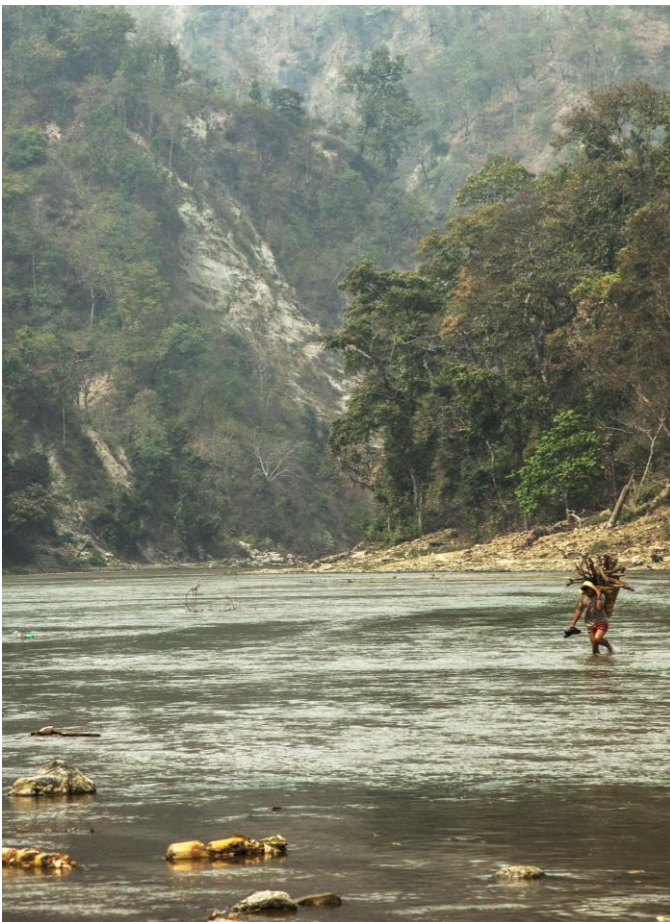UNIVERSITY OF AGDER

THE ROLE OF EARLY WARNING

SYSTEMS IN NATURAL DISASTERS:

A CONSIDERATION OF CONTEXTUAL FACTORS

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Preface

This thesis is conducted as the last part of the master program Information Systems at the University of Agder. To conduct the data collection for our thesis we discussed opportunities with the research groups in our department. From here we got in contact with our supervisors where we were introduced to two researchers from Nepal. This discussion gave us the chance to travel to Nepal for interviews and observations. As a result, this has formed this Master thesis which has been developed through the spring semester of 2018.

The purpose of this thesis is to understand the use of early warning systems for assistance in natural disasters and to identify contextual factors influencing the locals' perception of warning messages. The aim is to contribute with new perspectives and to learn how information systems are used in real-life situations.

Date: 30.05.2018

Place: Kristiansand

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Summary

To use an information system in the event of crisis caught our interest as it gave us the opportunity to deliver a thesis that crosses both technological and social aspects. The use of early warning systems to disseminate warnings of danger has been adapted worldwide to assist in the event of natural disasters. Through this research, the use of early warning systems in the event of extreme floods have been explored. Further, how contextual factors influence the locals' perception of warnings presented by the early warning system was identified. To research this two research questions were defined: *How do flood early warning systems operate in Nepalese context?* and *How do contextual factors influence the locals' perception in relation to warning messages presented by the early warning system?*

Our literature review evaluates related literature and relevant concepts for this study. The terms of natural disasters, disaster management and early warning systems are explained. Prior literature further unveils the adaption of the cycle for early warning systems to be present in Nepal. This cycle initiates four stages necessary for the disaster management to successfully perform the early warning system. The essential concepts of this study are then presented to display the relationship between them and present our area of interest.

For our thesis, the research approach used is an exploratory case study. The reason for choosing this approach is related to our journey to Nepal for exploring the early warning system implemented. Prior to our trip, the lack of related research reinforced our decision of an explorable research approach. The case is then described with a presentation of our research area in Kankai River and the focus of flood disasters which occur annually. The process of data collection is divided into three semi-structured interviews. The first is with national authorities, the second with local authorities and the main focus of interviews is with locals. Through our data analysis, two tools were used for assistance. NVivo was used to understand the use of the early warning system and to categorize and identify contextual factors influencing the locals' perception. The Ishikawa diagram was used to display the contextual factors effect on the locals' perception of warnings sent by the early warning system.

In our findings, the use of the cycle for early warning systems is explored. All four stages are presented through how the system is implemented and operated in Kankai River. Primarily, our study has addressed the stages of the EWS cycle and how it is used, in addition to identify the involvement of non-governmental organizations, national and local authorities. Our findings of contextual factors are secondly elaborated through how the locals explained their experience with the system. 23 contextual factors were identified and evaluated to be concerned within six categories; cultural, human capacities, physical, political, social and technical. The contextual factors were then illustrated in the Ishikawa diagram to display the causes and effects. The causes were discovered to be the contextual factors identified and the effect is the locals' perception of warning messages. The factors found to be the most interesting and important were highlighted and elaborated. To contribute to the cycle of early warning systems, the identified contextual factors were situated into the four stages.

Our discussion elaborates how the interesting and important contextual factors are presented in relation to prior literature. Most of the contextual factors were determined to be supported by prior literature, while a few of the factors contradicts prior literature. The remaining interesting or important contextual factors adds to existing literature through new or unique perspectives. Our discussion further seeks to contribute to practice with increased knowledge of how the early warning system is operated and with a focus on the locals' perspective. We have discussed the locals' perspective through how increased consideration of their opinions can improve the implementation of early warning systems. Suggestions for future research are given to further ensure importance of our findings with additional case studies and use of theoretical perspectives. Our recommendation is to apply the theory of affordance to our findings to understand the contextual factors to a wider extent. In addition, the limitations of our study are presented to be influenced by language complications and time constraints.

In conclusion, our study of how the cycle of early warning systems is applied in Kankai River is useful for practice. Other areas implementing a flood early warning system is better equipped as they know the arrangements of the stages prior to implementation. The actors involved have been addressed through our findings, and this is useful information for implementing EWS in rural areas. Additionally, considering contextual factors when implementing and operating their system will be beneficial. Through including the locals' perspectives, the transition is considered to be less challenging. The influences identified can therefore enlighten disaster management in further implementation of EWS.

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1. Introduction

The purpose of this research is to identify the role of *Early Warning Systems* (EWS) in natural disasters. To organize the EWS, the disaster management is assigned this responsibility. The disaster management is distributed at different levels within a nation; at national, regional and local level. Their responsibility is to operate the EWS and ensure communication between all levels. Operating EWS involves assuring preparedness, action and response in the event of a natural disaster to secure people in danger (Mercy Corps & Practical Action, 2010). The use of EWS in natural disasters is often distributed from the national level while the local perspective is not properly studied. Our thesis will therefore consider contextual factors in relation to the locals' perspective of EWS.

Prior literature presents a lack of a legal framework to explain roles and responsibilities within EWS (Gaire, Delgado, & González, 2015). Over the past years, the demand has been to use *Information Technology* (IT) to assist in and prevent natural disasters. To meet this requirement, EWS has been introduced to monitor and predict approaching disasters. Therefore, the use of EWS in areas prone to natural disasters has increased (Wafi, Abdmalek, Alnajjar, & Ahmad, 2015). The role of EWS is to reduce the communication gap in crisis situations, in addition to provide warnings and control in situations of confusion (Stankiewicz, Bindi, Oth, & Parolai, 2015). Challenges have been identified to concern the limited time available and inadequate infrastructure to evacuate safely (Smith, Brown, & Dugar, 2017). Through this study, it is interesting to recognize how an information system is used to lessen communication gaps and crisis challenges.

During the process of selecting a project for our Master thesis, we explored subjects with the interest to conduct a unique thesis. Our devotion gave us the opportunity to perform the data collection in Nepal. The reason for selecting Nepal was our interest to see how IT is used in a developing country and to learn how it is used to predict natural disasters. This focus crosses both society and technology which is inspiring and transferable to a number of circumstances. Additionally, to hear the locals' perspective and how they view the influence of technology was interesting to experience. Since Nepal is highly prone to natural disasters, climate change is expected to increase in frequency and intensity of flood, which will affect the local communities more than before (Gautam & Phaiju, 2013).

Prior research also confirms limited prior studies in relation to flood and proper use of EWS in Nepal, and more research is required (Gaire et al., 2015). Flood is the number one natural disaster in Nepal when it comes to economic damages and number two in loss of lives where epidemics are the main cause. The districts are increasing in population, mass of new buildings and geographical size which increases economic damages when a major flood arises (Mercy Corps & Practical Action, 2010). It is in our interest to look especially at Flood EWS, for the instance of longer response time and annual occurrence. Flood occurs in Nepal every monsoon

season, between June and September, and causes huge issues for the local communities (Gautam & Phaiju, 2013).

Our focus for this thesis is to conduct an exploratory study to understand the perspective of locals and their opinions in relation to EWS. The need for this study is further supported and confirmed as prior research illustrates the lack of local perspective in relation to EWS. This brings us to our focus of interest. EWS is researched in different contexts but how the system is operated in Nepal is not presented. To examine and understand this, the use of this information system is explored. Prior literature explains EWS as adapted to Nepal in its general use but does not explain how it is operated. For this reason, our interest is to conduct an exploratory study to investigate the use of EWS for floods with an open mind. Our main contribution is to evaluate the locals' perspective to identify the influence of contextual factors. Thereby, the research questions are developed to explore the role of Flood EWS and the locals' perception of EWS warnings:

How do flood early warning systems operate in a Nepalese context?

How do contextual factors influence the locals' perception in relation to warning messages presented by the flood early warning system?

The questions are designed to explore the use of Flood EWS and to identify contextual factors influencing the locals' ability to perceive warning messages. Prior literature has discovered a number of contextual factors under similar conditions, which will be determined whether is relevant in Nepalese context. Factors to consider involves lack of trust, lack of technical understanding and that people consider disasters to be brought upon them by faith (Jaiswal & van Westen, 2013). Since the Nepalese culture and social perspective are described complex, these aspects are therefore believed to influence this matter (Aryal, 2014). The importance of risk communication and how the information must be easy to understand for the locals are important factors addressed in similar contexts, and will be interesting to determine if they are equally important in Nepal (Tyagi, 2017).

To be able to study this phenomenon, a case study is conducted. A case study is appropriate as the interest is to increase the knowledge about a group in relation to a phenomenon (Yin, 2009). In our case, it is of interest to contribute to increase knowledge about the locals in relation to EWS. Since the study is conducted in Nepal, an exploratory case study is considered a suitable method to understand the research problem (Oates, 2006). Considering the elements of an unknown situation and the lack of prior research, an exploratory case study is helpful to be able to explore this phenomenon presented above. To analyze the data collected, tools are applied for assistance to understand the data compiled. We have used NVivo to structure and divide the data into the factors discovered through our data analysis. Further, we used the Ishikawa diagram to display the causes of the locals' perception to further answer our research question.

This report is organized by presenting relevant literature and concepts of importance in relation to our study. Further, the research approach is outlined to justify the choice of method. The research approach also introduces the case at hand to set the context of our research. The chapter also presents our process of data collection and how the data analysis is conducted. Next, the results and findings are demonstrated through how the EWS cycle is used in Nepal. The EWS cycle is authorized by multiple governmental and non-governmental agencies to function properly. The second research question is then in focus when the contextual factors are outlined and explained.

Through our discussion, our contribution for research and practice is asserted to increase the relevance of our results. Our suggestion is to conduct further research to improve the understanding of the contextual factors discovered. One approach to achieve this is to apply the theory of affordance. This suggestion of applying affordance is related to the opportunity of amplifying the importance of contextual factors in operating Flood EWS. In conclusion, our thesis has explored and identified how Flood EWS is organized in Kankai River. Thereafter, the main contribution has led to the discovery of how contextual factors influences the locals' perception of EWS warnings. These contextual factors are determined to be an important requirement to consider when implementing of Flood EWS in rural areas.

2. Theoretical Background

This chapter is constructed to define the essential concepts used in this research. The concept of natural disaster, disaster management and the general presentation of EWS is declared to present the context of our study. The EWS cycle, local perception and contextual factors are further presented to explain the central concepts within our research.

Natural disasters is the context where EWS is used to decrease complications in uncontrollable situations. The concept of disaster management involves national and local government and engagement of agencies to manage the EWS. These participants have appointed responsibilities within the EWS. To achieve a general perspective, it is beneficial to present how EWS is used in rural areas.

To designate how EWS is implemented in Nepal, the EWS cycle is introduced. The complete cycle of EWS illustrates a people-centered focus in accomplishing effective disaster management. The concepts of local perspective and contextual factors focuses on the locals' perception of EWS. The local perspective intends to address the influences which enables them to perceive information. These influences concern the effect of contextual factors, which determines peoples' abilities to perceive information. Last, the essential concepts are connected to explain their relevance in our study.

2.1 Natural Disaster

A natural hazard is defined as a natural process with the capability to cause great damage to those threatened. The most common natural hazards with the ability to cause major harm are floods, fires, landslides and earthquakes. The natural hazard becomes a natural disaster when serious damage affects a community. Serious damage involves loss or impact of individuals, property or environment highly affecting the community. Therefore, a disaster is often viewed as the result of a natural hazard in combination with vulnerable conditions and insufficient ability to reduce the negative consequences of the event (United Nations, 2009).

To prepare and recover from natural disasters, the disaster management are assigned with the function to support the communities in the time of crisis. The disaster management often implements an information system to predict and monitor the natural hazard in advance. In relation to flood, an information system is integrated into the main rivers of a country to benefit and provide for the disaster management. An information system can assist in predicting flood events and give the ones at risk time to evacuate from the danger. The advantage of this estimated time gives the locals more time to prepare for the flood and save their livelihood in addition to themselves and their family (Mercy Corps & Practical Action, 2010). Advanced preparedness gives therefore the communities more time to prepare and reduces the probability of a natural disaster.

2.2 Disaster Management

The disaster management are in charge during the event of a natural disaster. This team manages resources and responsibilities in the time of crisis, such as flood (Khan, Vasilescu, & Khan, 2008). If the responsibilities are carried out effectively, lives and livelihoods can be saved. The work of the disaster management includes plans of actions necessary for a successful response, in addition to assist in preparedness. Also, organizations involved must guide the coordination of the government, non-government, voluntary and private agencies. This includes organizing the best response in the event of crisis.

The responsibilities of the disaster management are performed through three segments, involving **preparedness, response and recovery** (Mercy Corps & Practical Action, 2010). All segments are designed to implement strategies and policies, improve capacities and reduce the impact of disasters. The purpose of the disaster management is to avoid and reduce the effects of natural disasters which includes prevention, preparedness and mitigation. Additionally, this process is produced in cooperation with different organizations and administrative directives to achieve the best support in the event of natural disasters (United Nations, 2009).

Preparedness is the knowledge about how to enhance communities' ability to recover or withstand all kinds of natural disasters. The objective of preparedness is to strengthen the infrastructure, procedures and awareness necessary to act properly in the event of natural disasters. This is executed with the help from government, professional response and recovery organizations. To be prepared for a disaster includes analyzing the level of risk, integration with EWS and the process of always being prepared for a natural disaster. An example of preparedness can be to store extra food or have an emergency pack with clothes and other important belongings easy accessible (Mercy Corps & Practical Action, 2010).

Response is the immediate actions necessary to save lives when natural disasters occur. This require emergency services and public assistance responding to the disaster immediately. By evacuating the community to safer areas and give the people basic needs, the most essential requirements are achieved. The focus of response is to identify immediate and short-term needs when disasters occur (Gaire et al., 2015; Mercy Corps & Practical Action, 2010).

In some situations, the response integrates with the **recovery** phase. The reason for this integration is an occasional need to provide, for example, temporary housing, medicines, food and water supplies during response. These actions are initially the responsibilities involved in the segment of recovery. Recovery is the segment of restoration after a natural disaster has occurred. In this segment, the mission is to restore what has been lost or damaged. Another focus is to implement improvements to reduce the risk for the next natural disaster. To recover from a disaster, this segment includes pre-developed strategies and policies for support during these circumstances. Strategies and policies are made to organize the different responsibilities for people from the Government, organizations and the communities themselves to help with

the assistance and aid necessary to recover (Khan et al., 2008; Mercy Corps & Practical Action, 2010).

In conclusion, disaster management is crucial to prepare and recover from crises. To be able to perform a thorough disaster management, the operation of this management must be well-implemented into the information system used, which is EWS (Mercy Corps & Practical Action, 2010). EWS is the information system developed to support the disaster management in decision-making and prediction of natural disasters. By integrating the disaster management into the EWS, the consequences of a natural disaster can be reduced or prevented. The disaster management and EWS are essential and must be implemented at both national and community level to operate efficiently (Fakhruddin, Kawasaki, & Babel, 2015).

2.3 Necessity of Early Warning Systems

EWS considers both a concrete system to monitor and warn about natural disasters and the required procedures surrounding these events. The following definition is highly acknowledged and used, and also adapted by the non-governmental organizations working in Nepal (Crawford, Pokhrel, Nepal, & Shrestha, 2012; Mercy Corps & Practical Action, 2010):

> *"The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a disaster to prepare and act appropriately and in sufficient time to reduce the possibility of harm or loss" (United Nations, 2009, p. 12)*

Many countries in the world suffer from flood due to monsoon season. Rural areas are especially affected as they are involved in this issue annually. For these situations, an EWS is helpful to reduce the consequences of floods. EWS seeks to improve the communication between districts and inform people about how to evacuate and save their most precious belongings in advance (Wafi et al., 2015). The crucial element of disaster risk reduction and EWS are precise EWS warnings (Fakhruddin et al., 2015). In this research, the concern is to look closer into how EWS is used and what influences the use of EWS. Therefore, three cases have been used to introduce the subject and acquire relevant knowledge about how EWS has been implemented in developing countries.

The two largest river systems in the world are connected in Bangladesh and these rivers flood annually. The flooding affects farmer's crops and livestock which is harmful for their economy. A successful implementation of EWS can assist the farmers to prepare and take appropriate action in the event of flood. An advantage of an advanced EWS is a forecasting system to help farmers change their crop patterns or planting time to reduce the impact of flood. Another advantage is that people are able to save their lives and crops with preparing for extreme flood. This study explores the possibility of a 10-day prediction which can give farmers enough time to prepare for a harvest (Fakhruddin et al., 2015).

Flood is also a major problem in Malaysia, especially since their climate gives them two monsoon seasons a year. Prior literature explains that flood control measures have been tested with some success, but it has not been very effective in reducing the issue of flood. Through this process, they have understood that the flood cannot be stopped from occurring. However, with the assistance from a flood EWS the loss of lives and damage to property can be reduced. The system integrated provides real-time information about the river's water level which helps the government of Malaysia to plan response in the event of flood. In Malaysia, the EWS is implemented to include involvement of disaster planning and management agencies. Coordination and the dissemination of information in the event of flood is achieved through an internet-based system where different agencies have access to real-time information and can exchange relevant and reliable data (Billa, Mansor, & Mahmud, 2004).

In Nepal, EWS has been implemented into the main rivers to monitor and predict floods. A relevant study to consider is conducted in one of the western rivers in Nepal called Karnali River (Smith et al., 2017). This study presents the integration of a people-centered EWS to effectively prepare and respond to flood at the community level. It is explained that the locals take responsibility in operating EWS at the community level, which has been tightly integrated with the national EWS through the last couple of years. The EWS is presented through four stages; Risk Knowledge, Monitoring and Warning, Dissemination and Communication, and Response Capability. Each stage is demonstrated through how the EWS is operated in Karnali River to outline the current status of EWS in Nepal. The main challenges and advantages are outlined in this study and concerns the limited time for evacuation, low running costs, little data requirements and a flexible framework to conduct the people-centered EWS (Smith et al., 2017).

