ANALYSING INFORMATION FLOW IN FLOOD RISK COMMUNICATION: A CASE OF GANDAKI RIVER BASIN

A Dissertation Submitted to

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In Partial Fulfillment of the Requirements for the Award of Degree of
M.Sc. in Environmental Science

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DECLARATION

I hereby declare that the work presented in this dissertation is a genuine work done originally by me and has not been submitted anywhere for the award of any degree. All the sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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RECOMMENDATION

This is to certify that **Mr. Binod Prasad Parajuli** has completed this dissertation work entitled **"Analysing Information Flow in Flood Risk Communication: A Case of Gandaki River Basin"** as a partial fulfillment of the requirements of M.Sc. in Environmental Science under our supervision and guidance. To our knowledge, this research has not been submitted for any other degree, anywhere else.

We therefore, recommend the dissertation for acceptance and approval.

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LETTER OF APPROVAL

On the recommendation of supervisors "Prof. Dr. Madan Koirala" and "Dr. Anjal Prakash", this dissertation submitted by **"Mr. Binod Prasad Parajuli"** entitled **"Analysing Information Flow in Flood Risk Communication: A Case of Gandaki River Basin"** has been approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements of M.Sc. in Environmental Science.

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This dissertation entitled **"Analysing Information Flow in Flood Risk Communication: A Case of Gandaki River Basin"** submitted by **"Mr. Binod Prasad Parajuli "** has been examined and accepted as a partial fulfillment of the requirements of M.Sc. in Environmental Science.

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ABSTRACT

Flood is a major disaster causing devastation every year in major river basins of Nepal and India. The risk associated with the floods can be reduced to greater extent with proper information flow regarding flood risk management. The flood information are generated and communicated with an aim to minimize the risk from probable flood events. In an effort to minimize the risk associated with flood, both the government of Nepal and India has separate flood forecasting and response system. Despite these efforts, there is huge economic and loss of human life every year due to flood events. Considering these facts, this study aims to qualitatively examine the flow of official flood information to the downstream communities through institutional mapping, case study methods and network analysis. In addition, it attempts to find the possibilities of integrating local knowledge of flood risk communication in official flood risk communication system. Analysis of institutional arrangements, key informant interviews from authorities involved in flood risk communication from both of the countries showed that official flood information system rarely reaches to the communities. Communication of flood risk information is influenced by many factors like institutional arrangements, infrastructures, education and other socio-economic factors and these factors needs to be reconsidered for effective information flow. Furthermore, there are gaps in different administrative levels as the information passes from source to the target groups. It has also been found that community people are more reliant on their own developed and managed flood information system than official flood information system. It is suggested to integrate local knowledge of flood risk communication with official system.

Keywords: *Communities, Flood Forecasting, Institutional Arrangements, Integration*

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ABBREVIATIONS AND ACRONYMS

%	Percentage
°	Degree
A.D.	Anno Domini
BDO	Block Development Office
CBDR	Common but Differentiated Responsibility
CBO	Community Based Organizations
CDO	Chief District Officer
CWC	Central Water Commission
DDMA	District Disaster Management Authority
DDRC	District Disaster Relief Committee
DEOC	District Emergency Operation Centre
DHM	Department of Hydrology and Metrology
DM	District Magistrate
DPNet	Disaster Preparedness Network
DWIDM	Department of Water Induced Disaster Management
FGDS	Focus Group discussions
FMIS	Flood Management Information System
GFCC	Ganga Flood Control Commission
ICIMOD	International Centre for Integrated Mountain Development
INGOs	International non-governmental organizations

IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
LDMC	Local Disaster Management Committee
MoHA	Ministry of Home Affairs
NEOC	National Emergency Operation Centre
NGOs	Non-governmental Organizations
SAARC	South Asian Association for Regional Cooperation
SDMA	State Disaster Management Authority
SMS	Short Message Service
SPSS	Statistical Package for the Social Sciences
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
VDC	Village Development committee
WHO	World Health Organization

CHAPTER I: INTRODUCTION

1.1 Background

Intergovernmental Panel on Climate change (IPCC) has mentioned in its fifth assessment report that the number of extreme events will rise with increase in human induced climate change. Also, new observations in increasing rainfall and discharge of some river basin indicates rising flooding risk at wider scale (IPCC, 2014). The evolution of education about risk creates new difficulties for risk communication, including how to clarify the procedure of informed choices to the overall population (Bier, 2001). Accountable decision making in flood risk management not only requires a consideration of existing risks, overheads and environmental effects, but also involves consideration of possible consequences of uncertainty on significant decisions (Hine & Hall, 2010). Individuals living in areas with high risks must be communicated about how to get ready for and secure themselves against the impacts of floods. Such measures could strongly help define the preparedness behaviour (Siegrist & Gutscher, 2006). Riverine floods are common in downstream regions of Asia, including Nepal, Bangladesh and India (Kundzewicz & Hirabayashi, 2010). With increased risk of flooding in the global downstream, it is important to communicate the potential risk of flood events in advance to help communities better adapt to possible disasters.

Risk communication is firmly connected to existing individual perception of risk and can play an important role in risk management (Kellens et al., 2013).Flood risk communication is influenced by scientific understanding of knowledge generators, personal decision making capabilities of communicators/ decision makers and the perceived understanding of end users. As the messages passes through different layers of people with different levels of understanding, it may sometime be filtered out and the actual message communicated to the end user may not be as efficient as it was in original source. Also, the way message is communicated, have greater influence in personal choices during emergencies.

1.2 Rationale

The risk associated with the floods can be reduced to greater extent with proper information flow regarding flood risk management. This is influenced by good institutional arrangements and proper function of flood risk communication systems. Current state of knowledge suggest that there is a gap between community and institutions regarding information dissemination in flood risks in developing countries and these gaps and possible barriers need to be explored. Recent advances in science have made flood information system more precise and accurate. Although, the ultimate goal of forecasting weather and extreme events is saving the lives and property of people, the effectiveness of flood risk communication is still of great concern. Stakeholders are continuously working on flood forecasting and the available information is shared prior to flooding but the flow of information is determined by many factors. As the risk is increasing at a global scale, there is need of improvement on adaptation measures as well as early warning mechanisms. Department of Hydrology and Meteorology (DHM) from Nepal update real time data about water level in the river. This information is being communicated to downstream regions of both Nepal and India through official flood information sharing system. Likewise, Central Water Commission, Bihar, India updates real time data on water level in gandak river and is responsible for communicating the available information with other stakeholders and communities. Furthermore, Flood Management Information System (FMIS) helps to analyse, visualize and share the available information with related stakeholders. But, the information shared either does not reach the community or is shared in more technical form. As the knowledge passes through different strata, actual knowledge perceived by the general public differs from what was intended to be communicated. In most of the cases, the available information is more technical or the proper message is not communicated to general public in a precise way that would lead to decisions of saving lives and property. Also, tailoring of the available information to suit local context is needed to increase the efficiency of risk communication. Communication of flood risk information is influenced by many factors like institutional arrangements, infrastructures, education and other socio-economic factors and these factors needs to be reconsidered for effective information flow.

1.3 Statement of the problem

Flood is one of most devastating natural disaster and claims huge economic and loss of manpower in different part of the world. Floods are recurrent in downstream region of Nepal and India causing huge losses every year mostly during the monsoon period. There are evidences that with proper communication strategies, the extent of loss can be minimized. Also, there is consensus among scientific community that flood and its associated risks can be reduced by informing people and institutions for effective decision making. To make current flood risk communication approach more efficient and people-centric, there is need to explore the possible barriers and gaps in different level as the information passes from source to the end user.

1.4 Research Questions

How does flood information flows between upstream and downstream communities?

The specific questions are:

a. What are the formal and informal institutional arrangements of flood information system in Gandaki River basin?
b. How does flood information is made available and disseminated at the local level?
c. What can be done to fill the gap (if any) in information for people to adapt to frequent floods in Gandaki River basin?

1.5 **Objectives**

The main objective of the study is to assess the formal and informal institutional arrangements and identify gaps (if any) in dissemination of flood information in Gandaki River basin.

The specific objectives of the study are as follows:

- To identify the information flow at the national, district and local level
- To assess the flow of information to the community level
- To advise the possible efficient way of flood information dissemination based on combined work of policy review and field work

1.6 Scope of the study

This study considers the institutions involved in flood risk communication from Nepal as an upstream country to Bihar, India as a downstream region. Institutions, policies and informal network of activists were taken into consideration from both the countries for information collection. Information flow mechanism at national, regional, local and trans-boundary level was assessed with institutional mapping followed by key informant interviews from identified institutions that directly and indirectly contribute on flood information sharing.

1.7 Limitations of the study

- The number of identified institutions are based on snowball sampling and current available formal documents, there are still other independently functioning structure which this study might not have able to incorporate.
- Since the study is of trans-boundary nature, respondents might have controlled the information shared with the researcher due to current political environment between two neighbour countries.
- During the interview with government officials, they might have hesitated to answer the questions very honestly due to their government's norms and values.

1.8 Thesis structure

This thesis is comprised of six chapters. First chapter gives the background, rationale and statements of problem. Objective is set with supporting 3 specific objectives to fulfill the research questions. Second chapter reviews the current available literatures to support the argument on need of comprehensive flood risk management through improved flood information system. Also, it reviews the policy interventions made between two countries of interest on flood risk communication and overall disaster management. Third Chapter highlights the methods adopted to achieve the set objectives in first chapter. Fourth chapter shows the results analysed from multiple sources and compares the findings. Fifth chapter elaborate with discussions with reference to the results from fourth chapter. Lastly, sixth chapter conclude the overall works and provides with key recommendations.

CHAPTER II: LITERATURE REVIEW

2.1 Floods and risk communication

Our environment is changing in a daily basis due to natural processes and risks associated with extreme events like floods are also increasing (Jongman et al., 2012; Plate, 2002; Eduardo, 2010). Flood is considered as one of the major natural disasters and it poses threat to many communities around the world (Birkholz et al., 2014) . Dang et al. (2011) defines flood risk as "a combination of flood hazard and flood vulnerability, in which exposure is considered a part of vulnerability". Haer et al. (2016) did a computer simulation study to find out the efficiencies of different communications strategies to flood and found that designing location specific information can be more efficient as compared to traditional "top-down" approach. This chapter reviews the global and regional literature on flood risk communication. It is divided into six sub-sections.

2.2 Risk communication

"Risk communication is any purposeful exchange of information about risks between interested parties" (WHO, 2001). Good risk communication and managing approach requires incorporating the societal vulnerability as an integral part of risk management (Koks et al., 2014). Risk communicators should be aware of local context and should tailor the messages as per the local need, considering social structures like age, understanding levels of audience and access to mediums through which they are expected to receive the information (Cole & Murphy, 2015; de Boer et al., 2015; Howard et al., 2017; Jan et al., 2007; Faulkner & Ball, 2007). Flood related information should not only contain information about approaching risk but also suggest possible actions to better cope with them (Bubeck et al., 2012). Also, community's own experience of coping with flood, history of residence of specific group of people in the specific region may have significant role to play on perceived risk of flood (Burningham et al., 2008). Muhonda et al. (2014) conducted a study in Zimbabwe and found that the community level adaptations to flood impacts can be improved with not only the quantity of information shared but the quality of shared messages. Good communication approach needs to consider more than one information source and media covering diverse group of people (Feldman et al., 2015)

2.3 Partnership and decision making in flood risk communication

When the power is centralized and decision making right is given to limited people with linear knowledge transfer, it does not support effective policy making (Mauelshagen et al., 2014). For effective adaptation to extreme events, it is important to inform people about past lessons and how their personal actions at local level can help make a difference in larger context (Glaas et al., 2015). Babel (2015) argues that "Whole system" method should be adopted to ensure the success of flood information system where scientific knowledge should be simplified and make understandable for community people.

As noted by Voorst (2015) in Jakarta, Indonesia, people in the floodplains and near river have used their own ways of dealing with the floods apart from what is suggested by subnational government. Khairi et al. (2013) conducted a study in Malaysia where they observed local people having their self-developed methods of coping evolved within the local area by learning from the best practices of their neighbours with respect to past flooding. There is need to develop understanding among risk communicators about how target audience relate received information based on their individual intelligence and social structures for specific hazard (Mayhorn & Mclaughlin, 2012). Also, the information shared to the community should be updated and revised considering the fact that similar extreme events may not replicate in coming days in a similar way (Fox-rogers et al., 2016). As the number of people living nears the coastal and riversides are increasing, it is necessary to inspect about people's motivation to participate in mitigations and use the scientific knowledge for social wellbeing (Shao et al., 2017). Kerstholt et al. (2017) argue that using existing social networks in efficient way and increased people's participation could result in increased resilience towards the disaster. Rather than focusing in one event, it is necessary to communicate probable risk frequently so that people stay engaged and alert about future flood events (Siegrist & Gutscher, 2006). Kasperson et al. (1988) discussed about "social amplification of risk through social, institutional, and cultural contexts in which the risk information is interpreted, its meaning diagnosed, and values attached". In some cases, people do not go with mitigation because they think there will be some assistance from the government if they suffer(Kunreuther et al., 2013). Partnership among all the stakeholders including government, private sector and target audience is essential to better cope with possible future hazards (Kunreuther et al., 2013). Adaptation actions to frequent extreme events should give more focus to local level (Mirza et. al., 2001).

Capacity building and equal participation of all the stakeholders involved in overall risk management may result in better management of future risks (Barbhuiya, 2015; Madan & Routray, 2015).

Transfer of decision making power at the local level may have increased benefit for local people and information may flow in more efficient way but there are equal uncertainties like power elites and decision making faults which need to be taken into considerations (Chau et al., 2014; Ravallion et al., 2015). Coping actions can have direct advantages in lowering the risk of hazards (Mathew et al., 2012). Effective flood information should also consider the local practices, knowledge, values and existing institutional arrangements (Cools et al., 2016).

2.4 Institutional arrangements on overall disaster management in Nepal

Flood is considered as a "Natural calamity" in natural calamity act, 1982 of Nepal. Department of Hydrology and Meteorology (DHM) under ministry of Environment in Nepal is main responsible body for generating the flood related information and communicating with wider stakeholders. Since flood is a cross cutting issues with broader dimensions covering water resource, disaster, information and security it is of great concern and responsibilities of diverse agencies within government (formal structure) and other developmental agencies as well. Ministry of Home Affairs looks after the communication and overall coordination about flood as a disaster in more holistic approach. Following Figure 1 shows the institutional arrangements for disaster management in Nepal (Koirala, 2014).

