Addis Ababa University

College of Development Studies

Centre for Environment and Development Studies

Perception and Response to Flooding Risk in Adama City, Ethiopia

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OCTOBER, 2020

ADDIS ABABA, ETHIOPIA

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A Thesis Submitted to Center for Environment and Development Studies, College of Development Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Environment and Sustainable Development

Addis Ababa, Ethiopia

October 2020

ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT AND DEVELOPMENT

This is to certify that the thesis prepared by BirhanuTeshome, entitled: *Perception and Response to flooding risk in Adama City, Ethiopia* and submitted in partial fulfillment of the requirements for the Degree of Master of Arts (Environment and Sustainable Development) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Acknowledgments

The completion of this thesis would have been impossible without the encouragement and assistance of many individuals. First and foremost, I would like to thank the Almighty God for all His mercy and live assistance throughout my life. Second, I would like to express my sincere gratitude for my thesis advisor Dr. Ermias Teferi for his strong commitment in giving me valuable comments, and constructive suggestions during the entire period of the study. Third, I extend special thanks for my brother; Tariku Dejene (Associate professor) for his strong devotion from inception to accomplishment of this work. Especially his encouragement as well as assisting in designing and acquainting me with the techniques of KoBoToolbox's data collection was invaluable to see the fruits of this work.

I would also like to thank Dr. Messay Mulugeta and Dr. Tamirat Tefera for their critical comments and practical experiences they rendered for this research during and after thesis examination. I am grateful for Yeshewas Tesfaye and Thilahun Teshome who helped me during data collection. Furthermore, I am glad to express my heartfelt thanks to Adama City Municipality and *Kebele* heads and workers for their assistance in providing me valuable information and allowing me to gather the data utilized in this research. Last but not least, I am grateful to my beloved wife Azenegash Asfaw and my children: Kebron, Firanaf, Ada and Tiya for sharing my responsibility and continuous encouragement.

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Acronyms and Abbreviations

AAU Addis Ababa University

ACA City Administration of Adama

ASTU Adama Science and Technology University

CSA Central Statistical Authority

CAPI A computer Assisted Personal Interview

CBO's Community Based Organizations

EWS Early Warning System

GIS Geographical Information System

GOs Government Organizations

IJFSE International Journal of Forest, Soil and Erosion

ISDR International Strategy for Disaster Reduction

KII Key Informant interviews

NGOs Non-Government al Organizations

NMA National Metrological Agency

OBN Oromia Broadcasting Network

TV Television

UK United Kingdom

UNEP United Nation Environment Programme

USA United State of America

US United States

WMO World Metrological Organization

Abstract

Flood hazard has become a serious challenge and resulted in social and economic crisis in cities of developing countries. This thesis is aimed at analyzing perception of and response to flooding in Adama City, Ethiopia. The research was carried out using cross-sectional study design with mixed approaches (quantitative and qualitative). Data were collected using Key Informant interview and household survey from high, medium and low flood risk areas of the city. Household survey was conducted on 312 sample households using KoBoCollect application software. *For qualitative data collection and analysis, 10 individual samples were selected based on the informants' knowledge and direct relevance on the issue under investigation. A multiple linear regression model was used to identify determinants of flood risk perception. The findings revealed that the high and medium flood risk areas lacked basic infrastructures and had a greater level of perception as compared with low flood risk area. The result of the assessment also disclosed that heavy rain, absence of protective or retaining construction and its maintenance, and poor urban drainage structure were the main perceived causes while housing damage and destruction of household equipment, loss of infrastructure and health problems were effects of flooding in the City. The preparedness and response measures to protect and minimize the flooding hazard found were householders' evacuation from their houses, filling sand in bags and placing around the edges of the premise as well as making a retaining wall-like structure with a hollow block despite it was not strong. In flood protection measures and Early Warning System, the support given from government and non-governmental organizations was inadequate. Thus, the government, community-based organizations and residents should take sustainable strategies for short and long term adaptation and mitigation measures.*

Key Word: Flooding, perception, risk, response measures, Adama City

CHAPTER I: INTRODUCTION

1.1 Background of the study

Flood is one of the major natural disasters that have been affecting many countries or regions in the world year after year (Dilley et al., 2005). Flooding represents approximately one third of all natural disasters in both the developed and developing countries (Bradford et al., 2012; Lechowska, 2018). Floods are also accountable for more than half of all disaster related deaths. The frequency and severe effects of flooding hazard is increasing at an alarming rate all over the world (Bradford et al., 2012).