2.4 The Cycle of Early Warning System

To perform sufficient EWS it is critical to have guidelines of how to conduct and operate the process. Through following a set of guidelines, EWS can support decision-making in a crisis situation. United Nation has developed recommendations which involves a consideration of four key elements when using EWS; Risk Knowledge, Monitoring and Warning, Dissemination of Information and Response Capabilities (United Nations, 2009). This has further expanded to a complete cycle of EWS, figure 2.2, which has been adapted to Nepal. However, there is a lack of literature presenting how the EWS is organized and who is involved to manage it (Shrestha et al., 2014). The complete EWS cycle is adapted to fulfill the requirement of understanding vulnerability and to focus on the people at risk (Crawford et al., 2012; Gaire et al., 2015). Accordingly, the EWS cycle is displayed to understand the elements involved in EWS. Figure 2.2 is based on literature explaining the four key elements to simply illustrate the EWS cycle (de León, Bogardi, Dannenmann, & Basher, 2006; Mercy Corps & Practical Action, 2010):
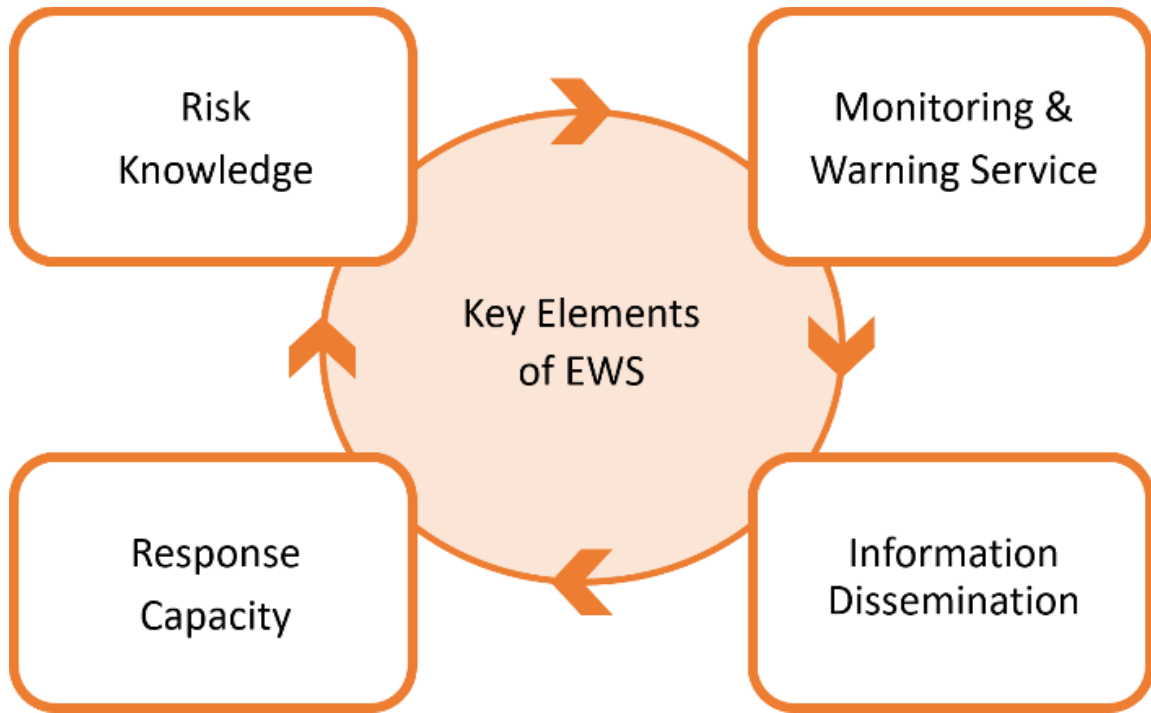
Figure 2.1: Key Elements of EWS

Risk Knowledge concerns the communities and a recognition of their own vulnerability towards flood. A risk assessment of the community and its vulnerability and exposure to flood must be conducted to understand the risk (Smith et al., 2017). This assessment includes determining the water level and estimate the levels for when the locals need to be warned. Further, this part also requires an assessment of the locals' knowledge to determine how aware they are about the risk and their exposure to suddenly events of flood (Mercy Corps & Practical Action, 2010). In the people-centered EWS, the local authorities are expected to have essential awareness and understanding of the risk. This might require training of locals to manage the system, and to understand upstream and downstream of the river, in addition to the level of risk and essentials of the EWS. This gives the local authorities the ability to correctly inform all individuals in the event of flood. Lastly, this element requires establishment of safe locations and routes for evacuation process, and must consider all individuals regardless of condition (Smith et al., 2017).

Monitoring and Warning Service involves both manual and automatic readings of the river basin. For the manual monitoring and warning process for the EWS, trained community readers monitors potential flood risk by registering the river levels (Smith et al., 2017). Additionally, a community reader is a local person assigned to monitor the water level or rainfall. The river levels have previously been estimated in the first element of the EWS cycle. These are alert, warning and danger levels which are implemented to distribute warnings during the dissemination element (Mercy Corps & Practical Action, 2010). The community readers responsibility is to further disseminate warnings downstream to the communities at risk with

the increased river depth. For the automated part of the EWS, an information system is installed to predict and forecast any unusual activity or potential water increase in the river. This system is owned and managed by the national government's Department for Hydrology and Metrology (DHM) (Smith et al., 2017). By continuously monitoring the rivers, possible critical warnings can be generated automatically and in a timely manner. This entire process can contribute to provide warning services at an earlier stage and increase lead time and awareness for the communities at risk (Mercy Corps & Practical Action, 2010).

Information Dissemination consider the actual process of distributing the warning information. This element is closely integrated with the element above, to be able to generate critical and timely information. When the river reaches warning or danger level, this element of the EWS is crucial. The communication is distributed by the community readers through phone calls using predefined communication charts. The communication charts consist of contact details for selected people, including the community disaster management committee, security forces and local media (Smith et al., 2017).

Two "top-down" dissemination processes are also implemented to the EWS to ensure distribution of warning information. The first is the responsibility at district-level. Their duty is to maintain electronic display boards with sirens and automated sirens to display risk at the different risk level for the river (Smith et al., 2017). The second automated dissemination route is SMS warning information. These messages are distributed to district officers, DHM offices and security forces (Gautam & Phaiju, 2013). When these parties receive the information, their duty is to take action according to their training. This element of EWS also concerns the consideration of the warning information ability to reach out. Further, an evaluation about the information should be conducted to assess if all communities understood and acted upon the warning (Smith et al., 2017). This element is the essence of our research: to contribute to improved understanding and appropriate action by the communities as little research has been conducted in this part of Nepal. Prior research shows the importance of the information to be simple, useful and understandable for the recipient of the information and act accordingly (Fakhruddin et al., 2015; Jaiswal & van Westen, 2013). However, as these studies are conducted in similar context, the factors might be recognized in the Nepalese context, but variations are also believed to appear.

Response Capacity concerns the activities of a disaster management. For this process, it is expected that disaster management plans are in place to sort responsibilities and resources in the event of a natural disaster (Mercy Corps & Practical Action, 2010). Well-defined plans of response should build upon local abilities and knowledge to assist the disaster management at both local and national level. These plans should be frequently tested through mock trails to educate the locals for appropriate action in the event of flood (Smith et al., 2017). Additional preparation should be performed to further prepare the local communities for appropriate response. Prior literature explains the use of awareness-programs for this purpose. However, there is a high variation in the effort depending on the engagement of the local authorities, causing different implementation approaches. These approaches vary from radio and posters to be integrated into the school curriculum (Gautam & Phaiju, 2013).

2.5 Local Perception

People do not necessarily share the same perception, which also applies for the underlying causes of a risk (United Nations, 2009). Therefore, local perception is viewed to concern the locals' capabilities and understanding of the EWS warnings. How people manage the risk within their known environment can be affected by several factors. These factors are for example, traditional beliefs and values, knowledge, custom, religion, social structure as well as historical and modern experiences. After assessing these factors, the knowledge can help guide risk assessment, risk mitigation and to determine the future actions needed to save lives when a disaster occurs (Harmsworth & Raynor, 2005).

When researching the local perception of the people in Nepal, a number of factors should be taken into consideration. Nepal has multiple strong cultures, social relations and characteristics that might influence their perception of new technology (Bista, 2008). Prior literature has been helpful to understand which factors can impact our research (Aryal, 2014; Jaiswal & van Westen, 2013). It is important to note that due to Nepal being multicultural and multi-ethnic, the characteristics varies and may not apply to all of Nepal.

The Nepalese people have a high believe in faith. Most Nepalese have been raised in the belief that one's circumstances are determined prior to their existence and therefore their lives have been fated. Karma determines your life, which means that if you had a happy and successful life you must have earned it in a previous life. This also has caused many poor Nepalese to curse themselves blaming their frustrations, failures and sufferings on their faith which they believe to be out of their control (Bista, 2008).

Faith greatly affect people's personal behavior and motivation as they believe their life is out of their personal control (Bista, 2008). It is believed that supernatural resolution must recognize your current efforts to possibly influence any afterlife. As a consequence, the effect of personal effort has a possible influence of your destiny but is not believed to affect your present life. This means that personal effort is traditionally low since a person's path through life is believed to be predetermined. As a result, there is no motivation to influence and change the course of the future appears futile. If you demonstrate personal competence, you are likely to be isolated and undermined by others. This traditional mindset makes it difficult to achieve personal success. On the other hand, there is a positive aspect to this. Due to low personal effort for change, people highly rely and depend on others. This makes it easier to adjust to strange situations, for example, technology (Bista, 2008). In the implementation of community-based EWS, an advantage is for the local authority to behave with respect and thereby achieve their trust. This gives the ability to perceive and react more appropriate to the EWS warnings distributed as they trust the source of information.

2.6 Contextual Factors

Contextual factors are concerned with the circumstances affecting a person in a given situation. In general, contextual factors may influence the relationship between an individual and their perception of information (Pintrich, Marx, & Boyle, 1993). These factors are identified to concern social, environmental and cultural influences.

Prior literature addresses contextual factors in similar environments where some are identified as relevant to this research. The context in focus considers the dissemination of EWS warnings to local communities. How the dissemination of warnings are performed varies, and literature vaguely presents the use of mobile technology, TV or radio (Fakhruddin et al., 2015; Fathani, Karnawati, & Wilopo, 2016; Smith et al., 2017; Wafi et al., 2015). Therefore, our interest is to research to learn how EWS warnings are disseminated in relation to how locals perceive this information.

Contextual factors are identified in relation to peoples' perspective about natural disasters and EWS. Literature presents a study conducted in a similar context where the following factors are identified: lack of trust, lack of technical understanding, simply accepting the risk, lack of emergency plans and that they only consider disasters to be brought upon them by faith (Jaiswal & van Westen, 2013). The Nepalese culture and social perspective are described to be quite complex due to lack of development and high vulnerability to natural disasters (Aryal, 2014). Therefore, contextual factors are considered to influence the locals' perception of EWS information. This is caused by differences and variations within the Nepalese culture.

2.7 Relevance of Concepts

To present the interaction between the concepts of importance in this study, figure 2.2 is developed. Some of the concepts above was only introduced to set the context and is therefore excluded from the illustration below. The essential concepts of our study are therefore presented to explain their relation.
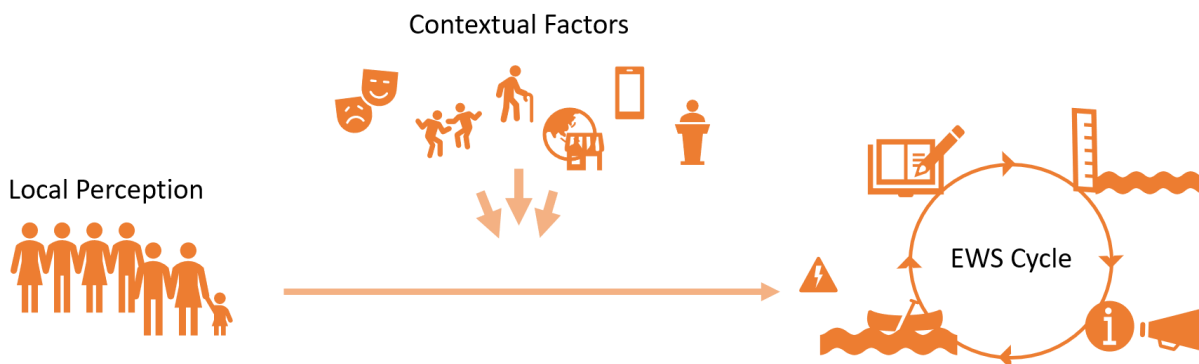
Figure 2.2: Interaction of Concepts

The information system in use is integrated into the EWS cycle, shown in figure 2.2, and is used for monitoring and support of the rivers. The effect of natural disasters is impossible to control and interacts with the EWS cycle as it triggers it to start. When the EWS cycle is performed properly, it is operated by the disaster management and cooperates with the locals. As described above, the disaster management is crucial to perform efficient EWS. Also, as the EWS runs to protect and inform the locals, appropriate perception is crucial. The major interest of this study is to identify the contextual factors which interfere with the interaction between EWS and the locals' perception. Through identifying these factors, awareness and focus can increase in order to improve the integration and efficiency of EWS.

The essential concepts and interactions of our study are interesting to research due to limited literature and inadequate information about preparedness in Nepal. The locals' perception of EWS is rarely mentioned and it is exciting to be able to identify the hidden factors influencing this matter. Our research question targets this through discovering potential factors by interviewing local communities. It is motivating to determine contextual factors to benefit the EWS in Nepal and potentially guide other implementations of Flood EWS.

3. Research Approach

An appropriate research approach for our thesis is to perform an exploratory case study. For the reason of insufficient literature about EWS in Nepal, an exploratory case study will unveil how the EWS is used and organized. This will be a valuable contribution that adds to the existing literature established through the national perspective. Our second contribution, explores the locals' perspective to identify their view of the Flood EWS. The case is developed to describe the details necessary for the study and to present the case at hand. The phenomenon of interest concerns both the social and technical aspect of EWS. Within these aspects the aim is to uncover the interaction and influences between EWS and the locals' perception. Our focus is to understand and examine the context of EWS and the contextual factors in their natural environment (Oates, 2006).

A qualitative research is effective to understand and explain this social phenomenon. In this study, data is collected through informants to gather information, quotes and observations to explore the use of EWS and identify contextual factors (Myers, 1997). The social phenomenon involves how people perceive warnings given by the EWS and the influences of their perception. Since the main aspect of our research seeks to understand this social phenomenon, a qualitative research is an appropriate approach. Within qualitative research, the case study method gives us the opportunity to study a specific case by conducting both interviews and observations within the determined context (Oates, 2006). Therefore, a case study is suitable and will answer the research questions at hand:

> *How do flood early warning systems operate in a Nepalese context?*

> *How do contextual factors influence the locals' perception in relation to warning messages presented by the flood early warning system?*

A "how" question leans towards a case study method, while both "what" and "how" questions are suitable for an exploratory case study. Since the research purpose is to understand the phenomenon of focus, an exploratory case study is appropriate. For an exploratory case study, the purpose is to form a suggestion for further research (Yin, 2009). In this thesis, it is of interest to discover factors that influence the locals' perception of EWS which will contribute to further research. The aim is to investigate the described area of interest, with its clear context. Thereby, further research can use the factors identified to elaborate and ensure importance of the results. The specific approach used is termed a single instrumental case study. This type of case study focuses on one issue and select one bounded case to illustrate this issue (Creswell, 2013).

The philosophical paradigm appropriate for this context is interpretivism, also called social constructivism (Creswell, 2013). The grounds for selecting interpretivism is to understand the social context of using EWS. Studies using the interpretivist paradigm try to identify, explore and explain how the social setting affects the situation. The intention is to understand how a

unique context makes sense in different situations, for example during a flood (Oates, 2006). Our interest is to understand the use of EWS and which influential factors that are important. The process is expected to be complex, as many views and perspectives need to be evaluated in order to understand our case.

Our study has several delimitations and principles important to consider. Since the data collection is conducted through a three-month travel to Nepal, it is important to reflect on the limitations regarding time and activities. Further, cultural understanding is another delimitation. To understand the Nepalese culture, their history and current situation are critical to comprehend when discovering relationships and to suggest valuable improvements. If these aspects are not sufficiently understood, the contribution of the study will be limited. Other potential limitations regard typical constraints, either inadequate number of informants or limited access to the necessary information, was considered possible complications beforehand. When any issue occurs, our plan is to seek guidance and support through our supervisor at Kathmandu University and our supervisors at the University of Agder.

Closely related to the selection of a case, ethical issues need to be considered through the process of collecting data. Ethical issues could be caused by cultural differences between us and the participants. This can be caused by different perceptions of what is right and what is wrong, which may influence the results. Therefore, understanding exactly what they mean is crucial. Making an effort to understand the culture and morals may be helpful to avoid ethical issues. A general focus on being an ethical researcher, will help reduce potential issues. Five objectives for an ethical researcher is maintained for the interest of both researchers and informants (Oates, 2006). These considerations are as follows: no unnecessary interruption, to behave with integrity, follow appropriate professional code of conduct, no plagiarism and to be an ethical reviewer. Along with following these practices for ethical research, good ethical practice also includes the issue of confidentiality. Confidentiality means keeping the informant anonymous to the level where they are not identifiable, but still provides value for the research purpose (Israel & Hay, 2006).

3.1 Case Description

The context for our research is the annual occurrence of flood in Nepal. Floods in Nepal are categorized a natural disaster due to its high intensity, short duration and a small area of extent. The floods occur within hours, only last for a few days and impact areas close to the river heavily (United Nations, 2009). One of the reasons for Nepal to be rapidly affected by flood is due to climate changes (Crawford et al., 2012). Climate change causes the amount of rain at the time of monsoon to increase and the rivers to change direction and structure due to the large amount of water. Additionally, the river bed grows and is another cause for the stream to change direction and to easier flood the plain areas of the country (Mercy Corps & Practical Action, 2010).

The other reason for Nepal to be highly prone to floods is due to high variations in the typography. The Himalayas are over 8000 meters above sea level and are located north in Nepal at the border to China. Middle Nepal is mountain area on the level of around 4000 meters. When Nepal borders to India in the south, the ground is flat and there are no highlands. These areas are called terai (Mercy Corps & Practical Action, 2010). Since the Himalayas are made of sedimentary rocks which consist of mud and sand, Nepal has an extremely complicated geophysical structure. The complicated typography in addition to the geophysical structure makes Nepal highly prone to natural disasters (Adhakari, 2013; Gaire et al., 2015).

In our research, the study area is located in East Nepal, within Jhapa district. Figure 3.1 displays the location of Jhapa within Nepal where you see Kankai River flows in the middle of Jhapa. The image clearly presents the extreme typography in this region of Nepal where huge mountains causes large amount of water to flow down. The smaller image shows Nepal in relation to surrounding countries ("Map of Jhapa's location in Nepal [image]," 2018).
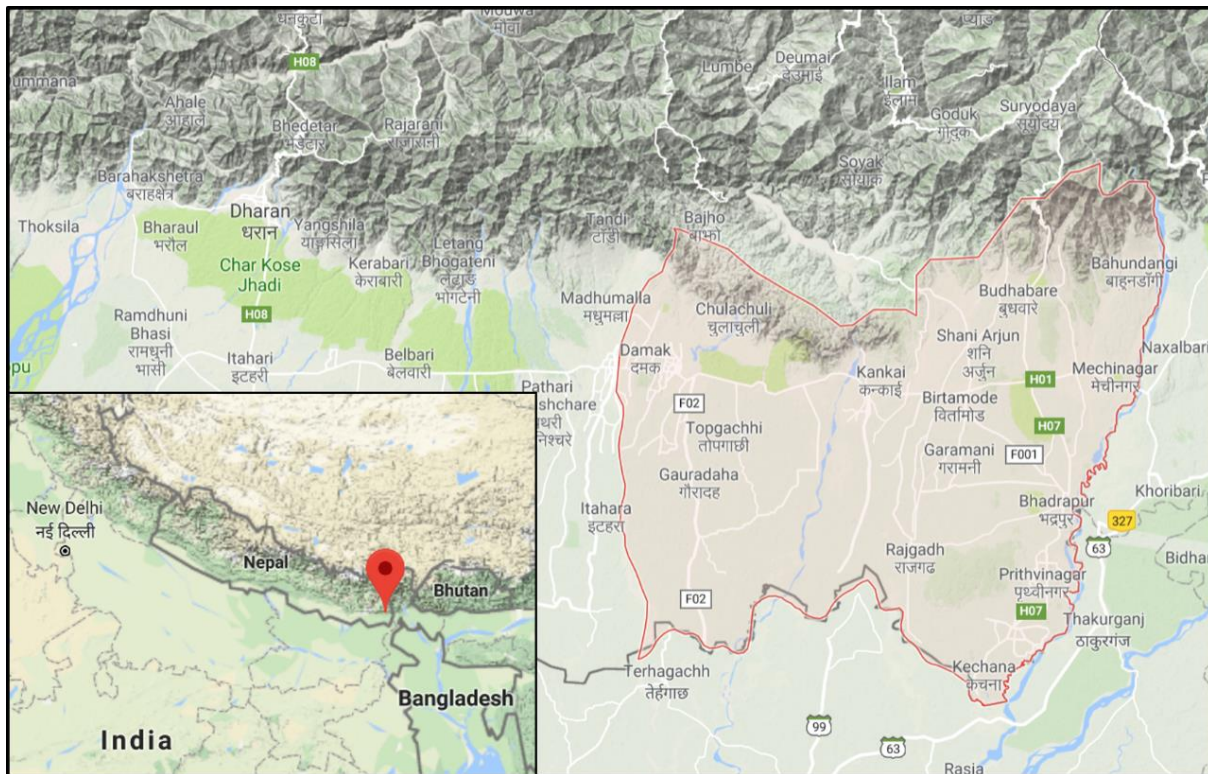
Figure 3.1: Map of Nepal, Pointing the Location of Jhapa

The aim of our research is to consider EWS in Kankai River and find out how this system influences the local communities. The Kankai River Basin has a well-implemented EWS and gave us the opportunity to limit our research to understand how EWS is integrated. Additionally, this gives us the ability to focus on the locals' perception of EWS warnings. The desire is to understand how the local population handles the invention of using information systems to assist in natural disasters.

How a local population interacts with an information system, offers us the possibility to identify the contextual factors influencing the locals' perception of EWS. Observing how people and technology interact with each other, and how it is affected by the environment will determine the contextual factors in our research. Through labeling the contextual factors, our interest is to give a perspective of possible improvements to implementations of Flood EWS in rural areas.

3.2 Data Collection Process

The data collection was conducted through interviews with multiple groups of informants and observations are conducted throughout the process. The exploratory case study gave us the opportunity to select informants during the data collection process. Upon arrival in Kathmandu, the first mission was to conduct interviews with national authorities. These authorities were required to have information and knowledge about the EWS in use. In total, six meeting were held where our proposal of research was discussed. These meetings gave us four informants relevant for our research. Out of the four, two consisted of governmental departments and two are *Non-Governmental Organizations* (NGOs) involved in the EWS. Through these interviews, it was decided to conduct the research in Jhapa, which is the district surrounding Kankai River Basin. The reason for selecting Kankai River Basin for our research was determined through the information received in the interviews.