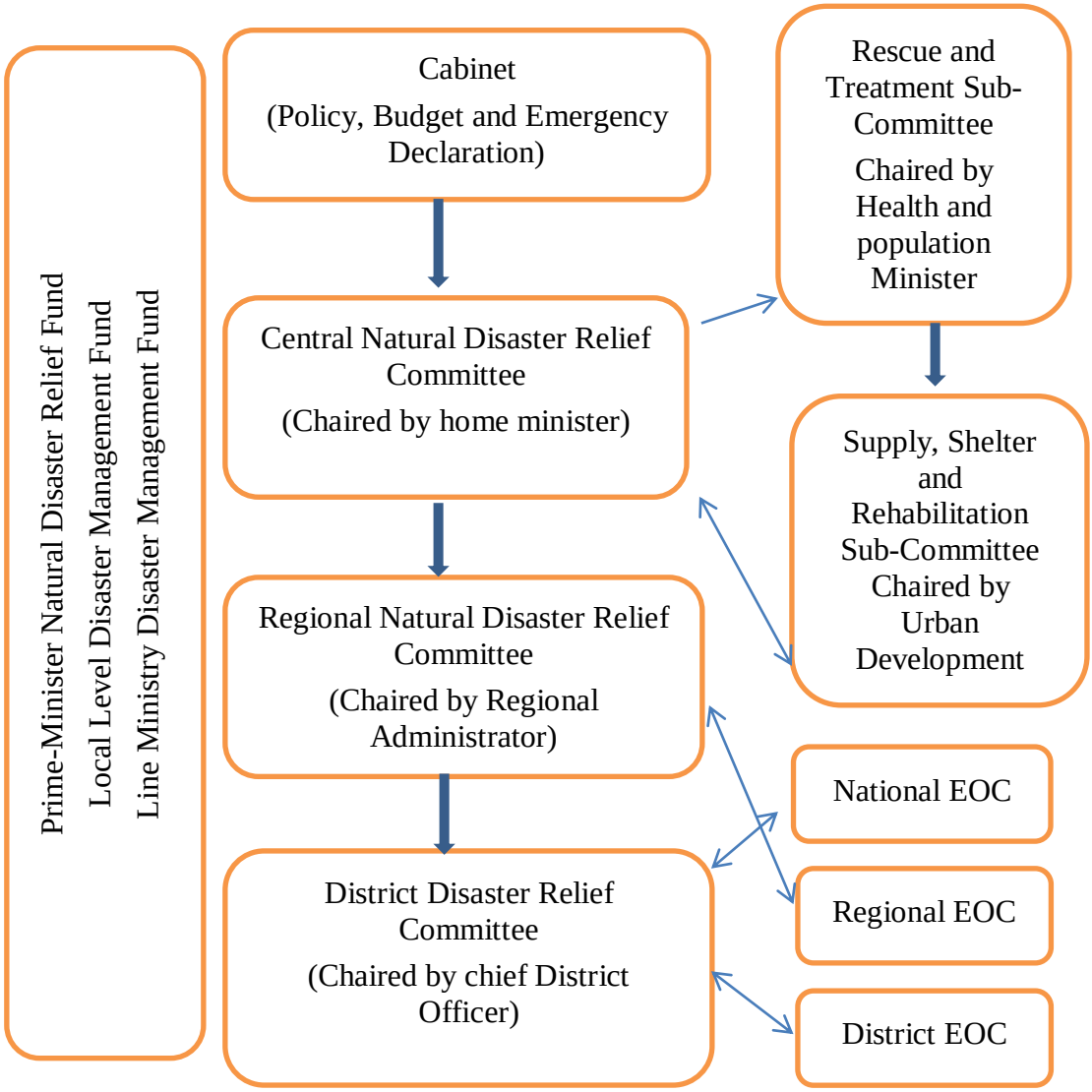

Figure 1: Institutional arrangements for disaster management in Nepal adopted from Koirala (2014).

2.5 Institutional arrangements for disaster management in India

Central Water Commission (CWC) formed under the ministry of Water Resources of Government of India is the technical and responsible body accountable for monitoring and generation of water related information and communicating with relevant stakeholders. Similar to Nepal, flood is considered as cross-cutting issues in India as well. Disaster Management Act, 2005 recognizes flood as a "disaster". The following institutional arrangement is set up as directed by Disaster Management Act, 2005 of India. Figure 2 shows the institutional arrangements for disaster management in India

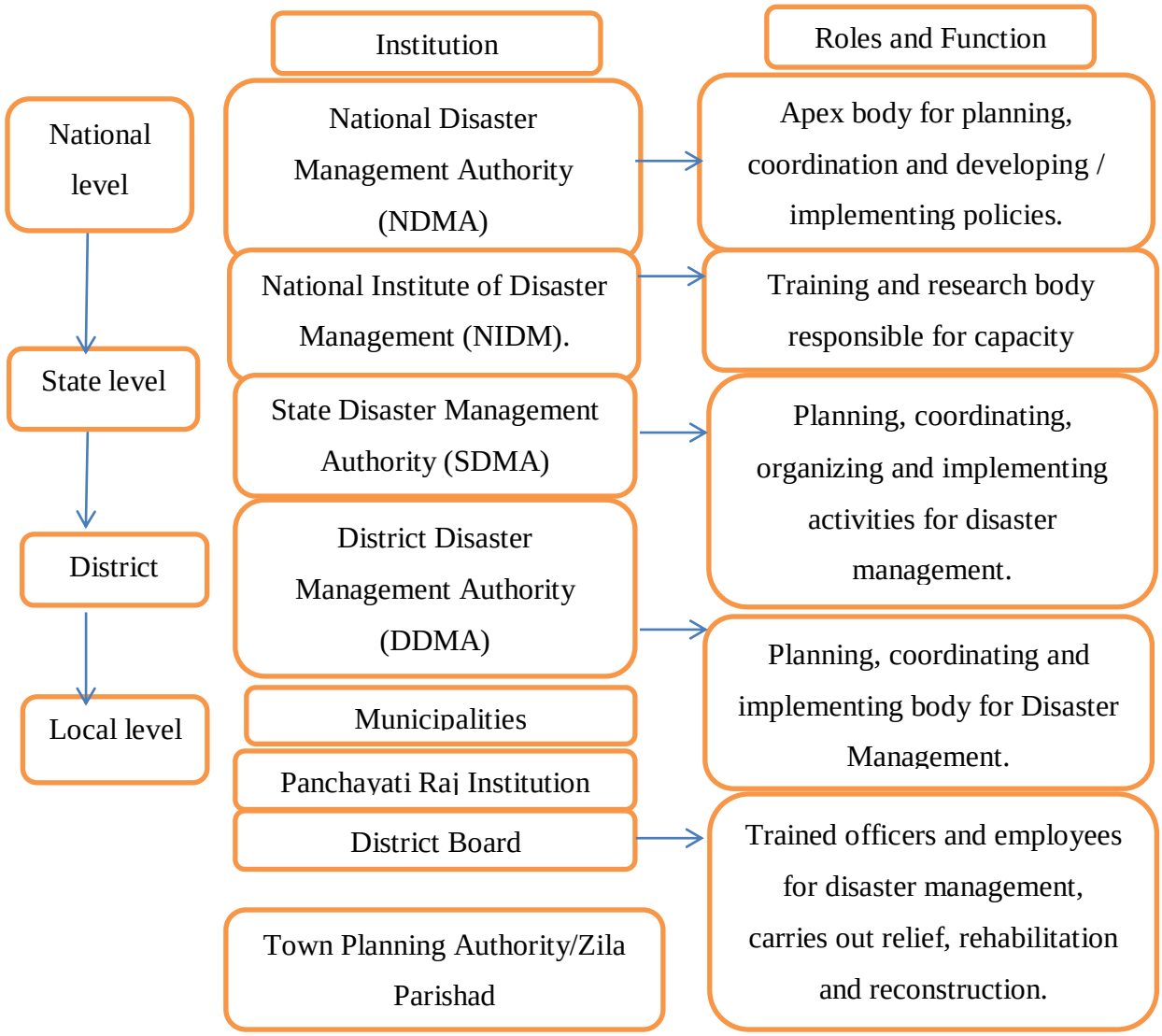

Figure 2: Institutional arrangements for disaster management in India adopted from Madan & Routray (2015)

2.6 Regional Cooperation mechanisms

Apart from countries respective institutional arrangements, there are regional level cooperation mechanisms set up by mutual understanding of more than two parties. The South Asian Association for Regional Cooperation (SAARC) participated by Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka was established on 8th December 1985. The main aim of this cooperation is to improve the quality of lives of people in this region through cooperative and mutual working as well as information sharing. This forum has achieved some milestones in disaster management. Following table 1 shows some of the initiatives taken by this cooperation in disaster management. Although, the coalition is intended to deal the issues at multi-lateral level these milestones can be considered as achievements for improved understanding between participating countries. Since India and Nepal are also part of SAARC, these milestones have contributed somehow to strengthen disaster management efforts between these participating countries.

Table 1: Major milestone for regional cooperation on disaster management in SAARC (prepared after review of decisions of different SAARC meetings)

Dates	**Achievements**
1987	Study on Causes and consequences of natural disasters in South Asia.
1991	Appointment of Committee of Ministers on Environment.
2004	Establishment of SAARC Meteorological Research Centre in Dhaka, Bangladesh.
2005	SAARC Coastal Zone Management Centre established in Male.
2006	Formulation of SAARC comprehensive framework on disaster management.
2007	SAARC disaster management centre inaugurated.
2008	Natural Disaster Rapid Response Mechanism setup.
2009	SAARC Expert Group Meeting on Natural Disaster Rapid Response Mechanism.
2010	Call for operational regional activities for preparedness and early warning system for risk management.
2014	Convention on Cooperation on Environment and Thimphu Statement on Climate Change. Pledges to work under the theme "Common but Differentiated Responsibility (CBDR)" of UNFCCC for better climate change adaptation in South Asia.
2016	SAARC disaster management centre set up in Gujarat, India.

2.7 Research gap in flood risk communication

There is now consensus in scientific community that communicating right message could help people inspire to take mitigation action as well as identify the best options to adopt with respect to their local situations (Morss et al., 2015). But, the relationship between information, availability of risk and individual's decisions which could help shape the adaptation options are not well explored (Lieske et al., 2013). Some of the authors including (Grothmann & Patt, 2005; Grothmann & Reusswig, 2006) have highlighted the importance to consider cognitive variables along with social context as a strong determinants of the actions taken at individual level which is strongly influenced by the information received by each individuals. Communicating the probable risk may have considerable influence on decision making at the individual level (De Boer et al., 2014).

Birkholz et al., (2014) did intensive review of literatures on flood management and perception of flood risk and found that current state of knowledge is not been able to better justify the relation among people's personal flood risk awareness and adaptation responses with respect to theories of managing the floods. Risk communication has gained increasing interest in flood risk management but very few research have tried to provide with applied and specific suggestion for improving the flood risk communication but there is a large gap to be filled in the field of flood risk communication research in future (Kellens et al., 2013).There is enough room to explore about what techniques and methedologies could help better integrate the societal understanding and experience in flood risk management (Evers et al., 2016).

Current literatures on risk communication is giving more priority for flood risk and very few have discussed risk communication in comprehensive way. Also, most of theses works have been done in Europe and some parts of Africa but very few study have been done in South Asian context. Although, there are some institutional arrangementes supporting flood risk communication both in Nepal and India, they have not been well documented to show how the information flows not only within the country boundry but beyond the boundary. Considering the fact, there is need of understanding and identifying current institutional arrangements that supports flood risk communication in Trans-boundary context between Nepal and India.

CHAPTER III: MATERIALS AND METHODS

3.1 Study Area

Study area included the institutions involved in flood risk communication in context of Gandaki River basin. The Gandaki River which is also known as the Narayani in southern Nepal and the Gandak in India. It is one of the three main rivers of Nepal and is important for estimated high potential of hydroelectricity. In the downstream, it is considered as one of the major tributaries of the Ganges River. The area of the basin in Nepal is about 35,000 square km which covers all the agro-ecological zones in Nepal (Terai, Hill, and Mountain, including Trans-Himalaya). As it enters India from Valmikinagar, it is named as a Gandak river. It flows through the Bihar state of India ultimately mixing to the Ganges near Patna slightly below Hajipur. This study focuses on downstream region of Gandaki River basin which includes study of two villages in Bihar state of India as a case study to understand how flood risks are communicated to the affected communities. Figure 3 shows the Gandaki River basin while Figure 4 shows the case study areas.

Figure 3 : Map showing Gandaki basin (Map source: HI-AWARE/ ICIMOD, 2017)

National, regional and local institutions which underpin the flood risk communication to the selected case study area were taken into the consideration. Also, existing flood risk communication strategies and mechanisms of both the countries Nepal and India were reviewed and analysed. Two of the case study area included Chharkhi Bhishambharpur and Bariyarpur village of the downstream region of Gandaki River basin which lies in West Champaran district of Bihar in India.

Chharki Bhishambharpur

Chharkhi Bhishambharpur is located in the river side (within the Gandak embankment) in West Champaran district of Bihar in India. Chharki lies 145 km downstream from Kathmandu. To the north of Chharkhi Bhishambharpur is the Gandaki barrage Valmikinagar at a distance of 175 kilometres (kms). To the east of Chharki is the Pipra-Piprasi embankment at a distance of 1 km. One hamlet of Chharkhi Bhishambharpur is situated on an old embankment, which are 2-5 feet high and 60-100 feet wide. This hamlet is approximately 20-25 years old, and the residents have moved here from Bhagwanpur village after they were displaced by the river for 3-4 times. This hamlet is now permanently located on the government land of the old embankment. Administratively Chharkhi Bhishambharpur hamlet is located as – Ward no 4, Bhagwanpur panchayat, Nautan block, Pashchim Champaran district. Through the exploratory visit, 102 households were recorded. With more focus on observational insights, 2 FGDs and 8 key informant interviews were conducted in the first visit to this village. Most of the people living in this village are poor and marginalized, frequently displaced by the floods. People in Chharki speak local *Bhojpuri* language and most of people cannot communicate much in *Hindi* language which narrows their boundary of communication and access to information.

