embankment site needs to be maintained) and then forward it further to the concerned Chief engineers (CE) of various divisions. After that, CE distributes the work schedule, and the concerned divisions execute the scheduled tasks at different weaker zones of the embankments before flood onset. The same work is carried out after the flood, too, if required. Explicating the process of maintaining embankments, one respondent from WRD shares:

Before the monsoon period starts, flood embankments are inspected and are repaired accordingly. After the monsoon, some processes are repeated, and various schemes are prepared for their (embankments) restoration, mostly completed before the next flood season. During the flood, there is a continuous visit of engineers to the embankments. Home guards are deployed in the ratio of one in each kilometre of the embankment. Along with that, necessary flood-fighting materials like sacs, bags, geo bags, and neon crates are kept ready to repair them in case of any erosion and breach. The engineers are empowered to employ a contractor to supply these flood-fighting materials on a nomination basis.

However, it was evident from the responses that regular maintenance is done before and after the flood. Although, this is also clear that embankments are time being safety measures as the deposition of silt by the river is a colossal hunch, yet there is no solution. The reason is that the government is mainly focusing on finding structural solutions to flood disaster management in the Kosi basin.

5.1.10 Steps to include in mitigation Decision Making

The next question asked from the respondents was regarding their anticipation of future changes related to mitigation actions in the Kosi basin as well as communities' role in the process. They counted many different changes.

One of the respondents from WALMI inferred that,

The public is not ready to let the government do anything for them. The only thing the affected communities want or expect from the government is to protect our property at any cost or pay a high level of compensation for the losses. Their dependency on the government has increased. This is one thing that needs to be changed. There should be some effort on the communities' behalf to minimize the losses.

The other significant change noted by them is that, as the government is becoming more and more sensitive to public opinions, there will be a more general inclination.

One of the respondents from WRD opines that:

In the coming time, better rules and norms related to flood protection will come, which will hopefully be holistic and will allow as well as empower every institution to work with their fullest capacity in the basin to maximize the benefits of every mitigation plan proposed.

They also see increasing awareness regarding flood issues and flood education among the new government officials and in the risk communities, which as per them, is very important for adaptation.

According to one respondent from FMISC:

We are recruiting proactive, well-informed people who know more about the problems and issues of flood disaster management. With the help of their new ideas and a focused

attitude, we are hoping to solve the basin problem to a substantial extent in the coming years.

However, some respondents believed that people would have to learn to live with the risk. They will have to learn adaptation skills to minimize the losses. Because no structural measure can guarantee a hundred per cent safety from a flood disaster. So, the effort should be towards non-structural steps.

5.1.11 Governmental values and norms

The participants revealed that, there are certain operational rules and beliefs that are followed within government organizations only. They also highlighted how they connect to the different aspects to vulnerability. The main reason to carry out this discussion was that the actions and policies adopted by the government are key variables in reducing flood vulnerability (Mileti 1999). In contrast to adopting different ways of vulnerability reduction, organizations engaged in decision making in the Kosi basin seem to have a somewhat narrow approach to addressing vulnerability (Jones & Shrubsole 2001). The tendency to solve flood management problems in the basin through a single objective followed by one solution was clear from the data. This was done by not only applying engineering methods but also without a comprehensive framework that can bring different perspectives and knowledge of various stakeholders. Also, the preference to adopt engineering solutions of flood by the institutions, are the most consistent solution of vulnerability approach. The engineering solutions of vulnerability reduction work by altering the movement of water to move away from the vulnerable areas and ultimately reduce the flood susceptibility of that particular place. However, the choice of such approaches are always problematic because they create some illusion among people that they will be saved.

In other words, they (Engineering solutions) change the way people interact with nature (Burton Kates & White 1978). It often results in blind development of flood-plain areas without considering the fact that these measures might fail. So, the best approach to reducing physical and social vulnerability to floods is a combination of structural and non-structural measures (Pal 2002). The inflexible characteristics of institutions, as revealed by the respondents, are not conducive enough for holistic vulnerability reduction. It also suggests that it will take a lot of effort on government officials to adopt new approaches of vulnerability where less emphasis will be given to the engineering solutions, and more focus will be on including the communities for cooperation in vulnerability reduction. However, change, restructuring or coming out of the comfort zone is often challenging for the organizations. For instance, FEMA (federal emergency management agency) of the United States, which relied on engineering measures earlier, shifted the focus and incorporated non-structural measures in its agenda after the severe flood of 1993 hit America (Mileti 1999). They realised that dependency on structural measures only could not guarantee safety from natural disasters like floods.

The emphasis on the process of decision making is a major attribute of flood management. They provide space to critique bureaucratic principles and values, limiting the variety of solutions explored in vulnerability reduction (Shrubsole 2001). Also, excluding the at-risk communities in the process of decision making undermines not only the capacity development of people but also underrates the local leadership which might create various problems (Pearce 1997). Similarly, negligible or less participation of the public in the decision-making process indicates that they have not been consulted regularly, opposite to what the participants have revealed. This restricts trust-building between the communities and institutions by reinforcing the perception that the decisions were already made in advance

without consulting the public and it is just a formality, which ultimately prevents awareness among them regarding flood management.

The top-down and authority centered characteristics of organizations reveals that they are bound by formal mandates and perform their duties within financial and budgetary constraints. Some of the respondents also seemed to lack understanding regarding the broader role of communities in the mitigation process. Community participation is an important tenet in flood management process and therefore have been given immense importance in different vulnerability approaches (Pearce 1997).

For decades, the government's response to flood events has been to provide compensation to the affected communities. This compensation becomes mandatory if the flooding occurs because of an embankment breach. However, these kinds of finances help prevent the citizens from searching for other ways of flood mitigation to minimize the losses and also create a sense of dependency among them (Beatley 1999). It is thus, the role of institutions with decision making power is very important to reduce the physical and social aspects of vulnerability. Therefore, it is high time for the institutions to change their values, norms and perspective, which are not conducive to flood vulnerability management. Besides that, they will also have to find new ways to make new plans as well as strategies to increase the involvement of at-risk communities in the decision-making process. It will help in generating new ideas and different approaches to reduce the losses. They will have to prepare the local leaders to take the initiative to make the public more and more aware of the various governmental projects of flood risk management. This will enable them to understand what is being done for people and will also motivate them to take part and share their parts of responsibilities. This kind of partnership will definitely be successful in achieving the goals of vulnerability reduction in the Kosi basin.

Further, to know about the perspectives and decision making of the organizations, agencies and institutions involved in the flood-fighting works in the Kosi basin, the responses from officials came out to be a better source of information. The first few questions were aimed to know about the current working procedure of the organizations, their current engagement, their idea of mitigation and the barriers they face in sustainable flood management. This helped to gain insight into the institutional decision-making process and their beliefs about vulnerability. The government officials viewed the mitigation decision process as driven by flood events, i.e. when the flood comes, they become active. Also, the legislative powers and their formal mandates were seemed to be the drivers of their actions. Apart from legislative requirements, changes in government and their changing demands and funding constraints are a significant concern for them. As per the officials, the decision-making process is disconnected, with governments priorities at the top, and an institution-specific approach to justify their usefulness and existence. The dominance of some governmental institutions in flood control and floodplain management explains the dominance of structural approaches to flood control. In this context, Rokeach (1979) argued that, the education and training provided to the members of an organization and the technologies used by them have a very high impact on the values associated with the organization. In the Kosi basin, WRD dominates the decision making process and distributes work as per requirements to other flood control divisions and agencies. This leads to effectiveness and consensus in leadership within organizations (Rokeach 1979). Although, this also reveals that changes would be slow within institutions (Nash & Calonica 1993). The focus on engineering solutions by these organizations can be seen as a predisposition or tendency to opt for structural mitigation options over other technological developments like more developed water monitoring, weather forecasting systems etc. In short, for them, floods are still a scientific issue that requires traditional scientific measures only.

There is also a preference for cost-benefit analysis among the agencies in adopting any mitigation plan for the Kosi basin. For this analysis, they use statistical data to calculate the physical measures like level of water, the composition of soil and duration of flood etc., with the help of topographical maps. However, the construction of dams, dikes and embankments have continued in the basin since the 1950s despite the unfavourable cost-benefit ratio. The reason for this, as cited by the officials, is that, the government is committed to saving the at risk communities at any cost, and it is possible only by building more and more dams. It came into light that political agendas and political pressure to diminish the losses due to vulnerability takes over any other flood-related assessment in the basin.

The official's responses revealed that they must abide by the political priorities of every government. Citizens apply pressure on the elected government on which they are compelled to take action, and in return, the government puts pressure on the agencies. As they work under them, their political agenda precedes many of the ongoing works. Because of this pressure, sometimes the long term mitigation planning gets hampered because they have to divert the resources in other projects as per changed priorities. Along with resource diversion, financial constraints, lack of long term planning, and short term goals are some of the major factors that hinder the mitigation process in the basin. There is a need to adopt a combined approach where communities, local leaders and government officials can work together for the larger benefit of the affected communities.

In addition to this, the responses showed that there is a lack of long term planning and vision of how to reduce the vulnerability of the Kosi basin, that requires changes in flood-related behaviour and the perspective of the individuals (Blaikie et al. 1994) and also resource investment in dealing with the at-risk communities for their vulnerability reduction (Mileti 1999). During the field study, it was also observed that many respondents, irrespective of the institute they are associated with, felt that avoiding communication regarding flood issues is a

significant barrier in sustainable floodplain management. They were of the view that, often, people make decisions to fulfil their personal goals, without even taking care of the gravity of flood disaster and the the impact that their decisions will have on the at-risk communities.

Although, it became clear that the more people will be educated, the more attention they will pay to the performance and working ability of the institutions and will elect good government leaders, which might create a problem for a few people in fulfilling their personal agenda. It will also pressure the agencies as they cannot bluff an educated audience. Also, new ideas to improve public engagement and participation in the decision making process may pose a serious challenge to some flood control institutions' traditional approach of the top-down model and their increased dependence on technical solutions.

Additionally, the responses from interviewees also shed light on the aspects they keep in mind when mitigation decisions are taken. The agencies involved in flood mitigation operations seemed to have some preconceived notions of flood vulnerability, community participation in the mitigation process, how to reduce flood vulnerability and what problems they will face in that process. Apart from this, most of the respondents also agreed that the organizations themselves are facing multiple constraints by various factors in fulfilling their responsibilities. These factors include financial constraints, short-term goals, politically fixed priorities, lack of formal mandate, inaccurate assessment, basin specific plan, etc., which makes it difficult to recognise, formulate and execute the proper solutions in the long run. Also, participation of at-risk communities in the decision-making process is what almost every respondent desired, but the answer to how to participate is not very clear. On the other hand, some respondents were ambivalent about public involvement, some thought that people would not calculate the risk and hence would not take any interest in the vulnerability discussions. However, those respondents having this perception forgot that it comes under the role of the organization to make people understand the severity of the disaster.

This contradicts various research which suggests that government institutions are obliged to lead and are responsible for promoting ideas (here, flood management) that is beneficial for the society (Rokeach 1979). The lack of a proper plan regarding sustainable floodplain management is also clear from the responses; the reasons being given were lack of long-term vision, lack of proper mechanism, and lack of collaboration among institutions and different structures of the organizations. Also, there was no plan of restructuring the financial and human resources to reduce the extent of losses and achieve the goal of sustainable floodplain management.