The EWS in Kankai River Basin is well-integrated and the people were described as being aware and able to contribute to our research. When travelling to Jhapa, it was decided to also interview local authorities involved in the EWS. The reason for interviewing these parties was to further understand the EWS and to see how it all was connected. Further, our plan was to interview locals from two to three villages around the Kankai River Basin to collect different viewpoints and knowledge. Also, to fulfill the requirements for the research, it was decided to conduct ten interviews with locals to retrieve a broader perspective.

The interviews followed a semi-structured design (presented in the appendices) for two reasons. First, a semi-structured interview is suitable to give the structure needed to collect the information required. Second, a semi-structured interview also gives opportunity for changes during the interview. If the informant presents a different issue or has more or less insight than first assumed, the interview can change to concern this new information (Oates, 2006). With using an interview structure open for changes, the reflections are believed to improve with the increased foundation of data.

For the first part of interviews with authorities, the goal was to understand the system and how warnings are distributed to the local communities. The interviews are designed to learn about and understand the EWS in place and how the procedures are carried out (Gaire et al., 2015; Jones, Oven, Manyena, & Aryal, 2014; Smith et al., 2017). Through the process of understanding the current situation, two governmental departments, two NGOs and lastly

three local authorities were interviewed to observe if the understanding of EWS were reflected at the local level. The three last interviews were conducted during the fieldtrip to Jhapa.

In the second part, for the interviews with locals, the goal is to understand the locals' perspective. These interviews were conducted in three villages along Kankai River Basin. Since there were language barriers, two students from Kathmandu University accompanied us for translation. Within the villages, the people chosen to be informants were randomly selected.

However, the selection proceeded as the locals with high confidence or with specific responsibilities were forward and eager to be interviewed and to share their perspective. During the interviews, the students translating for us often paused the interview to fill us in and give us the opportunity to give follow-up questions. Since the interviews prepared prior to the fieldtrip were semi-structured, it gave us the opportunity to fill in if it felt necessary or when our curiosity took over. In addition, the students assisting us also added questions, which was beneficial because it provided an even wider perspective.

3.3 Data Analysis

In a case study analysis, it is important to produce a detailed description of the research (Creswell, 2013). To conduct this, we used two tools to organize our results. First, the transcripts are uploaded to NVivo where they were categorized, and the contextual factors found. Second, we used the Ishikawa diagram to identify main causes of the given problem. This diagram was useful to discover positive and negative influences on the locals' perception towards EWS warnings. The structure of the diagram is displayed in figure 3.1 (Law, 2009).
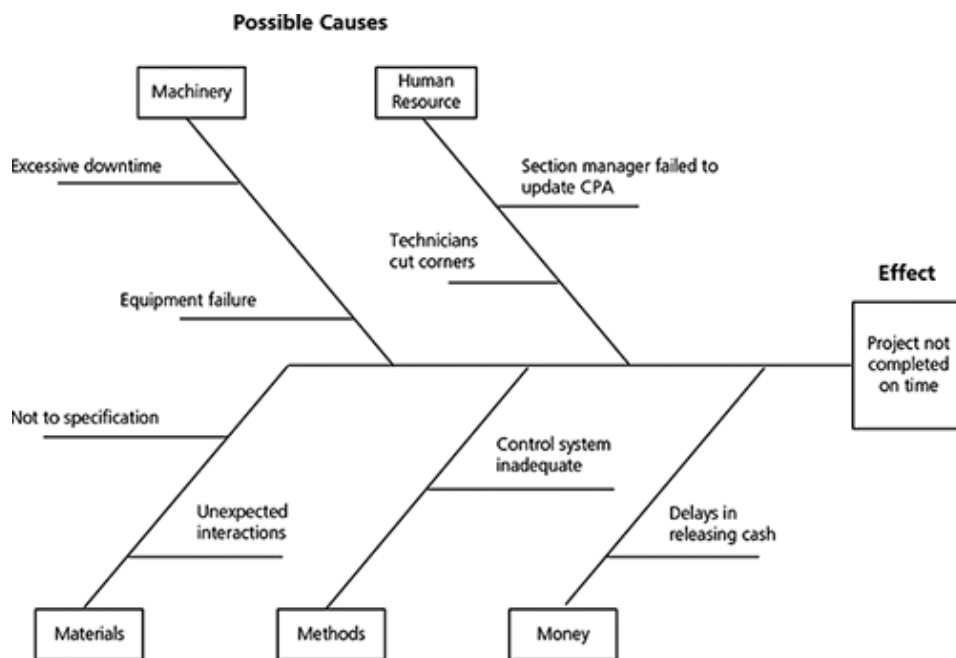
Figure 3.2: The Structure of Ishikawa Diagram

The method of using the Ishikawa diagram involves four steps. The first step is to analyze positive and negative influences of the locals' perception towards EWS warnings. The second step is to identify main factors of the causes leading to the effect of our data. In the third step, details of each factor were recognized in order to explain the cause of the overall factor. Lastly, the fourth step concerns to discuss and clarify the factors and details found, which is a part of our discussion.

For the data analysis, six general steps for analyzing data were used (Creswell, 2009, pp. 183-190; Stake, 1995):

Step 1: Organize and prepare the data for analysis

The first part of our interviews was with national authorities and was summarized with notes to have an overview of their content. The reason to have these interviews in noted form was a preference for overview and not details in the information. For the second part of our interviews, which were conducted in the field, our assisting students transcribed these in detail after the trip were completed. During the interviews, recordings were organized to collect every detail on the informants' perspective. Additionally, since our understanding during the interviews were limited beyond what was translated, observations were written to remember impressions and details about the communities. Observation notes are also useful for including the stories and information retrieved in addition to the interviews.

Step 2: Read through all the data

The data collected needs to be reviewed several times to be able to interpret the data. By reviewing the data several times, different perspectives were discovered, and it was possible to start identifying contextual factors through NVivo. First, contextual factors were briefly identified before a more detailed data analysis was conducted. Dividing the different factors were performed through detecting variations in our data. Then, our findings were discussed with our supervisors to understand the different perspectives in depth.

Step 3: Begin detailed analysis with a coding process

The focus for this step was to look for groups of factors in our data. For better view of the data, NVivo was used in this step. Through NVivo the data was analyzed and divided into categories according to relevant groups discovered. The categories were found appropriate to be divided into six main contextual factors, in addition to identifying how EWS is performed in Kankai River. Within the six contextual factors, multiple sub-factors were discovered to give a broader understanding of how the contextual factors influences the locals' perception of EWS.

Table 3.2 presents the contextual factors and sub-factors identified in our data analysis. The following factors was found to influence the locals' perception of EWS warning and is displayed to represent the sub-factors of each category.

Contextual Factors:	Sub-Factors:
Cultural	Common Sense
	Gender Differences
	Language
	Moral Values
	Set of Beliefs
	Traditions
Human Capabilities	Disabilities and Abilities
	Lack of Knowledge
	Misunderstanding
Physical	Environment
	Infrastructure
Political	Cooperation
	Governmental Assistance
	Trust
Social	Attitude
	Experience
	Lifestyle
	Personality
Technical	Automatic Warnings
	Equipment
	Lead Time
	Manual Warnings

Table 3.1: Contextual Factors Discovered through our Data Analysis

Step 4: Use the coding to generate a description of the categories for analysis

To identify the arrangement of the EWS cycle, the interviews with national and local authorities in addition to NGOs, were coded to define the four stages of the EWS. Included in this process, the involvement of different actors was recognized. Further in this step the contextual factors and sub-factors are discovered and described. The ideal number of categories is presented to involve five to seven and was used for guidance. Motivated by this, six categories were determined appropriate to describe the variations found.

Cultural factors are identified to concern common sense which is affected how family knowledge and experience crosses into social factors. The factor of gender differences is included as the probability of gender to influence EWS is present due to strong societies. Local language or variations varies and are formed by centuries of building up their culture. Moral values focus on how the informant are influenced to act determined by personal values and environment. Set of beliefs involves the people's religion and openness. Traditions are driven by family, societies, festivals and yearly events, and is the last factor identified.

Human capabilities are determined by disabilities and abilities within the community. The community needs to be conscience of people with disabilities, children and any others with special needs. The lack of knowledge is another sub-factor which influences the locals' perception. Both advanced and absent knowledge impacts this context. Misunderstandings are the last sub-factor for this factor and relates to locals not understanding the risk, possible impact of the flood and misconception of EWS warnings.

Physical factors involve visible factors, such as objects and nature. Environment concerns everything surrounding the locals. The environment covers animals, crops and nature essential to the community. Infrastructure includes roads, material, bridges and houses. These elements have crucial impact on the local communities if damaged.

Political factors are concerned with the relationship between the government and the locals. Cooperation involves the mutual effort between local communities and authorities in charge of the EWS. Governmental assistance focuses on how the locals view the support from the Government. Naturally, if the support is absent a negative relationship might appear and vice versa. Trust in general consider how high their confidence is in the EWS. For example, trust can be recognized in the locals' belief that the government is doing their best to support them.

Social factors identify social aspects influencing the locals' perception of EWS warnings. Attitude is positioned by manners, experiences and their mindset. Experience is determined by the locals' background and prior actions. Lifestyle is how the local live and what is important to him or her. As many of the locals have their livelihood at their door, their lifestyle will influence their perception. Personality is a combination of the persons childhood, experiences, manners and actions. Some of the social factors are highly individual and can be difficult to label the influences. The factor can be viewed to have some influence on the locals' perception.

Technical factors consist of technical components and physical items to support the technical system. Automatic warnings are essential since the EWS warnings has its main reach through automated warnings. This factor presents how the locals understand and perceive this information. Equipment involves tools and supplies necessary for the EWS to operate properly. This includes supplies crucial for the local communities. Manual warnings are included as it is necessary to ensure information dissemination. There are incidents where the automated warning does not reach all at danger and a manual process is therefore required. Lead time is the factor of time estimated before flood arrives. This factor influences the locals through how much time they have to prepare.

Step 5: Advance how the description will be represented in the qualitative narrative

The findings need to be presented and discussed, which is viewed through chapter 4. As explained, NVivo has been used to sort and categorize the findings into contextual factors. By creating nodes for each factor and sub-factor, connections can easier be drawn between the factors and their importance. Further, the factors displayed in table 3.2 were incorporated into the Ishikawa diagram to view the causes of the locals' perception of EWS warnings (Law, 2009). The Ishikawa diagram helped identify contextual factors causing an effect of influential factors towards the EWS and are presented through our findings. Through using the Ishikawa diagram, the cause and effect are illustrated nicely. The cause will be the contextual factors discovered through our data collection and will reveal sub-factors composing the cause of effect.

Step 6: Our final step involves making an interpretation or meaning of the data

Through this step, the findings are discussed and presented in relation to prior literature. This step includes asking ourselves "What are the lessons learned?" and "How do our findings contribute to related research?". Our attempt is to understand the data and present our contribution.

Pursuing the mentioned steps creates a solid data analysis for our research. These steps are useful to assess findings and look through the data. Conducting an accurate data analysis is helpful for the further process of concluding our results (Creswell, 2009). To achieve qualitative validity, the findings must be reviewed for accuracy. Validation strategies are considered and selected to ensure importance of our results. It is recommended to use multiple strategies to increase validity. For our thesis, two strategies are used. The first validation technique is *rich, thick descriptions*. This technique involves detailed descriptions of the setting, in addition to the interviews (Creswell, 2009). In addition to our transcripts, observation notes were conducted by us and the students assisting us through the fieldwork, to fulfill this criterion. The information seen as the most important to have detailed descriptions of are the interviews, research observations and other information collected throughout our journey. This collection is performed to ensure reliability of our thesis and to have evidence available if anything occurs (Yin, 2009).

The second strategy found suitable to increase validation, is *peer debriefing*. This is an important aspect because the lack of experience and incomplete understanding of previous research is a limitation. Therefore, discussing results and obtaining questions from a debriefer increases validity of our thesis (Creswell, 2013). Our supervisors have played the role as debriefers, as they are experienced in both similar project and similar contexts to our thesis. Therefore, the *peer briefing* strategy has helped us to provide confidence of our findings.

4. Findings

This chapter is divided into three subchapters. The reason for this is to understand the process of EWS, and to explain the different participants involved in EWS for then to be able to identify influential contextual factors.

First, the complete cycle of EWS is described through how it is used in Nepal. Our research has identified the stages of the cycle and the importance of each step. Then the involvement of all participants within the EWS cycle is revealed to comprehend how it is organized. The actors' involvement has been identified through the interviews with authorities at the local and national level, in addition to cooperative NGOs. Last, the main findings of the report are presented with the identified contextual factors. To display the contextual factors the Ishikawa diagram is used to analyze the cause and effect. The contextual factors seek to explain the influences of locals' perception with regard to EWS. To understand the whole picture of EWS, the contextual factors are explained within the stages of the EWS cycle.

4.1 Flood EWS in Kankai River Basin

Our study has shown that Nepal has implemented the complete cycle of EWS. This is to keep a people-centered focus in their effort to achieve full EWS integration. The interviews with national authorities, NGOs and local authorities have indicates that all parties are aware of the cycle and its importance to prevent flood disasters. This chapter presents the four stages of how EWS is performed in Nepal and the importance of each stage of the cycle.

To understand how Flood EWS is generally organized in Nepal, background information was conducted. The informant from the *Department of Hydrology and Meteorology* (DHM) explained how the Flood EWS is operated. DHM gave a general definition of EWS to indicate the importance of the system in the event of any natural disaster. Their purpose is to introduce the importance of EWS to all stakeholders involved, and presented the following definition and objectives of EWS:

> *"A system of data collection and analysis to monitor people's well-being, including security, in order to provide timely notice when an emergency threatens, and thus to elicit an appropriate response. The EWS objectives are:*
> * *Increase time for response mobilization before the disaster strikes*
> * *Increase coordination and mobilization of human and non-human emergency resources, including neighboring communities and districts, with respect to previous years*
> * *Increase real-time information to improve decision making process during a disaster"*
> *(PowerPoint given by DHM, 21.01.2018)*

Our results present and elaborate the EWS cycle and how it is implemented in Kankai River. Figure 4.1 gives the illustration presented by DHM. This illustration is frequently used to indicate the importance within each step of the cycle. Further, each step is described with the focus on how EWS is operated within Kankai River Basin. Our informants were helpful in describing the importance of each stage and to elaborate their involvement. To address the responsibilities within the EWS cycle, our informants have been essential to identify their assignments. The contextual factors influencing the locals' perspective of the EWS have been further recognized after the EWS cycle was understood and the involvement of the different actors are clarified.
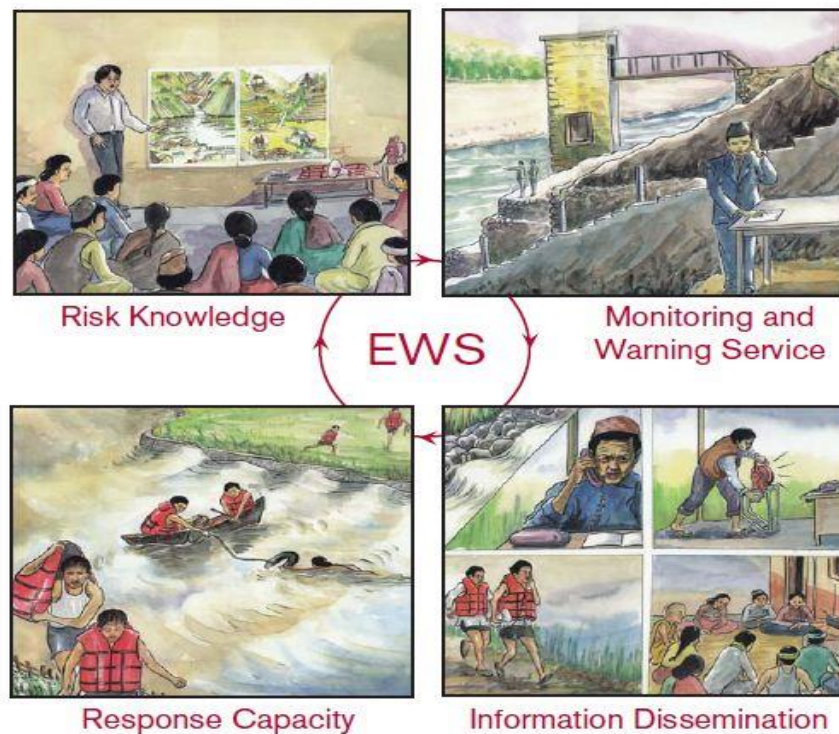

Figure 4.1: Flood EWS Cycle Used in Nepal

4.1.1 Risk Knowledge

Our study shows that the first step, Risk Knowledge, involve the elements of preparedness and awareness in relation to flood. Preparedness is concerned with people's awareness with regard to flood risk and vulnerability. It includes an assessment of the current situation within the community and for them to be prepared for flood. Important elements of this stage were presented by *Nepal Red Cross Society* (NRCS):

> *"The first phase of disaster preparedness is to find where the flood will come from and how much damage it has the capability to do. […] Also, if there are any vulnerable people like children, older people, disabled or pregnant women they are given first priority. This assessment is called Vulnerability Capacity Assessment (VCA). […] There is also a map in the community about where the safe place is and with contact numbers of required people." (Informant from NRCS, 03.03.2018)*

It is also essential that the assessment conducted at this stage covers any vulnerability of the community. Vulnerability within the community concerns all people with disabilities, as they require special attention in time of crisis. For preparation, each community has a sign which consists of a map with required information. The informant from *United States Agency for International Development* (USAID) elaborated the importance of these maps:

> *"Maps are developed for all the communities along Kankai River, where each map informs about the community. The map consist of information about how many people are disabled, pregnant and elderly. The map shows where people are and gives the disaster management the ability to go help them directly. These maps are updated before every monsoon season." (Informant from USAID, 21.01.2018)*

Further, the communities' responsibilities within this stage were also presented, as they are essential to the success of EWS. It was stated that the locals lack sufficient knowledge about the complete cycle of EWS. The locals were explained the necessity of having the required training for their role and obligations of EWS cycle but are clearly not sufficiently aware of all these stages. In the areas where EWS is implemented, the locals have attended flood awareness programs and are more aware then they were prior to EWS. However, Practical Action described this to be inadequate:

> *"People in general only understand SMS and siren warnings. People need to learn about the whole cycle that is included in the EWS. Without all stages they are not able to receive the warning message." (Informant from Practical Action, 24.01.2018)*

Local awareness was discussed in the interviews as to whether the locals are aware of flood risk and vulnerability to be able to carry out disaster preparedness. It was argued that local awareness varies and that it often relies on prior experience. DHM reflects about the variations in awareness among the local communities:

"In regions where people have experienced loss due to flood, they are more aware and motivated to act accordingly. At communities with less experience it is more difficult to increase flood awareness and issues arise. One issue is that people believe their own methods are more reliable." (Informant from DHM, 21.01.2018)

Nepal's level of preparedness was a focus in our interviews since it has a high influence on people's ability to prepare for the unexpected. USAID addressed that the national focus in Nepal lies in response rather than preparedness. The preparedness is therefore inadequate and the Nepalese population in general was described to lack flood awareness. Last year's extreme flood emphasizes this, as recognized by our informant from Practical Action:

"Five people died in the flood due to not taking the warning message seriously. They did not believe the flood to become as massive as it was predicted, and therefore did not believe their property to be affected. When they realized the danger, it was too late to cross the river. However, they still tried to cross which cost them their lives. This is a result of the gap in risk knowledge and awareness. (Informant from Practical Action, 24.01.2018)

To improve the matter of insufficient awareness, participating NGOs explain their high priority to increase the local knowledge. Their interest is to educate the locals to understand and improve disaster preparedness. For accomplishing this, multiple NGOs conducts local training, supports the communities with required resources through projects and performs mock drills. Mock drills consist of training where the locals can test what they have learned. Warning messages are sent to their phones as a flood is approaching and phone calls from authorities are received. This way the locals act as if a flood is coming and they can review if their training has been sufficient. Our informant from Practical Action presents the priorities as a cooperative NGO:

"Our highest priority is to increase local knowledge about rainfall, typography, risk and vulnerability as well as other signs to understand the approaching risk. […] Raising awareness and establishing training is a high priority. […] Risk awareness is needed for everybody and the Community Disaster Management Committee (CDMC) needs more specific training regarding the whole EWS." (Informant from Practical Action, 24.01.2018)

The *Community Disaster Management Committee* (CDMC) operates at the community level and has received training for their responsibilities during flood. Their training is specified to concern search and rescue and to perform first aid when necessary. Search and rescue operates as local disaster management and ensures safety of all locals. Their duty includes to conduct shelter management for the time of evacuation until it is safe to return to the community. In shelter management the CDMC oversees the safe place and ensures that people are secure, in addition to managing resources. One of the local informants expressed true appreciation of the training:

"Before when we heard the word flood, we would have been scared because we wouldn't know when and how much it would affect us. It would take all our house, animals and belongings. Now we are informed hours before the flood. We can bring our animals away from the river and gather people who are spread. We are informed about the water level and know how much impact the flood can have; therefore, we are not scared. We now know that we can help ourselves and the community." (Informant 2 from the first community, 04.03.2018)