Bariyarpur Village

Bariyarpur is a *Tola* (small administrative unit in village level) located near Chharki with similar socio-economic conditions. Most of the people living here are the Yadav caste people with very low literacy rate. There were total 105 households in Bariyarpur village. It lies in Mangalpur Kala village in Nautan Block in Pashchim Champaran District of Bihar State, India. . It is located 21 km towards South from District headquarters Bettiah, 6 km from Nautan and 154 km from state capital Patna.

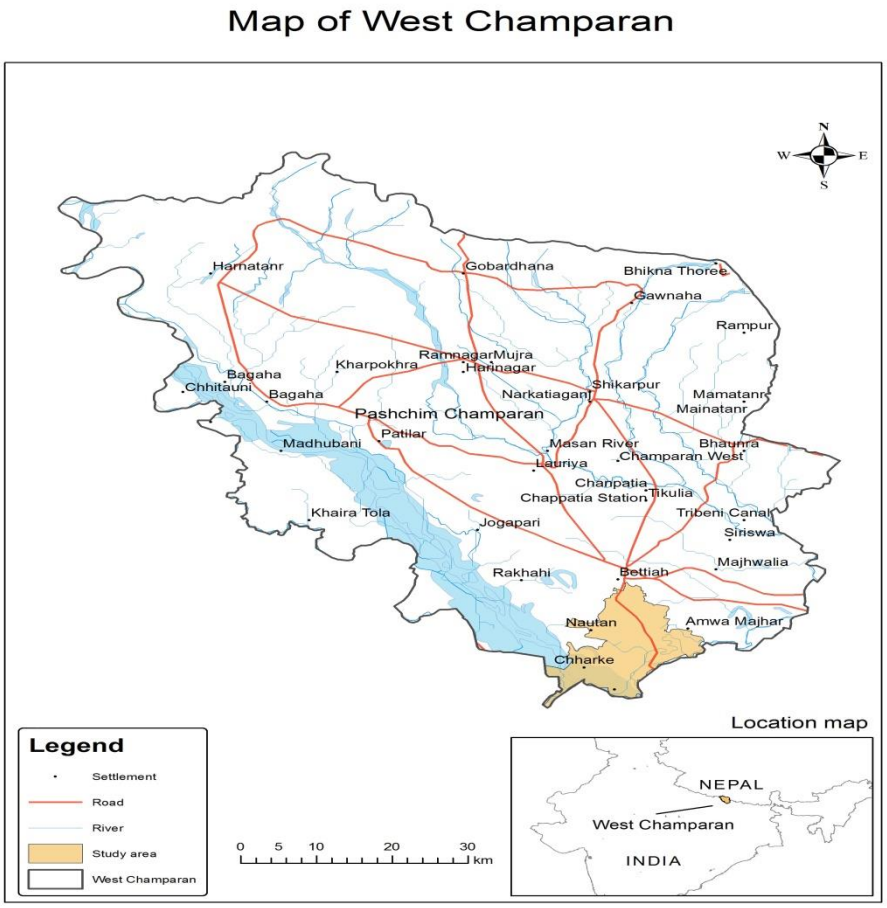

Figure 4: Map of case study area

3.2 Research Design

Mixed approach of research was selected for this study comprising both qualitative as well as quantitative research methods. Most of the qualitative research used descriptive research design using multiple methods such as case study, focus group discussions and participatory observations. For case study, target populations were the local people of Chharkhi Bhishambharpur community and Bariyarpur village of West Champaran, India. Also, number of institutions involved in the flood risk communication to Chharkhi Bhishambharpur and Bariyarpur were considered. The institutional mapping was done in four different strata - national, regional, local and trans-boundary for both the countries.

Probability sampling technique was used for questionnaire survey. Whereas, Snowball sampling was used to identify key stakeholders and key informants which helped institutional mapping. Theoretical saturation technique was adopted to define the optimal number of samples to provide sufficient information for key informant interviews.

3.3 Research Framework

As Shown in the Figure 5, research framework was based on mapping the institutional arrangements in National, local and trans-boundary level. Also, the process of information sharing including informal channels of risk communication was assessed. In addition to this, current policies underpinning flood risk communication for both of the countries were reviewed. At the community level, different forms of available information were documented. Study involved the iterative process of studying the flood risk communication process and triangulating with information gathered from multiple sources.

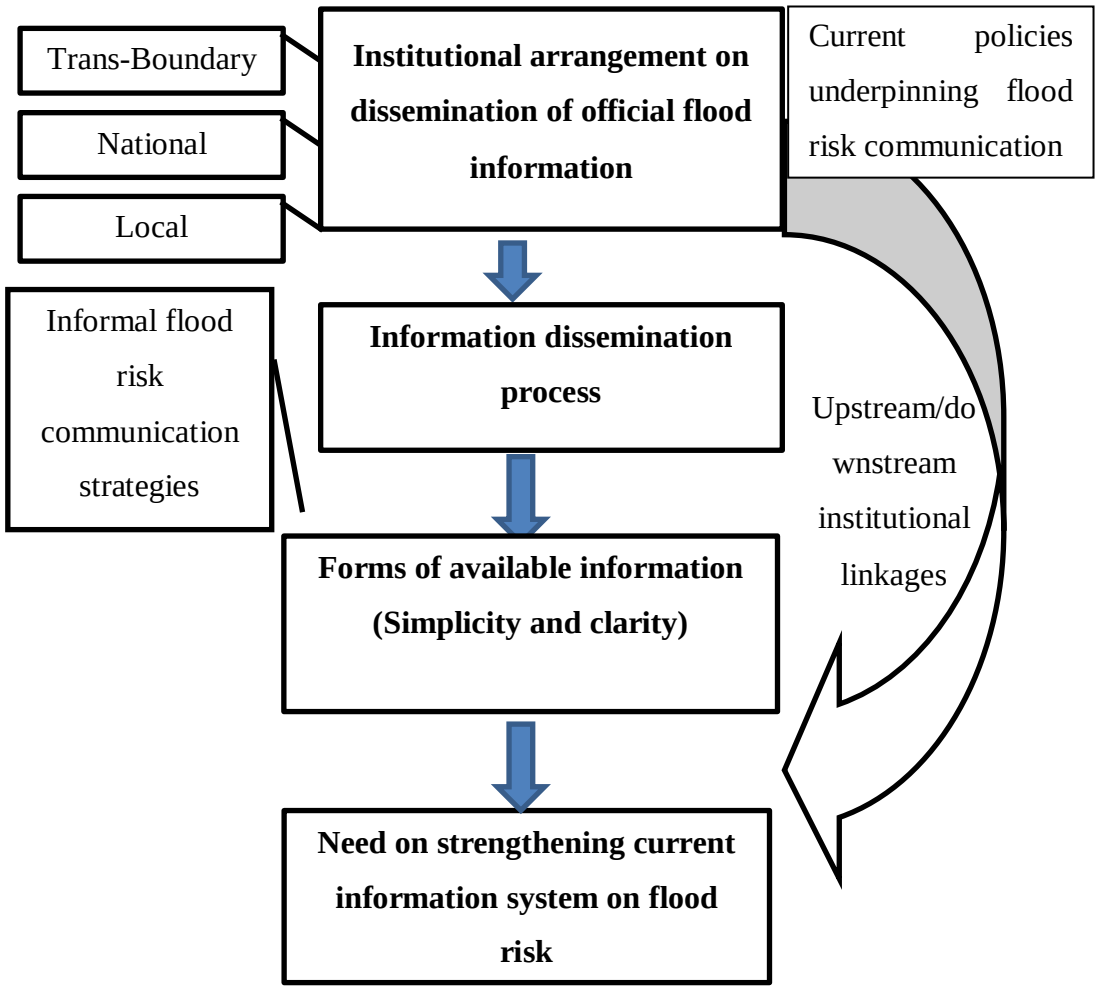

Figure 5: Framework for Research (Developed from document review and interviews)

3.4 Data Collection

3.4.1 Primary Data Collection

Primary data collection included the collection of data from the communities using questionnaire survey, key informant interviews using a checklist containing open-ended questions and validation of obtained information by triangulating the information from multiple sources. First pilot survey was done on October 2016 in Chharki Bhisambharpur of West Champaran and second village in Bariyarpur village and key institutions in Patna and West Champaran on April 2017. Furthermore, senior officers from institutions involved in flood risk communication in Nepal were interviewed in between October 2016 and April 2017 based as per the convenience. Following methods were adopted for primary data collection.

- **Institutional Mapping**

  The dissemination of information is influenced by the distribution of institutions and power. Distribution of this power and institutions influences the decision-making process as well as how available information is communicated and perceived by the community.. Institutional mapping was done first to identify the institutions involved in the flood risk communication and secondly to understand how the generated knowledge on flood risk is communicated through existing institutional set up, who gets the information first and how. This included institutions and policies of Nepal as well as in India. The information was gathered using both primary and secondary data collection techniques.

- **Questionnaire Survey at the Community Level**

  Questionnaire survey was conducted in Bariyarpur village of Kala, mangalpur in Nautan Block of West Champaran district in Bihar. Total 83 samples were collected randomly from the village using Slovin's formula, where total households were 105 and randomization was done using Microsoft excels.

  It was calculated as n = N / (1+Ne2).

  Where,

  n = no. of samples

  N = total population

  e = error margin / margin of error

- **FGDs**

  Two focused group discussions were conducted at the community level to gain the further insight about local knowledge of flood risk management, informal systems of communicating the flood risk. Also, some of the key issues related to floods were discussed. Total of two FGDs were conducted during the first pilot visit to the community on October 2016.

- **KII with relevant stakeholders**

  Once institutions were identified through institutional mapping, the in-depth key informant interviews were carried out for stakeholders involved in flood risk communication. This included government officials, NGOs as well as community based organization (CBO) representatives. Also, information gathered from the communities was triangulated with the information obtained from the key informant interviews and observations with the institutions involved in communicating flood risks.

3.4.2 Secondary Data

Secondary information was managed from respective department and institutions of Nepal and India as per the need. Thus collected data were used to analyse the findings from the primary data collection and analysis work.

3.4.3 Data Analysis

Collected data from both the primary and secondary methods were analysed. Community level survey was analysed using SPSS 20.0 and social network visualizer (SocNetV 201) was used to analyse and visualize the networks of institutions. Furthermore, adobe illustrator cc 2015 version was used to simplify the networks obtained from SocNet which shows the current institutional arrangements and information flow both at national as well as trans-boundary context.

CHAPTER IV: RESULTS

4.1 Formal and informal institutional arrangements for flood information communication

Communication of any information is possible through well established and managed institutional arrangements. Good institutional arrangement could not only communicate the right information but also help reduce the impact of undesirable events in future. This section presents the finding from the institutional mapping done based on the snowball sampling and key informant interviews with the authorities from the respective institutions. Review of available information like websites, information tool kits and archived information was done for institutions which could not be connected directly.

Table number 2 shows the name of the institution, their type broadly classified as formal, informal and influencer. Here, institutions are classified as "formal" to explain the institutions that are working as official institutions under the government bodies and are mandated by at least one official policy of their respective government. Whereas, "informal" institutions are aimed to point the institutions that are out of this official system, unwritten but are at the place. (Helmke & Levitsky, 2004) define informal institutions as "Socially shared rules, usually unwritten, that are created, communicated, and enforced outside of officially sanctioned channels" and this was taken as reference definition to define informal institutions, mostly at the community level. As a third category, a term "influencer" was used to represent the institutions which are neither the official ones taking part in the decision making process for official flood risk communication nor are the informal but are influencing the decision making process and well as whole information system. Influencer represents the INGOs, NGOs, social activists, and donor agencies.

Influencers are those who are working for strengthening the information system as well as having their role in decision-making more in indirect way. Also, respective working area and their expertise was visualized in 8 broad topics as shown in the following table. Following Table 2 shows the institutions and their expertise for flood risk communication in the context of Nepal. While, table 3 shows the same on trans-boundary aspect followed by Table 4 for Indian context.

Table 2: Institutions and their expertise for flood risk communication in the context of Nepal (prepared based on interviews with authorities, field data and existing literatures)

Name of the institutions	**Types**			**Expertise and involvement**								
	Formal	Informal	Influencer	Information generation	Strengthening information system	Coordination	Information communication	Mitigation works	Information visualization	Preparedness and awareness raising	Relief and response
DHM	✓			✓	✓	✓	✓		✓		
NEOC	✓					✓	✓			✓	✓
DEOC						✓	✓			✓	✓
DWIDM								✓		✓	
DHM field office	✓			✓	✓	✓	✓		✓		
LDMC	✓					✓	✓			✓	✓
CBOs		✓					✓		✓	✓	
Local NGOs			✓	✓	✓			✓	✓	✓	

Table 3: Institutions and their expertise for flood risk communication in trans-boundary context

	Types		**Expertise and involvement**						
Name of the institutions	Influencer	Information generation	Strengthening information system	Coordination	Information communication	Mitigation works	Information visualization	Preparedness and awareness raising	Relief and response
ICIMOD	✓		✓	✓	✓		✓	✓	
Practical Action	✓		✓	✓	✓		✓	✓	✓
DPNet	✓			✓			✓	✓	
UNDP	✓		✓	✓	✓	✓	✓	✓	

Table 4: Institutions and their expertise for flood risk communication in the context of India

	Types		**Expertise and involvement**								
Name of the institutions	Formal	Influencer	Information generation	Strengthening information system	Coordination	Information communication	Mitigation works	Information visualization	Preparedness and awareness raising	Relief and response	
Gandak Barrage	✓		✓			✓					
CWC	✓		✓	✓	✓	✓		✓			
SDMA	✓				✓	✓			✓	✓	
DDMA	✓				✓	✓			✓	✓	
DM office	✓				✓	✓	✓	✓	✓	✓	
GFCC	✓				✓		✓				
FMIS	✓			✓	✓	✓		✓			
Block office	✓				✓	✓	✓	✓	✓	✓	
Circle office	✓				✓	✓	✓	✓	✓	✓	
Thana	✓				✓	✓	✓		✓	✓	
Mukhiya	✓				✓	✓				✓	
CBOs		✓	✓		✓	✓				✓	
Local NGOs		✓		✓	✓	✓		✓	✓	✓	

4.2 Flow of information in national, regional and trans-boundary level

Based on the snowball sampling and simultaneous key informant interviews with identified institutions, a network of institutional arrangements was developed first using social network visualizer (SocNetv2.1) and this information was later used to create a network map and information flow both at national as well as trans-boundary level using adobe illustrator cc 2015. Following figure 6 shows the networks of institutions involved in communicating flood risk in the context of Gandaki River basin.