Over past decades, high fatalities recorded in Africa as a result of flooding hazard. The flooding evicted 2.5 million people in Africa in 2009 and more than a million in 2007. In general, African flood deaths increased by ten percent from 1950 to 2009 and over 15,000 individuals passed on amid the decade 2000-2009. On the other hand, the settlement in flood endangered zones moreover increased by ten percent over the same period and the recurrence and seriousness of flood in most parts of African countries has increased considerably (Selamawit, 2018).

In Ethiopia, there are various natural hazards. The common ones are drought, floods, landslides, pests, earthquakes, and forest fires. Droughts and floods are the recurrently occurring natural catastrophes in Ethiopia (Mac Ruairc, 2012). Flash floods and seasonal river floods are frequently appearing in Ethiopia, owing mainly to deforestation, land degradation, increasing climate change, and settlement patterns. There have been six major floods during the past two decades that have resulted in considerable loss of life

and property. Whilst large-scale flooding is confined to the lowland areas of the country, flash floods can occur in most parts of the country (especially when rains fall after prolonged dry spells or droughts). Heavy rainfall in the highlands can cause flooding of settlements in a number of river basins, particularly the Awash River Basin in the Rift Valley. Flooding in urban areas occurs annually (Mac Ruairc, 2012).

Moreover, floods have been happening more regularly and influencing the country nearly each year between 1993 and 2013. Between 1980 and 2010 an assessed 45 flooding occasions had happened in several parts of the Ethiopia. The most sorts of floods in Ethiopia are streak and riverine (flood of waterways and inundating the adjacent districts). The most catastrophic flood/surges reported have been in 2006, which influenced numerous locales of Ethiopia and an estimate of over 600 individuals were dead and more than 500,000 individuals affected (Tadesse & Ardalan, 2014).

The flood in Adama city happened strangely at the time of high rainy days overtops the normal flood ways and creates a lot of catastrophe to the residents. In the past, flood occasions happened and caused a part of devastation on properties and individuals completely different parts of the city. Each year, starting from the week of June, Adama city has been encountering flood at most parts of the city with noteworthy increment of calamity over the pasts. Extraordinary flood events in Adama city result in misfortune of life and cause considerable property harm. In June of 2016, flooding tragically resulted in the loss of property, life and many unaccounted hardships for Adama city (ASTU, 2016).

Although there are certain studies that deal with the estimation of flood peak discharges, mitigation of floods hazards, impacts of flood disasters, and vulnerability of people in Adama, further knowledge about the flood risk perception of people and their ability to prepare for response measures against disasters is needed. Therefore, this is why focusing on perception of and response to flooding hazard by households residing in the flood prone areas of Adama City.

1.2 Statement of the Problem

Adama is a city suffering from rainy season flooding. Flood hazard is becoming serious challenge and resulted in a social crisis in the city from time to time. This has been damaging the people and the livelihood of households. Among the potential common dangers that have caused troubling to the people of Adama, flood hazard is put at the primary stage. The city encounters numerous calamities from flooding danger. In like manner, from the year 1990-2015 during rainy seasons, due to flooding event that the number of passing toll isn't efficiently enlisted and reported. However, every year 2-5 people were estimated to be lost due to flooding and more than 5000 households were suffering from the flooding event (Mulugeta, 2016).

A study conducted by Merid (2016) on Adama with the aim of reducing flood risks and damages caused by frequent and extraordinary flood, tried to identify peak flood and recommend mitigation options based on the environmental and geological situation of the area. He attempted to employ application soft wares like Easy fit, ArcGIS, Global Mapper and AutoCAD. Using the softwares Merid covered peak flood discharge estimation and recommend mitigation measures in his study. Different data options like

gridded (DEM and contour), digitized (soil type, land use and 1:50,000 scale map) and rainfall data were used in the study (Merid, 2016).