When the EWS was implemented, difficulties occurred during training sessions. These struggles involved how to gather people for training as they did not understand the necessity of their attendance. The issue was that they did not understand why the system was being implemented or its purpose. Additionally, people were generally skeptical. However, it gradually changed as the EWS was adapted. Awareness programs were implemented to teach the locals about the EWS and their knowledge improved as they attended. NRCS explained the development through the implementation project:

"So, in the first year for the project, the people were little active, in the second year they were equal. Through the third year they were forward and then the fourth year they started asking questions." (Informant from NRCS, 04.03.2018)

4.1.2   Monitoring and Warning Service

In the second stage of EWS, Monitoring and Warning Service is performed. The main actor in this stage is DHM which is the Governmental department accountable for the system. DHM's responsibilities are to establish, operate and manage the flood forecasting stations. They are also in charge of updating all participating parties through their real-time information website. To develop river flood forecasting models in the main rivers of Nepal are included as DHM's obligation to provide required information for the Flood EWS. The informant from DHM listed their principal activities to fulfill their responsibilities:

- *Establish flood early warning systems on the main flood prone rivers of Nepal*
- *Prepare manuals and guidelines for the flood early warning systems*
- *Coordinate with national, regional and international organizations involved in disaster management*
  (PowerPoint given by DHM, 21.01.2018)

Technically, the Flood EWS consists of hydrology- and meteorology stations to predict floods. Hydrology stations monitors the level of water in the river and alerts when the water exceeds the warning or danger level. NRCS explained the water levels in Kankai River and introduced the obligations of the CDMC in the context. CDMC is here explained as task force:

> *"3.7 is the preparedness level where the task force gets prepared with the required resources for the approaching disaster. This is the warning for the disaster. 4.2 is the danger level where everyone performs their responsibilities as planned to be ready for the disaster to approach." (Informant from NRCS, 03.03.2018)*

One complication arose during our inspection of the EWS. The hydrology station got destroyed during the last flood. Through the absence of this station, both locals and local authorities expressed uncertainty. The informant at Mahinachuli, which was where the hydrology station was situated, made several requests for a new station. The request also included that the station to be rebuilt closer to the community and contain proper infrastructure to feel secure when monitoring water levels. Locals in the first community demanded the station to be rebuilt immediately and argued that without the station they would be clueless when the *District Emergency Operation Center* (DEOC) called to warn about any flood. The informant from NRCS expressed the importance of reconstructing the hydrology station immediately:

> *"If the hydrology station is not build within the next two to three years, the Early Warning System will collapse. […] The SMSs will still be distributed but the people won't be able to know the water levels. The communities won't get a lead time which is a major obstacle. For instance, the meteorology station will show that there have been 36 mm rainfall, but they won't know the water level and possible impact." (Informant from NRCS, 05.03.2018)*

The meteorology stations are where the rainfall is monitored. For the Kankai River Basin, one of these stations is placed in Ilam to monitor downstream. Typographically, Ilam is located at higher ground then Jhapa, the research area. Therefore, by monitoring the rainfall in Ilam, DHM are able to predict the flood in Jhapa before it occurs. Figure 4.2 shows the components of the meteorology station. DHM explained the components though their PowerPoint presentation which was presented in the interview. NRCS justified all components when the station was inspected during fieldwork. It was very interesting to see the small amount of IT components necessary to operate this part of the Flood EWS. The IT components of the meteorology station consists of only five elements:

Figure 4.2: Automated Rainfall Station for the EWS Installed in Ilam

1) *A solar panel to give the components electricity*
2) *A communication module where the SIM cards are located. The SIM cards send warnings at warning and danger level to inform the people and stakeholders in addition to DHM about the approaching danger*
3) *The data logger registers the activity at the location and is connected to DHM information center in Kathmandu*
4) *The charge controller is there to prevent overcharging and to protect the battery and hopefully increase the battery lifetime*
5) *The battery is there to ensure power savings for the components by storing energy from the connected solar panel." (PowerPoint given by DHM, 21.01.2018)*

Figure 4.3: Manual Temperature Measurement for the EWS

Figure 4.4: Manual Rainfall Measurement for the EWS

In addition to the automated rainfall station for the EWS, the station also has manual components for measuring rainfall, displayed in figure 4.3 and 4.4. One local in the community of Ilam, was assigned to look after both the automatic and manual EWS, to ensure Warning Service if the automated system is not functioning. The informant explained their responsibilities of logging the manual information and informing DHM:

> *"I send the data to the Department of Hydrology and Meteorology. […] I need to visit the station twice a day regardless of season and rainfall. […] I don't know the technicalities of the automatic one as the data directly goes to Kathmandu." (Informant from Ilam, 07.03.2018)*

The Flood EWS is implemented to generate real-time information about the rivers and rainfall. This automated information is sent from the hydrology and meteorology stations to DHMs and National Emergency Operation Center (NEOC)s departments in Kathmandu, in addition to direct updates to a website where each river of Nepal is monitored: http://www.hydrology.gov.np/. DHM is in charge of this website where they provide this information world-wide. The website gives people the opportunity to be aware of the probability or intensity of a flood in the monitored areas without being present. The process of distributing real-time information was elaborated by the informant from DHM since they are not able to present live information from the rivers:

> *"The information system of the EWS has implemented intervals for updating the real-time data. In dry season, this interval is every 15 minutes. During monsoon season the interval is increased to update every 5 minutes. The system has implemented SIM cards to notify all participating agencies, in addition to DHM, in the case of an emergency. These SIM cards are also set to update real-time information online." (Informant from DHM, 21.01.2018)*

The SIM cards implemented into the hydrology and meteorology stations of the EWS are generated to distribute SMS when warning and danger levels are reached. These warnings are distributed to Governmental departments, participating NGOs and locals within the reach of danger. To address the locals within the area of danger, Ncell and Nepal TeleCom are essential. Through these mobile operators, data are collected for the location of all Nepalese phones every 24 hours. To completely rely on SMS for warning distribution, however, is risky and it was asked what would happen if the system was inoperative. The informant from DHM explained the process of back-up:

> *"In case of emergency and the SMS is not working, the system is set to use satellite information. Then, the online information will be updated this way. Additionally, to reach the people, volunteers and part time employees within the communities will be at watch. These are further informed and assigned to then inform the locals by sirens and megaphones about the danger." (Informant from DHM, 21.01.2018)*

4.1.3   Information Dissemination

Information Dissemination contains the communication flow within the EWS and how the locals receive the message. The communication flow starts on the top with DHM distributing the message and ends with the local communities. Due to most of the EWS to be automated, more management is required at the local level then the national level. One of the main questions of the interviews with authorities concentrated on how the dissemination of warnings are managed. Figure 4.5 presents the communication flow when a flood occurs in Kankai River.
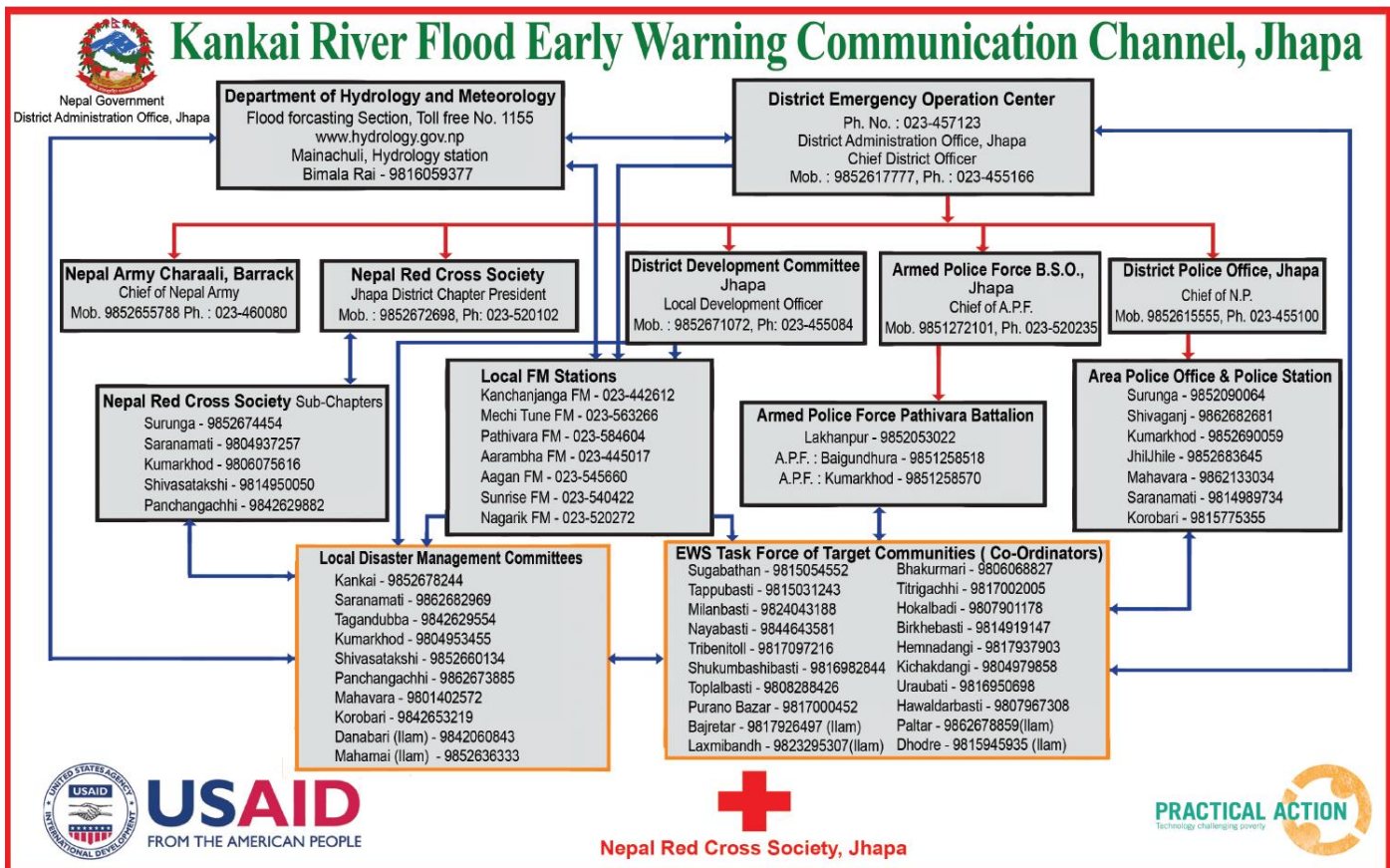
Figure 4.5: Kankai River Flood Early Warning Communication Channel 2017 for Jhapa District

The blue lines resemble two-way communication between the actors and the red lines resemble one-way communication such as mail or SMS. First, DHM receives the information about the water level and rainfall. If a flood is predicted, DHM contacts DEOC's office and the warning dissemination starts. The main responsibilities of DHM and DEOC is to communicate with the district and local level. Both DHM and DEOC are obligated to warn the local FM radio stations to urgently start the warning distribution. DHM is accountable in activating the *Local Disaster Management Committee* (LDMC) while DEOC contacts the CDMCs. CDMC is referred to

as EWS Task Force of Target Communities in Figure 4.5. As indicated, the communication channels are quite complex, and the different stakeholders end up receiving the information from multiple participates. This is to ensure warning dissemination to all necessary stakeholders who are involved in this stage.

DHM is accountable for sending out SMS warning to the locals in the event of flood. The locals are informed when the river is rising, and they are trained about how to act at warning and danger level. This way the locals are prepared when a flood occurs. At the same time, DHM sends email to inform the necessary NGOs for assistance. When the water reaches danger level the locals receive a message which includes information about the lead time and are asked to evacuate to the assigned safe place. The DHM informant recalled:

> *"Information Dissemination to people in case of flood, we will send an email to the responsible agencies. If the water reaches the warning level, DHM sends a warning message to the locals by SMS. This takes between five to ten minutes. A second SMS is sent if the water reaches danger level. The locals are then asked to evacuate to the evacuation centers to be safe from the flood" (Informant from DHM, 21.01.2018)*

There are four levels of warning: alert, warning, danger and the area is safe for return. The levels are initiated by using different color flags to warn the locals. At the same time, the CDMC receives a phone call from DEOC about the warning level and they warn the locals with the use of hand microphones, megaphones and sirens to inform the locals on how to be safe. The siren can be heard from a radius of 1-2 kilometers. NRCS declares this:

> *"As the level reaches 3.7, the people are warned through loud megaphones and a yellow flag. There is a siren that is heard with some breaks. But when the level reaches 4.2, a red flag and continuous siren is played. The SMS system and megaphones inform you the lead time which means the time it takes for the flood to reach the community" (The informant from NRCS, 03.03.2018)*

When a flood occurs the DEOC informs the CDMC through phone call. CDMC is then responsible for warning the rest of the community by using siren and microphones. In addition, everybody that will be affected by the approaching flood receives a SMS message. The message includes the information about the lead time as well as the impact the flood will have on the communities in the area. This community was informed by NRCS about their lead time and they thought this was both strange and scary. The local informant stated:

> *"15 minutes is the lead time for us. I felt really scared due to the shorter lead time. We must evacuate within 15-20 minutes. And to reach the safe space it takes 15-20 minutes as well. Lead time is equal to the lag time which makes the evacuation process difficult. I raised the questions regarding the lead time in the meetings as well. The other communities have the lead time of 1-2 hours. Whereas, for us the lead time of 15 minutes which is not sufficient." (Informant 2 from the third community, 05.03.2018)*

In some cases, DEOC calls the community to warn them about flood on a perfect sunny day which was presented as confusing for the communities. Depending on lead time, the flood approached the community as the warning stated. Last year, the flood occurred in the middle of the night and since people usually use their phones to play games in the evening, their phones where drained. For this reason, many people did not receive the SMS warning and the CDMC had to use hours to inform all the locals. CDMC notified the community by going house to house using megaphones and microphones. One community told their story:

> *"During the night time when the flood came we were out there till 10 pm informing people. People play games on their mobile phones and their phone batteries were drained out so some of them missed out on the information but even in that case they managed to get the information across" (Informant 1 from the first community, 04.03.2018)*

4.1.4   Response Capacity

Response Capacity is the last stage in the EWS cycle. In our research, the stage is given the least attention for two reasons. The first reason is that this stage is in place and is the priority of the Nepalese Government. Second, it is out of the scope for our research which seeks to explore the dissemination of EWS warnings and to identify contextual factors in relation to people's perception of EWS warnings.

The locals explained how the training from NRCS has helped them to understand how to save their people from flood. Now that they are informed hours before the flood occurs, they have time to save their possessions before evacuation is demanded. Additionally, the locals within the communities explained the importance of an emergency bag. This bag contains money and their citizenship, among other essential belongings, and is continuously available during monsoon season. The routine for evacuation was described by a local from the first community:

> *"When flood comes, it comes, and everything gets drowned. When there is pre-information, people can even walk slowly, do their chores and keep their belongings in a safe place. […] We have prepared what we call "Jhatpat Jhola" which is a bag that contains personal documents, snacks and other necessary supplies. The bag will help us survive for two to three days. Any other important but not critical possessions are hung high in our houses to survive the flood." (Informant 3 from the first community, 04.03.2018)*

Some of the locals in our research are volunteers in search and rescue which makes them integral part of the CDMC. These participants and their involvement in CDMC were described to include certain responsibilities during flood. Their tasks are to provide rescue and resources as necessary during flood. Additionally, the CDMC are required to carry out risk management. The risk management assesses the risk of the evacuation process to ensure safety of the locals. Since they are central in the rescue within their community, their responsibilities which were learned through training and experience were explained:

> *"When there is flood, the communication officer within the community gets the message through a phone call and then informs us. Then the rescue team members gather and act to save the people from danger by escorting their community to a safe place. […] We cannot run away anywhere because there are two rivers coming this way. So, we take children, old people and everyone to a higher place which is safe. […] The safe place is about 10-15 minutes by foot." (Informant 2 from the first community, 04.03.2018)*

Correct training of the CDMC is necessary to be able to assess and assist their community in the event of flood. The focus in training is to address all needs within the community and conduct mock exercises regularly. To satisfy all concerns, a plan is required to be developed and implemented through preparedness. The plan must include all people with disabilities to meet all their needs. A mock exercise is practice about how to act when a flood occurs. Mock

exercises are held every year on Environment Day, June 5th, to prepare the communities for the approaching monsoon season. Practical Action describes mock exercises:

> *"Practical Action manages mock exercises in the communities. The first question is "How many people have special needs in the community?" Also, it is important to consider that the people helping are also at risk." (Informant from Practical Action, 24.01.2018)*

During evacuation, the locals are not able to access any of their belongings apart from what they brought with them when they left their homes. Therefore, when a flood lasts for days, their emergency bag, Jhatpat Jhola, might not be sufficient. The necessity of increased funding for the communities were highlighted through the interviews with NGOs and national authorities. The communities have therefore collected emergency funds to use if required. The funds are called Disaster Risk Reduction Fund and is collected from all households in the community to assist flood victims and purchase resources. One local elaborated:

> *"For the emergency fund we collect 20 rupees per month from each household. The community consists of about 15 households. In the time of crisis, we even collect 250 rupees and even the Nepal Red Cross added some additional funds. So, at this date we have around 28.000 rupees in our emergency fund." (Informant 1 from the first community, 04.03.2018)*

Lastly, a few concerns were presented in relation to Response Capacity. Informants from the national level were concerned with the lack of motivation to perform EWS at the local level. The people within the communities who are annually affected by flood show high motivation. However, less affected communities seem to lack motivation. It was addressed that people had difficulties volunteering as there is nothing available to motivate them. There are limitations in resources which seems to affect their participation. Another possible reason is identified to concern additional training and education. If people were to be further informed about what is involved and required, they might show increased motivation. Since NRCS is pulling out and handing the responsibility to CDMC and LDMC, it will possibly be a greater challenge to organize trainings. Practical Action stated the following which supports the issue of limited motivation:

> *"It is difficult to find people to take responsibility at community level. It's a lack of people motivated to participate in disaster management and a lack of people with the interest to help out, and to volunteer. Also, people who have already signed up as volunteers, lack motivation. […] Additionally, the voluntary people's tasks when the red flag is up, causes confusion. They are unsure about if they should continue their tasks or evacuate. This gives a huge risk for the community." (Informant form Practical Action, 24.01.2018)*

4.1.5   Involvement of Authorities and NGOs

In our data collection, the roles within EWS are identified through the different authorities and NGOs to establish how they are organized. Figure 4.6 has been developed in this thesis as a means of contributing to an easy overview of the different participants. The figure is based on a communication chart presented by the DHM. Since this chart generally presents how the communication must flow within the Flood EWS in Nepal, our figure demonstrates in a clear way how they are involved. The figure is specified for Kankai River and the participants involved in the EWS implemented there. Both authorities and NGOs are involved to make the system function properly, and their responsibilities and roles are explained further.
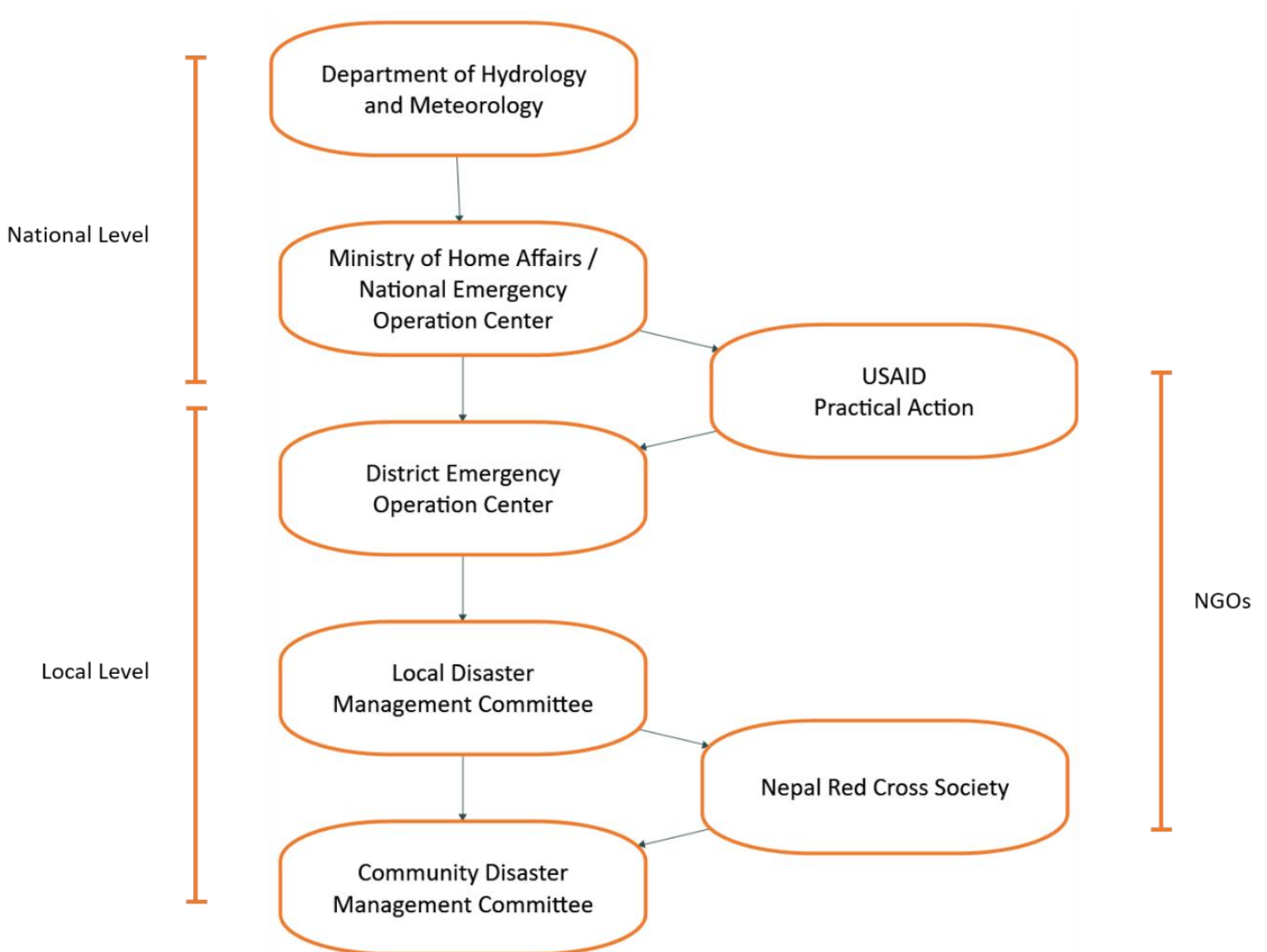

Figure 4.6: Involvement of Stakeholders

DHM is the department under the *Ministry of Science Technology and Environment* (MoSTE). This department is authorized to monitor all hydrological and meteorological activities in Nepal (Shrestha et al., 2014). DHM is responsible for collecting hydrological, metrological, and climate information. They are also in charge of disseminating information to the stakeholders involved. DHM as presented accountable in establishing, operating and managing flood forecasting stations where they also must upload their real-time data into the system. DHM has an important job of assessing disasters, vulnerabilities and risks in the different flood prone river basins around Nepal.