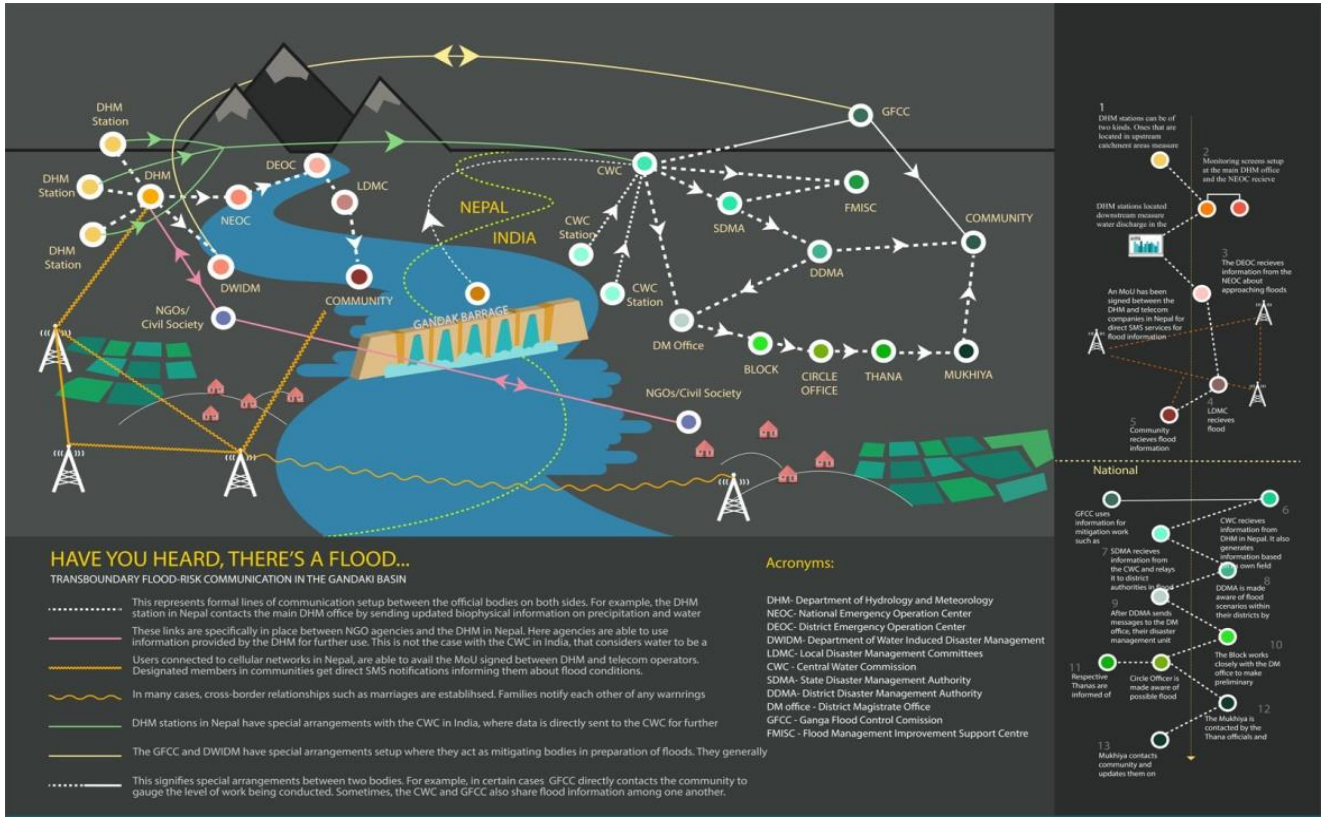

Figure 6 : Information flow in flood risk communication

4.3 Gaps in information flow

With support of above institutional mapping and key informant interviews with key 17 institutions involved in communicating flood related activities, seven broad issues were identified and the gaps recorded from the interviews were visualized and prioritized based on total count of each gaps in different institutions. Each interview was first transcribed in Microsoft word and then opens and selective coding was done manually with the help of Microsoft word as shown in appendix 8. The explanation for gaps of identified institution is discussed in the discussion section.

Table 5: Identified gaps in flow of information in flood risk communication

Name of the institutions	**Identified gaps**						
	Technological Gaps	Decision making faults	Insufficient information	Lack of human resources	Social power play	Technical messages	Filtering of message
DHM	✓	✓	✓	✓			
NEOC		✓	✓			✓	✓
DEOC		✓	✓		✓	✓	✓
DWIDM			✓	✓			✓
DHM field office	✓			✓		✓	
CWC	✓	✓	✓				
SDMA	✓	✓	✓		✓	✓	✓
DDMA	✓	✓	✓		✓	✓	✓
DM office	✓	✓	✓	✓	✓		✓
GFCC	✓	✓			✓		✓
FMIS	✓		✓			✓	✓
Block		✓	✓		✓	✓	✓
Circle office		✓	✓		✓	✓	✓
Thana	✓		✓		✓	✓	✓
Mukhiya		✓	✓	✓	✓	✓	✓
Community based groups		✓	✓	✓	✓	✓	✓
Local NGOs			✓	✓	✓	✓	✓
Total score	9	12	15	7	11	12	14

4.4 Results from the household survey data

4.4.1 Demographic information of the respondents

Total 83 respondents were interviewed for community survey. Out of which 15 were female and 68 were male. Figure 7 shows the percentage of male and female respondents during the household survey in each age group. Also, average household size was found to be of 8 with minimum 3 and maximum of 20 members. The reason behind the greater percentage of male (82%) than female (18%) is due to the reason that female at the community were not very much open to new people and even if they were there, they would prefer to call their husband or any male member in the family. This may have been attributed to social security and language barriers where most of the people speak their local language. The following graphics doesn't interpret the demographic information for key informant interviews done at different organizations and focused group discussions. The numbers of female were comparatively high in focused group discussion where they felt comfortable to speak when they were with other women from the same village.

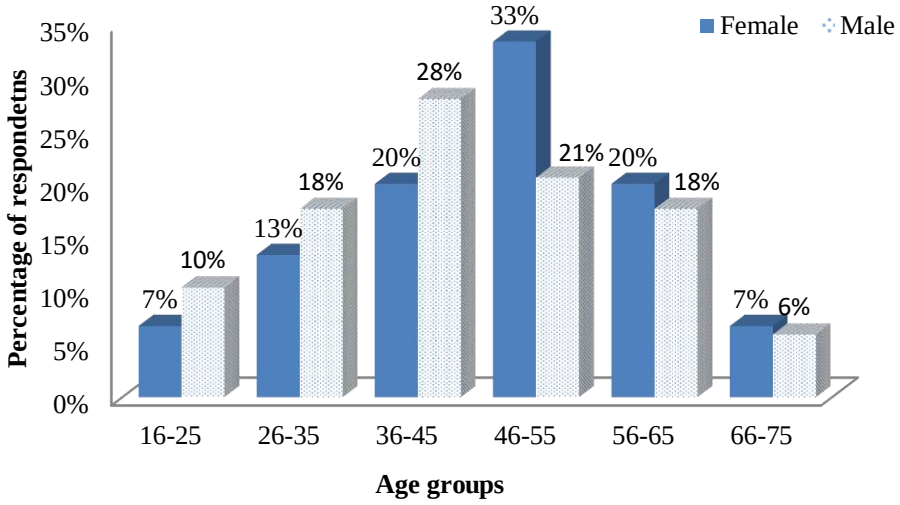

Figure 7: Disaggregated data on gender and age group

4.4.2 Head of the household and source of income

Out of total 83 households, there were only 3 households where female were head of the household, rest of the households were headed by male. Figure 8 shows the percentage of households having male and female as the head of the house. Main source of income for majority of respondents was found to be agriculture (92%) followed by livestock (5%) and wages (4%). Figure 9 shows the main sources of income of respondents in percentage.

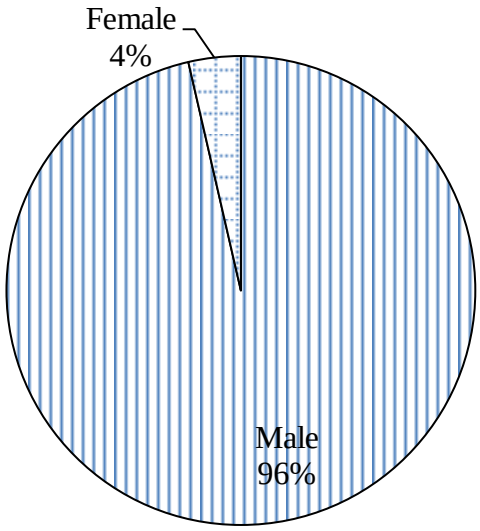

Figure 8: Head of the house

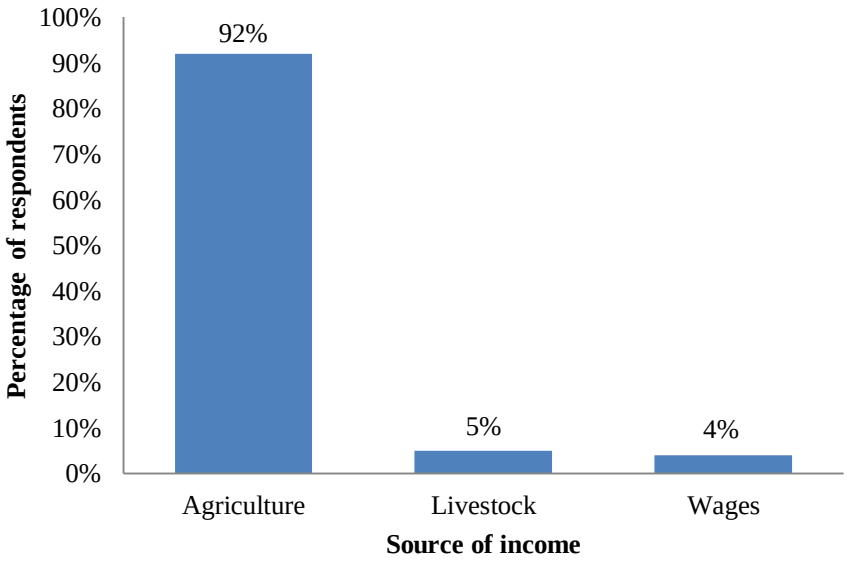

Figure 9: Sources of income

4.4.3 Perceived changes in flood frequency

While asking about the perceived changes in the frequencies of floods in the past 10 years, 46.7% of respondents think that there is no change in the flood frequency while 36% reported that the frequency is in increasing order. Only 1.3% of respondents think that the flood frequency is decreasing while 16% did no response. Figure 10 shows the percentages of people with different opinions about the frequency of flood.

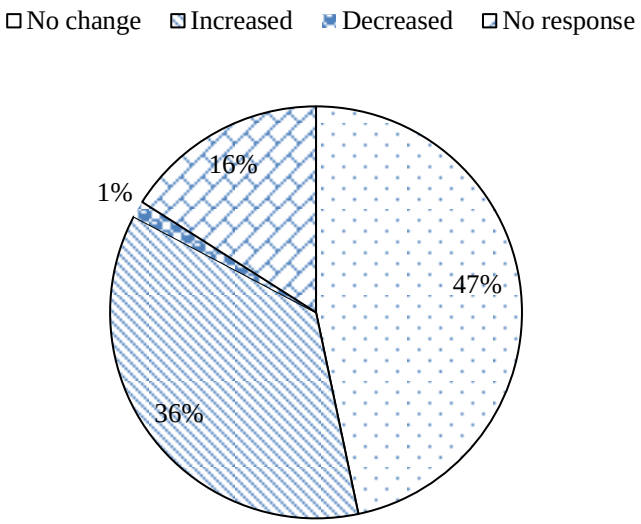

Figure 10: Perceived changes in flood frequency

4.4.4 Flood related information

Out of total only 53.7 % of respondents reported that they received the information about approaching flood while 46.3 did not receive any messages. Out of those receiving messages, 98% think that message was helpful in reducing the risk while 2% did not find the message helpful. Figure 11 visualizes percentage of respondents receiving and not receiving the information.

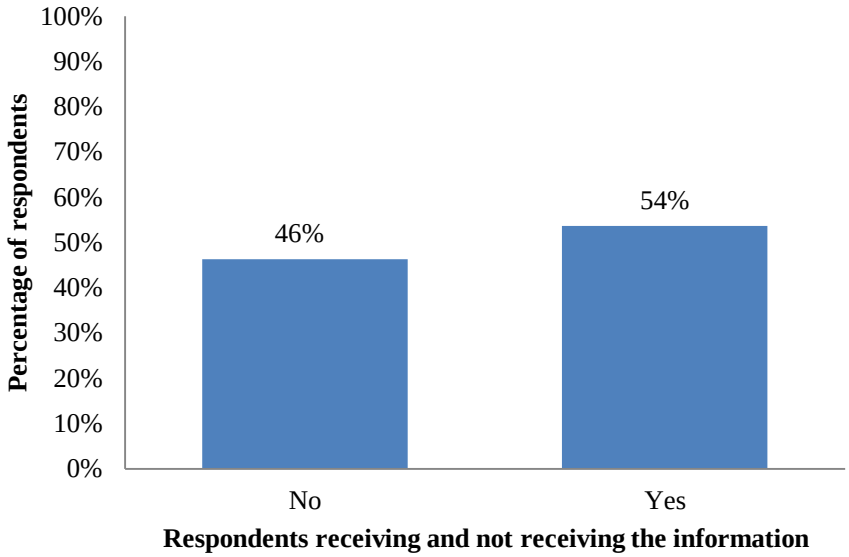

Figure 11: Flood related information received in community

4.4.5 Types and frequency of message received

During the interview, it was recorded that some of the respondents wished to receive the information not only during the monsoon period but also during rest of the time more about on trainings and capacity building. On asking about frequency of messages they received 54% of respondents reported that they received the flood related information only during the monsoon period while 46% did not receive the information at all. Out of the 54% who received messages, 72% received the information only about flood forecasting while 23% received about the safety measures to be taken during the flood and only 5% of the respondents hear about evacuation plans.