5.2 Community perspective

In addition to the interviews of government officials working in institutions engaged in flood control and management in the Kosi basin, Bihar, the study also focused on the household surveys conducted in the Supaul district. Within the district, those villages which were directly or indirectly affected by the floods were selected for household surveys to be conducted. Apart from this, Personal interviews with the community members, and PRI officials were also done to gain an understanding of the level of awareness among the residents regarding flood issues, their perspectives and expectations on the functions and role of institutions engaged in flood control in the basin and also the existence as well as the mechanism of early warning systems regarding the flood. However, the next section discussed the general values and norms of community.

5.2.1 General values and norms of Community

This section focused on the vulnerability level of the flood disaster-affected communities by focusing on their attributes, norms, values, and perspectives, as well as the strategies used by them to combat the effects of flood hazards. It also takes into account the issues of flood

management faced by the residents of at-risk areas. Communities are the ones who have to bear all the losses and have to face the consequences of a hazard in their daily life. They have their own understanding of the severity of flood risk and perception of vulnerability based on their past experiences as well as from their daily mitigation activities. The main aim of this section is to explore the ways and means used by the residents to respond and cope with the severity of the flood hazard. It also shed light on the expectations that these people have from the government in terms of reducing vulnerability and protecting their lives.

This section deals with various themes that emerged from the data to give a detailed insight into the perspective and priorities of the community regarding vulnerability reduction. The people of the Kosi basin exhibited some values which provided them with a sense of recognition and identity and also bound them with their communities. One such attribute is the sense of security that develops with the time after spending considerable time in a particular place. Among the communities of this basin, the focus is more on the overall security that develops from connectedness and a sense of belongingness with other residents. The role of social capital in developing a strong perception of security is very important. The residents of this basin are quite rich in terms of social capital. The respondents revealed that they have a strong past of reciprocal obligations, loyalties, strong familial and kinship ties as well as large social networks. The people are ready to volunteer in any situation when it comes to the survival of their community members. It shows the extent of loyalties presents within the community.

Besides this, social solidarity, mutual trust, cooperation, strong social relations and communal support are some other aspect of social capital that binds the people and makes their connection strong. There is also a high level of compatibility, and community's ability to work for the overall wellbeing of the society was found in the basin. The pattern of leadership in terms of managing the flood disaster has been the same for decades, as revealed by the

respondents. The local leaders play an important role in the distribution of compensation and relief aid. They make the list of people affected as per the guidelines of the government and then distribute the given aid accordingly. However, there is always favouritism in selecting the name of people. Also, most of the time, the local leaders are not available when they are required the most. They only reach after the situation gets better. In those situations, the general public, as well as the volunteers, are the ones who help the needy people. The responses from the interviewees revealed that there is very low participation of the common public when it comes to decision making regarding various mitigation activities of flood management issues.

5.2.2 Communities experience of flood

The focus group discussions and personal interviews held with community members of the Kosi basin was mainly focused on knowing how they handle flood disaster, the measures that these people use during floods and the strategies they adopt to meet their key needs, saving lives, properties as well as their livelihood. The respondents were selected from villages that are situated inside, near or at some distance from the embankment. From the discussions with the respondents, it emerged that the basic problem is almost the same in every block of the Kosi basin. The kind of life lived by the people from the flooded areas are quite different from the life of the non- flooded areas. The respondents from villages situated inside the embankment revealed that the main reasons for the flood are the water released from the upper catchment area of Nepal after heavy rainfall and rising silt deposition in the river bed. They also revealed that in recent years, the river has been changing its course continuously, which has emerged as the major reason for flooding in the area. Earlier it was not the case.

Recalling his old days, one of the respondents revealed that:

When I was young, the whole village used to eagerly wait for the flood to come every year. Because our agricultural produces were directly linked and influenced by the

floods. The paddy varieties that we used to grow could suit every level and depth of water. Every year our land was rejuvenated with the fresh silt and water carried by the river, leading to a surplus yield of crops. Apart from this, the availability of fishes were also in abundance. We had boats to communicate with other villages. In almost every village, few people were deployed to beat drums at the time of Durga Pooja which was an indication of the ending of the flooding season. But now everything has changed.

Talking about the problems and severity due to flood, another respondent shared that:

Sometimes if you open your eyes in the middle of the night randomly, you will see 2- 3ft water in your house. In that situation, nothing much can be done as everything is already wet. Our ration, clothes, everything gets drenched and of no use. The major challenge that we face is the arrangement of drinking water and washrooms.

For respondents residing in villages situated outside the embankment, the problem along with flood is the phenomenon of permanent waterlogging. As there is no proper mechanism of the drainage system, the water that seeps from the embankment gets accumulated at one place and remains there for a longer period of time. They also complained of several damages in the embankments resulting in the entry of floodwater into their villages in every monsoon.

As one respondent shared:

Flood water comes and goes every year, but the earlier waterlogging problem was not that severe. Now, water remains in our field for 8-9 months of the year. I had to sell my livestock because of this, as I did not have money to buy fodder. Earlier I used to take them to the field to feed them. Now, we are starving, so from where would we feed them. Everything is in god's hand now.

The community members think that the problem of flooding is increasing by every year with increasing intensity. Previously the water level used to go down in a few weeks, but now the

whole village is submerged for months or sometimes for most of the year. Although it affects everyone, the most affected people by the flood losses are the ones who belong to the lowest income group strata of society. Given the condition of severity, they usually shift to some higher places to save themselves and their belongings.

As one of the respondents revealed:

There is no place for people like us on the earth. We are not allowed to enter other people's houses, let alone settle in the village. That's why we have made our houses outside the village. But since that is a lower land, whenever a flood comes, we are the ones who are affected first and worst. We have to leave our houses all of a sudden. It happens every year. Till the waterlogging remains, we stay on the embankment with our cattle. Sometimes we carry food items like Rice and pulses with us but arranging firewood to cook the food becomes challenging as everything get wet due to the flood, and we are not rich enough to purchase the things. Most of the time, we remain empty stomachs till the government relief of some NGOs reaches us.

The past experiences of floods help people in estimating the current tangible and intangible losses. But in recent years, the river Kosi has shifted its course and started dipping into new places, which has extensively increased not only financial losses but the loss of human lives the most.

5.2.3 Aspects of flood vulnerability

It is the opinion of the villagers that after the construction of the embankment, flooding has increased, because of rising silt and sand level in the embankments, the river changes its course, and new areas are being inundated. There is also an opinion that the officials visit the damaged site and embankment only during the flood. The respondents claimed that they keep bags filled with sand to close the damaged embankment sites and stop erosion which is not completely

helpful in preventing them. When they were asked to describe the extent of vulnerability as how much vulnerable they feel they are as the government official claims that the vulnerability has reduced to a certain extent in the basin after a lot of their efforts and the situation is improving by every year.

According to one of the respondents:

During the flood, our condition becomes so pathetic that if someone from other places has to face it, he will cry, but we survive. We are not left with even a single dry place to answer our nature's call. It is more difficult for women as they cannot go outside. There is no single product left, and every day we are face to face with death. The relief operations carried out by the government could help us in surviving, but that comes after days or sometimes after weeks or months. The government claims to serve people, then, what kind of serving is this when thousands of its population are starving.

Describing the situation in detail, another respondent explained:

I have never seen so many dead bodies the way I witnessed in the 2008 flood. Would you believe if I say that I must have come across 250 bodies of all ages? It was just a nightmare. I was getting calls from my sister, who lived in a nearby village, and she was repeatedly asking for help. I was completely helpless. I did not even know whether she was even alive or not and whether I would be able to find her body. I was completely clueless and helpless. There was no one to whom we could approach for help. Simply no one. The political leaders are only to take a vote; they take us for granted. This shows how cheap our lives are; there is no value for us.

When the river Kosi changes its course, the people not only have to face the sudden onset of flood but also have to face soil erosion, waterlogging, sand casting, completely dissolved communication system, scarcity of drinking water, collapsed health services, the onset of

several diseases because of dead bodies of humans and livestock's along with other problems. Reflecting upon the severity of the situation and how it is not only difficult but almost impossible to survive; one respondent added that:

No one can imagine the situation. Till the place your vision reach, you will only find water. Everything gets inundated. Our ration, clothes, beds, nothing is left. The rich people have access to dry fruits, but for poor people like us, begging is the only option left. And because everyone is facing the more or less same situation, it makes survival more difficult. In the last flood of 2015, not a single relief operation was carried out by the government for 15 days. The scarcity of boats led to many fierce clashes among people as everyone wanted to save their lives.

5.2.4 Livelihood vulnerability

The effect of losses from the flood is severely grave and dreadful (Sinha & Jain 1998) which makes more than half of the population of rural areas vulnerable. It creates a livelihood crisis for the people residing in the Kosi basin. One of the primary agendas of The Millennium Development Goal is to eradicate extreme poverty and hunger by creating more livelihood opportunities. While livelihood creation is the core concern of this agenda, it is also important to protect the lives and properties of the community, which requires prompt action on the part of the government. However, given the severity generated out of flood disaster, this seems quite impossible to achieve this goal. The severity of flood hazard has serious implications, particularly for those who are poor and come under BPL (Below Poverty Line).

In light of this, the main source of livelihood in the Supaul district is agriculture and allied sectors such as cattle rearing which includes cow and buffalo rearing, pig rearing, goat rearing and poultry farming mainly. Although, these sources have suffered greatly in recent

years due to excessive floods in both within as well as outside the embankment. This is because of continuous waterlogging, silt deposition and soil erosion, that the grazing fields have either disappeared or have shrunk. When the floodwater enters into the field, it does not only ruin the crops standing in the areas and other property resources but also sweeps away the main source of their livelihood, which is the result of years-long hard labour and struggle. The sudden onset of flood hazards is the worst nightmare for poor people because it does not give them a chance to think or plan anything. Continuous waterlogging in the area has increased the livelihood vulnerability of people as the survival rate of cattle has decreased sharply. During the flood season, there are not many pieces of dry land left which makes the cattle stand in the water for longer days leading to several water-borne diseases among them. Non availability of fodder makes them either die of hunger or live on water hyacinth, which is the reason for several stomach diseases. As there are no medical facilities available in the crisis, they ultimately die, leading to huge losses, especially for the marginal class. In addition, if the relief and rescue operation run by the government is delayed and not provided on time, it generates many layers of poverty for already poor beings.

Explaining the livelihood vulnerability, one respondent asserted:

We had six goats and one buffalo that helped us in earning a livelihood. But flood snatched everything from us. Last year there was very heavy rainfall in our village, everything was inundated. We ran towards the embankment to save our lives. I cut the ropes of my cattle and left them to survive on their own. After that, I did not see them again. All of them must have been dead, and their bodies must have been swept away in the floodwater. We are poor people and have no savings to purchase the livestock every time. We work as daily wage agricultural labour, and since there is everywhere water, including agricultural fields during the flood, we don't get work for months. Many times we sleep empty stomach because it always takes time for the government

relief to reach us. There are no other sources of livelihood left for us in the village, so we are thinking of migrating to Punjab. I have heard that they provide good wages to labour like us.