In Nepal, DHM has established 286 meteorological stations. There are 170 hydrological stations located nationwide where 20 stations monitors sedimentation (Shrestha et al., 2014). DHM administrates institutional capacity to be able to predict future floods. DHM goal is to increase the network of hydrology and metrology stations and improving the forecasting systems nationwide (Smith et al., 2017). The informant from DHM explained their responsibilities:

> *"Our main task is to manage the monitoring and observation of Hydrological and Meteorology information of the system. […] We are also responsible for the communication and dissemination element of the EWS cycle." (Informant from DHM, 21.01.2018)*

NEOC was established in 2010 by the *Ministry of Home Affairs* (MoHA). NEOC is operated with a team of 9 members. Their job is to coordinate and communicate disaster information across Nepal. NEOC accountable for communicating with Governmental agencies and NGOs that help with the response and recovery phase of EWS (National Emergency Operation Center, 2014). The informant from NEOC elaborated:

> *"NEOC receives information about approaching flood from the DHM. Further, NEOC sends the information to the Ministry of Home Affairs and agencies to activate the response procedures. Our job is to ensure a coordination mechanism with stakeholders for disaster preparedness and response." (Informant from NEOC, 21.01.2018)*

Altogether, NEOC works with the disaster management from a national level which is supported by the district- and local authorities. At NEOC there are people working around the clock to gather the information. Their main focus when disasters occur is to provide immediate response and humanitarian assistance. NEOC is in charge of promoting preparedness activities to both the national government and local governments (National Emergency Operation Center, 2012). NEOC presented their main role regarding the Flood EWS:

> *"NEOC's objective is the communication flow and nature. NEOC is also responsible for the process of establishing and developing mechanism for leading and coordinating of search, rescue, humanitarian aid and support at the time of disaster. […] We are responsible for ensuring women's rights, children, old-aged, and physical challenged people during disaster response." (Informant from NEOC, 21.01.2018)*

The main mission of **USAID** is to promote development of resilient, democratic societies that are unable to realize their potential. USAID believes in working on growth of rural areas through promoting free, peaceful, and self-reliant societies with effective and legitimate Government. The organization seeks to cooperate with partners in different countries of the world rather than imposing on them. Additionally, their mandate is to work in countries and advise them on how to build sustainably (USAID, 2017). USAID has several projects in Nepal, helping with the EWS and *Disaster Risk Reduction* (DRR) plan. Their mission is to assist the communities with implementation of EWS and integration of the DRR plan to further make the community self-reliant. The USAID informant supported this by acknowledging:

> *"When the system is fully implemented and working, USAID's interest is to hand it over to the local community to continue the work. This needs to be further funded by bigger organizations." (Informant from USAID, 21.01.2018)*

This NGO mission to guide Nepal in preventing, mitigating and responding to disasters. They work with the Government of Nepal to focus on vulnerability and how they can use programs to improve preparedness and response in relation to natural disasters. USAID is working to increase the understanding and awareness of how important disaster risk reduction measures are. The informant from USAID assured this by presenting:

> *"Younger people are coming into the government, which sees the need for disaster preparedness which is a very good sign. New local representatives in Nepal's districts is a positive development." (Informant from USAID, 21.01.2018)*

USAID is implementing measures into the Government plan which involves budgets, increased engagement of private sectors and enhance the media coverage to cover all aspects of natural disasters. These plans are to increase the populations awareness and understanding towards risk and how the people can protect themselves from natural disasters. Furthermore, they help the communities to develop resilience and educate the community on how to build disaster resilient infrastructures (USAID, 2018). USAID is one of the NGOs involved in Flood EWS and have a high focus on disaster management.

Practical Action is a British organization and was established in 1966. It is an Intermediate Technology Development Group which attempts to use technology to defeat poverty in developing countries. They are enabling communities to produce practical solutions to simplify their lives. This is accomplished through the assistance of Practical Action's innovative thinking and technical knowledge. Practical Action's goal is to assist in an open and transparent way (Practical Action, 2018b).

Practical Action supports Nepal in reducing poverty through providing appropriate technology. This organization has long experience with technical knowledge and global experience on technology development. Their goal for Nepal is to establish effective community-based early warning systems across the nation. Practical Action are working towards saving lives through the DRR sector (Practical Action, 2018a). Practical Action has worked with Flood EWS in Nepal

for the last 15 years and are currently assisting the EWS project in Kankai River. One of their responsibilities are to arrange mock exercises for the locals to be prepared and to support the local disaster management. As stated by the informant:

> *"Practical Action manages the mock exercises in the communities. […] We support the local communities and local authorities in their work with the local disaster management. The CDMC are scheduled to meet once a month or at least before the monsoon season." (Informant from Practical Action, 21.01.2018)*

NRCS has over the years grown to be the largest humanitarian organization in Nepal. NRCS consists of district departments which are located in each of the 75 districts in Nepal. Their goal is to relieve human suffering and to reduce vulnerability in the country. Additionally, the NRCS is working on this through community participation and mobilization with the help from volunteers. By expanding and strengthening the structure of the communities and building collaboration with authorities and NGOs, NRCS will help these communities towards a better life (Nepal Red Cross Society, 2017). The informant from NRCS describes the responsibilities between the Government and NGOs:

> *"The District Emergency Operating System gets all the data and then it disseminates to the stakeholders and community as well through communication channel where there are DHM, DEOC, DAO, Police, Army and VDC inform its lower unit. […] The responsibilities among people are divided in terms of different hierarchy. First, the CDMC. Secondly, Task force which includes 4 people. Third, LDMC." (Informant from NRCS, 21.01.2018)*

MoHA is in the process of establishing a **DEOC** in each district in Nepal. In Jhapa, they have established a command center where they have details about the water level and rainfall. This information is displayed on a TV screen at their office for them to follow. DEOC is in charge of maintaining the system and communicating any alarming situations that might occur to the downstream areas of the river (Ministry of Home Affairs & Disaster Preparedness Network-Nepal, 2015). The employees in this office includes people from the Nepal Police and the Nepal Armed Police Force. DEOCs role in the EWS was explained by an informant from DEOC:

> *"When locals receive the information, they go to a safe place and then our manpower which includes Nepal Army, Nepal Armed Police, will go wherever there is most need of manpower. […] Depending on the weather conditions, we are updated by frequently communicating with Nepal Army, Nepal Armed Police Force and Rescue unit about the weather. We are updated every hour." (Informant from DEOC, 06.03.2018)*

LDMC has newly been established in each of the disaster-prone villages in Nepal. Practical Action helps the LDMC's with technical and financial support (Gautam & Phaiju, 2013). DHM communicates directly with LDMC when a disaster occurs by giving the LDMC information about the situation (Ministry of Home Affairs, 2013). The LDMC is collaborating closely with the

CDMC which has developed a strong relationship over the years. This was declared by the informant from LDMC:

> *"The interaction between the CDMC and LDMC works really well and they communicate regularly. When the EWS was established, CDMC receives the message and informs the LDMC, which works well. This partnership is working out great. [...] In CDMC as well as LDMC includes local and community members. In the CDMC there are local people and now we even have a local representative. Before we did not even have that but still the partnership was good. We believe that the partnership has become strong because now we find representatives everywhere. In the future it will get even stronger."*

The role of the LDMC is to handle the emergency rescue, assist the locals in evacuating to a safe place and give the locals the resources they need to survive during a flood. LDMC has the duty to care for the community during the event of flood. It is explained that NRCS is responsible for the district- and local level which involves local societies. The LDMC informant clarifies this:

> *"We help the locals where there is a need for emergency rescue. Our job is to bring them to a safe place and give them the appropriate resources. [...] In the district level we have the Nepal Red Cross and another NGO. At the local level we have local social workers, local groups, respected people of the community and social personnel are also helping."* *(Informant from LDMC, 04.03.2018)*

The role of **CDMC** is to coordinate the disaster management at the community level. Their job is to help the community with the response in organizing and distributing relief and to assist the district security personnel with search and rescue in the event of flood (Zurich, 2015). The CDMC includes one president and a Task Force which includes 4 people. These are trained to act accordingly and carefully during flood. Their role includes to assess the situation, give first aid to wounded people and perform shelter management. The CDMC informant discussed this in addition to elaborate on handling emergency funds the community has saved up to use during flood:

> *"The CDMC is a unit of the government. The CDMC is responsible for handling and managing the money for crises. Now the CDMC should continue these tasks because of the project with the non-government organizations is ending."* *(Informant from CDMC, 04.03.2018)*

In conclusion, the involvement of the different actors presented has been appointed to the EWS cycle. Figure 4.7 displays how the Governmental organizations and NGOs are integrated in the EWS cycle. This illustration has been developed through our data analysis by identifying the involvement of the different informants. The informants presented their responsibilities and provided documents giving information about their work. A few of the actors are involved in multiple stages and are therefore displayed within all stages they participate in. This indicates the variety of responsibilities implemented to ensure a successful EWS.

Nepal Red Cross Society
Practical Action
United States Agency for International Development

Department of Hydrology and Meteorology
District Emergency Operation Center
Practical Action

Risk Knowledge

Monitoring & Warning Service

Key Elements of EWS

Response Capacity

Information Dissemination

Community Disaster Management Committee
Local Disaster Management Committee
Nepal Red Cross Society

Community Disaster Management Committee
Department of Hydrology and Meteorology
District Emergency Operation Center
National Emergency Operation Center

Figure 4.7: Involvement within EWS Cycle

4.2 Contextual Factors within Flood EWS

In this chapter, all the contextual factors identified are presented using Ishikawa diagram. Figure 4.8 displays the categories discovered through our data analysis and represents the prime contextual factors introduced in chapter 3. This diagram is used to present the cause and effect of how the factors influences the locals' perception of Flood EWS. Throughout this chapter, all factors and their influence are demonstrated to show the causes of how the locals' perception of EWS warnings are affected. Last, the complete diagram is displayed to present all the influential factors discovered in our research.
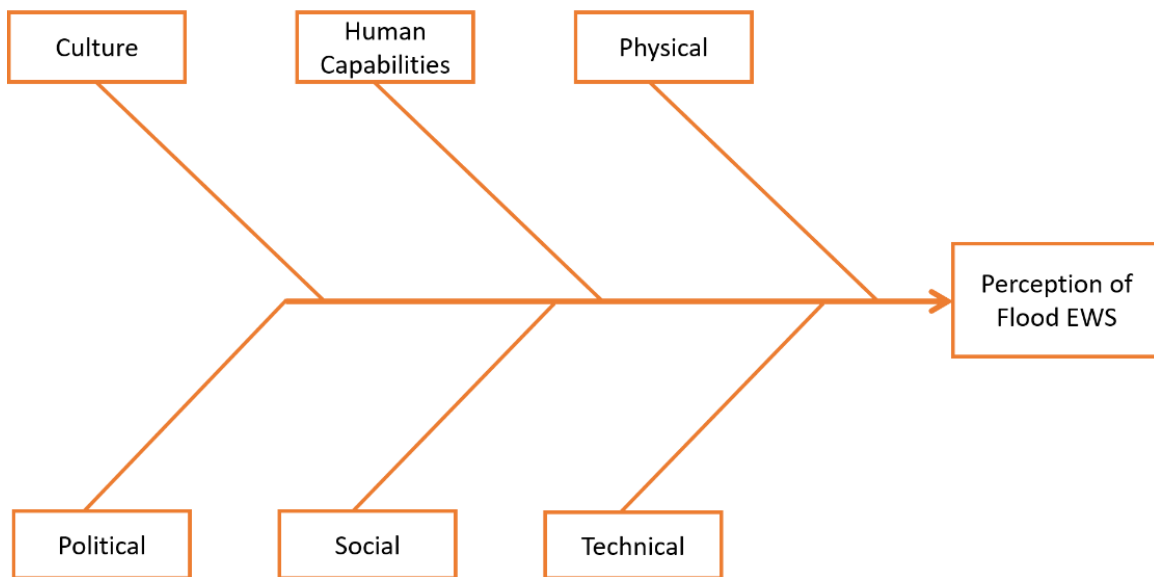
Figure 4.8: The Effects Causing the Perception of Flood EWS

4.2.1   Cultural Factors

The first factor is **common sense** which has an impact on the implementation phase of the EWS. In the time prior to EWS, the locals had their own methods to understand when a flood was approaching. In the event of flood, the people did not know how big the flood would be or when the flood would occur, which had negative consequences for many lives. They were completely unaware of how much a flood could impact them.

Our research discovered that before EWS, the locals acted on the signs of flood when they heard the noises of the water closing in. As it implies, this gave no lead time. If you were in the wrong place, you might not have the time to reach a safe distance before the flood occurred. The locals also used to follow the thunderstorms and clouds, especially, when seeing black clouds, the locals knew a flood would occur.

Another method to recognize a flood was by looking at the waves of the river. When the locals saw the river approaching their area they ran to find a safe place. Since the locals believed in these methods it was difficult for them to comprehend how EWS would help them. Common sense has affected the locals' perception of EWS as they previously did not have reliable methods to predict flood. Now they have EWS to give precise flood information. One local listed previous methods to predict flood:

> "Many methods helped our ancestors to survive the floods; They looked up North at the clouds, listened to the mooing of the cows, looked at the ants coming out of their holes and moving in line with food on their backs, they listened to the sounds of the birds and also the ferns and plants deposited in the water banks were signs of the flood that is about to occur" (Informant 2 from the second community, 05.03.2018)

Gender Differences identified to influence the people in the initial stage of EWS. In the beginning of the project, difficulties were experienced in gathering people for the training and to ensure women's participation. A major problem was that the locals did not share the information from training with NRCS. Only men attended the training and was described to not share this information with their women. It was first when the NRCS traveled into the communities and encouraged them to share their knowledge that the women first started to understand the importance of the training. After this, women became informed and started to attend the trainings.

In the past, there were a set of rules and traditions that only women had to follow and illustrates the strong gender differences in the communities of Jhapa. Women were not allowed to interact with people outside the family, not to mention that school was prohibited for girls until recently. School was believed to not be a relevant or appropriate place for girls as they needed to learn to take care of the household.

Today, it is easier for girls to go out, and they are allowed to talk to people and have their opinions heard, in addition to attending school. However, this causes complications as the older people in the community still consider women to be overly smart when they try to explain the EWS to them. This leads to some resistance in this generation in relation to EWS. The locals' perception of EWS is affected by gender differences and it complicates the integration of EWS. The challenge of gender differences was elaborated through how it was before and how it is now:

> "Women care more about their household than men. […] Women and men are both uneducated and the mentality of people was different then. They used to say the benefit you will get by listening. So, because of that, they used to listen and then not share at home. To women they used to say, why do you have to leave home and work to go to training. Now it has changed, and women attend the meetings and have equal participation. […] Women are more responsible than men during flood because they are home. Now there is active participation of women and everyone shares everything with each other." (Informant 2 form the first community, 04.03.2018)

Language affects the locals' perception of EWS warnings throughout the whole EWS. There are many variations of the Nepali language which means that warnings are perceived differently. In one of the communities visited they had their own variation of the Nepalese language. They practiced both their own language and Nepali where they spoke their own language but read in Nepali. For them, their own language and Nepali are quite similar. However, the students accompanying us did not understand the language, which indicated larger differences than they first explained. This community had neither proper knowledge about their own script and was more accustomed to the Nepali script. On the other hand, few in this community spoke both languages.

The warning message from Ncell, was found to be presented in Nepali script and is the most useful for locals. Not to mention that this community is highly depended on this script. The messages from Nepal TeleCom are not useful because only the younger generation can read Latin script. Even though the other communities speak and write Nepali, it was frequently mentioned that the language in the SMS was important and that Nepali script made it easier to comprehend. Understanding the message has an impact on how people perceive EWS which is crucial. A local revealed how the older generation receive EWS warnings:

> *"My son and daughter inform me when the flood is coming. They know and then take me to the safe place. Only my son and daughter know. I don't know how to use a mobile and also, I won't be able to read." (Informant 3 from the third community, 05.03.2018)*

The factor **Moral Values**, additionally affects the locals' perception on how to act towards the Flood EWS. Since they have received training, the locals explain the EWS has become a part of their culture. It took about two to three years before people started to understand and acknowledge how the system could help them in the event of flood. Through this period, it was difficult to explain the system to the locals because people were not educated, uninterested and unmotivated to make a change.

After some time, people started to see that they are able to save the whole village not just themselves and their own homes. In one community, it was discussed that radio might be a greater way to receive the warning. For instance, it was mentioned that somebody might be sleeping, and others may be drunk. This shows that moral values affect the perception of EWS. How the locals' act and the need for extra resources to open their eyes to understand the huge risks at hand. The older generation did not believe in the system and did not comprehend what the others were doing during crisis. Further, this was made clear through one of the informants on how the older generation reacted to the Flood EWS:

> *"When flood comes, they just keep quiet and sit in their houses. We would have to go and tell them the flood is coming, to keep their belongings in the safe place and collect people. The people also did not know about the training. They used to tell, you don't have work, they get a lot of money from this, so they call you. This was the mentality of people. Before even we were lazy and did not want to go. But after training, now we*

want to attend more meeting and learn more." (Informant 2 in the first community, 04.03.2018)

Set of Beliefs is found to impact the locals' perception through their openness when it comes to religion. An interesting finding in one of the communities where that the locals had converted to Christianity. This conversion in beliefs makes the local profoundly open to changes. Today, there is a general increase in people converting to Christianity in Nepal. The community which had converted to Christianity was revealed to be more prepared to continue the work with EWS without the help of NRCS.

In the other communities encountered during the research, were Hindu. These communities had also integrated EWS, but they expressed a more traditional mindset. They were more anxious about how the EWS would continue without close cooperation with NRCS. One local expressed this fear and wanted the project with NRCS to continue for two or three more years to feel safe. Another community was found to slowly opening their eyes towards EWS and that they have learned to be logical and rational. In contrast, our research discovered one local to not show as high openness:

> *"Honestly speaking there is nothing in this village. There is neither a proper road nor electricity here frankly speaking, we are living just like these cows and goats. We were born in this mud to die in this mud. To charge our mobile devices we need electricity and it costs money." (Informant 3 from the second community, 05.03.2018)*

Traditions was looked upon to highly influence the locals' perception of EWS, which turned out to have less importance than expected. Prior literature stated that traditions has huge impact on people's perception of systems, which was the reason for this assumption. Through our interviews with the locals it was found that traditions do not have this large impact. It was explained that during the monsoon season there are no festivals arranged.

The only concern related to traditions is that if a large flood occurs during the monsoon they will lose their crops. Other times festivals might be affected if the flood had ruined their homes. This influenced them as they had no place to celebrate. In conclusion, traditions have a small effect on the locals' traditional events due to only be affected in extreme occasions of flood. A local supported the small effect:

> *"The festivals start post-monsoon, so floods don't directly affect the festivals. The river swept our crops away so when the festivals are around the corner we don't have the crops and we cannot exchange crops for other items. This affects our festivals." (Informant 3 from the second community, 05.03.2018)*

4.2.2   Human Capabilities

Disabilities and Abilities is important because it concerns the most vulnerable and is a challenge within each community. A challenge discussed by informants involved how to help the disabled in the event of flood. To cover this aspect where the abled support and help the disabled, one has to have suitable alternatives for all actors during the crisis. People with a disability includes pregnant women, small children and elderly are highly prioritized when flood warnings are sounded and receive assistance to be evacuated from the community at the warning message stage. Under the evacuation, the locals appointed at CDMC assist anyone with handicaps first, before pregnant women, children and elderly.