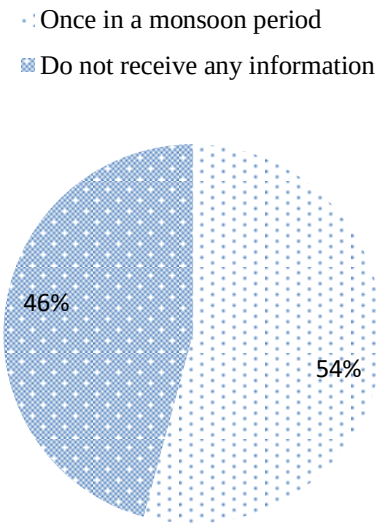

Figure 12: Frequency of message received

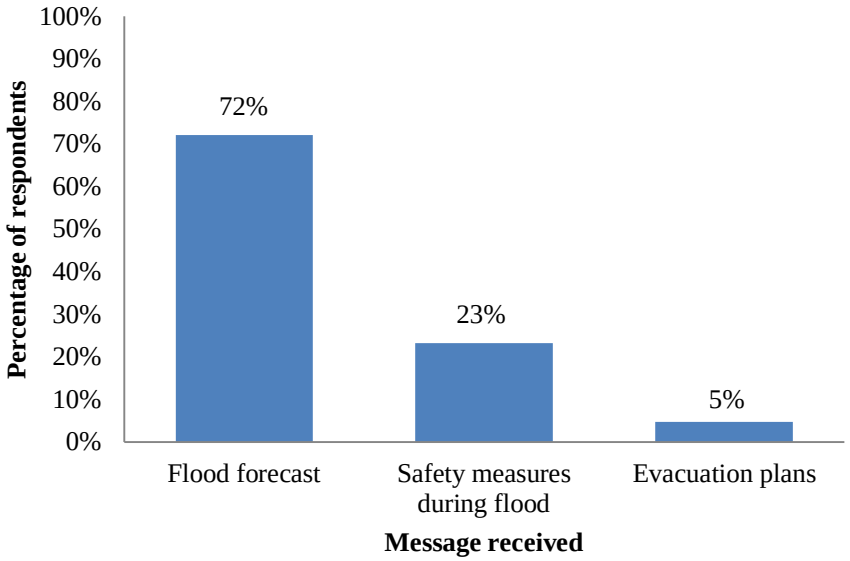

Figure 13: Content of information

4.4.6 Flood related information in local language

56% of the respondents reported that the flood related information are not shared in local language while 44% reported that flood information is shared in local language as well. Following Figure 14 shows the percentage of respondents with different opinion on availability of information in local language.

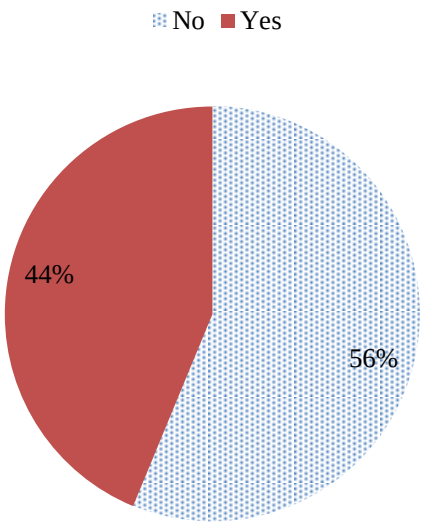

Figure 14: Sharing flood related information in local language

4.4.7 Sources from where flood related information received

When asked about the source of the information about flood, 27% respondents reported that they received the information from government officials and 36% respondents received information mostly from their friends and relatives. Likewise, 14% respondents received information from nearby police officers and rest of 23% from other informal sources as shown in Figure 15.

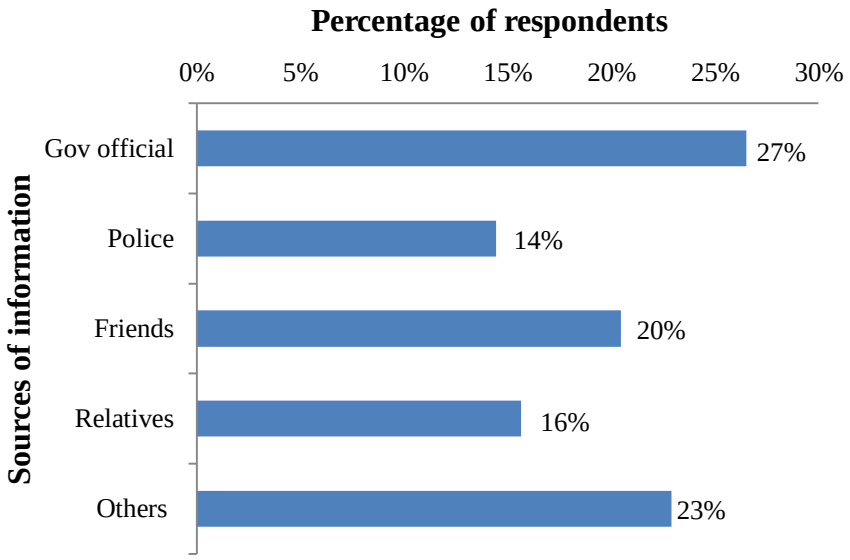

Figure 15: Sources of flood related information

4.4.8 Assistance received during flood

While asked about the sources of assistance they received during flood, about 47% said they did not receive any support. 20 % of the people received support from their neighbours, 18% from their families and only 11% received support from government. While, 4% of the people among the respondents relied on their self-formed help group as shown in Figure 16.

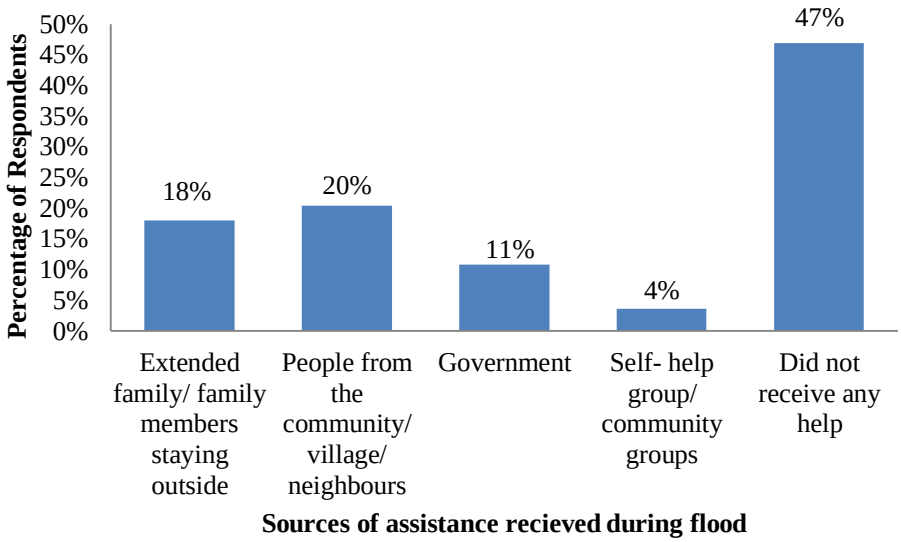

Figure 16: Different sources of assistance received during flood

4.4.9 Effort of adaptation actions at the household level

While asking about the individual efforts of coping with flood at the household level, following observations were recorded. Figure 17 represents the effort made before the flood where 48 % respondents move their family to safe place, 18% store the food to use during the flood, 18 % leave their family members in a safe place, 12% remain on the same place and 3% take their important items in the raised place, remaining respondents adopt other options based on the situation. Figure 18 shows the percentage of respondents making an effort of adaptation during the flood.

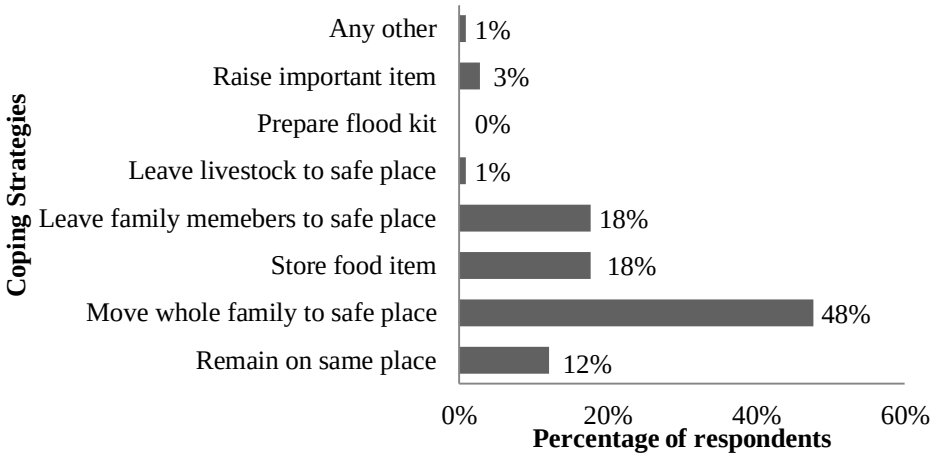

Figure 17: Coping strategies

4.5 Findings from observations and FGDs

First one week of community visit was more focused on knowing the local way of living and the observations. During one week of stay, two FGDs and 8 key informant interviews were conducted at Chharki Bhisambharpur to know the issues of flood and flood risk communication. Also, living at the one of the house of the community provided an opportunity to experience their daily activities and way of living. During the first visit, resource mapping was also done during FGDs to know the resources and risks of the communities for further studies. Open- ended questions were asked to explain and document the phenomenon in their own way. Following subsections describes the results and findings from combined work of researcher's own observations as well as issues raised during the focused group discussion.

Even if efforts were made to facilitate the equal participation of all the members, younger participants were not as expressive as the elder ones. Also, there were language barriers where they speak their own local language, Bhojpuri. Most of the participants can understand the hindi but very few of them were able to response in Hindi language. This may also have role to play during the discussion.

4.5.1 Observed flood risk in the area

First village Chharki is within Bihar and is northeast of Bishambharpur, northwest of Bariārpur Khuntahi and west of Mangalpur Kalān. Chharki lies at distance of only 637 metres from the river bank. Chharki have an elevation of 75 meters above mean sea level. There were 106 houses out of which only 2 were small concrete building. First one was used as *Aganvadi*- a place where children are taught before they go to school and second one was used for community meetings and centre for health treatment with very minor availability of medicine. Rest of the houses were made of locally available materials using Bamboo and mud. This village lies out of the embankment area made by the government to prevent riverine water entering the village.

Only one raised hand pump was seen in the village, whereas others were very prone to contamination and would submerge under water during the flood. Most of the people do not own their own land. They are dependent on their own grown grains which may be swept away by the floods. Some people were dependent on the farming done right at the bank of the river which means increased uncertainty of food security during the flooding.

Second village which is very much adjacent to the first one is Bariyarpur which lies under the *Panchayat* Mangalpur Kalān. This village lies more northeast of Chharki Bhisambharpur and southwest of Mangalpur Gudaria and Telua. It has an elevation of 76 meters and lies at approximate distance of 2.10 kilometres from the river. Bariyarpur village has total of 104 households with similar socio-economic conditions and housing patterns. While river is flowing at an elevation of 74m there is only marginal difference of 2 meters which indicates the high probability of flooding. However, the other side of village looks comparatively less vulnerable due to recently constructed raised Betiah-Gopalgunj road which may prevent water entering the other side of the road.

Many of the women in both of the village could not speak in other language than their local language and were illiterate with less access to information. Most of the women in the villages do not have swimming skills and have to wait till the rescue boat (locally called as Dengi) comes and rescue them. There were only 3 boats operating in the region with possibility of mobility in the large area.

4.5.2 Local knowledge of flood prediction and risk communication

In addition to this, there was different type of flood prediction among which looking at the colour of water in the river was the most common. Community's people predict the high rainfall in the upstream area if they observe the increasing redness in the river water. In addition to this, some people observe the colour of the cloud; dense black cloud may signals to approaching intense rain.

Also, they have different reference point in the river bank where they have set a reference point on their own to define normal, danger and above danger level. There is more or less similar level of water during other seasons unless there is sudden opening of the gates in Gandak barrage in Valmikinagar. But, there is also a point where community has set to define the normal monsoon level water. They have planted the different layers of crops with increasing distance from the river. First comes the Sugarcane, secondly the grains and lastly the seasonal vegetables. As the water approaches near the sugarcane field, it is time to be alert but not very much worried. When it crosses the sugarcane field and inundates the grains, this time is the time to be ready to escape. Finally, when water enters the vegetables lands, it's above danger level and time to escape. When the normal monsoon water level raises and comes above the danger level, they shout and communicate with other members in the village. They call this action "*Halla bol*" which generally means making people aware of approaching

flood in the community. With emergence of technology, there is increasing use of mobile phone for communicating this risk mostly among male members. This information will not help them to store the available foods in the raised places and prepare important stuffs and be ready for escape.

4.5.3 Own ways of living with floods

Apart from this, these communities have developed their own ways of living with floods. With their own informal type of flood information system, they also have learned to cope with the recurring flood. This included storing the food for emergencies, making raised structures to stay during the floods, use of locally made big boats which can accommodate more than 50 people to evacuate during flooding.

Almost every households in the community have a food storage bucket called "*Beri*" in their local language. This bucket is used to store the grains which not only prevents from pest infection but also secure the food from inundating in water since it is raised from the ground. *Beri* is shown in the photo 1.

Also, many household have raised sitting places known as *Machan* made from locally available Bamboo which women uses during the floods to keep their children safe before the support reaches. This *Machan* is also a good place to have a sit and talk about social and family issues. *Machan* is shown in the photo 2.

Generally owned by *Mukhiyas* and *Sarpanch*, there are freely available boats known as *Dengi* which they use it during the flood for the evacuation purpose. These boats are available all the time in the river even if there is no floods and hence used for transportation purpose from one side of the river to other side. This service is free of cost and anyone can get in, in return community donate some foods, grains and milk products to the owner of the boat. This shows that even if there will be no one from outside to help them during the emergencies, they have developed their own ways of living and adapting with recurrent floods. Although in less number, there were raised hand pumps in the community which could be very useful during flood.

4.5.4 Power play and education in receiving the information from the government offices

As the information passes through official channel in different level, there is unique power play both at the higher and lower level. Most of the people during individual interviews and focused group discussion reported that, there is high possibility of

getting information from Block Development Office, Circle Office and *Mukhiya* if there is someone you know who works in these offices. Therefore, social networks play an important role in reducing flood risks. Also, if one is educated as compared to others, there is chance that he/she will get information sooner than the illiterate person both from telephone calls as well as other communication mediums. During the interviews with the focal persons responsible for sharing the information at the local level revealed that their priority will be the region where they belong. If one *Mukhiya* is elected from one particular village and there are two villages at equal risk of approaching floods, his/her priority would be the village where he/she belongs.