Similarly, assessment of Adama City flood risk indicated dimensions of flood risk level in the city using multi criteria approach and mentioned 10.4% of the total city is within high flood hazard zone; 32,670 residents who lived in 8 kebeles are living in flood risk area; 867.6 ha of land in the city shows significant economic risk (Dejene et al., 2017).

Based on the researcher's knowledge ; studies on perceptions and response to flooding have received very little attention in Ethiopia and a great deal of insight can be derived from how people react to changes caused by flooding. Perception and attitude of people may reveal the urgency with which the problem needs to be tackled and which sectors are most vulnerable. Again, development of strategic policies and implementation needs to rest on resident's perception and attitude towards flooding. Risk perception alludes to the instinctive chance judgment of people and social bunches within the setting of limited and uncertain information (Mwango, 2010).

Individuals of a community may view the danger of being flooded very differently, because they do not have similar information about the probability of flood hazard events in their region, about flood mitigation measures and their effectiveness, and that they perhaps have an unique historical background regarding the experience of living during a flood plain and of being flooded (Frank and Volker 2005). Factors like age (Greening L. et al, 1996; Millstein and Halpern-Felsher, 2002), social organization (Heimer, 1988; Rogers, 1985), the likelihood of an outsized -scale disaster (Von Winterfeldt, John, and

Borcherding, 1981), personal belief (Dake 1991; Fishbein and Stasson 1990), and trust (Slovic 1990, 1993) can determine risk perception.

Therefore, the practical relevance of knowing perception of flood risk can certainly play a positive role in narrowing or minimizing the challenges of the flood risk vulnerable households. It also may reveal the urgency with which the problem needs to be tackled and which government or any other body should take proper measures.

1.3 Objectives of the Study

1.3.1 General Objective

The major objective of this research was to assess perception and response to flooding risk in Adama City with specific reference to the households residing along flood prone areas.

1.3.2 Specific objectives

More specifically, the specific objectives of this thesis were to:

1. Assess perception about flood risk of household residing along flood prone areas.
2. Analyze the major factors affecting the perception of households to flooding risk.
3. Identify perceived causes and consequences of flooding by households residing in flood prone areas
4. Describe the preparedness and response measures taken by households and the government against flooding hazard.

1.4 Research Questions

1. What are the household heads' perceptions of flooding risk in Adama City?
2. What are the factors influencing flood risk perception in flood plain of Adama City?
3. Which and how do different factors affect perception of households on risk of flooding?
4. How do the perceived causes and consequences of flooding by households are interlinked with perception of flood risk?
5. What protecting measures and coping mechanisms taken by household heads' against flooding in Adama City?
6. How helpful are the measures employed by the government against flooding danger in Adama City?

1.5 Scope of the Study

The study is delimited to perception of and response to flooding risk in Adama City with specific reference to the households of three kebeles of different risks residing along flood prone areas. To make the study more manageable and be completed within the specified time and available resources, the study targeted three urban kebeles: **High risk** (kebele 02 around Migira area); **medium risk** (Kebele 03 around Lugo or Tikur Abbay) and **little/low risk** kebele (kebele 04 around OBN and Adama University). So, to collect information on the problem, KoBo data collect method was employed through KoBoToolbox's data collection app. The study was based on quantitative data collected from household heads about perception of and response to flooding hazard residing along

flood prone areas. Besides, qualitative data was collected from Key Informants and city municipality as well as concerned regional Environmental authorities in the year 2020.

1.6 Limitation of the Study

The researcher has faced difficulties in collecting the required data from sample households due to the pandemic Covid-19. As a result of which the study period was extended. In addition, the hesitance of the some informants for Key Informant Interview (KII) and the unavailability of related data about perception and response of flooding in Adama city was the problem that the researcher was facing during this study. However, so as to keep the quality of the paper to its best level, the researcher tackled the problem by using different alternatives such as keeping social distancing, hand washes and using sanitizer and face mask to win the trust of respondents. In addition, to dispel the doubt of KIs, the purpose of the study was sufficiently described after which they were willing to provide their honest opinion and experiences.

1.7 Significance of the Study

Various researches evidenced that flooding has socio-economic, environmental and psychological effects on the household livelihoods. In order to minimize and avoid the problem, there should be a research that can identify perception and response to flooding in the study area. Hence, this research can be helpful from the following perspectives.