Many people of this area reportedly visit other places for their survival. This stands in line with the findings of the study done by Armah, Yawson, Justice, & Afrifa (2010) where they found that the households visits other places for their livelihood. The recovery of physical assets, as well as the re-establishment of previous kinship and familial networks that is lost because of the flood, is another major concern for poor households. However, building temporary shelters evacuating the people, their belongings and their livestock promptly before the flood are some of the aspects that can reduce the losses to a certain extent.

For the poor people whose livelihood depends on agriculture and the allied sectors in the Kosi basin, living in normal days is not easy in itself as they are paid less in comparison to labourers of other areas (such as construction labour) and on top of that, flooding makes it worse for them. The ineffective governmental policies, unfavourable political and socio-economic conditions, as well as adverse climatic occurrence, make the deprived people extremely poor by creating a poverty chain where the poor becomes poorer, and the rich become richer. The flooding makes the situation worse by degenerating the already fragile structure of the livelihood, which provides the base for poor people's survival. The agricultural condition of the state, which already has fragmented landholdings, low produce and lower output, further deteriorates because of continuous waterlogging for a longer period of time in the field.

Explaining the situation, one respondent added:

My grandfather owned two bighas of land that was very fertile. All the male members of my family used to work in the field, and our profit was also good. We had taken a

loan from the bank for cultivation and were paying the instalments. But in 2008, a flood swept away all the produce of our land. And after that, there is permanent waterlogging in the field. Initially, we paid the instalments from our savings but ultimately had to sell the land to pay the debt. My grandfather passed away because of that sorrow. Now I and other members of my family work as a daily wage worker in other fields. During monsoon, we become unemployed as there is water everywhere. So we have to beg the landlords to give us some household works to feed our children. Sometimes we manage to get some food, but most of the time, we remain hungry for days.

This shows the gravity of the situation faced by the communities at the grass-root level. Although the government of Bihar claims to have several flood control programmes to minimize its losses, most of the plans are executed after the occurrence of a flood which also means that when the damage is already done, the government tries to compensate it.

5.2.5 Impact of structural measures

When the respondents were asked to share their experiences of embankments, dikes and levees in reducing the effects of flood disaster, most of the participants were of the opinion that since the time embankments have been constructed, the severity of flooding has increased. They also asserted that, as per the government, the only way to mitigate flooding is through the use of structural measures. Structural measures are tangible structures like dikes, levees, embankments and floodway channels that are used as technological solutions to flood mitigation by the government to tame the river water. However, these solutions have failed to reduce the vulnerability and have only increased the intensity in the basin. Before the river was embanked, the water of the Kosi river was flowing through various different channels and during the flood, water would spread over larger areas, but now all the water has to run within a specified area of an embankment, causing disaster for the entire Kosi belt.

As one of the respondents shared:

In our village, more than 90% of the agricultural land is trapped within the embankments. The government built the embankments on this village's land. Apart from this, they also acquired a sizeable area of land to rehabilitating the affected people, and whatever land they left is submerged. Now, what should we do is a major question. All these problems have their root cause in the construction of the embankment.

The river Kosi is habituated to taking a shift from its natural course, and in recent years it has changed its root at various places, inundating several new areas. After the 2008 floods, at many places, as the old river channel is sand-filled, it has taken a new root. More than lakhs of the population have suffered undiscussed miseries because of embankment construction on the Kosi river. They have been exposed to the currents of the river in the name of safety.

As shared by a respondent:

My village was situated within the embankments. We were four brothers and had a big house where we lived in a joint family. We used to wait for the monsoon for our paddy crops. If there is good rain, then we will have a good harvest. When the river was flowing through different channels, the flood levels were not that deep. We used to grow our traditional variety of paddy. But in the 2012 flood, the Kosi river took everything from us. All our crops were destroyed, and our land was submerged. The flood that was a boon for us became a curse. All this happened because of the embankment, it was supposed to protect us, and this is how it has protected us. Since then, we have made the embankment itself our permanent home. But the government is not happy with this also as they blame us for the non-maintenance of embankments. We have not seen any official doing any kind of maintenance work after the monsoon, but they say they come from time to time, but repair works cannot be done if people are moving on it.

The structural measures to tame the river water have led to continuous water logging in the villages. The floodwater enters the villages before the land could dry after the last flood. To save their lives and belongings, people sometimes settle on the embankments themselves. Although they get several notifications from the government to vacate the place, they do not do so. Most of the people residing on the embankments come from the marginal class who do not have sufficient wealth to restart their life after every devastation.

The respondents were also asked how often the embankments are maintained by the government. It was visible from the responses that they were not satisfied with the current working pattern of the government officials. Most of the respondents were of the opinion that the government officials visit the embankment to look after the damaged sites only during the flood. The embankments are chased by a lot of problems like erosion of land, continuous waterlogging in the village area and sudden surge of river water due to embankment breach. The respondents claimed that they are the ones who, along with other members of the village, put effort to save themselves.

According to one of the respondents:

No one comes to help us. The leaders come only when they have to take a vote. When there is a breach in the embankment, we are the ones who put bags filled with sand to prevent the breach. However, this does not help in the prevention of soil erosion and embankment damage. The soil erosion has taken many acres of our valuable lands. But we are helpless in front of God.

Another respondent extended the argument by saying that:

The officials come to show their faces during floods only. Then also they don't come to our villages. Before their visits, they inform the 'mukhiya' and 'sarpanch', and with them only they do the formality. We are so fed up with their attitude that last time they

came for maintenance work, we 'gheraoed' them and asked for a permanent solution to the embankment breach. They started giving assurance that all our demands would be fulfilled by the government. They will report our situation to the higher authorities. Also, they said that all the damages of embankments would be corrected within the stipulated time. After these promises, people allowed them to go.

The failure or breach of embankments severely affects the daily lives of both living inside as well as outside the embankment. It is the primary job of the concerned department to protect these structural measures. Inundation maps are one thing that, if taken care of, can save many lives and losses. It provides an idea about the depth of flooding and also the lower areas that come under the high-risk zone. This will also provide a rough idea of which place can be taken as flood shelters so that people can be shifted there during an emergency. Once there is resettlement of people, relief operations can be organized in a better way leading to minimum corruption.

5.2.6 Flood warning system and perception regarding various mitigation activities

No matter how many embankments are built and maintained, the efforts will not be fruitful until there is a well-developed warning system exists that can give prior information regarding any breach in the dams and any possible flooding in the area to the people residing in the basin. Electronic media such as radio and T.V can be of immense importance in flashing the news regarding flooding levels in the basin. Also, loudspeakers can be used at the local level to make people aware of the emergency situation. Panchayati Raj Institutions (PRI) can be of utmost importance in this step. However, the participants revealed that there is no such warning mechanism exist in the basin.

As one of the respondents narrated:

There is no warning system, or early flood forecast system exist. As a result, no concrete information reaches us, resulting in severe loss of lives and properties. Whatever information we get is through discussions among us in 'CHAUPALS' (Public space). We also watch T.V., but it gives a general view of the situation. If some concrete information can be shared with us, we could shift ourselves to a higher place to minimize the losses.

In the Kosi basin, there is no means exists that can predict the exact timing of embankment breach or can provide messages of floodwater surge for the benefit of the people. The Flood Management Information System Cell (FMISC) established by the GOB is responsible for handling flood forecasting, early warning system and emergency response needs of the government. However, it seems that they are yet to develop a proper mechanism of real-time flood water surge that can help the ground level people.

When the participants were asked about their understanding of various projects and operations of flood mitigation run by the Government of Bihar, from the responses, it became clear that there is a weak public perception among the community members in understanding flood risk and mitigation operations carried out by the government in terms of information, interaction, engagement in flood fighting works and flood-related decisions in the basin. They were also asked if any kind of formal meeting was organized with the villagers or any kind of training is provided to them regarding flood issues or flood fighting measures. Most of the participants were unaware of any such meetings and had not attended them.

According to one of the respondents:

Since these programmes are government-funded they just go with fulfilling the paper. On record, everything happens as per the procedure, but in reality, they just consult a few people like 'mukhiya' and 'sarpanch', and the training of the entire community is

done. As a result, we don't know what to do during the flood and how to save our lives, assets and properties. When the floodwater enters our villages, there is chaos everywhere as most of us are still dependent on the traditional means of flood mitigation.

5.2.7 Involvement in flood management

The responses also shed light on the fact that why most of the plans are unsuccessful in reducing the vulnerability in the basin, despite the government investing hundreds of crores in the name of flood mitigation or flood relief. The main reason could be that If the public is not aware of the programmes made for their help, how will they coordinate with the officials. This shows the huge communication gap that exists between the representatives of the government and the common people.

As highlighted by one respondent:

The officials come to visit only the breached site of the embankment and have a conversation with selected members only. They never come to our village to meet with the different marginalised classes and feel their miseries. Until and unless you will see the level of severity, how will you know what we actually need? No one includes us in any of the planning and meetings then from where will we contribute.

The discussions highlighted that there is huge dissatisfaction among the residents regarding the way flood-fighting works are being carried out in the basin.

As shared by another respondent:

In many villages, some middlemen are assigned with flood-fighting works. They are hired on a contract basis. Most of these people are dishonest and have a set of forces whom they always involve in the work. It is very important to get any kind of work

during the flood as it helps to survive. Last time these contractors were short of people, so they asked us to help them. My friends and I worked for them for about ten days, but they did not pay us. We are poor people; we work for money, and if we don't get that, why would we work.

The participants also complained that their advice and suggestions were not taken into account by the leaders. It also emerged from the discussion that there is nothing called planned strategies used by the communities. They act as the situation requires.

As explained by one respondent:

As the floodwater enters suddenly, we do not have much time left to make strategies. But we unite in the crisis and help each other as much as we can. We also help the officials in filling the holes of the embankment that too without payment. Most of the male members of our village are well versed in swimming, and for the women, kids and elderly people we hire boats. Although it is very expensive, we do not have any other means to evacuate. For rich people, it's still easy to survive, but for the poor who cannot afford to hire boats, banana trees and bamboo acts as lifesavers.

The participants also revealed that the elderly people of the village, by looking at the current of river water, forecast about flood situation. Most of the time, they have proved to be correct. If they find something serious, they also inform their local representatives about this.

5.2.8 No Relief only compensation

Once the government fails to control the floods, the next thing they do to save themselves is to announce relief packages for the affected population. Generally, reliefs, aid and compensations are announced when the impact of the flood is severe. However, most of the flood victims are unaware of the announcements since they do not have the resources to purchase newspapers

and electronic items like radio or T.V. where this news is broadcasted. The officials take advantage of these and give the responsibility of relief distribution to their favourite persons. Consequently, most of the time, the relief materials are misused, mishandled and manipulated by the distributors and does not reach the actual needy person. Most of the respondents asserted that there is no flood preparedness activity done by the institutions. The government mainly focuses on providing aid and skips easily from other responsibilities. For the people residing in the Kosi basin, the main sources of income are agriculture and cattle rearing. While the agriculture gets destroyed as the standing crops are drowned in the fields, and there is no future scope of other products because of waterlogging. The big farmers somehow handle the situation with the help of their friends and relatives, but the problem arises for the small farmers as there is no source of income left for them. Given the water level and its swift current, the people caught in the flood are not able to contact the government offices for a longer period of time. The government also takes benefit of the situation and does not start its relief operations until the situation gets somewhat better. However, they do not forget to show on papers how many lakhs and crores they have spent on distributing reliefs.