4.6 Findings from policy review and insight from key informant interviews

Both of the countries do not have specific plans for flood risk communication but are influenced mostly by disaster management acts and plans. The flood risk management in Nepal is seen in broader picture as disaster risk management and is guided by Natural Calamity (Relief) Act, 1982. This act was formulated in 1982 with greater focus on post disaster relief activities. The name itself contains the word "relief" indicating the act is more focusing on the post-disaster efforts. This act defines flood as a "Natural Calamity" and have provision of providing relief in case of damage from the flood, based on the situation but lacks it poorly discussed and addressed the issues of risk communication and preparedness. Similarly, The Disaster Management Act, 2005 of India has somehow tried to incorporate the issues of preparedness and awareness rising with prior communication of information about disasters but has not mentioned particularly about risk communication. Also, the policies follow the more top-down approach of commands and operating procedures giving authorities at the higher level more power.

Both of the governments seemed more focused on post disaster activities as compared to risk communication prior to any disaster events. One of a senior officer from West Champaran, Bihar who is responsible for informing people and risk management told during the interview that they mostly work after the flood events. He added "unless there is a flood, we do not have anything to do."

CHAPTER V: DISCUSSIONS

5.1 Institutional arrangements for flood risk communication

Result section in 4.1 demonstrated the institutional arrangements for the information communication in flood risk. Total 28 institutions are presented indicating the type of the institutions and their respective expertise. This section elaborates the expertise and institutional arrangements based on the result.

DHM is the official information creator in Nepal, hence referred as formal institution. The information in DHM is collected by their own stations. Also, there are continues efforts to make this information system more efficient in future. DHM not only generates the information but also coordinates with other governmental bodies for the communication of generated information. Furthermore, DHM has made efforts to visualize the available information through websites and social Medias. Likewise, NEOC, at the national level has responsibility and ability of coordination for information sharing, preparedness and taking control of relief and response work in post-flood scenario. DEOC at the district level which is formed under NEOC with similar expertise and responsibility downscaled at district level. DWIDM, as a formal institution to mitigate water induced disasters in Nepal has responsibility of looking over mitigation works to reduce the impact of the flood and raising awareness in some cases. DHM has its field offices with the responsibilities of collecting data and sending it back to main DHM office and vice-versa. At the village level, there are LDMCs responsible for coordination and communication of information as well as relief distribution and improving preparedness to disasters.

ICIMOD, referred as influencer in this study, works in Trans-boundary aspect of flood risk communication. It has expertise on strengthening the flood information system, information visualization, communication of available information, coordination and awareness building.

Practical Action, an international NGO, has its involvement in flood in formation and works beyond the border with expertise similar to ICIMOD. Similarly, DPnet-Nepal is a network of stakeholders working in disaster preparedness in Nepal. With more focus on preparedness activities, it has involvement of coordination and awareness raising. UNDP, as influencer is also working in trans-boundary aspect of flood information

system with coordination, strengthening information system, communication of information and preparedness activities.

Gandak Barrage is constructed near the Indo-Nepal border and is under the control of Indian Government, it was built in 1968 A.D. with an aim to facilitate the irrigation and electricity generation to benefit the both of the countries. But, the operation of this barrage has been seen as the causes for increased flooding in the downstream region. This barrage have their own water discharge causes and can provide information about the water level and communicate it to the CWC in Patna, Bihar.

CWC is the mandated formal body under Indian government responsible for generation of information as well as communicating with other stakeholders. It has expertise and responsibilities in India similar to DHM of Nepal. Likewise, SDMA under state government is responsible for overall coordination of disaster related issues at the state level and have responsibility to alert and communicate the associated risk of any hazard to the district level agencies. DDMA at the district level has almost similar expertise as of SDMA and runs under the direct command of SDMA. DM office at the district level is a formal and supreme body at district level responsible for overall coordination and communication of flood related information through disaster management department under DM office.

GFCC is the body under central government with engineering expertise mainly responsible for mitigation works to reduce the impact of floods in Ganga and its associated rivers. FMIS in Patna, Bihar is a centre established for improving flood information system with increased coordination, data visualization and communication. Block office at the block levels are the offices operating under the command of DM office and has overall responsibilities of disaster management similar to DM office. Circle officer works under the direct command of block officer and has coordination mechanism with nearby police station called as "Thana". At the community level, there are respective *Mukhiyas* at each *Panchayat* responsible for communication the information sent from the circle officers and police stations. Also, there are some local NGOs in both of the countries working at the local level to strengthen the flood information system.

Identified as informal, there are community based groups, social values and traditions which are spontaneously working in the communities. Overall, institutional arrangements are satisfactory for information sharing but number of gaps in each

institutional level were recorded which needs to be minimized. Identified gaps are discussed in the section 5.3.

5.2 Information flow and analysis of flood risk communication efforts of the authorities

5.2.1 Context of Nepal

This section discusses the flow of information in brief with respect to the result 4.2, mostly about the formal arrangement as well as informal system of communication.

As shown in the figure 6, DHM has their own stations in different watershed as well as river basin. The stations at the watershed level measures precipitation, hence known as "rainfall stations" whereas those at the river basin level measure the discharge of the river, called as hydrological stations. Some of the stations are automatic and sends the information directly to the server located at main office of DHM at Kathmandu whereas some of them are manual where there are persons assigned for recording the information and sending this to DHM. This information is visualized as real time information in web portal of DHM. Additionally, there are two screens setup with 24 hours of functionality mainly during the monsoon period at DHM office and NEOC which shows the real time information of river discharge and associated risk.

The information once communicated to NEOC, there are DEOCs chaired by CDOs at the district level in Nepal which runs under the command of NEOC. DEOCs are responsible for communicating this information to village level government authorities formed as LDMCs chaired by VDC secretary. These LDMCs sends the information about possible flooding at the community level. Alternatively, there is agreement between DHM and a telecom company, Ncell where the information about the specific river basin is sent through SMS service. The SMS is sent directly to the individual mobile phones taking reference to the nearby mobile tower they are connected to. Separate 4 types of messages are prepared and communicated based on the situation as shown in appendix 5.

Although there is no any clear mechanism of communication flood related information to DHM. The information sharing is done manually to DWIDM in case of need and this information is mostly used to identify the flood prone areas for mitigation actions.

Also, there are IGOs/ NGOs and civil societies taking reference of the information generated by DHM and communicated through their own channels at the community levels.

5.2.2 Context of India

CWC in India is responsible for generation of information. CWC has its own stations in Gandak River and there are staffs working in the Gandak barrage updating the real time data. The information about possible flood is communicated to SDMA through telephone. SDMA communicate these messages to respective district level DDMAs. Also, the FMIS is established to facilitate the information communication and the information is visualised in the website. FMIS however do not communicate the message with communities but share the information in with other stakeholders. Sometimes, The DDMA directly communicates the information to communities based on the situation. But, the normal way of communication is through DM office at district level. There is separate disaster management department under DM office which communicates the information to Block Development Office at block level. The information is then communicated to Circle Officer and nearby police stations. From circle officer, then it is communicated to *Mukhiyas* at respective *Panchayat* and finally to communities.

5.2.3 Trans-boundary aspect of information sharing

During 1987 and 1989 there was government level meeting and agreement between government of Nepal and Government of India with the provision of strengthening Nepal's flood forecasting network and information sharing to India about floods. Based on this agreement, DHM of Nepal provides the information of major river basins flowing from Nepal to India. For this, the wireless system is set-up between DHM of Nepal and CWC office in Patna for automated information sharing. Furthermore, for manual stations and additional information, there is one special officer assigned at field office of DHM located at Sindhuli district who shares the information about water level. Also, the information from Gandak barrage in between Nepal and India is communicated to CWC.

Apart from this, DWIDM uses the information from DHM for planning the mitigation works in trans-boundary aspect in collaboration with GFCC. There are bilateral minutes sometimes in annual basis and sometimes with the gap of 2-3 year. This is the

high level meetings of focal persons working in flood risk management led by DWIDM from Nepal's side and GFCC of India. The group of this negotiation team includes senior engineers, policy makers and senior officers working for flood forecasting.

5.3 Elaboration of identified gaps in flood risk communication

The result section of 4.3 presented the gaps identified in the 17 key institutions interviewed during the field work. These gaps are identified based on the combined work of visit to respective offices and key informant interviews with senior officers from the respective agencies. Also, telecommunication was used in cases where it was impossible to meet officials. This sub-section elaborates the identified gaps for each institution with respect to result of 4.3.

From Table 5, we can see that lack of sufficient information has been a major gap in most of the institutions followed by filtering of messages, decision making faults and technical difficulties in messages, social power play. Likewise, technological gaps and lack of human resources were found to be least as compared to other factors. Technological gaps in DHM referred to the unavailability of enough rainfall stations as well as hydrological stations. Also, the lack of finance to adopt latest available technology in the market is the measure issue. Furthermore, with limited resources and high uncertainties within the current technological set-up at the department, there were incidents where the model projected floods did not occur in real resulting in the decreased trust among the communities. Also, the insufficient information is fuelled by lack of resources and financial constraints. One of the other major concerns is the lack of sufficient manpower. The flood forecasting division under DHM had only 3 staffs specialised for flood forecasting. The load of work increases during the monsoon period and these officers have to work overtime but they are not paid extra for overtime work they put in. So, there is need to increase the skilled person power and accompany them with extra facilities in case of additional work loads. The alternative approach of flood dissemination through SMS is appreciable but these initiatives are only effective when end-user have access to mobile phones. Also, there are possibilities of damage in the telecommunication system during the emergency situations, so there must be back up plan to avoid the breakage of communication. At the field level, there are very limited officers appointed for data collection and communication which creates greater risk with no alternative backup plans.

NEOC, supreme body for emergency operation formed under MoHA is also subjected to decision making faults about individual disasters. With increased responsibilities, more generalized type of work is done and focus is more on post- disaster related activities. For floods, NEOC have to depend on the information sent by DHM and do not have alternative sources of information for the information validation which means amplification of decision making faults from DHM to NEOC as well. Also, the staffs in NEOC are not specialized on understanding the hydrological terminologies and data interpretation which makes them generalize the each information and communicate them in the same way. With difference in understanding and analysing skill of human resources working in NEOC, there is filtering of message and the quality of information decreases as it passes through the down channel. DEOC also have similar gaps as its supreme body NEOC but there is increased power play at the district level since the body overlaps with the DDRC responsible for relief and response work. Even if, the mandate of NEOC and DEOC is communicating the information and facilitating information flow in advance, most of the work is done either right during the emergencies or after the flood events.

Although DWIDM has overall objective of management of water induced disaster, it has its greater focus on mitigation work. Very less priority is given for communication of risk and greater focus is given for erosion control and control of flood rather than reducing the possible risk from probable flood hazards. The received information at DWIDM is used mainly for planning the mitigation works and this organization is not very much involved in communicating the flood related information at the ground level. DWIDM has common problems like lack of human resources and filtering of the message as it reaches the ground level.

CWC also has technological gaps in communication risk with not so very smooth information sharing mechanisms within different stakeholders. There are also decision making faults attributed to limited availability of information. One of the senior officers from CWC reported that even if there are the mechanisms to receive the information from Nepal's DHM, they rarely rely on this information. The lower dependency on upstream shared information is due to insufficient information amplified by political distrust and social settings.

SDMA as a state level authority have mandate of managing overall disaster based on whole of the disaster cycle. But, there are technological as well as administrative gaps

when it comes to information sharing. This authority is not specialized for flood risk communication but have mandate of looking over all types of natural disasters. Officers from the authority claim that they are organizing the awareness raising activities in the communities but the community people did not hear about them. DDMA at the district level is also having more or less similar types of issues.

As a supreme body, disaster management department under DM office has mandate for disaster management at the district level. But, it was found that the department is only focused on post- flood relief distribution works. One of the senior officer from the department said that "we work only during the flood and rest of the time, we have other priorities". GFCC is only focused on flood control and mitigation measures and have very low role to play in the flood risk communication.

FMIS, do not generate their own information but are rather dependent on the data provided by CWC and other scientific sources. They generally visualize and do modelling for preparation of flood inundation maps and share mostly with governmental authorities and upload on their web portal. However, they share this information only with government authorities and are mostly in digital forms.

BDO offices are dependent on the information and command sent from the DM office and acts mostly during and after the flood event. These offices are influenced by political power play, insufficient information and decision making faults. Same "top-down" information is passed to circle officer and nearby police stations ultimately reaching to *Mukhiyas* at community level.

Above findings and discussion shows that there are many gaps in each administrative levels for flood risk communication which needs to be addressed and minimized for effective flood risk communication.

5.4 Possible ways of minimizing the communication gap

This section discusses the results from household survey at the community level and comparing it with the key information received from the authorities involved in the process of communicating risks.

5.4.1 Balancing the knowledge of science and society

Flood risk communication involves understanding both science as well as communities, so there is need of sensitization among the experts about balancing both of these aspects during the information sharing. (Leskens et al., 2014) argued on their study that

there is need to communicate scientific information as soon as possible which are generated from computational simulation because they might be subjected to change over the time which may lead to less effective decision making

Most of the man-made structures in the water bodies are constructed with developmental perspective focusing in irrigation and hydro-power generation. Thus, there is need of comprehensive planning putting "people" at the heart of planning. There are issues relating to the advancement of technology and capacity of respective government to be able to afford these changes which could be mutually solved through increased regional cooperation between two governments. As the knowledge evolves with time, there is need of evaluation of each strategy at the agency level to better strengthen these strategies in coming days. Reflexion of knowledge from local people, developmental sector and other relevant stakeholders can help create integrated flood risk management (Weng, 2016).

5.4.2 Tailoring of the message as per the local need

Result section 4.4.5 shows that 56% of the respondents did not receive flood related information in local language. It was found that the message communicate by authorities were more in generalized form and did not include the information about how much it is going to affect the specific communities. Also, it did not considered the understanding level of target communities. This result is favoured by (Birkholz et al., 2014) argued that the more focus should be given to more holistic approach of thinking about risk perception of all the stakeholders and decision makers rather thinking about one particular group of people.

5.4.3 Consideration of other sources of information

As discussed in the result section, there are other undocumented ways of communication in the flood related information which are not really considered as information in official flood information system. Although, they are not documented well, they are actually having greater impact at community level as compared to documented flood information communication strategies. A study conducted in India found that for effective information transfer, authorities need to identify not only the various information sources but also how the information are filtered when flowing from one to other (Jameson & Baud, 2016) .