One of the communities visited explains struggles due to unsuitable land for farming. This forces the younger generation to work outside of the village. As a result, the community is at higher risk since it is mainly the disabled that stays in the village at daytime. This makes it difficult for the ones staying home, because they are less suitable to act when a flood warning is received. Many of the elderly do not understand the SMS warning because they either do not know how to read or do not own a phone. At the time of a flood, this can be dangerous as they might not receive the warning information in time.

The disabled have a large impact on the perception of EWS, especially considering how they need to be taken care of and that they require a plan of how to help them in the event of flood. It is necessary to take care of the people with disabilities but is also a challenge to communities. This point of frustration and concern was emphasized by one local who would not know what to do when a flood occurs in the middle of the day and no one is there to help:

> *"I will know it from my son, but I won't know where my son is. He will be far away. He won't be able to come here and how will he inform me? Look, we are living with these small children. What will they do?" (Informant 3 from third community, 05.03.2018)*

In the initial stage of implementation of the EWS, the **Lack of Knowledge** was a major issue. People did not understand why and how this system would help them. As they started to learn about EWS, they started to believe in the system. At first, the people asked the NRCS if they could make two big dams in Kankai instead of using a SMS warning system. These types of suggestions from the locals made it extremely hard for NPRCS to involve and train the locals to understand EWS.

Before EWS was implemented, our findings revealed people to be scared when they heard the word flood. This was because the locals were not aware of how much impact the flood would have on the community as well as prior experience. An example of the lack of awareness is that people in one of the communities did not even know if they were part of Nepal or India. A reason for this was that the community were poor and lacked knowledge.

Today, they are knowledgeable on how to save their animals along with other personal belongings. Further, they are now informed on how to act, what to do when flood occurs, where the safe place is and how to take care of personal possessions. Knowledge is needed to understand the system properly. However, the lack of knowledge still impacts the locals' perception of EWS since our result revealed locals to still believe flood can be stopped. They are aware and have learned how to act during flood, but some still want the NRCS to build a dam around them to stop the flood. In the community with the shortest lead time, a local gave us an example:

> *"I will give you my view. We got training from the Red Cross which is fine, but they are doing this to reduce the casualties during the flood. The helping pattern is flawed. This helping pattern forces them to constantly help us. I will give you an example, for instance if a snake enters your house through a hole you kill the snake. Another snake enters your house you kill that snake as well. But, perhaps you should plaster the hole. [..] If the dam can be constructed as it should be. Instead of messages why not completely stop the water instead. For how long should we run? If we run every monsoon we will get injured one day. So that is my complaint. The flood must be stopped by dam." (Informant 2 from the third community, 05.03.2018)*

Misunderstandings impact the perception of EWS in a way that people either do not comprehend the message or so not know how to act in the event of flood. This is extremely risky, and people will get hurt. In the beginning, people did not trust the system as they did not see the importance of training. This is an example of how misunderstandings can occur due to not understanding the purpose of training.

Another challenge is that many locals misunderstand how to act on the different warnings and flags. The people were explained to be unsure about if they should continue their tasks or evacuate when warned which is setting the community at extreme risk. Misunderstandings has a huge influence on how the locals perceive EWS, since this can be a distinguishing factor between life and death situations. One local explained his challenge when they started to implement the system. It was implied that the communities still lack sufficient understanding, especially when stating that there is currently no issues:

> *"We used to go to training. We did not know what to do, but as the training progresses and we started to be more forward. Today, we don't have any problems" (Informant 3 from first community, 04.03.2018)*

Training is important since it gives the locals necessary knowledge about how to be prepared for a flood. Training has taught the locals how to act, how to store food and how to save their fellow citizens. In the beginning of the EWS, it was pointed out the difficulties in motivating people for training. For the locals, this system was entirely new, and people were unaware which made them less motivated to learn.

There were several skeptical people in the communities who did not have confidence in the system. When they saw that the EWS in action their confidence increased. Now the locals are determined to be independent and can stand on their own two feet. Through trainings the locals have learned to be more prepared. This improves their perception of EWS warnings. A local shared their experience from the beginning when training started to how it is today:

> *"So first when they called us for the training, what they would ask, not ask, we did not know anything. Before I even felt lazy to go to the training. We had so much household work to do and at that time, they called us for the training. I didn't want to go to the training leaving household work. And then later the NRCS came here to us and encouraged us to go to the training by saying the training would benefit you because now you don't know what to do when flood comes and how to save yourself but after you take the training, you'll know about this stuff as well. After that, we started going to the training. We got trained for about 2 to 3 years, I believe in myself and I'm happy I took the training."* (informant 2 from first community, 04.03.2018)

4.2.3   Physical Factors

Through the years climate change has increased its impact on the Kankai River Basin. The **environment** has impacted the locals' perception on EWS since the size of the flood is expanding each year. For this reason, dams are being built around the most vulnerable communities for redirection of the river. The dams close off parts of the river in order to direct the water around these communities which saves lives during monsoon season. This helps the communities to prevent flooding and it occurs only under extreme occasions.

The communities located close to the river tend to flood each year. Years ago, this was never a problem since less water came into the communities. Suddenly, the water in the river started to rise and more floods occurred. This was a surprise for the communities who did not understand the natural explanation of climate change. As a result, the locals living close to the river tend to listen and trust the SMS warnings due to previous terrifying experiences with flood. However, for the people living further away from the river, which have not experienced the extreme capacity of flood before, have recently been affected. In the flood last year, these communities did not believe in the system and did not take the EWS warnings seriously. Therefore, these communities were heavily affected, and locals lost many of their valuables.

Floods bring enormous amounts of sand which negatively impacts the soil, making it less fertile and affects the quality of the crops. Sand ruins the crops and makes farming more difficult. The locals explain that they have considered alternative vegetables and fruits to grow as the amount of water makes it difficult to grow what they traditionally have. In this case, the farmers in one community have made a competition where they try to come up with new ideas on what to grow. The one who can find a vegetable or fruit that can grow in a muddy and sandy lands wins. This shows innovation and the ability to adapt to hardships.

Our findings presented that the communities with assistance from NRCS has spent money to grow bamboos to redirect the water away from the road leading to the community. Once the water entered the community they moved east to find a safer place to live. Flood occurred also at this place, and the locals moved even farther eastward. Again, flood affected this area and they decided to return west. This has made the locals confused and disproved their traditional methods and forced them to trust the EWS. Environmental change has had a huge effect in these communities which creates fear, especially when flood tends to expand each year. One local explains how the environment has changed:

> *"I was really scared of the flood this time. Before this I don't remember being this scared because flood never really entered the village before. I have seen the shifts in the river though. During last 25 years the river has changed the direction in which it flows. […] There was a jungle in this area. There was landslide from the hills, which shifted the river towards the forest and the forest was swept away by the flood. Due to the fear of the river the government was forced to build an emergency dam here. Then again, the river was flowing in its inherent state."* (Informant 2 from the third community, 05.03.2018)

Infrastructure is affecting the locals' perception on EWS because this damages their escape route. The roads, bridges and buildings are annually destroyed by flood and the discussion of reconstruction emerge each year. The damage to bridges causes significant issues as it is difficult to bring supplies and food in and out of the community. Additionally, this interferes with the evacuation route as mentioned. One community pointed out that there is only one road leading to this community, which makes them highly dependent on this one road. The lack of alternative roads was a concern that emerged in all communities.

One community conveyed that the roads are insufficient for evacuation as they do not have any well-planned alternative routes. Their evacuation safe house is only a temple which is not sufficient for longer stays. The community is lacking an appropriate and sufficient place to stay when flood occurs. In another community, their evacuation route includes a bridge which is annually destroyed by the flood. NRCS helped building a solid bridge of concrete since the old one was built with bamboo. The bridge was made with a solid construction so that it would not get destroyed annually. In last year's flood, even the bridge of concrete was washed away. This illustrates that the communities are in desperate need of proper infrastructure.

People in the communities are anxious that the roads are not good enough for providing a safe evacuation. This affects the locals' perception on how to act when they receive the SMS warning because they do not trust the evacuation route. If the roads were adequately built, people would have confidence in the roads, in addition to feeling safe when flood occurs. The perception of EWS will be improved when there are no uncertainty and people feel secure. In the first community, one person acknowledged the infrastructure to be the biggest challenge of EWS:

"Well the biggest challenge is road. In any place around the world, to connect with other communities a road is required. The road is very important, and we are also working on the road. We just made a road from labor funds. We made it once, it got destroyed. We have requested them to build it again so that it is easier for people to run during flood because it would be more difficult if there were water all over." (Informant 3 from the first community, 04.03.2018)

4.2.4   Political Factors

Cooperation is involved in the complete cycle of EWS. Our findings are related to the direct involvement with locals. This collaboration was mainly described as the communication between CDMC and LDMC together with CDMC and DEOC. Additionally, the locals and CDMC are supported by NRCS and other NGOs for training and guidance, which was evaluated with regard to importance for the locals. The locals often presented the relation to NRCS as crucial for the EWS success. It was informed that NRCS involvement had moved locals from not knowing anything to competency about how to store, save their belongings and themselves.

Since the project of NRCS has ended, the locals are now considered to be independent where they have the ability to continue this by themselves, along with the participation of LDMC and DEOC. Considering that the authorities of LDMC and DEOC are locals from the Jhapa area, the locals are positive to this relationship. The relationship is already established and must be maintained to ensure cooperation. It was observed that some communities are more independent than others which made them more prepared to continue their work with EWS. These variations can influence the communities need of close support from authorities and therefore some communities demand the project of EWS to continue.

The factor of cooperation in the communities have developed differently which also impacts their sense of completion and self-sufficiency. This affects the locals' perception of EWS to vary between the different villages. The common element is the necessity to support the communities by authorities until they gain confidence in their own abilities. NRCS highlighted that as long as the communities are supported and funded, in addition to be given EWS warnings when there is danger, they will do fine. However, as the project ends, the locals have doubts about to what level local authorities will participate and one informant presented their uncertainty. Microphones are presented as mics by the informant:'

"There was a program for CDMC and LDMC. There was a question raised, which CDMC will not forget because it works during crisis and we are the community people. CDMC will do search and rescue and their other tasks. From LDMC resources like life jackets, mics, tubes and hand mics are given but get damaged. So, the question is whether LDMC will reimburse again? CDMC will stay because even though the project is over, we are not, but what from the side of LDMC? […] We were given ropes and sandals too. So, LDMC should fulfill our needs." (Informant 3 from the first community, 04.03.2018)

Governmental Assistance is tightly related to the factor above. However, this factor is identified to involve resources given by the Government. A few concerns were raised, especially to funding and infrastructure. The local communities themselves do not have resources and are saving all they can to survive each monsoon season. Therefore, funding is crucial for the communities to build and rebuild the community to survive and be able to evacuate from flood. So far, the focus of the Government has been to conduct response instead of risk preparedness which affects the locals' ability to perform preparations before flood.

During the interviews the issue of the lost hydrology station was an important subject. The loss of this station raised high concern with both local authorities and local communities. Without the station, the locals knew that they will not receive the usual SMS about warning and danger level and it made them unsure about what to do. Since the communities are trained in receiving warnings through these SMS's, the loss of the station generated concerns as to how this would affect the EWS warnings. They are aware that they will still receive a warning message, but without any information about the water level. Therefore, they expressed that it does not help them, and they demand that the hydrology station to be rebuilt.

This inconvenience interferes with the locals' perception as they do not know when or where the flood will come and are therefore unsure if they are able to act accordingly. NRCS acknowledged that without the station the locals would not know what to do and presented his concerns:

> *"If the hydrology station is not built within the next two-three years the early warning system will collapse [...] The attitude of the DHM staff is; "Let them die.". The Government does not even provide incentives. Even small things like a raincoat and boots was provided by us." (Informant from NRCS, 05.03.2018)*

During the interviews with locals, a high level of **trust** in the EWS was identified. Our informants showed high confidence in the system and trusted what NRCS had taught them through training. Also, no locals had experienced any incidence of not being reach by EWS warnings. The issue of trust lies at the national Government and their support. It is reviewed as the higher up it goes the less confident the locals are. The local communities collaborate with and trust local authorities rather than at the governmental level. The distance to the Government reinforces the lack of trust between local and governmental authorities.

There was a process of gaining confidence in the EWS. In the initial stage, the informants explained some locals as naysayers. A naysayer is a person with negative attitude which means that person was resistant to the system and its ability to support them. Then as the SMS arrived and the flood approached they changed and grew positive to the EWS. Through the project, which has lasted for four years, the local communities have integrated the EWS into their lives and routines. This factor therefore interferes with the locals' perception of EWS positively as the locals have high confidence in the EWS. EWS has helped the locals to understand and prepare for flood and one informant presented this in relation to trust:

"Before I did not have full trust. I did not know what training was or what they would tell. Now, these things were learned in practice. Therefore, when Ncell sends the message we know flood is coming." (Informant 2 form the first community, 04.03.2018)

4.2.5   Social Factors

When it comes to the social factors, **attitude** was identified to influence the locals' perception. In general, the communities were observed to have a very positive attitude towards the EWS. The locals were also positive to the engagement of NGOs for support and supervision and thankful for the help and support. Additionally, the locals seemed aware and knowledgeable about the EWS and its purpose. This change in attitude was described to be caused by the training the locals received through NRCS. The locals clarified that they are now prepared and ready to go if the SMS comes, they are not scared anymore and are confident in their responsibilities.

NRCS acknowledged that there are differences between the communities who had undergone training or not. Therefore, it is difficult to be sure if the training given by NRCS has increased awareness and affected their attitude positively. The attitude factor has a negative and positive influence on the locals' perception of EWS. Our analysis shows that the attitude towards EWS are determined by training and knowledge about the system.

In conclusion, in the communities given training, the attitude influences their perception of EWS positively. For the communities without training, there is a negative attitude due to their lack of understanding. Since last year's flood was more extreme than previous years, the flood affected broader areas and thereby communities without training were also touched. NRCS elaborated the variations:

> *"During this year's monsoon, what happened was, everyone from the community where the project was had awareness. They were safe, but the water level was so high that it flooded a different village. This caused death in the other village because people there were not prepared for the flood because the project was not in that village." (Informant from NRCS, 03.03.2018)*

In the initial interviews with national authorities, **experience** was indicated to influence the locals' perception. DHM presented that communities with experience acts accordingly, while others might not believe the Government's method to be the best. The communities which were visited during our fieldtrip have experienced flood several times before. However, the locals explained that prior to EWS and training they were terrified of flood. They described threatening floods that took everything away from them. Many stories about flood were presented, and they expressed the increase of flood to be frightening and stressful.

Since EWS was implemented, the locals expressed gratitude for the training, their experience with EWS is positive and it calms them knowing they will receive warnings. Their experience affects their perception of EWS as they see the improvement with the EWS warnings. The EWS warnings has given them the ability to prepare and evacuate before the flood approaches, and it makes the locals confident. One informant explained this difference:

> *"Yes, we are ready. We will be ready and when the flood comes we would know beforehand […] Before there used to be human casualties because there used to be no warning. The flood used to come, people would be walking on the way and then it would take away people. The context was much different then and now." (Informant 3 form the first community, 04.03.2018)*

Lifestyle is identified to include farming, preparation of flood and storing of their values. Our informants within the communities explained that before the floods used to destroy their land and cattle. Goats, ducks, hens, buffaloes and calves drowned. Most of the communities along the Kankai River are farming communities and use the land to produce foods for their families and sale. The locals express the EWS to have become a part of their lifestyle and gives them the ability to save their livelihood before flood. Since the locals are warned ahead, they have the time to save what are the most important. Thereby, they can bring their animals to high ground and take care of their fields before the flood approaches.

This factor improves the locals' perception of EWS warnings since they appreciate the time they have before the flood reaches their community. One informant acknowledges the advantages of EWS warning:

> *"We cannot leave this place just like that because we have farms and crops here. It will depend on the message entirely and how much water which will come. Flood does not happen every monsoon. The water level depends every season." (Informant 3 from the first community, 04.03.2018)*

Personality is a highly individual and is important to consider within EWS. Many personalities combined requires consideration since each person is different. Even though the locals' personalities are difficult to examine, an evaluation of today's situation will benefit the EWS. Through our observations the communities appeared independent and curious. The locals were engaged in the EWS and their responsibilities and eager to answer our questions. Their perception of the EWS warning is determined to be positively affected with the locals' response as open and forward. The reason for this positivity was explained to root in their increased confident through the project of implementing EWS in Kankai River. Some locals expressed the EWS training to be the reason for their evolvement and one local stated:

> *"Before, we were not able to talk in front of people and did not dare to go and speak to authorities." (Informant 3 from the first community, 04.03.2018)*

4.2.6 Technical Factors

Automatic Warnings are distributed from the EWS itself. Automatic warnings concern the interaction of mobile phones, radio and TV in reaching the locals for disseminating information about flood. In this factor the automatic warnings are therefore viewed as the warnings reaching the locals without their effort. When discussing these elements with the locals there were some variations in what medium they preferred.

Our analysis quickly addressed that even though there might be a few people without a mobile phone, the majority had one. In fact, most Nepalese own two mobile phones. Therefore, the SMS was reviewed as an effective way to distribute EWS warnings. In addition, radio and TV are used for information dissemination. These medias are used to assure information to reach everyone in danger and to inform the rest of the district.

How these factors influence the locals' perception is related to their understanding of these warnings and the locals' abilities to act accordingly. It was disclosed that the locals highly trust the EWS warning presented through the mobile phones. Even older people who cannot read preferred this method as they saw its efficiency and were instead warned by their friends and family. Variations of the following statement were frequently repeated through the interviews:

> *"I trust mobile. Mobile is easier because you will need to turn on the radio. But, mobile is with you all the time and you will get the notification, so it is the most helpful medium."*
> *(Informant 2 from the second community, 05.03.2018)*

Equipment focuses on the materiel necessary to conduct proper EWS at the community level. The communities in our research explained the necessary material to include tubes, lifejackets and solar panels. Due to poor infrastructure, the communities are in need of these supplies to be able to reach the safe place securely.

Additionally, none of the communities had electricity installed and therefore depended on solar panels as the source of power. In our observations, it was described that the communities have tiny solar panels and often only one or two, which is their only source to charge their mobile phones. Our informants expressed fear if the solar panel were to be broken. Two out of three communities had only one solar panel. This is frightening since the EWS warnings completely relies on their mobile phones which require charging.

The communities are warned of flood through SMS and phone calls, and without mobile phones the information is not likely to reach the community in time. This factor therefore influences the locals' perception of EWS warnings extremely. Without the necessary equipment the locals will not receive the EWS warning. Locals supported the following statement which underpins the lack of proper power sources:

"We prefer mobile devices as every household has a mobile device whereas there are very few televisions in the village and also there is a problem of power cuts which makes the dissemination of information through television ineffective." (Informant 1 from the first community, 04.03.2018)

Lead time consists of the period from when the communities receive the danger warning until the flood reaches the community. The locals are trained to know the time lap for their community as the period varies depending on the location of each community. Communities high up in the Jhapa district, close to the Ilam district border, has a short lead time usually only minutes. On the other hand, communities far down the river, closer to the Indian border in the south have longer lead time of up to four and a half hours.

Naturally, this variation in time affects the locals' perception of EWS warnings, where some wish more time while other have more than enough. For the communities with limited lead time correct perception is crucial. If these communities do not act on the warning as it is received, the flood will enter their village without any other warning.

Regardless, the locals highly appreciated the EWS warning for giving them time to evacuate safely and save their most valued belongings. They were grateful for the training teaching them how to act and to use the time prior to flood wisely. One local informant expressed how useful the lead time within the EWS warnings are:

"We get informed from SMS messages, and after getting trained we are informed about how to act. We know where to go if the flood comes, where the safe place is and how to take care of personal possessions […] When we see the message we know the level of water and the time it takes for it to reach the village." (Informant 3 from the first community, 04.03.2018)

The **manual warnings** are the EWS warnings distributed within the community by the locals. These warning routines are provoked when DEOC calls the CDMC to distribute the message of an approaching flood. At the warning level, CDMC gather to assign responsibilities for the evacuation and then warns the community through sirens, megaphones and flags. There are two different routines, one at warning level and one at danger level. These routines have different intensities and sounds for the siren and various colors of the flags.

When everyone within the community are warned, the CDMC are responsible for ensuring that everyone reaches the safe place. The routine of distributing these warnings are of concern in the factor of manual warnings. The locals' perception of these warnings concerns the few not receiving the SMS or anyone in doubt of the SMS. There were presented multiple reasons for this, such as some might not own a phone, others forget to check it, or it might be drained. Therefore, manual warnings influence the locals' perception as it assists the locals to act accordingly and assures everyone in the community perceives the warning and danger levels.