As one respondent elaborated:

The officers show their face only after the flood comes, and that too to our local leaders only. They do not visit our village to know whether we are alive or dead. They just complete their visit for formality. They do not meet with us but only with our local leaders to take the list of affected people for providing relief and compensation. It is clear that the government is not interested in providing relief but in providing compensation as it will save its resources. It will have to provide compensation to fewer people who will survive the disaster.

Another respondent extended the argument by saying that,

In the last flood of 2012, no relief of any kind was available till the eighth day. Whatever help was available came through friends and neighbours and also through some local NGOs. After the eighth day, some readymade food packets were made available by the government, but that was not sufficient for the entire affected population. Many people could not survive because of the unavailability of food items, and it almost happens every year.

Many respondents also shared the partiality or favouritism that occurs while adding the name of people to the compensation list.

As per one respondent:

There is nothing free. Even if the government sends the aid for us, we cannot get it until we pay some bribe to the local leaders. This bribe increases or decreases as per the status of the person. If someone denies it, he/she does not get the help. So all of us have compromised with the situation.

Every year the government promises to compensate for the agricultural losses to the people, but they are also aware of the fact that it is not possible to count every single loss. Most of the time, they run out of funds and ask the central government for help. The government officials are of the view that with the current finances, it is not possible to compensate everyone. Also, there are many people who, as per them, do not work to improve their condition because they have become dependent on the government and take reliefs as their right. This leads to the moral degradation of the community by making them beggars. However, it is not totally correct. The person who has lost everything to flood has no other way left than to be dependent on the government. With time population has increased, and so has the number of flood disasters. And the government is responsible for taking care of every citizen. The amount of relief funds has reached from lakhs to crores, but the plight of people has become worse. The

government needs to understand that the people lose not only their land but also the crops they plant, and the savings they invest, and in many cases, they also have to pay the loan instalments, which makes them more helpless. The government needs to have empathy and a focused vision to understand the problems of compensation and rehabilitation. If possible, the land should be compensated for land, not for cash or anything else. This will help in reducing the disparity to some extent.

5.2.9 Seeking rehabilitation

The most important concern that the majority of community members showed was regarding their resettlement and rehabilitation. Given the severity of the flood, every year, they have to move from one place to another to save their lives. Losing monsoon crops was a normal thing in the basin, but now because of waterlogging, even winter crops are also under threat. However, despite the losses, the community has to pay the land revenue tax every year. The issues of safety, compensation and resettlement of people residing in the Kosi basin should be of utmost priority for the government, which needs to be dealt with empathy.

As shared by one respondent:

Every year flood comes and takes away everything that we claim is ours. Our standing crops are ruined completely. Most of the time, it washes away our huts, leaving us to survive on roads that are already filled with water. But we have to pay the revenue at any cost to the government. Many of us who are now landless labourers migrate to states like Punjab and Haryana during monsoon to search for livelihoods. They return only after the flood subsided.

After the construction of embankments, three distinct patterns of the landscape emerged. The first one is the area covered between two embankments. This area is regularly attacked by the river water. Also, the problem of soil erosion and sand casting is more intense in this area. That

is why some of the people who got settled on the rehabilitation site have moved back to their original places because their land has been trapped within the embankments, and despite waterlogging, sand erosion and sand casting, that is the only source of livelihood for them. However, within embankments, if any piece of land is eroded, the landowner loses it, and the ownership goes to the government. Even if the land re-emerges after some time, the ownership remains with the state till the original landowner claims it to be resettled in his name. In most cases, since the landowner does not stay within the embankment, the state becomes the legitimate owner of the land.

As shared by one of the respondents:

In the past 42 years, 14 times our village has been eroded, and every time we built new houses. My agricultural land was located inside the embankment. In 2008, the flood was so severe that my land was completely eroded, and I could not locate it. However, sometimes back, it re-emerged after sedimentation, and I tried to make use of it. But then I came to know that it does not belong to me anymore. When I approached the office regarding this, he said they enquired, and because no one came for the resettlement of land ownership, it automatically went to the state.

It shows how most of the people are compelled to leave the rehabilitation site and go back to their ancestral habitat and fields because of livelihood compulsions. After these people leave the rehabilitation site, the government gives the vacant land on lease for agricultural purposes to farmers.

The continuous shift in the river course, soil erosion, sand casting, rising riverbed due to deposition of silt as well as lack of irrigation and marketing facilities are a few important factors that are not only ruining the agricultural production and livelihood possibilities but also making the overall economic condition vulnerable for the people of Kosi basin.

As shared by one respondent:

Our lives are just trapped within the embankments. There is no difference; whether we are in water or water is inside our house. There has been waterlogging for about five to six months. We have to use the boat to go to our neighbour's place or even to answer nature's call. Almost 20,000 people live in our panchayat, including a primary and middle school and all remains under deep water for more than five months. The river bed level is rising continuously, but the authorities are not paying any attention to it. It is affecting the floors of our houses, and the size of doors has been reduced to the size of a window. We were rehabilitated in another place, but that area got submerged a few years back. That is why we have made the embankment itself our permanent home.

This highlights the plight of those who lived and have continued to live in the Kosi basin. All these constructions have been done by the government in the name of development, but this government has not been able to secure the lives and properties of lakhs of people who become homeless every year. There is no choice left but to migrate to places like Punjab and Haryana for livelihood.

5.2.10 Need for non-structural measures

In contrast to the emphasis on engineering measures of flood control such as the construction of dams, embankments, dikes and levees, there is a need to develop different non-structural measures like early warning systems, flood forecasting mechanisms, river mapping and also floodplain management policies that can help the people in fighting the flood disaster in a more practical way. Non-structural measures focuses on human perceptions and behaviour that play an important role in reducing vulnerability. If real time information can be disseminated to the at-risk communities through various sources like radio, T.V, and newspapers it will increase

their trust in the government and also will save their lives and properties. Haynes et al. (2008) in their study based on volcanic hazards have emphasized on the fact that the hazard management agencies should develop and maintain a trustworthy relationship with at-risk communities to improve their coping capacity. The advantage of non-structural measure is that it expands the range of resources to the common people.

As one respondent explained:

This is our land. Our forefathers have been living here for centuries. We know how to survive flood emergencies. We cannot leave the place as the land belongs to us. During emergencies, we shift to higher places. The only problem is that the flood water enters suddenly. If we could get the information a little early, we can minimize our losses to a great extent. We do watch flood related news on t.v. but it gives very general information. The government should find ways to predict the flood situation and also ways to manage the floodplains. This will help lakhs of the population to survive in a crisis.

As mentioned by Scanlon (2007) The role of media (t.v., radio, internet) in any hazardous situation is very crucial in transferring or sharing information within a larger section of society. During any disaster real-time effective warning to the audience can be reached through media participation (ibid). However, in our study respondents showed lack of trust in the information provided by various media sources. The balance between government and community priorities, providing flood education, and thorough understanding of local people's perceptions and experience about flood risk challenges and mitigation is a better way to lead sustainable flood management. But unfortunately, the decision-makers do not consider these aspects but only relies on structural measures. No attempt is made by them to bridge the gap. The concept of 'living with floods' should be given top priority as it is impossible to completely shift this

much population to a safer place, and no dam or embankment can guarantee a hundred per cent safety. That is why this concept needs to be encouraged along with the use of modern science, which does not mean stepping back or total surrender but finding ways along with the natural forces. The main reason behind the meandering behaviour of the river is the excessive load of sediments which causes soil erosion. Soil erosion has been taking place for ages, but it is more severe for people residing inside the embankments. There is no permanent solution for the problems faced by the people as per the government, but this can be minimized to a certain extent if floods are planned well.

5.2.11 Local Knowledge / Indigenous Technology

A large number of technical solutions have been applied to mitigate the flood disaster, but they have failed to protect the flood victims. The failure can be primarily attributed to the local peoples' exclusion from the strategic decision making regarding flood mitigation activities. The local people are the primary stakeholders who might give strategic insight into flood mitigation activities with the help of their indigenous knowledge (Vari & Ferencz 2006). The households' capacity to manage their vulnerability is referred to as "Resilience functions." (Sapountzaki 2012). The emphasis of The UN Yokohama strategy is on the significance of indigenous knowledge. It says, by giving recognition to the traditional practices of the local communities, they can be made resilient and self-confident to cope with flood disasters. Indigenous knowledge referred to the strategies of the communities developed over a period of time while being at the ground level to cope with and recover from any hazardous condition (Castro & Ettenger 1996). The indigenous knowledge and skills of the at-risk communities enable them to adopt different measures suitable to fight flood disasters. It also makes the community capable of living with changes and uncertainty (Kundzewicz & Schellnhuber 2004). Therefore, the role of indigenous knowledge is very crucial in meeting the flood

challenges both during and after a flood disaster. It is the result of an individual's stay in a particularly flood-prone area which enables them to develop and collectively respond in the emergency situations of flood disaster (Kreps & Boswrth 2007). The community's resilience measures include temporary mobilization and shifting from flood-affected areas to highland areas, sharing of resources in order to survive, limiting their resource consumption, changing agricultural patterns, plantation of erosion-resistant plants, utilization of kitchen gardens and also using non- agricultural options of livelihood (Corbett 1988).

When the participants were asked what the measures or techniques are that they apply to deal with the flood disaster within their household or farm, one of the members stated:

Since flood is a recurring phenomenon in the area, we have become habituated to living with it. We have our own ways to cope with it, which we have learnt from our forefathers. Most of our elder people are experts in analyzing the river current, and as per their advice, we become ready to evacuate the place.

This stands true with the findings of the study which states that the past flood experiences stimulates the households flood preparedness which is based on their familiarity and understanding of flood devastation (Basolo et al. 2009). The term 'Local Knowledge' consists of practical capabilities that emerged from local conditions and natural surroundings. These capabilities have been tested over a long period of time. One example of such knowledge is the use of a makeshift boat (Jugadu Nao).

As explained by one respondent:

It's like overnight; you wake up and see there is water everywhere. Sometimes the roads are filled with 2-3ft water. In that situation, we cannot wait for the government to come to immediate rescue. So what helps us then is our traditional system of making makeshift boats. We use Banana trees as 'nao' to reach a dry place. That's why we

purposefully plant Banana trees in our courtyards so that they can help us in our time of need. We also use tubes to make temporary boat. Last year my sister in-law was pregnant, and we were waiting for the due date. Suddenly, one day when we woke up, we saw 4-5ft water in our village. We came to know that the nearby embankment has breached. All my family members started panicking, and my sister-in-law got labour pain started. I immediately called our 'mukhiya' for help. But he switched his phone off after saying that he could not do anything as it was an emergency situation for everyone. Then I called my cousins from the neighbourhood; we gathered four tubes and placed a 'chachra' (made of bamboo woods) on it so that my sister-in-law could lie down as she was unable to sit. Finally, somehow we were able to send her to PHC. Although it was quite a risky affair, it was a do or die situation for me.