CHAPTER VI: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Based on the above findings it is clear that there are many gaps and challenges at different level as the messages passes from upper level to lower through different mediums. Also, it was found that official flood risk communication strategies in both of the countries adopted "top-down" approach of communication with low community participation. Also, most of the agencies focused only on sending flood warning information to the communities in generalized way without considering the local and external drivers leading to increased risk. Furthermore, the authorities involved in flood risk management are focused mostly on providing some minor support during the flooding. With so many institutions at place, there is nothing clear division of roles and responsibilities of each authority for effective information communication on flood risk. In some cases, the issues and responsibility was found overlapping while in some cases no one seemed to take the responsibility of certain issue solely. As it is guided more by "top-down" approach, very few of them have well established feedback mechanisms to know the effectiveness of their own communication strategies.

6.2 Recommendations

Based on the research work, following recommendations are made:

6.2.1 Considering the local needs

As found in this study, the context and specific need of the target audience may differ from place to place. There are different social norms, values, different language spoken at different places. People have different level of understanding based on their educational background which should be taken into consideration to identify best types of information to be communicated for different target groups. Also, the access to medium is another important aspect to be considered. If majority of people do not have access to certain mediums of communication, there is no use of sending messages through that medium, no matter how important messages are. So there is need to tailor the information with respect to specific target audience for efficient flood risk communication.

6.2.2 Ownership

Flood risk management is a cross-cutting issue with responsibility of multiple authorities. When the issue is broad, it needs the attention of more than one authority with their respective expertise. Based on the expertise of each stakeholder, some important aspects may be overlapping and some important aspect may not be priority of any of the stakeholders involved. So, there is need of distinction of roles and responsibilities of each involved stakeholders in each level.

6.2.3 Community as a partner

Current flood risk management approach considers community only as a beneficiary or end user with no roles and responsibility in overall risk management. For effective and comprehensive flood risk management with proper risk communication, there is need to involve community as a partner of risk management rather than only beneficiary. There are believes in the downstream that the reason behind the flooding in the areas are largely due to the action of people living in the upstream which needs to be clarified for increased trust and efficiency of communicated information.

6.2.4 Incorporating local flood risk communication strategies in official system

Local people are the master of their land. They have developed their own ways of living with the existing risk in their area. There are locally developed systems of flood risk communication at the village level which are best fit in local context and these systems needs to be integrated with official risk communication strategies to the best possible extent.

6.2.5 Increasing harmony between scientific community and society

Communicating flood risk involves understanding both science as well as need of the communities. Therefore, there is need of exchanging information among the knowledge generators, communicators, decision makers and communities for increased understanding. Scientists are often seen as not very good communicators of the work they are doing, this could be minimized with increased sharing and simplification of available information.

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Appendices

Appendix 1: Schedule for Household Survey

Questionnaire No._____

Analysing the flow of information in flood risk communication: A case of Gandaki River Basin
(Household level questionnaire)

All the information collected through this questionnaire are highly confidential and purely for research purpose. Respondents' comments, suggestions and personal information will not be used beyond the research purpose.

Respondent's Name: ……. Date: ……..

Respondent's sex: …….. Village: ……..

Tola/VDC/union council: ……..... District: ……..

Country ----------

Interviewer's Name: …….

GPS Coordinate:…….

1. Household's basic information

101. What is the HH size?	102. How many dependents your household has?	103. What is the no. of female members in your HH?	104. What is the sex of HH head? Male = 1 Female = 2	105. What is the main source of income? Code	106. What is the education status of HH head? Code	107. What is the age of HH head & members (yr.)?	108. How many migrants sent by HH? (if no migrant, leave this blank)
						HH: 1: 2: 3: 4: 5: 6: 7:	<u>Within country:</u> Total: Female: <u>Overseas:</u> Total: Female:

CODES for Q 105	
01 = Agriculture	05 = Private employment
02 = Livestock	06 = Small business
03 = Wages	07 = Remittances
04 = Govt. employment	08 = Other (specify)
CODES for Q 106	
00 = Illiterate	04 = Masters
01 = Primary schooling	05 = Above Master
02 = Intermediate	98 = Don't know
03 = Bachelors	

2. Flood early warning information/communication

201. When the last flood happened in your area?	202. Did any member of your HH receive flood related information before the flood in last 3 years?	203. What message did your HH receive?	204. What sources of communication your HH has?	205. How often does your HH receive flood related messages in monsoon?	206. How does your HH use the flood related information?	207. Who shares the flood related message mostly?
Year	No = 0 (skip Q 203 to 212) Yes = 1 (ask Q 203 to 212)	A = Flood forecasting B = Safety measures during flood C = Evacuation plans D = Advices on safety of drinking water E = Other (specify)	A = Mobile phone B = Landline phone C = Radio D = TV E = Computer with internet F = Newspapers G = Local gatherings H = Schools I = Govt. officials (disaster Dept.) F = Other (specify)	1 = Once in a monsoon period 2 = Once in a month 3 = Once in a week 4 = More than once in a week 5 = Daily 6 = Other (specify)	A = Start preparing to cope with flood risks B = Communicate message to other community members C = Other (specify) D = Does to use at all	A = Govt. Officials B = Police C = Friends D = Relatives E = Other community members F = Others (specify)

208. Are flood related information messages in local language?	209. How many days (tentative) before the flood your HH mostly receive information messages?	210. Do you think flood related information messages are helpful in preparedness?	211. How will you rate the communication tools/sources in terms of its effectiveness? 212. (The most effective source is 1)
No = 0 Yes = 1	Number of Days	No = 0 Yes = 1	( ) = Mobile phone ( ) = Landline phone ( ) = Radio

			( ) = TV ( ) = Computer with internet ( ) = Newspapers ( ) = Local gatherings ( ) = Schools ( ) = Govt. officials (disaster Dept.) ( ) = Other (specify)

3. Perception of Floods and coping actions

301.Has your HH perceived any change in the frequency of flood compared to 10 years ago?	302. Has your HH perceived any change in the level of flood water now compared to 10 years ago?	303. What coping steps does your HH mostly take before the onset of flood?	304.What actions does your HH usually take during flood to sustain the livelihoods?	305.From where your HH receive assistance during flood?	306. W hat action do your HH take to support your food security during flood?
A	**B**	**C**	**D**	**E**	**F**

Codes A **Codes B** **Codes C**

No change	0	No change	0	Remain on same place	A
Increased	1	Increased	1	Move whole family to safe place	B
Decreased	2	Decreased	2	Store food items	C
No response	3	No response	3	Leave some family members to safe place	D
				Leave only livestock to safe place	E
				Prepare flood kit	F
				Raise some part of house to save important items	G
				Any other (specify)	H

Codes D	Codes E	Codes F
A = Borrow Money	1 = Extended family/ Family member staying outside	A = Consume stored food
B = Rely on own savings	2 = People from the community/ village/ Neighbours	B = Borrow money from friends & relatives
C = Change eating patterns (Relied on less preferred or cheap food)	3 = Local / International NGO	C = Borrow money from bank
D = Reduce expenditure on non-food goods and services	4 = Insurance company	D = Reduce consumption of food by all HH members
E = Sell farmland	5 = Government	E = Reduce consumption of food by adults
F = Sell livestock	6 = Self-help group/community groups	F = Any other
G = Sell household assets	7 = Village level organizations	
H = Abandon farming	96 = Did not receive any help	
I = Change farming practices	99 = Other (specify)	
J = Invest in livestock	98 = Don't know	
K = Migrate/relocate to another place		
L = Work extra time		
M = Receive disaster preparedness training		
N = Move to community place/ shelter home		
O = Find off-farm activities		
P = Seek medical treatment from government health facilities		
Q = Seek medical treatment from private health facilities		
Y = Other (Specify)		
Z = Did not do anything		

Thank you for your time and cooperation!!

Appendix 2: Checklist for KII

- Could you share me about your organization and about your works?
- How long have you been working with this office?
- What are the activities your organization involved in?
- Can you share me the sources from where you receive information about flood and flood risks?
- How do you share the available information? What are the different methods you are using?
- Does anyone (any agency from Nepal) communicate any authority here about water level in Gandak river basin?
- What do you think of these messages communicated to community people? And how could they be improved?
- Do you have any idea, how do they share this information about water level?
- In your experience, what are the other formal and informal institutions working in flood risk communication?
- Who should I visit with to learn more about my questions?

Appendix 3: List of Respondents from the community

S.N.	Name	Address
1	Motilal Yada	Bariyarpur, West Champaran
2	Paras Yadav	Bariyarpur, West Champaran
3	Satrudhan Yadav	Bariyarpur, West Champaran
4	Ram Akeval Yadav	Bariyarpur, West Champaran
5	Bacchu Shah	Bariyarpur, West Champaran
6	Byas Mani Yadav	Bariyarpur, West Champaran
7	Mahesh Yadav	Bariyarpur, West Champaran
8	Laxman Yadav	Bariyarpur, West Champaran
9	Laisa Devi Yadav	Bariyarpur, West Champaran
10	Mina Devi Yadav	Bariyarpur, West Champaran
11	Mani Lal Yadav	Bariyarpur, West Champaran
12	Harandar Yadav	Bariyarpur, West Champaran
13	Santos Kumar Yadav	Bariyarpur, West Champaran
14	Sangita devi yadav	Bariyarpur, West Champaran
15	Hari Narayan Yadav	Bariyarpur, West Champaran
16	Jiten Yadav	Bariyarpur, West Champaran
17	Upendra Kuma	Bariyarpur, West Champaran

18	Yogendra yad	Bariyarpur, West Champaran
19	Rajendra yad	Bariyarpur, West Champaran
20	Naresh Kumar	Bariyarpur, West Champaran
21	Ramesh Yadav	Bariyarpur, West Champaran
22	Jedi yadav	Bariyarpur, West Champaran
23	Sigasan yadav	Bariyarpur, West Champaran
24	Saroj Devi	Bariyarpur, West Champaran
25	Rita Devi	Bariyarpur, West Champaran
26	Baburam muldhania	Bariyarpur, West Champaran
27	Hiralal yadav	Bariyarpur, West Champaran
28	Surya muhi devi	Bariyarpur, West Champaran
29	Raju yadav	Bariyarpur, West Champaran
30	Jagadis yadav	Bariyarpur, West Champaran
31	Birendra yadav	Bariyarpur, West Champaran
32	Prithivi Yadav	Bariyarpur, West Champaran
33	Puja Yadav	Bariyarpur, West Champaran
34	Jamdar yadav	Bariyarpur, West Champaran
35	Chatu yadav	Bariyarpur, West Champaran

36	Mohan lal	Bariyarpur, West Champaran
37	Muktar yadav	Bariyarpur, West Champaran
38	Priti devi	Bariyarpur, West Champaran
39	Lal pari devi	Bariyarpur, West Champaran
40	Ajit kumar	Bariyarpur, West Champaran
41	Dwarika yadav	Bariyarpur, West Champaran
42	Sabitri devi	Bariyarpur, West Champaran
43	Shree krishna	Bariyarpur, West Champaran
44	Rukhmani yadav	Bariyarpur, West Champaran
45	Ram chetri yadav	Bariyarpur, West Champaran
46	Chotu lal chaudhari	Bariyarpur, West Champaran
47	Krishna chaudhari	Bariyarpur, West Champaran
48	Surendra sohani	Bariyarpur, West Champaran
49	Balistar sohani	Bariyarpur, West Champaran
50	Sakal dev chaudhary	Bariyarpur, West Champaran
51	Mukh dev Sohani	Bariyarpur, West Champaran
52	Ragbir Sohani	Bariyarpur, West Champaran
53	Mahant Singh Yadav	Bariyarpur, West Champaran

54	Chandev Sharma	Bariyarpur, West Champaran
55	Kailash Sharma	Bariyarpur, West Champaran
56	Anurudh Singh	Bariyarpur, West Champaran
57	Shivnath Yadav	Bariyarpur, West Champaran
58	Bishwonath Yadav	Bariyarpur, West Champaran
59	Baburam yadav	Bariyarpur, West Champaran
60	Sipai Yadav	Bariyarpur, West Champaran
61	Masankar yadav	Bariyarpur, West Champaran
62	Birbal yadav	Bariyarpur, West Champaran
63	Shaheb yadav	Bariyarpur, West Champaran
64	Bira yadav	Bariyarpur, West Champaran
65	Narayan Singh	Bariyarpur, West Champaran
66	Devilal Singh	Bariyarpur, West Champaran
67	BInda Singh	Bariyarpur, West Champaran
68	lal babu singh	Bariyarpur, West Champaran
69	Saral Yadav	Bariyarpur, West Champaran
70	Saganti Devi	Bariyarpur, West Champaran
71	Ashok Thakur	Bariyarpur, West Champaran

72	Bishwanath Yadav	Bariyarpur, West Champaran
73	Shahoran Yadav	Bariyarpur, West Champaran
74	Jhalli Devi Yadav	Bariyarpur, West Champaran
75	Byam Yadav	Bariyarpur, West Champaran
76	Krishna Yadav	Bariyarpur, West Champaran
77	Naresh Yadav	Bariyarpur, West Champaran
78	Sukul Yadav	Bariyarpur, West Champaran
79	Dhani lal Yadav	Bariyarpur, West Champaran
80	Nagendra yadav	Bariyarpur, West Champaran
81	Shibnath Yadav	Bariyarpur, West Champaran
82	Hari Ram Yadav	Bariyarpur, West Champaran
83	Dharma Shila Yadav	Bariyarpur, West Champaran
84	JanakDev Rao	Chharki Bhisambharpur, West Champaran
85	Munna Majhi	Chharki Bhisambharpur, West Champaran
86	Sunena devi	Chharki Bhisambharpur, West Champaran
87	Vulu chaudhary	Chharki Bhisambharpur, West Champaran
88	Banka chaudhary	Chharki Bhisambharpur, West Champaran
89	Maniya devi chaudhary	Chharki Bhisambharpur, West Champaran

90	Surendra yadav	Chharki Bhisambharpur, West Champaran
91	Babulal Yadav	Chharki Bhisambharpur, West Champaran
92	Chanmati devi Mala	Chharki Bhisambharpur, West Champaran
93	Geetadevi	Chharki Bhisambharpur, West Champaran
94	Brijesh kumar majhi	Chharki Bhisambharpur, West Champaran

Appendix 4: List of Key Informants Interviewed

Since most of the personnel interviewed involved governmental institutions and authorities, they didn't prefer their names to be disclosed. So, only the designation is displayed.