Additionally, it was addressed that locals do not completely trust the manual warnings due to previous events. It has happened that the siren has been played without any actual danger and locals therefore confirm the situation with the SMS before acting accordingly. One informant explained the details of conducting manual warnings. Microphones are presented as mics by the informant:

> *"There are two ways to play the siren. When the siren is played they take the hand mics and go to different villages informing people about the water rising and dangers of flood during warning level. After doing that, there is a phone call from the DEOC office, informing if the water level has risen or stopped. If danger level has come, the people take the red flag and play the siren of danger." (Informant 3 from the first community, 04.03.2018)*

4.2.7 Contextual Factors Influence on the Locals Perception of EWS Warnings

The overall contextual factors are illustrated through the Ishikawa diagram. Figure 4.9 presents the findings of contextual factors through the data collection and analysis. The Ishikawa diagram highlights the factors that influence the locals' perception of Flood EWS. The six factors are influential causes for how locals perceive EWS information and warnings. Further, the reason for highlighted factors is explained.
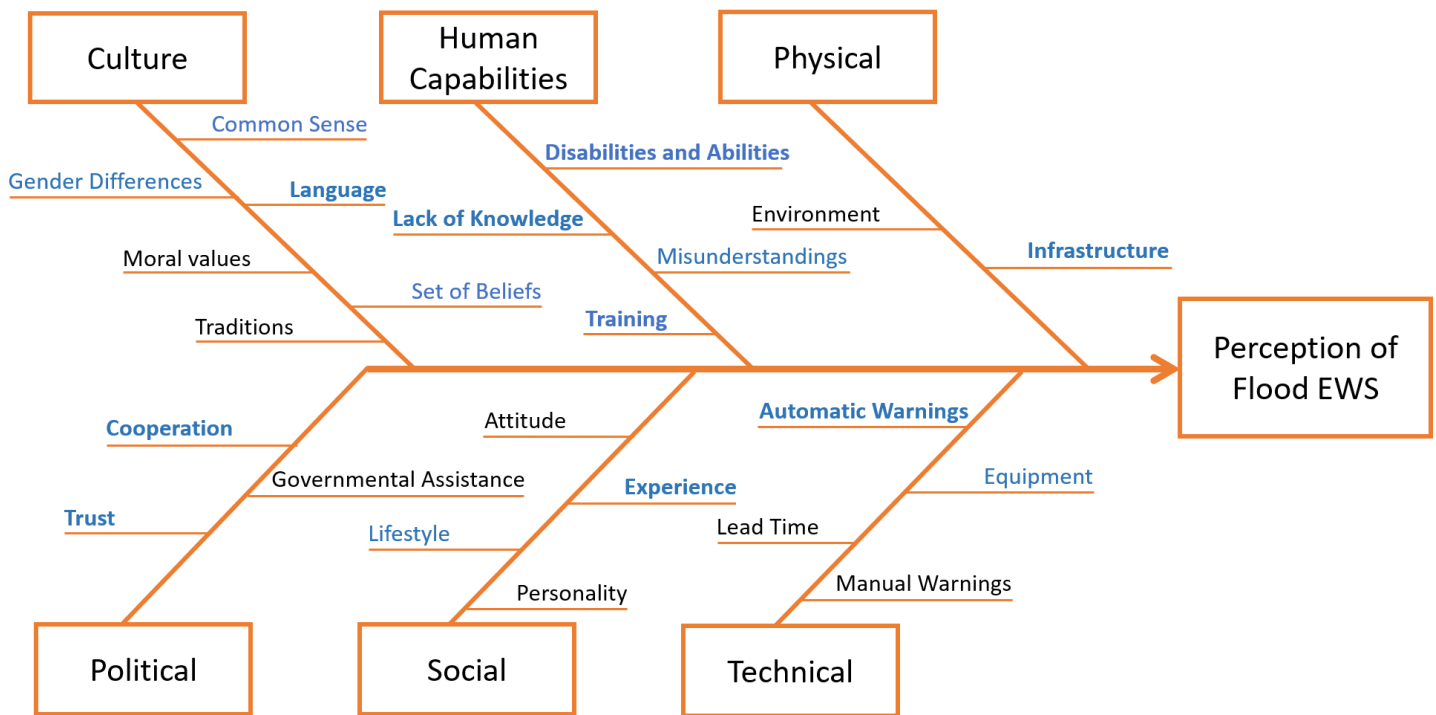

Figure 4.9: Contextual Factors Influence on EWS Perception

Through our results, we identified that some of the factors are more important than others when implementing EWS. These are key factors for the disaster management to be able to function the EWS properly. By defining these prior to implementation of EWS the disaster management can ensure a less complicated transition for the locals. Additionally, some factors are considered interesting as they appeared unexpectedly. These factors add new perspective and can ease the change for the locals when implementing Flood EWS. For this reason, the factors presented in blue are found interesting to discuss further in this chapter. For the factors in bold blue, these are proposed crucial for the locals' to be able to perceive the EWS warnings.

Common sense is an interesting aspect which is influenced by traditional knowledge of how to predict flood. This factor considers how older methods have been used to predict flood, which challenges the implementation of EWS. However, the methods were assessed unreliable and as the EWS occurred accurate the locals quickly began to trust the system.

Gender differences are interesting as the traditional mindset is still evident in the older generation. This makes it difficult for women to participate in the EWS, at least in its initial stage. It was discovered that the EWS as it is slowly integrated in the communities, the locals' open up in line with their understanding of potential advantages.

The factor **set of beliefs** is interesting due to one of the three communities conversion to Christianity. Our research discovered the locals within this community to be more open and curious for outside information and has made the integration of EWS simpler. The other two communities had followed their ancestors' paths, which made them more resistant to changes. As observed, in general more and more Nepalese convert to Christianity which is a positive development regarding innovations such as EWS.

Misunderstandings are determined interesting as confusion is still affecting the locals' perception of EWS. The influence of this factor can be reduced by adequate training, however, as the locals attained increased understanding of the meaning of training. This indicated an even lower level of local knowledge than the authorities estimated in the implementation of EWS. Correct estimation of the communities' knowledge is therefore crucial in the initial stage.

The factor of **lifestyle** is different as this is caused by the influence of the locals' everyday living. This increases the locals' perception since they are now able to save their animals and crops before flood occurs. This gives the locals a feeling of safety and gives them some sort of control as they know when the flood will approach. **Equipment** is an interesting factor as the locals completely rely on SMS warning while they have insufficient power sources to charge their mobile phones.

The key factors presented in figure 4.9 is essential for appropriate perception of EWS warnings. **Language** has this level of importance due to language variations across Nepal. During our fieldtrip, one of the communities did not have Nepali as their mother tongue, which was interesting as the villages was nearby one another. This highlights the importance of clear and simple language in the EWS warnings for the locals to be able to perceive the warning correctly.

During evacuation the factor of **Disabilities and Abilities** is crucial. The diversities within the community is important to consider when planning routes for evacuation and disabled people are easily forgotten in this process. Since most communities are located off-road it is challenging to make plans that accommodate and safeguard the disabled. On the other hand, it was reassuring to discover that this was a natural priority for the community in the process of implementing the EWS.

Even though **Lack of Knowledge** is an obvious factor of influence, it is necessary to acknowledge its importance. Our findings recognized that there was a great deal of fear in relation to the word flood prior to EWS. Many challenges regarding the initial stage of EWS were presented, as many are caused by lack of knowledge. One example is that people still believe floods can be stopped. It is essential to consider the level of knowledge prior to EWS implementation, to be able to communicate properly with the locals and for the locals to understand from the beginning.

The factor of **training** is equally important as the locals needs to be prepared for flood. It was also evaluated that it is necessary for the locals to understand the complete EWS cycle and how to carry out their responsibilities. Our research addressed the challenges detected through the initial stage of EWS that were caused by the locals' lack of motivation. Furthermore, this was influenced by the locals' uncertainty of what EWS was. To improve this negative influence proper training is required.

Infrastructure is a factor closely related to disabilities and abilities. Both are concerned with roads and bridges to withstand the evacuation of people and supplies. The lack of proper infrastructure was mentioned multiple times and the locals demand more support to build secure evacuation routes. Without the security of proper infrastructure, the evacuation is unsecure, and many people will be at risk.

To have a functional EWS, the factor of **cooperation** is essential. The locals are dependent on the support from authorities and NGOs to understand and operate their part of the EWS. During EWS warnings, it was discovered that this collaboration is a necessity to deliver the EWS warnings. Therefore, to ensure successful EWS cooperation must be in place.

The factor of **trust** is required to have a functional EWS. Without confidence in the EWS, the locals' will not focus on the EWS warnings and thereby be at risk. It was presented that the locals have high trust in the EWS and automated warnings due to its accuracy. Additionally, since local authorities are directly involved with the communities the locals explained that they trust their words. It was also revealed that the locals did not trust national authorities to the same extent because of the distance between local and national authorities.

Experience is self-explained as locals with experience sees the EWS as a solution to their problem of insufficient warning for flood. On the other hand, for communities without prior experience of flood, the increased frequency has taken them by surprise. Therefore, it was observed that for locals annually affected the integration of EWS was accepted quicker.

The last crucial factor of EWS is **automatic warnings.** This factor concerns the media used to distribute EWS warnings and is mainly performed through SMS. It was a surprising discovery that the SMS warnings was blindly trusted and that everyone owns a mobile phone. At the basis of this level of dependency, locals stated that they trusted the SMS more than the manual warnings.

The contextual factors have also been evaluated to understand how they influence the four stages of the EWS cycle. Figure 4.10 displays this influence of connection between the contextual factors and the EWS cycle to illustrate the importance of contextual factors in organizing EWS. Further, the factors are described in relation to where it is involved within the EWS cycle.

Political: Cooperation

Culture:
  Common Sense
  Gender Differences
  Moral Values
  Set of Beliefs

Social:
  Attitude
  Personality

Human Capabilities:
  Lack of Knowledge
  Misunderstanding
  Training

Risk Knowledge

Monitoring & Warning Service

Physical:
Environment

Key Elements of EWS

Response Capacity

Information Dissemination

Culture:
  Traditions

Political:
  Governmental Assistance

Human Capabilities:
  Disabilities and Abilities

Social:
  Lifestyle

Culture:
  Language

Physical:
  Infrastructure

Political:
  Trust

Social:
  Experience

Technical:
  Automatic Warnings
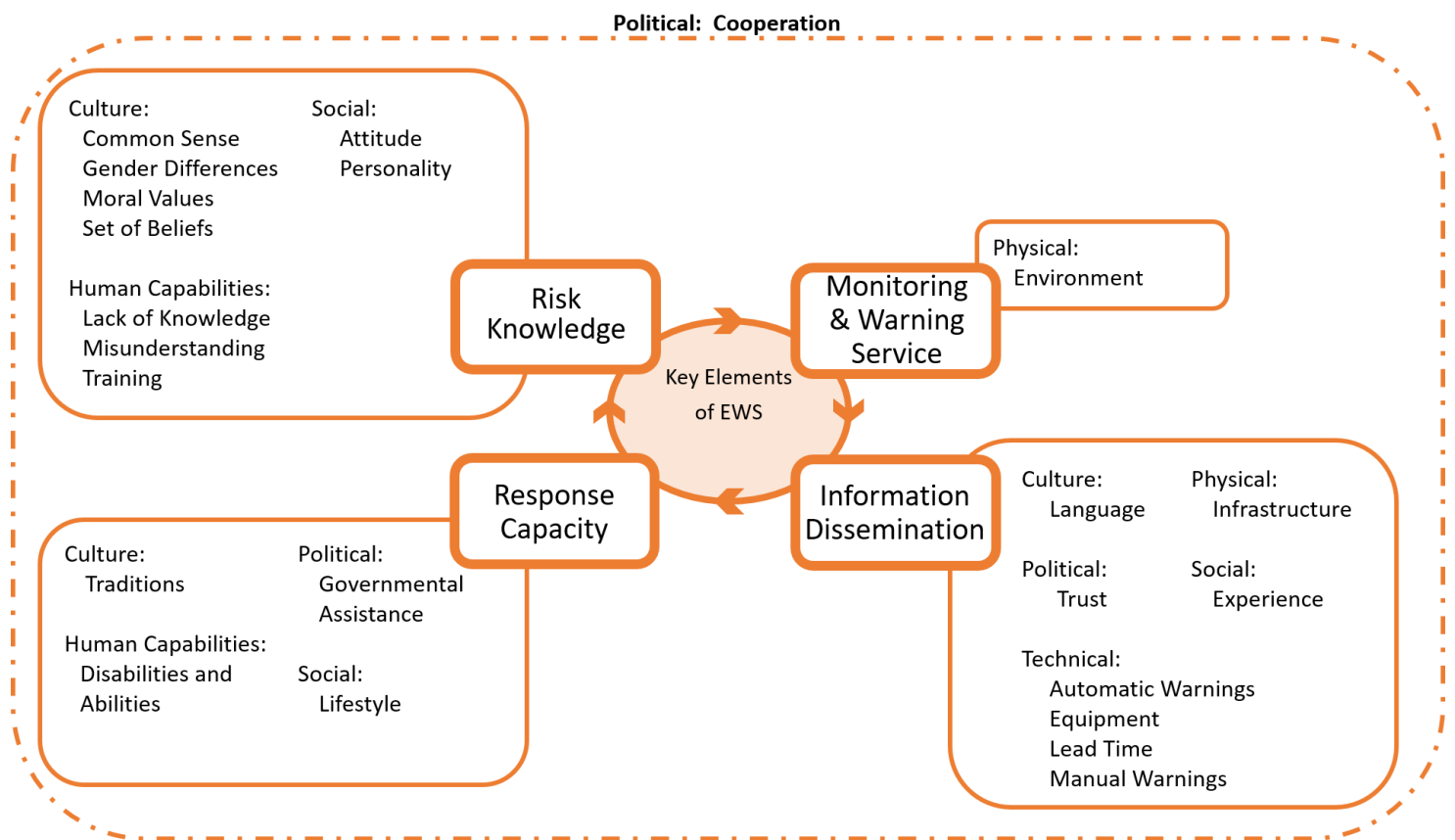 Equipment
  Lead Time
  Manual Warnings

Figure 4.10: Contextual Factors with the EWS Cycle

The political factor cooperation is influencing the complete cycle of EWS as illustrated in figure 4.10. The factor is continuous through all stages with the intention to ensure a successful EWS. Cooperation is a crucial factor since the whole EWS would fall apart if absent and issues arises.

Within Risk Knowledge, most of the contextual factors concerns the locals' capabilities. These factors are related to culture, society and human capabilities and are discovered to influence the locals' knowledge. For the second stage of the EWS cycle, Monitoring and Warning Service, only one contextual factor is determined. The reason for this is related to our direct focus on the locals and their perception of EWS. Since the locals are rarely involved in this step of the process, only one factor is found.

In the third step of EWS, Information Dissemination, the factors are closely related to the distribution process of EWS warnings. This step is influenced by most of the contextual factors identified: culture, political, technical, physical and social factors. The variation of factors interfering in this stage indicates that the distribution process demands a broad view of the population at danger. For the last stage, Response Capacity, a variation of factors identified is either affected directly during response or in the aftershock of a flood. This step also requires support for the communities to recover from the flood damages. The experiences related to these factors will influence, positively or negatively, the locals' further ability to perceive EWS warnings.

5. Discussion

In this thesis, we have conducted a case study in Nepal. The implementation of Flood EWS project in Kankai River is completed and is further expected to continue without involvement by NRCS. The EWS needs to be carefully implemented to benefit the vulnerable communities. Due to wide variations in the context of the areas where EWS is implemented, it is essential that the disaster management acknowledges these variations to achieve a successful implementation.

This study has been conducted to explore how EWS is adapted to Kankai River and to identify the influential factors affecting the locals' perception of EWS warning messages. The first part of our study had the focus of understanding the use of EWS, how authorities and NGOs are involved and how the system is implemented to the community level. In the second part, locals were interviewed to gain their perspective towards EWS and observe their abilities to perceive EWS warnings. This was further analyzed to identify contextual factors influencing the locals' perception of EWS warnings.

Our findings identified how the EWS cycle is organized in the context of Kankai River. We identified the stakeholders involved, and what is included in the four stages of EWS. The EWS cycle were acknowledged to be directly adapted to the research area through the requirement of integrating all four stages from national authorities. During the initial stage of EWS in Kankai River, NGOs have participated in adjusting the EWS to the communities affected. Due to lack of related research it was necessary for us to understand these aspects of EWS to better comprehend the communities and understand the context of this area.

Six contextual factors influencing the local perception of EWS warnings were identified. These six factors are categorized to present sub-factors affecting the locals' perception. Through our data analysis, these were established and reasoned to understand their connection within the EWS cycle. The data was further analyzed to involve a total of 23 sub-factors which describe the differences revealed within each category and to label specific concerns that needs careful consideration.

Through this research, the major focus has been to explore contextual factors which affects locals' perception towards EWS warnings. These factors are explored as to their affect by cultural, human capabilities, physical, political, social and technical elements. In our result, the most interesting and the key factors were elaborated to highlight the factors that need careful consideration through the implementation of EWS. The key factors are previously acknowledged through related research while the interesting factors contributes with new factors or aspects to consider in the adaption and use of EWS. Thereby, these factors and their influence intend to justify and explain our second research question relates to the locals' perception of EWS warnings. The contextual factors are identified to detect all variables influencing the locals' perception of these warnings. From labeling all influences, it creates the possibility of determining and controlling the locals' ability to perceive EWS warnings correctly.

5.1 Contribution to Research

The complete EWS cycle has been presented through our findings to represent how it is used in Kankai River Basin. All four stages were identified to be present and well-integrated in the communities of our study. The local communities are discovered to be involved in the stages of Risk Knowledge, Information Dissemination and Response Capacity since their participation is required. The stage for Monitoring and Warning Service is conducted by DHM and part-time employees because of the inherent demand of specific training (Smith et al., 2017). For the EWS cycle to properly function and be successful, cooperation was considered to be essential through all four stages. Since the locals are not directly involved in the second stage of EWS, their awareness and collaboration to and from this stage is necessary for the EWS to be successful.

Mercy Corps and Practical Action have developed a handbook for establishing community based EWS in Nepal. The book combines experiences from different communities to establish a guide for implementing Flood EWS. This implementation focuses on all four stages of EWS to ensure collaboration throughout the complete process of EWS (Mercy Corps & Practical Action, 2010). Since this book does not include experiences from Kankai River our mission was to determine if the arrangements of EWS were reflected here as well. As presented through our results, the complete cycle was recognized to be present in Kankai River Basin. This ensures importance of the handbook, while our research supports their effort to establish the use of the EWS cycle across Nepal.

Additionally, a study in the Western part of Nepal emphasizes this conclusion by presenting the complete EWS cycle to be existing there as well. Like our study, this research assesses how the EWS cycle is organized in its part of Nepal, in this case the Karnali River Basin. Further, this study discusses successes and limitations of EWS which our study elaborates. These successes and limitations focuses on technical impacts to improve the EWS warnings through advanced forecasts. These forecasts seek to increase lead time for the community to be prepared for flood (Smith et al., 2017). In our study, this focus is broader as our aim is to see how EWS impacts the locals. On the other hand, our research discovered a variety of other influential factors in addition to the significance of lead time. Therefore, our study supports lead time, along with revealing a wider range of factors necessary to consider in the implementation of EWS and to ensure local perception.

While understanding the use of the EWS cycle in Kankai River, the involvement of different actors within the cycle was resolved. This was performed to identify which organizations are involved and how they assist in the EWS. Prior literature states the importance of collaboration within EWS, however there is no specification about how they are organized (Gautam & Phaiju, 2013). The responsibilities of the actors involved are initiated, still related literature lacks to present their association (Mercy Corps & Practical Action, 2010). Our contribution seeks to fill in this gap by introducing a chart, introduced in figure 4.6, to present how the actors are involved in the Flood EWS in Kankai River Basin.

Further, the existing literature describing the cycle of EWS explains the four stages without considering contextual factors of influence. A few labels factors of importance, however, the locals' ability to perceive EWS warnings is not discussed (Mercy Corps & Practical Action, 2010; Shrestha et al., 2014; Smith et al., 2017). Our findings of contextual factors are further assessed to either support existing literature, contradict prior literature or add to what is already noticed before.

5.1.1   Supported Contextual Factors

Out of the factors determined as important or interesting, eight of these are completely, or to some extent, supported by prior literature. In the initial stage of EWS, the factor of **common sense** is interesting and involves the use of traditional methods to predict flood. This use of traditional methods is supported through prior literature without being specifically described, traditional methods are presented to be more trusted then EWS warnings (Fakhruddin et al., 2015). Our research discovered this factor's influence in increasing the locals' experiences that the EWS warnings were more accurate than their own methods.

When it comes to the consideration of **disabilities and abilities**, prior literature underpins this critical assessment. It is described that all disabilities within the community must be evaluated and cared for (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). Through our own deliberation, it was reflected that this factor was carefully considered in the integration of EWS. Additionally, the communities presented that they are required to update their information annually. This information registers how many women are pregnant, and how many children and elderly live in community. However, this procedure can easily be omitted and overlooked, and its importance is therefore highlighted.

The factor **lack of knowledge** is supported by prior literature as crucial for success. From presenting the demand of stopping flood with the use of dams, to not knowing what causes flood, shows the lack of knowledge to be evident (Billa et al., 2004). This is declared to be a major constraint regarding Flood EWS due to traditional knowledge and lack of education (Mercy Corps & Practical Action, 2010). This was also reflected in our findings where the locals initiated their lack of knowledge with unawareness in the initial stage of EWS.

The importance of the factor **cooperation** is supported by prior literature mentioning the need of community-based EWS and outlining the importance of collaboration. In other parts of Nepal, they have discovered the necessity of NGOs involvement within EWS (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). In our results, it was discovered that the locals highly appreciated the support from NGOs, especially NRCS. It was explained that their help had opened their views which has increased their ability to perceive the EWS warnings accordingly. This is further supported with the demand to build relationships and create engagement prior to disaster (Zurich, 2015). Through our research, this was disclosed through the locals' appreciation of the collaboration with local NGOs and authorities as it has made them aware.