For the people living in the Kosi region, a boat is of utmost importance for their survival during the flood. Since government boats are very few or only one for many villages, the villagers use their own skills to build makeshift boats. This is consistent with the findings of the study which asserts that the indigenous knowledge of a household plays a vital role in their survival and livelihood resilience (Nyakundi, Mogere, Mwanzo, and Yitambe 2010). Some rich people purchase wooden boats, and these people enjoy higher status in the village. As a result, people invest more in purchasing boats than Anything. This has also led to an increase in the business of boats.

As per one respondent:

The majority of weddings take place between May-July and during this period except for boats, no other means of transport works here. So, people hire boats instead of cars to travel in marriages. This is the primary reason why people invest more in boats than inexpensive vehicles. There are different types of boats with different price tags. Boats

made up of 'Jamun' (Blackberry), and 'Sakhua' (type of wood) are very expensive and costs around lakhs per boat which is almost equal to the value of a small car. There is a saying in our village, that the larger is the size of the boat; the higher is the influence of a person in society (jiski jitni badi nao, samaj me uski utni badi moonch). However, there are also less expensive boats that are used for carrying firewood and fodder for animals. In comparison to other parts of the country where people purchases large, heavy vehicles to show off their status, in this region, having a boat is a synonym for higher status. Rich people who can afford purchases boats that have motor engines while the poor people prefer smaller ones.

As per another respondent:

I am a boat mechanic. This is our family business. We are earning quite better from this business. This year since there was an early flood, the boat business reached its peak. In comparison to the last few years, the sales of boats are more this year. However, the demand for smaller boats has increased simultaneously. Those people whose lands are trapped within embankments have to travel a long distance daily. So, they prefer smaller boats that they can drive by themselves. It saves their money, as hiring a boat for the everyday course is quite expensive here.

The people of the Kosi basin keeps an eye on the flood situation and remains ready for the emergency that may arise. They also have places identified to put their items when floodwater covers the danger level. Also, they shift to safer areas by taking as many items as they can carry with them. Whenever any disaster takes place, immediate rescue operations are started by the community members only. Government reliefs reach them only after days or sometimes months. In this situation, another method used by them to save themselves is the use of a higher place on a tree which they usually call 'Machaan'. It is a temporary house built at a relatively

higher or elevated place where normal flood water cannot reach. It is generally made of bamboo sticks , and the roof is covered with a plastic sheet.

As shared by one respondent:

Flood is a regular phenomenon. We are habituated of living with it. In the initial stage, when the water level starts rising, we take the edible items with us and shift them to our tree house (Machaan). If our luck works fine, we return to our original houses in less than a month. Otherwise, we place our tent(Tambu) on the roadside and wait for help.

The heavy items of the household that cannot be carried out are either tied or kept on the rooftops of the houses. Temporary arrangements with the help of plastic sheets are made along the roadside, railway tracks, national highways, or any elevated areas. When the situation gets normal, people return to their original places. This stands in line with the studies done by (Pahl-Wostl, Mostert, & Tabara 2008; Fatty & Patel, 2013) having similar findings which states that in such conditions households have no other option rather than getting back to their traditional indigenous knowledge and utilizing them to create temporary shelter at more safe places. As all the firewood gets wet during a flood, food is rarely cooked by the affected communities. The arrangement of drinking water and other essential items remain a challenge for them. Sometimes, there are food packets distributed by the government, but it is not being made available to everyone. While one person gets many packets, some people die out of hunger. Also, most of the time, the food packets fall short of fulfilling the requirements of the flood victims.

As shared by one respondent:

We keep dry items like flaxseed(Tisi), flattened rice (Chura), gram flour (Sattu), Jaggery (Gud), and gram (Chana) with us to meet our food requirements. These items

do not need to be cooked and can be eaten raw. These are ready to eat items and fill the stomach for longer hours. It can also be stored for months.

As the duration of the flood has increased, the cropping pattern has also changed. Earlier, the inhabitants used to go for traditional farming.

As shared by one respondent:

Before embankment construction, we used to have mixed cropping that included maize, paddy and green gram. Among all these crops, maize was susceptible to flood water, so we used to sow it in early February or March. We had different varieties of paddy for different depths of water like Dasharia, Bakol, Kasahan, Bbelaur etc. In the Rabi season, we used to grow wheat, khesari, raincha, oilseeds and mustard. At that time, the moisture was so good that we did not need much irrigation. Now, the water remains there in the field for almost the entire year, and then there is early flooding. This has changed the entire cropping pattern. Now we grow mostly paddy that too of a different variety than the earlier.

Adding to this argument, another participant explained:

We were very happy earlier with the blessings of the Kosi river. But we have made her angry. It is because of her displeasure that she brought silt and sand to our land, causing soil erosion. The Kosi river has always been worshipped as a holy river. Earlier, whenever she became angry and caused a flood, women used to offer vermilion to her. And because Kosi is an unmarried girl who is afraid of losing her virginity, she would run away after looking at the offering. However, it does not happen now because the level of our sins has increased.

People in the basin think that the continuous waterlogging spread of sand and silt in the canals and beds is the result of their sins. People also complained that while their fields are submerged

under flood water during monsoon, in other seasons, they have to put a lot of effort to irrigate their fields. No Kosi canal produce sufficient water for irrigation.

As shared by one respondent:

We have our farm where we produce paddy. But we have to arrange for irrigation by ourselves. It's been more than a decade since we got irrigation water from the canal. We use bore-wells for our agricultural purposes. Our village has more than 20 bore-wells, including bamboo wells. The bamboo wells work for three years.

Another respondent extended the argument by saying:

Ten-fifteen years backwater used to flow in the canal. It was of immense help in the Kharif season. However, in the Rabi season, we always had to manage on our own. The reason behind this is the deposition of sand in the canals and distributaries. But we have to pay a certain amount whether or not we use the canal water. We have also complained to the concerned official in the irrigation department. But he says he cannot do anything as it is a governments order. We silently deposit the money as we cannot fight against the whole system. We think of this irrigation tax as one of our agricultural expenses.

The canals that were dug with so many expenses are of no use for most of the villages. Only some of the villages which are close to big canals get some benefit. Other than that, it is more of an expense for the people. If some of the farmers refuse to pay the irrigation bill, they are bullied by the officials. Furthermore, the villagers use bamboo or iron rod to determine the depth of silt and sand and accordingly reschedule their cropping system. These findings are consistent with the studies of (Burke & Lobell 2010) which states that the various practices of agriculture including rescheduling of cropping and sowing patterns, and increasing or shifting of cultivation area are being explored by the households as means of survival in a flooding

condition. Bamboo is used in hand pumps to extract water. The farmers tie a seed pot around their belly, carry a cotton piece of cloth which they call 'Gamachha' and float in the marshy land to sprinkle the seeds in the field. flood damages have made the life of people hell. This is the reason they take it as a curse. Continuous flooding snatches all the resources and support systems of the residents of the Kosi basin. The government officials by joining hands with the political leader, either digest all the relief funds sent for the flood victims or distribute them among their favorite ones. A lot of scams are listed in the name of political leaders. It seems like an open loot that no one takes action against despite several complaints.

Conclusion

This chapter has discussed the norms, values, perspectives, measures and priorities of the government institutions involved in the flood mitigation activities as well as the beliefs, values, perceptions, behaviour and strategies adopted by the communities to fight flood disaster in the Supaul district. The findings of this chapter suggests that the authorities needs to understand the grass root problems of the communities in order to solve them. It also reflects that, the lack of communication and information dissemination between the authorities and the communities is one of the primary reasons behind failure of many of the flood management programmes run by the government. Also, more focus should be on preparedness and mitigation rather than relief and compensation. The next chapter provides a summary of the findings of the study, followed by limitations of the study and future scope of the study.

Chapter VI

Conclusions

The level of flood risk perceived by society does not coincide with the levels of flood risk determined by the experts (Duzi et al. 2014). They tend to perceive flood risk more realistically than the whole of society (Krasovskaia et al. 2001). The underestimation of risk is a major problem and a challenging task in terms of managing it. Knowledge of factors shaping subjective flood risk perception can provide a solution to this persistent problem. There is a need to understand the relational arrangements between various elements of risk and the potential factors influencing it. In light of this, the present study examines the influence of socio-demographic characteristics and social capital stocks and place attachment levels on flood risk perception. The present chapter provides a summary of the findings of the study and draws conclusions in relation to the argument presented earlier. The following section discusses the limitations of the study and sheds light on the scope of future research in the field.

6.1 Summary of the findings

The present study has been divided into six chapters. The first chapter has introduced various components of the thesis attempting to capture review of literature, research gaps, research questions, objectives of the study, methods of data analysis, the structure of the thesis, and so forth.

The second chapter provided a socio-historical analysis of the nature and extent of flood damage in the state of Bihar in general, for the period of 1980-2020, and in Supaul district in particular, for the period of 2000-2020. The chapter also sheds light on the morphology, flooding aspect, and changing course of the river Kosi including a brief history of the embankment around it. By providing a brief record of the flood policies adopted by the government of India, the state of Bihar reflects the strategies planned by them for the mitigation

and control of flood disasters. It also brings forth the details of the government institutions engaged in the field of water resources and flood control and management in the state of Bihar. The study's findings suggest that although floods are an annual phenomenon in Bihar, their frequency and severity have increased in the last four decades. The primary reason for disastrous flood events in Bihar is the presence of the Kosi river. The river often meanders and shifts its course, and while shifting, it inundates new areas of land. In the late eighteenth century, the river flowed east of Purnea, but in the last two centuries, it has taken a westward shift and now flowing near the Supaul district of Bihar. A large part of fertile land has been laid waste because of the shifting nature of the river. Besides that, high river discharge and overbank flooding have caused extensive damage and long-term inundation in various regions of Bihar. This is the primary reason the river is called the 'sorrow of Bihar.' While the government repeatedly blames the shifting nature of river Kosi as one of the root causes of flood events in the state, it does not actually focus on the reason behind this. The river Kosi carries a very high load of coarse sediment, soil, and silt. It is the highest sediments-carrying river in India. The accumulation of these sediments, soil, and silts have increased the river bed's level. As a result, when the water level rises in the river, it spreads to new places and submerges them. Also, the presence of these silts often chokes the drainage system of canals, spurs, and reservoirs leading to severe long-term waterlogging in the areas. If the solution to dispose of the sediments and silt could be managed, this would be a great step in flood disaster management in the state.

All the major flood calamities in Bihar from 1954 to 2020 are the result of mismanagement of the Kosi river. After the devastating floods of 1953-54, the government of Bihar, in an attempt to solve the problem of flood disaster, came up with an idea of embanking the river known as the 'Kosi project, which was started in 1955, right after the adoption of the first flood control policy in 1954 in India. Although many engineers opposed this decision by

citing that the high sediment load of the river would make the embankment useless for some time, but no one listened to them. Built under a bilateral agreement between Nepal and India, the project mainly focused on hydropower generation, flood control, and irrigation in both countries. Though the project did serve the purpose of irrigation and hydropower generation, it failed to fulfill the state's main aim of flood control. Not only did the severity of floods increase, but the rise of river bed level, drainage congestion, and permanent water logging outside the embankment are some of the additional adverse effects of the Kosi project, which is not taken care of by the government. The government's belief that the final solution to the floods faced by the people in the Kosi basin is the construction of high dams, spurs, revetments, and embankments on the river is visible in the policies and strategies adopted by them.