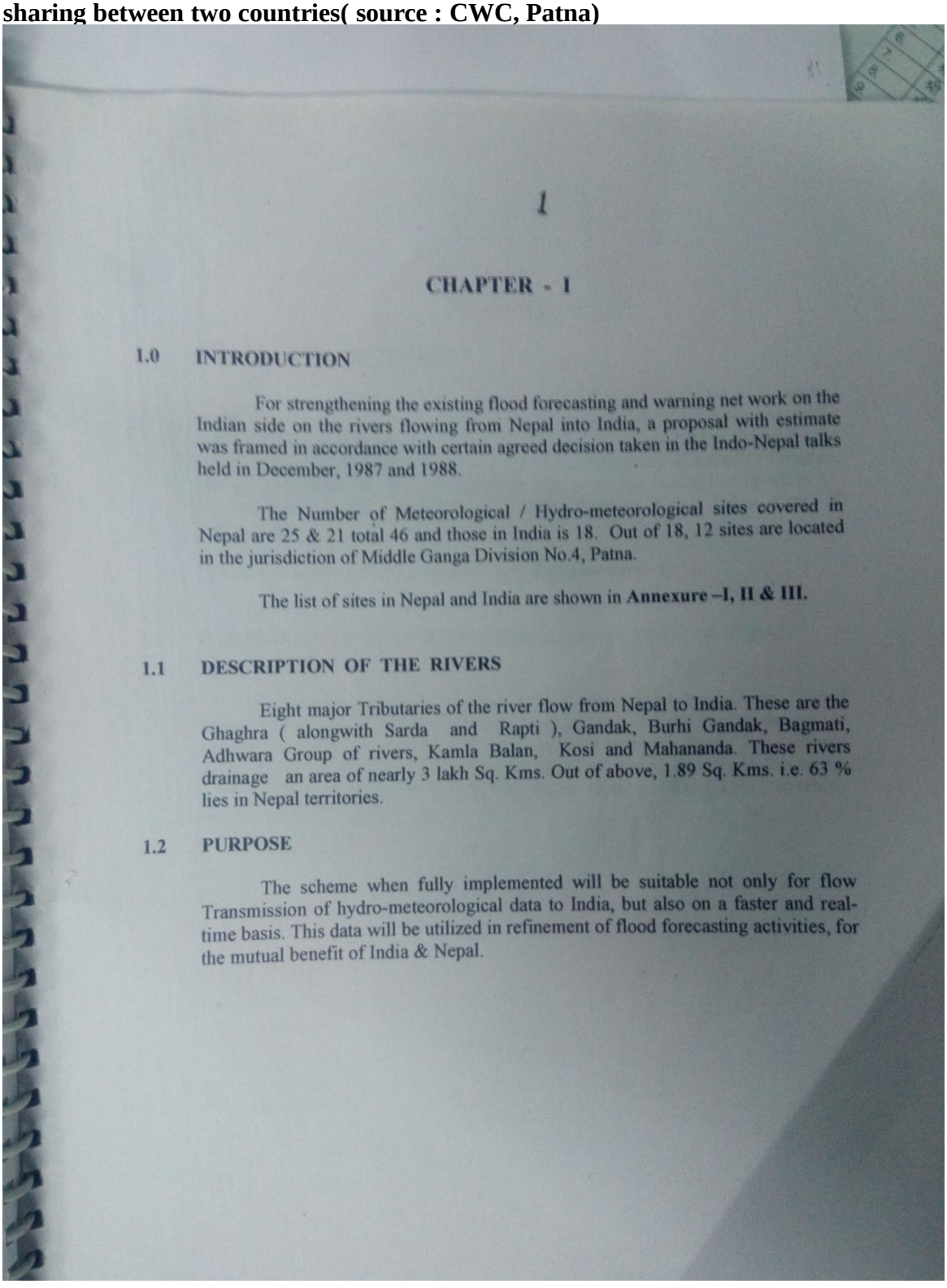
S.N.	Organization	Source/ designation of person interviewed
1	DHM	Senior officers
2	NEOC	Chief of NEOC
3	DEOC	Senior officer
4	DWIDM	Joint- secretary
5	DHM field office	Field officer
6	LDMC	Officer
7	CBOs	Members from respective CBOs in Nepal
8	local NGOs	NGO staffs
9	ICIMOD	Senior officers working in flood related projects
10	Practical Action	Officer
11	DPNet	Document review
12	UNDP	Website review
13	Gandak Barrage	Liaison officer
14	CWC	Senior officer

15	SDMA	Manager
16	DDMA	Senior officer
17	DM office	Senior officer
18	GFCC	Senior engineers
19	FMIS	Senior officer
20	Block office	Block Development officer
21	Circle office	Circle officer
22	Thana	Police Inspector
23	*Mukhiya*	*Mukhiya*
24	CBOs	Member and chairpersons
25	Local NGOs	Field staffs

Appendix 5: Different messages used by DHM for flood early warning (Source: DHM)

	* Please add "-DHM" at the end of SMS content while sending	SMS Messaging			
SN	Polygon Name (File Name in FTP location)	Rising water level: near warning level	above warning level	above danger level	falling water level: below warning
1	WestRapti_Basin_Hydro_West Rapti_Kusum	Westrapti Kusumko jalamapan kendrama jalsataha chetawani taha najik pugekole sajag rahanuhuna anurodh chha	jalamapan kendrama jalsataha le chetawani taha par garekole sajag rahanuhuna anurodh chha	Westrapti Kusumko jalamapan kendrama jalsataha le khatara ko taha par garekole surakchhit sthan ma rahanuhuna anurodh chha	Westrapti Kusumko jalamapan kendrama jalsataha samanya awasthama farkiyekole tatkal kunai khatara chhaina
2	Kankai_Basin_Hydro_kankai_d/s	Kankai Mainachuliko jalamapan kendrama jalsataha chetawani taha najik pugekole sajag rahanuhuna anurodh chha	jalamapan kendrama jalsataha le chetawani taha par garekole sajag rahanuhuna anurodh chha	Kankai Mainachuliko jalamapan kendrama jalsataha le khatara ko taha par garekole surakchhit sthan ma rahanuhuna anurodh chha	jalamapan kendrama jalsataha samanya awasthama farkiyekole tatkal kunai khatara chhaina
3	Kankai_Basin_Rain_IlamTeaState	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			
4	Kankai_Basin_Rain_KanyamTeaState	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			
5	Kankai_Basin_Rain_MaiPokhari	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			
6	Kankai_Basin_Rain_Rake	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			
7	Kankai_Basin_Rain_SoktimTeaState	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			
8	Kankai_Basin_Rain_Jeetpur	Tapain raheko wa aaspasko chhetra ma bhari barsa bhayeko chha viralo jaminma pahiro ra najikaiko khola nalama badhi aauna sakchha sachet bhaie surakchhit sthan ma rahanuhola!			

Appendix 6: Copy of appraisal report from CWC, Patna mentioning information sharing between two countries(source : CWC, Patna)



1

CHAPTER - I

1.0 INTRODUCTION

For strengthening the existing flood forecasting and warning net work on the Indian side on the rivers flowing from Nepal into India, a proposal with estimate was framed in accordance with certain agreed decision taken in the Indo-Nepal talks held in December, 1987 and 1988.

The Number of Meteorological / Hydro-meteorological sites covered in Nepal are 25 & 21 total 46 and those in India is 18. Out of 18, 12 sites are located in the jurisdiction of Middle Ganga Division No.4, Patna.

The list of sites in Nepal and India are shown in **Annexure –I, II & III.**

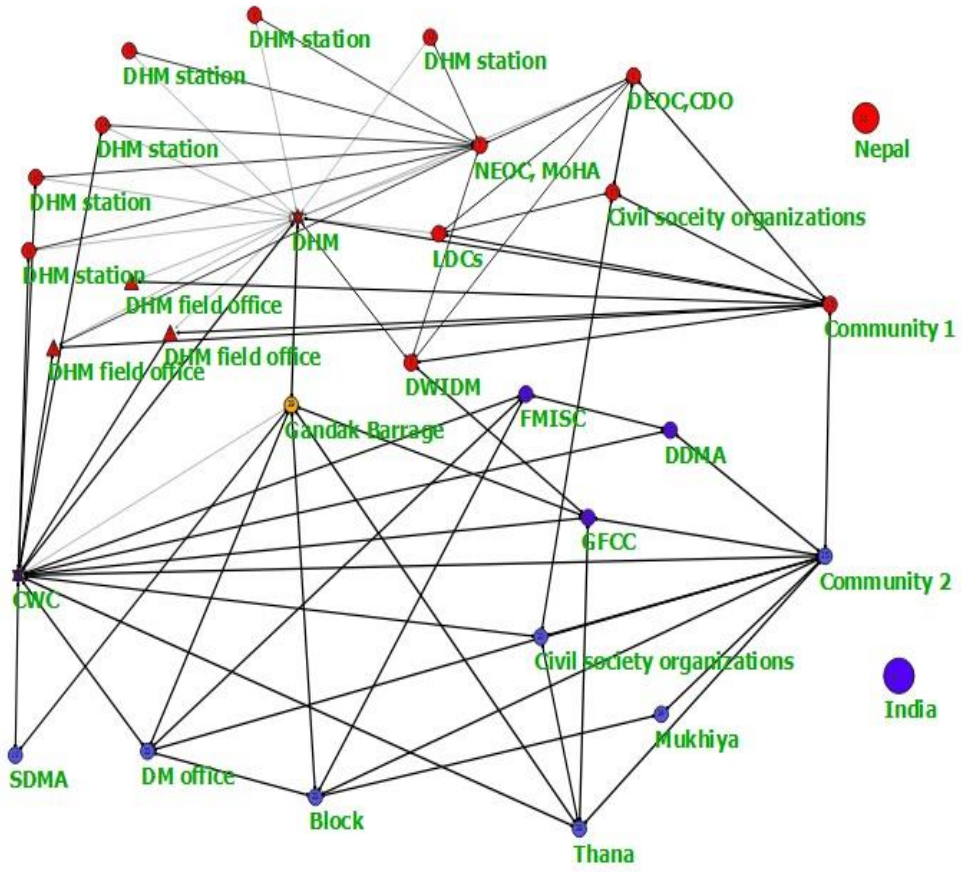
1.1 DESCRIPTION OF THE RIVERS

Eight major Tributaries of the river flow from Nepal to India. These are the Ghaghra (alongwith Sarda and Rapti), Gandak, Burhi Gandak, Bagmati, Adhwara Group of rivers, Kamla Balan, Kosi and Mahananda. These rivers drainage an area of nearly 3 lakh Sq. Kms. Out of above, 1.89 Sq. Kms. i.e. 63 % lies in Nepal territories.

1.2 PURPOSE

The scheme when fully implemented will be suitable not only for flow Transmission of hydro-meteorological data to India, but also on a faster and real-time basis. This data will be utilized in refinement of flood forecasting activities, for the mutual benefit of India & Nepal.

Appendix 7: Institutional network and issues developed using social network visualizer



Appendix 8: Example of coding and summarizing process of key informant interviews

Institution	Person interviewed	Major summary	Open codes	Selective codes
DHM	Senior officers	To disseminate information from DHM two approaches is used. One is technological approach and next one is awareness approach. Real time stations are set and data comes there. Warning level, danger level is set accordingly so that warning can be issued. According to the changed technology and use of modern system qualified manpower should be added and those stations should also be operated regularly. Field visit is also being promoted in remote area. Technical and Human resource challenge is the most. Technically station requirement is not sufficient. There is no monitoring system in remote area. Similarly, Staffs and trained manpower is not sufficient.	Flood warning, information dissemination, technological gaps, lack of manpower, coordination	Technological gaps, insufficient information
DWIDM	Under secretary	DWIDM mainly focuses in mitigation part to minimize the risk of water induced disasters also provides financial support to projects who needs them. Similarly , DHM mainly contributes on flood forecasting and communication	Mitigation, water induced disasters, flood forecasting	Flood mitigation

Appendix 9: List of photographs

Photograph 1: Picture showing *beri*

Photograph 2: FGD conducted sitting on the *Machan*

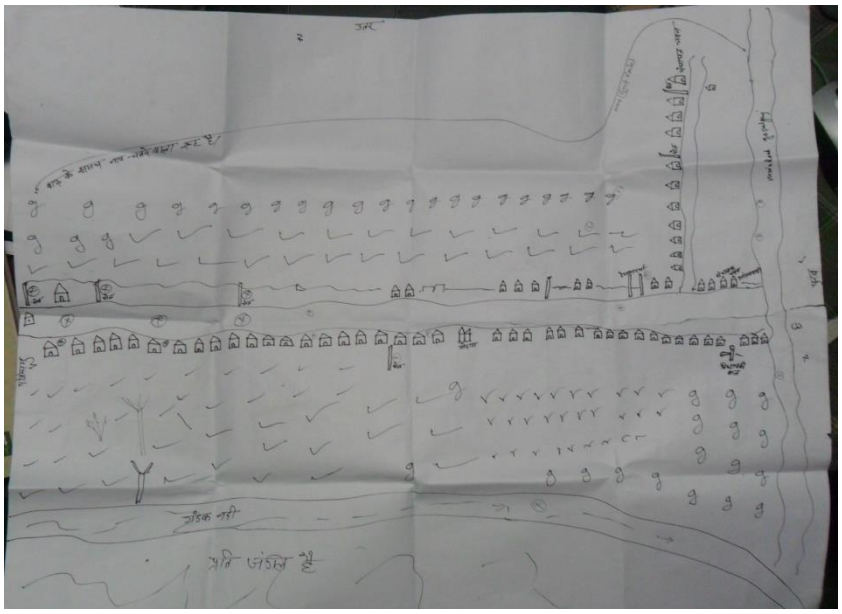
Photograph 3: Interview with Key Informants

Photograph 4: Interview with Activist from Patna

Photograph 5: Key Informant Interview with Senior Officer from DHM

Photograph 6: Monitor setup for real time information in DHM head office

Photograph 7: Interview with senior officer in DWIDM



Photograph 8: Map prepared by local people of their area

Photograph 9: Interview at the community

Photograph 10: Preparation of village map with community

Photograph 11: Gandak barrage at Indo-Nepal border near Tribeni