First, it can provide valuable information about households' perception and response to flooding in Adama City and may provide some ways in which the community in flood risk prone areas protect themselves from the flood. Secondly, findings of the research may be used by the concerned bodies in the study area (government offices, NGOs,

community) and it can also contribute to the literature on studies related to flooding hazard and this may open the gate for further studies. As such, it will also encourage other researchers to conduct a study in the sector with a wider scale and greater depth. As an outcome of this study, the concerned governmental organizations and NGOs working in the area will make objectives and well-informed decisions. As such the results of this study will help the concerned bodies to the Flood Management plans and to adopt Early Warning System (EWS).

Besides, the study underscores the need to consider the perception households to flood risk in designing long-term effective response measures and flood control practices in the City Administration of Adama (ACA). The research can also contribute in the implementation of environmental protection strategies and thereby, the improvements of environmental protection and human wellbeing.

1.8 Definition of Terms

Awareness: Flood risk awareness is defined as understanding or awareness of the flood danger that an individual or a group of individuals faces.

Coping strategies: People, organizations, and systems' ability to face and manage unfavorable conditions, emergencies, or disasters using available skills and resources.

Early Warning System: The timely and accurate dissemination of information that enables flood-affected individuals to take action to minimize or reduce their risk and prepare for an effective response.

Flood: is an overflow of water that submerges normally dry ground.

Urban Flooding: The inundation of land or property in a constructed environment, especially in densely populated regions, caused by rainfall exceeding the capacity of drainage systems such as storm sewers is known as urban flooding.

Hazard: Any source of possible damage, harm, or adverse effects on something or someone is considered a hazard.

High risk areas: high flood- prone areas in Adama City based on previous GIS assessment made by Dejene et al., 2017.

Household: A person or group of people who occupy the same dwelling as their primary residence.

Low risk areas: Low/little flood-prone areas in Adama City based on a previous study based on GIS evaluation by Dejene et al., 2017.

Medium Risk: Areas medium prone to flooding in Adama City based on prior GIS assessment made by Dejene et al., 2017.

Preparedness: The ability to respond effectively to flood damage.

Risk: The likelihood of flooding having harmful implications for the human population.

Risk perception: Risk perception is the view of risk held by a person or house hold/group and reflects cultural and personal values, as well as experience.

Response: Flood risk response is an attempt to reduce the impact of a single flood disaster. Flood response can take a variety of forms. This is shown in the many adaptation methods implemented in the aftermath of a flood, such as relief and rehabilitation, insurance, warning systems, technological aids, and land use management.

1.9 Outline of the thesis

This thesis consists of five chapters. **Chapter One** presents the general introduction of the thesis that includes: background of the study, statement of the problem, objectives, research questions, significance of the study, scope, and limitation of the study and definition of terms. The **second chapter** devoted to a review of literature through which various concepts relevant to the study are discussed. The **third chapter** comprises of general descriptions of the study area, the study methods, the data sources and processing as well as method of data analysis. The **fourth chapter** also devoted to discussion and analysis based on the processed primary and secondary data of the study. And finally the **fifth chapter** is dedicated to conclusion and recommendation based on the findings of the study.

CHAPTER II: REVIEW OF LITERATURE

2.1 Theoretical foundation

Four theoretical approaches related to this study are described below. These theories are related with perceptions and behavioral responses of flooding risks.

2.1.1 Rationalist approaches

Chauncey Starr, an American electrical engineer, released his work on revealed preference in 1969, in which he attempted to measure technology dangers against their benefits in order to establish how individuals choose "how safe is safe enough" (Starr, 1969). His revealed preference approach aimed to establish which risks society deemed acceptable; a key finding from his study is that people will accept greater risks if they are voluntary as opposed to involuntary (Starr, 1969; 1972). Starr's research utilised historical data to determine the risk-benefit trade-offs that societies and authorities choose when faced with uncertainty regarding the benefits and costs associated with technological risks. His work largely inspired the research of Paul Slovic, Sarah Lichtenstein and Baruch Fischhoff, based at the University of Oregon, into cognitive processes behind societal-risk taking (Slovic, 2000). His revealed preference model further influenced Amos Tversky and Daniel Kahneman's to question the anomalies around human behaviour and judgements made under uncertainty (Tversky & Kahneman, 1982). In light of this interest, two significant schools of thought around the notion of risk and risk perceptions developed: the research involving the psychometric paradigm (Slovic, 2000) and the research into heuristics and judgement (Tversky & Kahneman, 1982). People are said to rely on their available knowledge while making decisions in uncertain situations or around uncertain events (Tversky & Kahneman, 1982).