Despite the increasing investment in flood disaster management, both flood-prone areas and flood damages are increasing in Bihar (Mishra 2003). Despite having a five-decade-long history of managing Kosi floods, the river continues to bring hardships to people's lives. It often puts a question mark on its population's survival and challenges the government in terms of mitigation and control. Among all the natural hazards, floods are the most dangerous and costlier, which not only cause economic losses but also sweep away human hopes and aspirations. When it comes to controlling the flood disaster, Bihar extensively relies on structural methods of flood protection. However, the embanking of the Kosi river in a confined space has increased the problem rather than solving it.

The extent and magnitude of flooding can be assessed through the frequency of its occurrence and the damages done by it. Floods not only cause physical and economic loss but hinder the overall development of a nation in the long run. Analysis of past flood damage data reflects the magnitude, frequency, and severity of the disaster and also offers ways to manage them properly in the near future. In the last four decades (1980-2020), flood loss data analysis of the state of Bihar reveals that major damages to crops, the total area affected, cropped area

affected, the population affected, house damage, and public utility damage have been caused on an annual basis by floods. Agriculture plays a major role in Bihar's economy and is also a major livelihood source for the state's population. Even then, major crop damage on an annual basis has occurred in the region because of floods, which means the hard work of lakhs of farmers has been swept away in one blink. In the last forty years, 2015 marked the most devastation regarding the highest crop damage. It is the same year when maximum damage to the cropped area, total area, house damage, and public infrastructure. In addition, the decade of the 2010s accounts for the highest crop damage caused by flood disasters. Moreover, the maximum damage in every aspect, including house damage, area affected, and public property damage, occurred in the same decade. This indicates that not only millions of the population became homeless, but were also deprived of good food and the basic amenities of health and education. The losses of all these tangible and intangible assets make the lives of the population measurable and push the growth of a nation decades back. The continuous increase in overall flood damage is the present condition of Bihar.

In North Bihar, the Kosi river challenges the government and the population regarding recurring flood hazards and continuous water logging. Among 38 districts in Bihar, 28 comes under flood-prone areas but floods severely hit 15 districts on an annual basis. Supaul is one of those districts where floods are an annual phenomenon. It makes the district one of the most flooded in Bihar and India. The main occupation of the people of Supaul district is agriculture, and cattle rearing, both of which are most vulnerable to floods. The data analysis of the last two decades, 2000-2020, reveals that major damages to crops, houses, public utilities, and human lives have occurred in the district almost every year. However, in 2008 the maximum crop damage occurred. The primary reason for the 2008 floods was an embankment breach in the Kosi barrage in Nepal. The same embankment constructed to protect the people from the floods brought one of the rarest disasters in the state's history. The level of the 2008 floods can

be assessed by the fact that it was given the tag of a 'national calamity'. In the 2008 floods, supaul was one of those five districts whose 90 percent population was affected by the disaster. All 11 blocks of the district were affected, but five blocks were wholly swept away by the flood water. However, the year 2001 with regard to total loss of crops, houses damaged, human lives, and public utilities have proved to be most disastrous. Supaul has faced continuous severe floods in the last two decades, making the decade of the 2000s most vulnerable for the population in terms of survival.

All these annual losses in the Supaul district and in the state of Bihar indicate the failure of structural measures of flood protection. The present solution to flooding control in the state heavily depends on the engineering solutions of dams, embankments, flood walls, reservoirs, etc. Though, if these structures are adequately maintained, they protect a few areas. But, due to improper maintenance, many of these constructions collapse, and floods due to embankment breaches are more devastating than the normal ones as they spread quickly because of its rapid flow and swift current, submerging the areas. Also, the overbank flooding causes long-term waterlogging in the areas outside the embankments, making it hazardous for the population. This is similar to what Beck (1992) has argued: modern societies' innovations have failed to address the impacts of globally emerging hazards and have changed them into "risk societies". This new form of society requires new methods and approaches to deal with the problems.

The government should consider the fact that embankments are temporary solutions to flood disaster and provides a sense of false security among people. Therefore, it's high time to look beyond them and adopt a more holistic approach to flood control and management. An integrated flood management policy that could involve the local engineers, scientist, and community members in developing a long-term plan to deal with the problems of flood management, soil erosion, and silt deposition is the need of the hour. The focus on disaster relief and recovery should be shifted to disaster preparedness, and here comes the role of non-

structural methods like flood forecasting, land use planning, early warning systems, etc. These measures should reach every person through information and communication technologies to minimize the loss.

The third chapter examined the influence of socio-demographic characteristics and social capital on flood risk perceptions. It also captured how the two forms of social capital enhance the coping abilities of flood-affected households. The first section analyzed the variation in the household's stock of social capital as per their socio-demographic profile. The study's findings reflect that the marital status of the households does not contribute to variations in their stock of social capital. The results also revealed no influence of family types on the household's social capital stocks. The education attainment of households also seems to not contribute to the stock of their social capital. However, a slightly uneven distribution of bonding social capital across the different occupation categories was found to indicate a somewhat higher stock of bonding social capital for households engaged in farming activities.

Furthermore, the result revealed a strong connection between the length of residence of households and their levels of bonding and bridging social capital. This indicates that those who stayed in the area for more than thirty years have higher stock of bonding and bridging social capital. Other variables such as caste, religion, income, and gender were not found to be contributing to the variation of social capital stock of the households. The following section has analyzed the correlation between the two forms of social capital and flood risk perception of the households. The findings suggest a positive correlation between perceived risk and bonding and bridging social capital. The correlation coefficient of bonding social capital was found to be the highest with household perceived risk. As the individual's risk perception is based on subjective risk assessment, their socio-demographic characteristics play an important role in shaping their risk perception. The findings suggest that, among socio-demographic characteristics, occupation, length of residence, gender, and cast were found to be significantly

associated with the risk perception of households. This means that residents whose livelihood is dependent on cultivation perceive more risk than their counterparts. One of the study's major findings is the significant relationship between the length of residence and flood risk perception of the households. This reflects that the more time a household stays in a flood-prone area, the more likely he will perceive flood risk. In other words, the time an individual spends in a particular area determines his level of risk perception. If individuals stay in a flood-prone area for a longer period of time, their risk perception will be higher than those who had stayed at the place for a shorter time period. Another major finding of the study is the significant relationship between gender and flood risk perception. As per this study, the male household's risk perception is higher than their female counterparts. However, the result does not correspond with the findings of earlier studies by Flynn et al. 1994; Finucane et al. 2013; Brown, Largey, & McMullan, 2021 where women were found to be perceived risk higher than men. This variation could be attributed to the different research areas, sample size, and the type of risk studied. Finally, the significant relationship between caste and flood risk perception reveals that the households that belong to a non-general caste (OBC, ST, SC) have a higher risk perception than the general category of caste.

In contrast to these, the variables such as marital status, family type, education, religion, and income seem not to influence the risk perception of the households. Therefore, the study finds that flood risk perception of households varies as per their socio-demographic characteristics, viz. occupation, length of residence, gender, and caste. Ulrich Beck conceptualized risk as democratic and risk society as everyone's problem (Beck 1986). Our findings show that risk is not democratic in nature and is distributed quite unequally along occupation, length of residence, gender, and caste of individuals. The flood is not shared evenly as Beck depicted. It varies across socio-demographic characteristics of individuals. Beck did not focus on the cultural differences in the salience of different kinds of risk, although it is clear

that policy framing and responses to risks vary widely even between socially and comparable regions, such as North America and Europe (Jasanoff 1986). Therefore, a region's socio-cultural milieu and local condition play a salient role in shaping individuals' risk perception.

The regression analysis reveals that bonding and bridging social capital are positively and significantly related to flood risk perception. It shows that both forms of social capital contribute to the flood risk perception of the households. In other words, those individuals with a higher stock of bonding and bridging social capital perceive flood risk as higher than those with a lower stock of bonding and bridging social capital. However, the effect size of bonding social capital is higher vis-à-vis bridging social capital. This means that households strongly connected with their family, neighbors, and close friends will perceive risk as higher vis-à-vis households loosely associated with their family, neighborhood, and close friends. The strength of strong ties (bonding social capital) was found to be dominant in determining the perceived risk level of households. This shows that the key elements of bonding social capital, i.e., trust, social norms, reciprocity, and community participation, play an instrumental role in determining the subjective risk assessment. Therefore, households with a small and less diverse social connection tend to influence their risk perception more vis-à-vis households with large and diverse social ties. The positive linkages between social capital and flood risk perception provide insights on how to best utilize social relationships for effective flood risk management. Strong social embeddedness in bonding and bridging social capital can reinforce households' experience and thereby augment risk perception (Siegrist and Gutscher 2006). Simultaneously, the formation of social norms can elevate the coping abilities of households. Combined, these two outcomes can lead to improved risk communication (Slovic 1993).

Furthermore, the thematic analysis of qualitative data indicates that social capital strengthens the coping abilities of the households. Social capital as an indicator of coping

appraisal plays a critical role for the households of the Supaul district, who are under constant threats of flood disaster. The findings suggested a strong relationship between bonding social capital and coping abilities of the households of the Supaul district. In other words, those households with more stock of bonding social capital had higher abilities to cope with the disaster. There are usually two forms of support that households get from their bonding networks; financial and non-financial. One form of mutual support is the financial help that households receive from their family and friendship network. These networks are based on mutual trust depending on a person's capability to repay the loan and reciprocate these exchanges when required. Family and friends help the households financially without any interest charge in stressful situations. It is evident from the interviews that the practice of informal moneylending is very strong in the region. If an individual does not have the stock of bonding social capital, he often fell prey to these moneylenders who lend money at higher interest rates. As a means of survival, households accept the money at any cost, often making them sell off their properties or be a slave to that moneylender. However, the households having strong bonding social capital are saved from the claws of this. The study also reflected that bonding social capital network does not lead to a positive outcome in every situation, especially in the case of the poorest households. Due to the same situation, sometimes family members cannot help each other. In that situation, the network of exchange and reciprocity comes in the form of financial help from the money lenders outside their community. This shows the benefit of bridging social capital. Because the outsider moneylender is unaware of the household's economic condition, it saves the families from further exploitation. While these financial associations help the poor resettle and act as a major coping mechanism, it does not work in the long run as these exchanges are for a shorter period. This indicates that the internal money lending and exchange mechanisms are insufficient to provide secured benefits to the poorest

section of society and do not generate a wholesome environment that can strengthen the self-efficacy of the poor.