The factor of **Lifestyle** is considered interesting as it influences their everyday lives. Related literature indicates that the EWS gives the locals ability to save their livelihoods prior to flood (Fakhruddin et al., 2015; Mercy Corps & Practical Action, 2010). Our study has reflected that the locals highly appreciates the opportunity of saving their livelihood. It was presented that before EWS cows, ducks, hens and buffaloes drowned, today they have time to save their animals from flood. Being prepared makes them able to protect their farms and possessions and to further save themselves from flood.

The locals **experience** is assessed a key factor because it influences their motivation towards EWS. Flood experience versus none has high impact on locals perception of EWS warnings (Mercy Corps & Practical Action, 2010). It is described that flood experience increases locals' perception of EWS warnings (Jaiswal & van Westen, 2013). The factor is important as it determines their ability to perceive EWS warnings and was additionally realized in our findings.

Equipment is introduced as a factor due to the interesting finding of absent power supplies. This caught our interest since they rely on mobile phones to receive EWS warnings and thereby are extremely dependent on electricity. The lack of power supplies are not a new problem and are acknowledged by related research (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). However, the locals' dependency of electricity is interesting as they lack proper power supplies within the communities.

The importance of **language** regards EWS warnings. EWS warning must be carefully and simply written for everyone to understand (Jaiswal & van Westen, 2013). When designing the setup of the warning message the language needs to be understandable for all variations of the national language. In our research, it was discovered that the local preferred the message in the national language and not in their local language. This finding contradicts with literature presenting the local language to be an advantage for easier perception by the locals (Gautam & Phaiju, 2013).

5.1.2   Contradicting Contextual Factors

When considering our findings in relation to prior literature, three of our factors contradict with other studies and underscore therefore that our findings are meaningful. First, **set of beliefs** is interesting as it is maintained to be caused by faith in prior research (Bista, 2008; Jaiswal & van Westen, 2013). In contradiction, our findings diminish the support of faith as means to influence the locals' perception. Instead, religion was determined to affect their perception in terms of openness as one of the communities had converted to Christianity. They were open to new views and changes such as IT, which made the implementation of EWS less complicated.

The importance of proper **infrastructure** is determined crucial to provide safe escape routes and houses. Prior literature states this issue to be improved after implementation of EWS (Gautam & Phaiju, 2013). However, our fieldtrip discovered few signs of development or improvements regarding infrastructure. A few attempts of improving the infrastructure were

recognized to be insufficient and washed away with the extreme capacities of the floods. At the same time, the importance of infrastructure is equal between our findings and prior literature (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010).

The issue of **trust**, presented to be large through prior literature, does not uphold through our findings. It is explained that locals lack trust in relation to flood warnings disseminated through the EWS (Mercy Corps & Practical Action, 2010). Through our research, locals explained high confidence in the EWS warnings they receive directly from the EWS. When it comes to trust between NGOs and the local communities, it is described that prior experiences ruins this collaboration (Zurich, 2015). This was neither reflected in our findings since the locals described a close relationship with NGOs, which had improved their perception of EWS warnings.

5.1.3   Contributing Contextual Factors

In reflection of our findings and existing literature, four of our factors contribute to the field of research within EWS in similar context. The interesting factor of **gender differences** provides a new perspective since prior literature only considers women weak in relation to EWS. The women are only mentioned if pregnant or with small children and are not needed to assist within EWS (Mercy Corps & Practical Action, 2010). In contradiction, our findings have discovered the participation of women to be necessary and was reflected to be equally important as the participation of men. Since women are at home it is easier for them to respond when the EWS warning is received. Other literature supports our findings through vaguely mentioning the advantage of women's involvement in EWS (Gautam & Phaiju, 2013; Shrestha et al., 2014).

The challenge of **misunderstandings** is discovered in our research to be an interesting factor, which requires attention to be avoided. Misunderstandings were described to be present and cause complications for the locals. It is therefore determined to be highly important for further implementations of Flood EWS. Since the implementation has a large impact, ensuring mutual understanding will ease the transition for the locals. In the literature available, the issue has not been considered, which is frightening as the consequences of misunderstandings can be catastrophic.

When it comes to the requirement of **training**, our findings agree with the literature with regard to its importance and need. It is necessary for the locals to be aware of the complete EWS cycle and to know their responsibilities within the EWS (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). Our research detected that the locals had trouble with their motivation in the initial stage of EWS. The problem was not related to laziness directly but is caused by unawareness and lack of knowledge. They described that they did not know what training was, what it meant or what it required of them. This represents a large challenge for the initial stage of EWS and requires consideration by NGOs to assist in engaging the locals for training.

Automatic warnings are recognized as a key factor within the EWS. The factor is barely discussed before and if so the necessity is only acknowledged, or the use of SMS is vaguely mentioned. Therefore, our contribution is to introduce the media used for information dissemination and to show the positive effect this factor has towards the local communities. Our findings within this factor determine the SMS to be highly trusted by the locals as they have found the message helpful and accurate which fulfill their needs for flood warnings.

5.2 Contribution to Practice

In our research, the focus of how EWS is implemented in Kankai River and which contextual factors that influence the perception of EWS warnings are our main contribution. Our fieldwork in Nepal contributes through giving new perspective, both from the locals and as outside researchers observing the situation. Due to a difference in culture and knowledge, our reflection of their circumstances adds value with evaluating their culture and interests objectively.

Since our perspective is not integrated to the Nepalese culture and their way of pursuing EWS, our findings have discovered how the EWS is received. Through addressing the involvement of different actors, prior literature was insufficient in describing the participation of governmental and non-governmental organizations (Shrestha et al., 2014). Therefore, our assessment of involvement is a useful contribution to the practice of implementing EWS in rural areas of Nepal. Our guidelines presented about considering the locals' opinions in implementing and functioning the EWS is valuable for practice.

Through our research, it was discovered that the complete cycle of EWS was adapted to Kankai River. The responsibilities of the EWS was determined to be organized through DHM, NEOC and DEOC in addition to be supported by NGOs. This adds to related literature with the contribution of addressing the governmental and non-governmental organizations actually involved in Kankai River. Prior literature presents the involvement of many governmental and non-governmental organizations which was not reflected to be present in the EWS integrated in Kankai River Basin (Shrestha et al., 2014). With developing this chart of involvement, figure 4.6, the locals and stakeholders are aware of who to contact in regard to this Flood EWS. This gives them the ability to acquire information through the responsible actor when necessary.

Our study discovered the responsibilities of the communities to be essential and necessary to function the complete cycle of EWS. Training the communities is important for the locals to be aware of the EWS, know their responsibilities in the event of flood and to assist each other during evacuation and recovery. This reflects the local disaster managements to be present within the communities through their responsibilities of preparedness, response and recovery (Mercy Corps & Practical Action, 2010). Beyond presenting the need of a local disaster management, prior literature does not address their responsibilities and actions further (Gautam & Phaiju, 2013). This was therefore explored through our research and identified

present with high engagement from the locals. In practice, our findings discovered motivation of the locals to be essential within the EWS and disaster management. By accomplishing this, a successful and beneficial integration is achieved in the local communities.

Another contribution to practice involves the contextual factors identified. So far, it has been addressed that there are challenges in relation to the locals' perception of EWS warnings, but these have mostly been labeled and not elaborated upon (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). The literature has so far avoided the focus on locals' perspective which is the focus of this study. Our purpose is to feature the locals' perspective within EWS by including their valuable opinions. Increased awareness about their point of view is believed to heighten the possibility of a successful EWS integration. The knowledge of the locals' opinions has identified the content of the challenges, improves motivation and cooperation within Flood EWS. For projects installing EWS, listening to the knowledge of locals will assist the process of installation and function as the locals are experts about their own community and needs. Implementing their views and limitations will improve the integration of EWS and polish the extreme change for the locals.

The Practitioner's Handbook, which is previously introduced, gives a guide of establishing a community-based EWS (Mercy Corps & Practical Action, 2010). The guide presents key factors to consider during EWS implementation, however, the locals perspective is limited. Our study has identified the locals' perspective of influential factors, which is a necessary improvement in establishing EWS. Some of the contextual factors discovered are listed in this book but needs further elaboration. Since our study explores the locals' perspective, this is considered a valuable perspective in guiding the implementation of Flood EWS. Through introducing the perspective of locals and their opinions, future installation of EWS can be eased and improved through a close collaboration between all actors involved.

Our study discovered nine crucial and six interesting contextual factors which affects the implementation and practice of EWS. The key factors contribute to practice by confirming the influence discussed in prior literature (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). These require awareness programs and training to be held by governmental or non-governmental organizations for the local communities throughout the implementation of Flood EWS. Additionally, it was discovered that cooperation and trust is required for a functional EWS. Our findings showed the local communities to be open for information and influences from the EWS. However, this is questioned in related literature which indicates a need to address this prior to implementing EWS for a clean integration. Our contribution to this perspective is therefore to consider the locals openness when presenting them with the integration of EWS.

The interesting factors identified through our findings contribute to practice with new perspectives. Even though some of the factors are previously labeled, our discovery elaborates from a different angle. Related literature explains these factors from a top-down perspective without knowledge from the locals (Gautam & Phaiju, 2013; Mercy Corps & Practical Action, 2010). Therefore, our insights from the locals' perspective gives these factors a bottom-up perspective and additional meaning. One study is conducted in a similar context and has

elaborated on the influence of the factor lifestyle. This view pertains to future development of EWS and not the current situation (Fakhruddin et al., 2015). Our contribution to practice presents influential factors interesting to consider in the implementation of EWS. Through evaluating the influence of these additional factors, the integration can ease the change for the locals. A focus of considering the local communities as a whole, gives the locals a sense of being included. This consideration will be valuable for communities unexperienced about flood or negative to change.

5.3 Future Research

Our study is an exploratory case study with limited prior literature to assist us. It was early determined to study how an information system affects a local population. The focus has therefore been to discover how EWS is used, who is involved within EWS and to understand the locals' perspectives towards EWS warnings. Due to constraints of limited literature and our interest to research the locals' perspective, our study was narrowed to concern how EWS is organized and how contextual factors influences the locals' perception of EWS warnings. The locals' opinions towards this subject, in addition to the lack of sufficient research, caught our interest and formed this study.

The reason for conducting an exploratory study is related to traveling to a foreign country for data collection and exploring the use of EWS. When exploring all presented concepts, the communities appreciated our interest in their perspective which led to people being welcoming and shared information freely. This gave us a lot of information and contributed to huge amount of data to analyze. As a result, 23 factors were identified which caused our time to be insufficient for considering our findings in relation to the theoretical perspective first proposed.

One of our suggestions for further research is to use the theory of affordance. To illuminate the phenomenon of interest in relation to the local perspective, the theory of affordance is appropriate. Originally, the theory of affordance was described as what the environment offers the animal, both good and evil (Gibson, 1986). Further, this theory has evolved and adjusted to be useful in multiple fields of research, including the field of *Information Systems* (IS). One way of applying the theory of affordance into our findings is through focusing on affordance as the relationship between people and technology, in its considered environment. There is also a consideration of perception and actualization in affordances which is described to be influenced by contextual factors (Thapa & Sein, 2017). Our findings can therefore reveal different affordances in the context presented through considering the contextual factors identified.

In IS, affordances is commonly used as a lens to discover the relationship between technology and users (Stendal, Thapa, & Lanamäki, 2016). The theory of affordance allows to determine peoples social and technical perspective in their use of technology (Fayard & Weeks, 2014). In future research, the theory of affordance can be used to reveal different affordances of EWS, and our contextual factors can be identified to determine the influence of affordances

actualization. Involving affordances to this study will give additional understanding about how the different factors influence the locals' perception of EWS. To completely understand this relationship and these influences applying the theoretical perspective of affordances is beneficial. Similar approaches have been used in the information technology for the context of developing countries, however affordances is not found to be widely used in the EWS context (Thapa & Sein, 2017). Our study indicated that locals are not fully aware of the affordances of technology, and how it can be actualized. Therefore, the affordances lens can discover interesting aspects and relations in the reported context, in addition to give further meaning and determine the influence of the contextual factors.

In general, there are several other approaches to evaluate the consequence of contextual factors. Further studies in this area can ensure and elaborate the importance of the contextual factors discovered. One approach is to apply other case studies to understand the impact of these factors to a wider extent. This can also unveil increase or decrease of importance or identify additional factors influencing the relationship between EWS warnings and the locals' perception. The use of theoretical perspectives can facilitate the understanding of our findings, for example through applying the theory of affordance as recommended. The use of a theoretical lenses is beneficial to explain the importance of the context in implementation of EWS in rural areas of Nepal.

5.4 Verifications and Limitations of our Research

The contextual factors discovered through our research are identified to improve the implementation of EWS and reduce the impact of change. Our data analysis has been conducted and assured importance through the use of two validation techniques. First, it was assured to use rich and thick descriptions. This was pursued with detailed transcripts of the interviews and observation notes from several observers. Secondly, the method of peer debriefing was used through meetings and discussions with our supervisors, both in Nepal and Norway. Even though the factors are validated within our data analysis, further research is required to conclude their level of influence. The reason for requiring further research is to increase the opportunity of adapting our findings to similar contexts. Prior literature indicates the possibility of adaption across Nepal and to similar countries to be present. However, this is not a definite conclusion, where further research is recommended for acknowledgement.

Some of the discovered factors requires further research due to lack of support in related research. These contextual factors have been explained as contradicting or new in relation to related literature. Due to the limitations of our study, it demands to be studied in depth. Three of our contextual factors contradicts with prior research and causes questioning of our findings. Since our study is limited to one area around the Kankai River, further research is required to conclude these specific contextual factors.

Four of the contextual factors are presented to add value to existing research since it has not been introduced through related literature. These four are specifically related to the initial stage of Flood EWS and close consideration of these will simplify this process. The factors are not revolutionary but contribute with additional perspective and value for the initial stage.

Challenges were experienced during our data collection process in Nepal. Language was the main struggle and is determined to have influenced the interviews to some degree. The interview guide prepared was simplified but our assisting student discovered it to not be simple enough. This was experienced when the interviews took place in the first community. From here even further simplification was made to reduce further complications. To our advantage, NRCS was experienced with communicating with locals and clarified the questions for the locals to understand which reduced the impact on our transcripts.

Another challenge assumed to influence our data collection, is the translation process. Our understanding of the Nepali language is nonexistent which means content can be lost. Through analyzing the data, the translation was discovered to have limitations. Specifically, this included some misuse of terms and insufficient sentences. Additionally, the lack of education within the communities can also have caused odd phrasing of responses in our transcripts. These challenges of language can therefore have influenced our understanding of the data. Close evaluation was, however, conducted to reduce the consequences.

It is important to present one possible influence of our research which concerns our informants. The interviews were conducted in Kankai River where the locals are experienced in relation to flood. The reason for selecting Kankai River is precisely for their flood experiences. It was desired to retrieve their perspective and for this reason flood experience was necessary. On the other hand, conducting the same research in another area or context will give a variation of the contextual factors found. Through researching an experienced area, we have discovered the communities to be aware of the influence of their participation to reduce flood consequences. The communities still expressed challenges due to uncertainty in the initial stage of EWS. We therefore consider many of the contextual factors identified to be recognized in other areas in the situation of Flood EWS.

6. Conclusion and Implications

This thesis presents an exploratory case study conducted to investigate the use of Flood EWS in Nepal and to identify contextual factors influencing locals' perception of information presented through the EWS. The EWS in focus is a Flood EWS implemented to predict flood prior to its occurrence. Through monitoring the rainfall in the area and upstream, in addition to measuring the water level, the prediction gives the locals time to evacuate before the flood reaches their village.

The Flood EWS has the purpose to assist coordination and communication in crisis situations, and involves cooperation among national and local authorities, as well as the support of NGOs and local communities. Their involvement was to understand the roles and responsibilities within the complete EWS cycle. This study evaluates how the EWS is organized and examine the locals' opinions to identify contextual factors influencing their ability to perceive EWS warnings. The findings identified the involvement of participants in addition to describe 23 contextual factors influencing the locals' perception towards the Flood EWS integrated in Kankai River.

The contextual factors were identified to concern six categories, cultural, human capabilities, physical, political, social and technical. When evaluating these factors, six of them were considered interesting and nine were evaluated as crucial for the implementation and use of Flood EWS. These factors were further elaborated and discussed in relation to prior literature. In the discussion, eight of these factors were determined to be supported by prior literature and elaborated new aspects of these factors. Three factors were detected to contradict with prior literature, and therefore requires additional research to ensure their influence. Four factors were discovered as new or provided new perspectives about existing influential factors. Since these factors contribute with completely new perspectives, further research is also required here to ensure importance of their influence. Therefore, our research has offered support, but also conflictual and new perspectives in relation to prior research.

All 23 contextual factors have been evaluated to address how they influence the locals' perception of EWS warnings and how they impact the EWS cycle. Figure 4.10 displays the contextual factors impact at the different stages within the EWS cycle. Our guidelines for how the contextual factors' influences each stage of the EWS cycle contributes to the performance and implementation of Flood EWS. Through understanding the influences at each stage, authorities and NGOs can incorporate the opinions and challenges presented by the locals early on, and thereby making the changes less overwhelming. Figure 4.9 presents how the contextual factors influence the locals' perception of EWS warnings. The figure highlights the important and interesting factors discovered in our data analysis. The key factors are evaluated to be crucial for the function of EWS, while the interesting factors influences the locals' perception are superior than expected. These factors are further elaborated to determine how these contextual factors influence the locals and their perception of EWS warnings.

This study has investigated the role of Flood EWS to assist in relation to natural disasters. How the EWS is used and organized are presented through the four stages of EWS adapted to Kankai River. Additionally, the involvement of different actors is assessed to understand how the complete EWS is operated in the Nepalese context, and specifically Kankai River Basin. Further, our study seeks to identify contextual factors influencing the locals' perception of EWS warnings. The knowledge of contextual factors contributes to further implementation of EWS in Nepal and raises awareness about contextual variations necessary to consider. Our theoretical contribution explains contradictions with prior literature, addressing similar contextual factors to have diverse influence. For this reason, our recommendation of future research presents additional case studies and employment of theoretical perspectives to ensure importance of the contextual factors identified.

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8. Appendix
8.1 Interview Guide National Authorities

1. Can you describe the EWS in use?
   - Is more than one in use?
   - For different purposes?

   - Who authorizes the system?

   - Are several organizations involved?
   - If so, what kinds of organizations?
   - What are their role in the EWS?

2. Can you describe your role in EWS?
   - Do you participate with other organizations or citizens in your role?

3. Can you describe how the EWS is used?
   - What is it specifically used for?

   - Do you have protocols of how to use EWS?
   - Are there procedures in handling these situations?

   - Are the staff trained in using the system?
   - Is there a specific design for warnings distributed to the citizens?

   - Challenges or gaps with using the EWS?

4. What channels are in use for sending out warnings to the citizens?
   - Media?
   - Internet?

   - Any protocol for how to send out warnings?
   - Do you have any opinion of what works better?

5. Do you see any challenges with the warnings distributed?
   - Do you consider cultural factors, if so, which?
   - Are there any other challenges you can describe?

6. Any additional comments?

8.2 Interview Guide Local Authorities

1. Can you describe the EWS in use?
   - EWS cycle: Risk Knowledge, Monitoring and Warning Service, Warning Dissemination and Risk Response

2. How is the management organized in the Flood EWS?
   - Can you describe your role in the flood EWS?

   - Who manages the system at district and local level?

   - Which organizations are involved at the local level?
   - Please explain their role
   - Are the staff trained in using the system?

   - Are there any factors influencing the management of flood EWS?

   - Do you have an organizational overview of who is involved? If not, let's illustrate

3. How are the responsibilities divided?
   - Between the different stakeholders?
   - Are protocols in place for managing the flood EWS?

   - How are the stakeholders notified about the threat of flood?

   - How do the stakeholders participate in warning the locals?
   - SMS warning is not their responsibilities, correct?

4. Can you describe the dissemination process?
   - Of warning the locals?

   - Do you have suggestions of improvements?

   - Are there any factors influencing which affects the dissemination process?
   - Already aware of or not?

5. Do you see any challenges in the flood EWS?
   - Are there any challenges in the warning of locals?
   - Are there any other challenges you can describe?

6. Any additional comments?

8.3 Interview Guide Locals

1. Have you previously been affected by a flood?
   - Please tell about how the event affected you
   - What is your impression of why a flood occur?
   - Are you prepared for a flood?
   - Have you prepared your property for a potential flood?

2. Have you previously received a flood warning?
   - How did you receive the warning?
   - Did you know how to act when you received the warning?
   - What did you think about the warning?
   - What did you do?

3. Do you find the flood warnings useful?
   - Was the warning understandable for you to act upon?
   - Gave the warning enough information for you to act accordingly?
   - Do you believe the warning message to be trustworthy?
   - Did it give well instructions of how to act and where to go?
   - Did you follow the warning instructions?

4. Did the warning give you enough time to prepare for the event?
   - Did you manage to save your personal possessions?
   - Did anyone you know get hurt?
   - Have the floods had the expected impact? (Larger or smaller?)

5. What is your impression of the flood EWS?
   - Do you find the flood EWS helpful?
   - Is it necessary to have such a system?
     (Technical system to prepare the community in advance of flood)
   - Do you believe the locals feel included in the flood preparations?
   - Do you feel included?

6. How would you prefer to receive flood warnings?
   - Media channels? Phone? Other?

   - How would you prefer the warning to be presented?

   - Who do you prefer to receive the warning from?
   - Local or national - does it make a difference?

7. Any additional comments?