The Oregon School's research focused on demonstrating that risk is a subjective notion that can be psychometrically defined to disclose quantitative judgment levels (Fischhoff et al., 1978; De Marchi, 2007). Their original research focused on gambler uncertainty (Slovic, 2000), from which the Psychometric Paradigm was born. Later, their research expanded to include judgments made in response to natural and technological threats (Fischhoff et al., 1978). In the years that followed, their research expanded to encompass attitudes regarding technical dangers (Fischhoff et al., 1978), as well as other topics. Their approach of statistically assessing and characterizing risk perceptions, known as the Psychometric Paradigm, has had a significant impact on subsequent risk perceptions research.

Fischhoff et al. found nine risk factors or qualities that influence how people perceive hazards in their 1978 study: 1) Voluntary vs. involuntary (are the risks voluntarily taken); 2) The immediacy of effect (how readily is the effect of the risk experienced); 3) Extent of personal knowledge of the risk; 4) Extent of scientific knowledge of the risk; 5) Chronic vs. catastrophic potential of the risk (chronic risk is one in which people are killed one at a time, and a catastrophic risk is one that kills a large number of people at once); 6) Common vs. dread (to what degree have people learnt to live with a risk and its effects); 7) Severity of consequences (how likely is it that a type of risk will have fatal effects); 8) People's level of control over their exposure to the danger; and, finally, 9) The risk's novelty.

When they asked a group of 76 respondents from the Eugene, Oregon League of Women Voters (52 women and 24 men –spouses) to rate the risk of a variety of common activities (i.e. smoking, alcoholic beverages, bicycles, commercial aviation,

contraception, electric power) in relation to these nine dimensions, they discovered that dread and novelty were the two factors that explained the majority of the variance (Fischhoff et al., 1978). Since this initial study, research into the psychometric analysis of risk perception has included larger, more diverse groups of respondents, with variations in the scales used and the hazards investigated; a more conclusive review of this research into the psychometric paradigm can be found in Sjörberg et al. (2004) and Boholm et al. (1998). The other group of psychological research influenced by Starr's theory is the research done by Amos Tversky and Daniel Kahneman concerning financial decisions, and earned one of the authors [Daniel Kahneman] the 2002 Nobel Memorial Prize in Economics. They discovered that when faced with uncertain hazards or risk events, people frequently use mental guidelines to make decisions (Tversky & Kahnem). These decisions are based on the availability of relevant (personal and external) knowledge about a risk; nevertheless, these "guidelines" have been demonstrated to be prone to inaccuracy, since they result in bias that overshadows real probability measurements (Tversky & Kahneman, 1982)

Johnson & Tversky (1983) investigated the impact of affect (emotion) in determining a person's estimate of the frequency of a dangerous occurrence, building on Tversky & Kahneman's (1982) findings. They point out two examples of bias or inaccuracies in people's risk assessments: 1) they tend to overestimate infrequent causes of mortality while underestimating more common causes; and 2) they tend to underestimate causative factors. Short (1984) emphasizes the role of the media in contributing to this bias in judgment, stating that more dramatic and devastating incidents receive more media publicity than everyday hazards. Because of this penchant for disaster and clickbait

headlines, everyday dangers are regarded as less threatening, less frightening, and more readily solved, resulting in underestimation.