One of the study's interesting findings suggests the role of SHGs in increasing the coping capability of households. These microfinance networks based on collective action are usually characterized by bonding and bridging social capital. They provide small loans to the poorest section with nominal interest rates. Access to these SHGs led institutions helps the poor not only be self-sufficient but also saves them from the exploitative relationship with the moneylenders. There is evidence that in many cases, they either waived off the interest rate or extended the time duration of repayment for the flood-affected people if required. However, the main focus of microfinance institutions is to create diverse economic opportunities for the households and the community's overall development. It helps the poor people in two ways. It minimizes the disaster's direct and indirect consequences on households' livelihood. And it also increases the coping ability of the household to deal with the aftermath of a disaster by making them self-sufficient. So, it can be inferred that social capital network-based institutions like SHGs are pivotal in creating and maintaining the coping abilities of flood-affected households. Therefore, there is a need of more institutions like this in the Supaul region to strengthen the coping abilities of the households.

Besides financial exchanges, bonding social capital also helps in survival by procuring food from the neighborhood. During stressful times, the community members work collectively and provide food items to needy people. These food-based exchanges are life savors for people who lost everything to the floods. Although it is a short-term coping mechanism, it helps people survive until government relief reaches them. However, these collective actions are mainly available for the family and kinship network, and their access depends on a household's bond of trust and their stock of social capital. This form of social

capital retains people at their places and prevents local mobilization. Therefore, it is evident that the higher stock of bonding and bridging social capital provides a safety net for flood-affected households by reinforcing their coping abilities, further enhancing the affected communities' overall resilience.

The fourth chapter has examined the impact of two types of place attachment, i.e., economic and genealogical, on the flood risk perception of the households. The first section of the chapter assessed variations in the household's level of place attachment as per their socio-demographic characteristics. The findings revealed that marital status contributes to the variations in the household's level of genealogical place attachment. Next, the nuclear family type was more genealogically attached to place than the joint family households. The results reflect that occupation also prompts variations in the household's level of genealogical place attachment.

Furthermore, the findings established that the length of residence of the households contributes to both economic and genealogical components of place attachment. However, the magnitude of attachment was stronger in the case of the economic vis-à-vis genealogical components of place attachment. Nevertheless, caste was found to be marginally affecting the economic place attachment level. The results also showed a considerable contribution of gender to the economic place attachment levels of the households. Male households were found to be more attached to their places owing to economic reasons vis-à-vis female households.

Furthermore, the economic and genealogical place attachment was evenly distributed across other socio-demographic variables such as religion, age, and income. One of the interesting findings of the present study is that place attachment positively influences the flood risk perception of the households of the Supaul district. This positive influence of economic and genealogical place attachment on flood risk perception indicates that those people with higher levels of economic and genealogical place attachment tend to perceive the flood risk high.

However, the impact of genealogical-induced place attachment on flood risk perception was higher compared to economic-induced place attachment. Thus, in terms of the degree of influence, the genealogical rootedness to the place dominates over the economic-driven place attachment. Cultivation, cattle rearing, and fishing are three major economic mainstay activities in the Supaul region. Every year flooding causes massive damage to these three sources of livelihood, leading to negative implications on the socio-economic conditions of the people. Therefore, the vulnerability of cultivation, cattle rearing, and fishing to recurring floods leads inhabitants to perceive flood risk as higher. Furthermore, communities are tied to each other through kinship, marriage, and common ancestors. They deeply revere their ancestors and belongings, especially ancestral homes and valuables. Since flooding in the Supaul region causes a huge physical loss every year, people have experienced how much a flood can be detrimental to their ancestral properties. Hence, the threat appraisals for ancestral artifacts are the main reason for the higher risk perceived by the households.

Despite being in a flood-prone area, the residents of Supaul district mentioned many positive characteristics of the district with positive descriptions. This reveals that the flood disaster has not entirely turned their thoughts negative about the place. For most people, the main reasons behind staying in Supaul are they were born and brought up there, their ancestral property is there, or they have a family commitment. Most households mentioned that floods have brought them closer to their communities and enhanced their companionship, which refers to the social aspect of floods. Flooding has also increased the majority of residents' attachment to their houses.

Analysis of qualitative data shows that river attachment is perceived as an important physical aspect of place attachment and is understood as an emotional connection that people establish through their day-to-day activities and experiences. Also, as most of the flood management

strategies are based on the rivers in the form of structural solutions to flooding disaster management, it is important to understand people's connection to the river as a physical aspect of the place. This could give an idea of households' preference for flood management strategies. For the people of the Supaul district, the Kosi river is an integral part of their landscape and culture. The majority of people have early solid memories and childhood experiences associated with the river, which forms the basis for their strong connection with it. Their flood risk perception is based on past flood stories and experiences based on various flood events.

The fifth chapter has examined the beliefs, norms, values, and actions of the four government institutions involved in flood control and management in the Kosi region of Bihar. It provides in-depth insight into the grassroots problems faced by the flood-affected communities of the region, as well as their views and opinions on the measures provided by the institutions in the name of flood management and control. It also discussed in detail the values, perspectives, and measures of flood control adopted by the communities of the Supaul district. The findings suggest that the officials follow a top-down approach in terms of decision-making in the basin. Among all the departments, WRD is at the top and dominates others in terms of resources, manpower, planning, funding, and execution of flood disaster management-related policies and strategies. The other departments like FMISC, SDMA, and WALMI support WRD in flood combating works, but their roles and authorities are limited. They are supposed to abide by the procedures and work schedules provided by WRD. However, the findings suggest that this top-down approach in decision-making leads to delays in executing several flood mitigation programs as the assigned authority invests most of the time in taking approvals rather than execution. As per the findings, major key challenges faced by institutions in sustainable flood plain management are the lack of financial capital, lack of a comprehensive long-term plan, and lack of wider approaches related to water issues. One of this chapter's significant findings

reflects a lack of information dissemination among the concerned departments. The higher authority rarely visits the damaged sights and thus has no proper knowledge about the on-location problems. These inflexible characteristics of institutions are not conducive enough for successful vulnerability reduction of the communities. Fund allocation is another major problem, as cited by the respondents, in getting the maintenance work done on time. The analysis suggests that although the government claims that vulnerability has reduced and the situation has improved in the basin, this does not comply with the community survey findings.

Based on the findings, it can be interpreted that the communities are becoming more and more flood vulnerable with each passing year. This is because heavy rainfall, water discharge from Nepal, continuous waterlogging, poor drainage system, soil erosion, shifting of the river course, silt deposition, and rising river beds are making people's lives miserable and creating a livelihood crisis for them. The river water that used to flow in a wider area through different channels is now supposed to flow in a certain confined area without an arrangement of a proper drainage system leading to the breach of the embankment. These breaches occur at many parts of the embankments because of no or poor maintenance done by the government. As a result, the fields that used to be dry for four-five months now remain submerged for almost the entire year. The government only depends on engineering solutions to control floods, but they do nothing to manage the soil erosion and deposition of silt by the river. One of the study's concrete findings is miscommunication between the organizations and the affected communities. There is a weak public perception among the community members in understanding flood risk and mitigation operations carried out by the government in terms of information, interaction, engagement in flood fighting works, and flood-related decisions in the basin as most of the time they are not informed about the same. This exclusion of at-risk communities who are the real stakeholders in the entire process of flood management is one of the primary reasons behind the failure of government programs.

It is evident from the study that the Kosi basin residents have ways and strategies to tackle floods which they have developed from living in the area over a particular period and also learned from their forefathers. These strategies include relocating the families during monsoon on a highland area which they call 'machhan', making makeshift boats with the help of bamboo and tubes, which is famously called 'jugadu nao', and carrying dry food items like flattened rice, gram flour, jiggery, gram etc. which can be eaten raw and also planting trees which can stop soil erosion. This corresponds with the findings of Pahl-Wostl, Mostert, & Tabara 2008; Fatty & Patel, 2013 which state that in emergency situations households get back to their traditional knowledge and utilize them to survive as there is no other option left. Based on the above findings, it can be inferred that despite the investment of infinite money and time on the engineering solutions to flood management, it has not only failed to solve the problem but also increased the severity. The increasing intensity of human and economic loss are significant examples of the failure of the structural means of flood control. The best approach to reducing physical and social vulnerability to floods is a combination of structural and non-structural measures (Pal 2002). Therefore, it is the demand of the situation that instead of focusing more on structural solutions, the focus should be more on non-structural measures, which along with the use of modern science, can reduce vulnerability to a certain extent. The main benefit of these measures is that it expands the range of resources to the common people. Further, the findings suggest that the government should use the indigenous technologies used by the communities, as certain interventions can be of great help in making the communities more resilient. There is a need for a mid-way approach that will include the experience and knowledge of local people and the resources made available by the government. The resilience-based approach, including sustainable river management and disaster risk mitigation, is crucial. The Kosi region needs a comprehensive plan that could bring out the best of innovation and applied technology suitable for this region and suggest some long-term measures of flood

control and management. Apart from that, improved communication, goal-oriented decision making, and joint initiative toward flood management are required if the goal of flood control and management has to be achieved.

6.2 Concluding remarks

The findings show that perceived flood risk is distributed quite unequally along occupation, length of residence, gender, and caste of respondents. The study found positive exchanges between components of social capital, place attachment, and flood risk perception. The components of social capital and place attachment have emerged as determinants of flood risk perception. Nevertheless, place attachment predominated social capital in terms of the degree of influence. This exhibits the dominance of place-specific factors over social-relational factors. The study's findings enhance our understanding of the influence of social capital and place attachment and risk perception. A thorough understanding of the intersectionality of social capital, place attachment, and risk perception will also enable policymakers to develop effective and inclusive flood risk communication strategies. The knowledge of flood risk perception is important in achieving effective risk communication strategies and flood management (Kellens et al., 2011). For Messner and Meyer (2006), the process of risk communication strategies should be encouraged as the cornerstone of the politics of flood risk management. Risk communication strategies informed by the knowledge of how social relationships and place-specific factors influences flood risk perception will lead to improvement in communicating the risk and decreasing it. A better understanding of the interplay between social capital, place attachment, and flood risk perception will find itself necessary to inform risk evacuation, relocation programs in the face of upcoming flood hazards, and coping interventions. To be specific, assessing households' social capital levels and their influences on flood risk perception may help decrease the flood risk in the Supaul region by

enforcing local adaptation. Social capital as part of integrated flood risk management may positively affect adaptive behavior (Hudson et al. 2020). Furthermore, positive interactions between social capital, place attachment, and risk perception systematize previous research findings; thus, methods and models implemented in the study can be used to study other flood-affected districts of Bihar with a certain degree of confidence. Moreover, as research on flood risk perception is socially significant, the findings of the study contribute to the current body of literature in this field. To conclude, embracing the social, psychological, and place-specific approach while studying flood risk in the Supaul district could be instrumental in developing integrated flood risk reduction strategies, which could ultimately contribute significantly to the endeavor of protecting human and physical loss.

6.3 Limitations and future scope of research

The future scope of studies lies in its limitation. Despite the meaningful and encouraging findings, the study has a few limitations. First, only one item was used to measure bridging social capital, as the previous study (Hudson, Hagedoorn, and Bubeck 2020), particularly in the context of social capital-flood risk perception relationships, did not use multiple items to measure this variable. Therefore, the bridging social capital variable may be susceptible to internal consistency issues or reliability issues. However, in future studies, more items may be included within the variable for more robust results. Second, the study is limited to only one district of Kosi Basin. Therefore, the result cannot be generalized to the whole Kosi Basin because risk perception is context specific and susceptible to local factors. There are other severely flood-affected districts in Kosi Basin, such as Saharsha, Purnea, Araria, Khagaria, and so forth, with a distinct socio-cultural milieu. These districts can be studied in the future to understand the nuances of relationships shared between social capital, place attachment, and flood risk perception. Finally, the study used cross-sectional data to achieve its research

objectives. This raises concerns about causal directions between variables used in the study. The inferences drawn in the study should be therefore interpreted with a caveat. Based on previous studies, the study assumes a causal impact of social capital and place attachment on flood risk perception. But this doesn't mean that social capital and place attachment will always precede risk perception. The causal directions may be reversed. It is possible that a high sense of risk leads to a high level of social capital and place attachment. Moreover, it is imperative to note that place attachment has been measured in a number of ways by using multiple methods and tools. However, very few studies have considered place attachment as a dependent or outcome variable, while most studies have considered it a predictor or intervening factor (Bonaiuto et al., 2016). A few previous empirical studies have assumed and successfully established that place attachment has a causal impact on environmental risk perception (Armas, 2006; Bonaiuto et al., 2011; Bernando, 2013). These studies lend support to the causal approach used in the present study. Nevertheless, a longitudinal study considering plausible circular causation between place attachment and risk perception will help parse out this relationship. It can be an appealing research theme for future studies.

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ANNEXURES

COVER LETTER

Department of Humanities and Social Sciences
Indian Institute of Technology Guwahati
Guwahati – 781039

Dear Respondents,

I am a Research Scholar in the Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati. I am working on the impact of sociodemographic characteristics, social capital, and place attachment on flood risk perception for my PhD research. The findings of the study will enhance our understanding of the influence of social, spatial, economic, psychological, place, and regional conditions on the perceived flood risks.

The attached survey questionnaire is related to your personal opinions about flood impact and the livelihood resilience of households. Please answer all the questions carefully. All information you provide will be strictly confidential. The responses will be used for academic purposes only.

Thanks for your kind support.

Sincerely,

Tulika

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Survey Questionnaire

1. Socio-demographic Information

1.1	Name of the Respondent	
1.2	Name of the Block	
1.3	Name of Panchayat	
1.4	Name of the Village	
1.5	Age	_____years
1.6	Religion	(1) Hindu, (2) Muslim, (3) Other (Specify)_____
1.7	Caste	(1) SC, (2) ST, (3) OBC, (4) General
1.8	Types of family	(1) Nuclear, (2) Joint
1.9	Total annual income of the family	(1) Between ₹ 5000- ₹ 10,000, (2) Between ₹ 10,000- ₹15,000, (3) Between ₹ 15,000- ₹ 20,000, (4) Above ₹ 20, 000
1.10	Education	(1) Illiterate, (2) Primary School, (3) Middle School, (4) High School (5) Higher Secondary
1.11	Marital status of the head of household	(1) Unmarried, (2) Married, (3) Widowed
1.12	Gender	(1) Male (2) Female
1.13	Occupation	(1) Cultivation, (2) Fishing,(3) Service, (4) Business,(5) None
1.14	Length of Residence	(1) Less than 5 years, (2) 5-10 years, (3) 10 -20 years, (4) 20-30 years, (5) More than 30 years

2. Flood Risk Perception

All statements are about various dimensions of flood risk perception. Kindly rate these dimensions by marking a tick (✓) on a 5-point scale consisting of 1 = strongly disagree, 2 = disagree, moderately = 3, agree = 4, and 5 = strongly agree

Individual Items and Scales	1	2	3	4	5
A potential flood affects my health					
A potential flood damages my possession					
On an average, flood come every year					
A potential flood affects my quality of life					
A potential flood worries me					
A potential flood intimidates me					

3. Social capital

All statements are linked to the bonding and bridging dimensions of social capital. Kindly rate these dimensions by marking a tick (✓) on a 5-point scale consisting of 1 = strongly disagree, 2 = disagree, moderately = 3, agree = 4, and 5 = strongly agree

Individual Items and Scales	1	2	3	4	5
Bonding social capital scale					
My family members often participate in community/village activities					
My family members actively participate in a local management committee					
Me and my family members regularly interact with other members of my village/community					
Most of the people in my village/community can be trusted					
I am confident that my village/community members will help us in a time of need					
I help other families when they need help					
My village/community is united					
In my community, I feel accepted and at home					
Bridging social capital scale					
Number of groups/associations in which the respondents are involved					

4. Place Attachment

All statements are linked to the economic and genealogical dimensions of social capital. Kindly rate these dimensions by marking a tick (✓) on a 5-point scale consisting of 1 = strongly disagree, 2 = disagree, moderately = 3, agree = 4, and 5 = strongly agree

Individual Items and Scales	1	2	3	4	5
Economic place attachment					
This place is good for business					
At this place, I have friends who can provide me with financial support during any crisis					
At this place, I can get a loan easily					
This place provides me with bread and butter					
This place provides me livelihood opportunities that no other place can offer					

I cannot think of a place other than this because I have fertile land here					
Genealogical place attachment					
I get inspiration by seeing the used places of my ancestors					
I get all kinds of support here because of my ancestral place					
I find the memory of my parents/grandparents in every piece and corner of this place					
This place is important to me because my ancestors/forefathers stayed here					

5. How would you describe Supaul?
6. Could you tell me what first brought you in Supaul?
7. How did the floods affect the town?
8. Have the floods affected how you feel about Supaul?
9. What do you think of the embankments?
10. How did the floods affect your house?
11. Would you say that you actively use the river or riverside? If yes, how often do you use it and what activity do you undertake the most?
12. How do you cope up with the floods?
13. Does your family, neighbours, close friends, and community members help during floods? If yes, how?
14. How do the groups you are associated with help you cope with the floods?

Thanks for your time.



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Invitation to Participate

To whom it may concern

This is to inform you that I am currently registered as PhD candidate with the Department of Humanities and Social Sciences, IIT Guwahati. In fulfillment of Doctor of Philosophy (PhD), I am required to research a topic and produce a dissertation. The topic that I have chosen is “Social Capital, Place Attachment and Flood Risk Perception: A Study of Kosi River Basin in Bihar”.

This study will dwell upon the actual practices in the field in relation to flood control and management. It will enable us to understand the field level process and procedures of flood control and management in Bihar. It will identify problems, constraints, and issues confronted at the macro (institute) and micro (field staff) during the course of flood management in Bihar – India. Moreover, under broad canvas, it would accumulate suggestions and recommendation for effective flood management system in Bihar. Such study is sociologically significant in the context of knowledge production in the flood management and its application in backward state such as Bihar.

As your organization has been identified as a major stakeholder in flood management and decision making in Bihar, I would be extremely grateful if you could complete attached questionnaire. It will take approximately one hour of your precious time. The IIT Guwahati is committed to research integrity and ethical conduct of research projects. Needless to say the information provided will be treated with strict confidence and individual names will not be identified. The data collected through this process will form part of a PhD thesis and finding will be reported in academic publications along with adequate acknowledgement of the participating institutes. Simultaneously, a copy of summary report will be available to your institutions if so required. Most importantly, a formal permission has been already taken from the head of your institute for conducting this survey. It can be verified from your concerned if it is required.

If you have any queries or questions, kindly contact on this number 7896260215 or to above-mentioned emails.

Yours sincerely,

Tulika

Interview Schedule

Profile of the Respondent

Name of the Institution:

Year of joining current institute:

Department:

Designation:

Areas of Specialization:

Gender:

Marital status:

Age:

Educational Background:

Course	Subject/Discipline	Institute/University
Bachelor		
Master		
PhD		
Post-doctoral		

Total years of job in current institute:

Name of the previous institute (if any):

Total years of job and designation in previous institute:

Have you always worked in the flood division (Yes/No)?

Total number of years in flood division:

Total number of years in the irrigation division:

Have you received any training on flood management? If yes, when and by whom?

Any other expertise:

Interview Schedule

Interview Identification Number _____

Kindly read the instructions carefully:

- *Please answer all of the questions. If you do not wish to answer a question, simply indicate no comment and move on to the next.
- *Kindly answer the questions in English or Hindi language only.
- *Data obtained through the questionnaire will be used for research purpose only. Strict confidentiality will be made.
- *Please return the questionnaire no later than September 5, 2018. This timeline will help us to complete this research in time (by winter 2018).
- *Your cooperation is greatly appreciated.
- *If you have any questions, please email: tulika.2015@iitg.ac.in; tulikakumar89@gmail.com

Kindly answer the following questions:

1. Kindly reflect upon your area of expertise?

2. What is the role of your organization in the development and governance of flood management system in Bihar?

3. What is your opinion about the current national policies on flood plain management?

4. Do you think all these regulations work in practice? Please comment.

5. Do you agree that more comprehensive and adaptive strategies (i.e., ‘learn to live with risk’) are needed for effective floodplain development and risk management? Please elaborate.

6. As a regulatory agency what kind of challenges are you facing?

7. What do you believe are the biggest barriers to sustainable floodplain management, and why?

8. Does the community assist you during flood events? If yes, please describe how/in what way; if no, please describe why not.

9. Describe how your agency works with local communities (with whom? Frequency of meetings?).

10. Kindly share your experiences about the public responses to such gatherings and meetings

11. What are the barriers that hamper effective flood management partnerships between communities and government agencies?

12. Do you have specific people in the community that you work with on flood management? Please describe who and the role they play.

13. What is the process for maintaining flood embankments? How often is this done?

14. What equipment and facilities are available for maintenance?

15. Do you think that this system is adequate? If not, what suggestions do you have for improvement?

16. Does the community participate in maintenance of the embankments? If yes, please describe how/in what way; if no, please describe why not.

17. What kind of technology do you utilize in your work in flood management? (Please tick all options that apply)

- i. Remote Sensing
- ii. GIS
- iii. MIS
- iv. Computers
- v. PC Tablets
- vi. Other (please specify)

18. To what extent and in what ways these technologies are effective?

19. What is your perception of how vulnerable is the community in the flood prone areas?

20. What variables do you think most influence the level of vulnerability?

21. What are the primary reasons for frequent flood in Kosi region?

22. What are your views regarding current policies related to Indo-Nepal water Agreement?
To what extent these policies are relevant in the current scenario?

23. According to you, how successful these policies have been particularly in the context of Kosi region of Bihar?

24. Do you think that water discharge from Nepal is the main reason behind Flood in the Kosi region of Bihar? Please comment.

25. Kosi Basin floodplain management requires international cooperation between India and theNepal, specifically for mitigation strategies and floodplain management. Please comment.

26. Could you please briefly explain your thoughts on the following two questions below?
a. How can resources be optimized, shared or managed

- b. How can coordination and communication be improved between international institutions?



27. What are the focus and priority of the recent flood control and management in Bihar?



28. How deep/far is the involvement of NGOs in the recent flood planning as well as the relocation plan in the context of Bihar? Kindly elaborate.



29. How do stakeholders coordinate with each other in the decision-making process of Bihar flood planning and management?



30. How do the government entities articulate risk of flood? What is considered as acceptable risk?



31. How do the communities articulate risk of flood? What is considered as acceptable risk?



31. What are the barriers to understand the risks? How strong is the influence of those barriers to the success of flood planning?

Any other suggestions or recommendations:

Thanks for your time.