Johnson and Tversky (1983) asked 72 paid participants from the University of Oregon to estimate the frequency of fatalities from a list of 18 risks (i.e. tornadoes, floods, lightning, fire, electrocution, accidental falls, traffic accidents, airplane accidents).They discovered that, in general, people make decisions that are compatible with their current mood (affect), even if they are not aware of it. This suggests that the potentially manipulative impact of mood on lay judgments should not be neglected when analyzing public perception of a risk (Johnson & Tversky, 1983). In Paul Slovic's latest book, "the sensation of risk: new perspectives on risk perception," the influence of the affect (emotions) heuristic and associated elements, such as mood, has been more recently described (2010). One example is how individuals react to visuals of dangers and occurrences (Finucane et al., 2000). When questioned about accompanying imagery, people ‘tag' hazards or occurrences with unpleasant or positive feelings, and to the extent that feelings are available, they make risk/benefit judgements (Finucane et al., 2000). People's mental representations are said to have an affect tag attached to them, which alters their risk/benefit assessments of an object, event, or hazard (Finucane et al., 2000).

2.1.2 Constructivist approaches

During the 1970s and 1980s, a growing number of sociologists and anthropologists questioned the rationalist paradigms' assumptions and approaches to technological and natural risk, as well as risk perception (Short, 1984; Douglas, 1985; Johnson et al., 2004). They said that the dominant paradigms at the time were unduly positivist and behaviorist

in nature, and that they failed to account for the social structures and organizations that shaped risk perceptions (Tierney, 1999). The reaction was the formation of political ecology, as opposed to traditional human ecology, within the geographical disciplines (Mustafa, 2002). Political ecology studies aimed to better understand society's relationship with natural hazards in the context of social structural restrictions and political economic issues that lead to disparities in resource access and susceptibility among marginalized groups (Mustafa, 2002). The focus shifted away from perception and behavior study and toward investigating the role of contex. Natural dangers are viewed as "acts of God" outside the social structure, and thus as irregularities in the system, according to constructivist theory. Disasters, hazards, and risk are regarded as social constructs that do not exist outside of society and are thus influenced by the social dynamics (culture, institutions, organizations, values, beliefs, and so on) (Oliver-Smith, 1996; Tierney, 1999; Weichselgartner, 2001; Johnson et al., 2004). ‘Constructivist arguments go beyond simply pointing out that the world is not naturally given,' Clarke and Short (1993, p.382) write. Surprisingly, no single integrated theory of risk and risk perception exists in the discipline of sociology (Short, 1984; Clarke & Short, 1993; Tierney, 1999). Instead, a study approach emphasizing how risk is constructed, defined, and understood in its environment is encouraged (Clarke & Short, 1993). This agenda rejects the idea of objective truth and emphasizes the significance of studying the social relationships and meanings that underpin risk (Clarke & Short, 1993). Issues relating to the collection and utilization of information by decision makers; the role of power in the allocation and management of resources; and how power operates in shaping the terms of risk debate are all important variables for this study; the media's function in presenting

and informing about risk; organized interest groups' effect on risk policy; and the role of organizations and elites in risk policy.

The emphasis on dangers as an essential component of society is an intriguing result of constructivist study. People's attitudes toward hazards are thought to determine society's ability to manage with them, based on their perceptions and comprehension of the dangers and advantages associated (Johnson et al., 2004). Similarly, the emphasis has shifted away from the assumption that technology defense is essential to prevent natural catastrophes and toward the importance of social interventions in reducing natural disaster losses and damages (Clarke & Short, 1993). As a result, initiatives and procedures to modify risk perceptions are developed in order to improve people's and communities' coping mechanisms.

2.1.3 Cultural Theory of Risk

According to cultural theory, risk perceptions can be predicted based on cultural adherence and social understandings (Douglas & Wildavsky, 1982). It tackles the issue of risk in society from the standpoint that social organization structures impart and reinforce risk.

The hypothesis is founded on "the uniquely human capacity to classify experiences, symbolically embody such categories, and convey such abstractions to others" (Oltedal et al., 2004, pp. 17). This process of indoctrination of a younger generation by the elder generation acts in order to perpetuate the established "style of life" (Oltedal et al., 2004). Mary Douglas (1978) distinguished between "cultural bias" (common values and beliefs) and "social relations" (patterns of interpersonal relations) and regarded "style of life" as a

mix of the two. She proposed that, based on a two-dimensional group (representing cultural diversity), approach (representing social ties) and grid (bias) approach, variation in social engagement can be divided into unique and distinct worldviews or worldviews, regardless of time and geography (Douglas & Wildavsky,1982).

2.1.4 The social amplification of risk

Kasperson et al. (1988) observed that all the different schools of thought around risk served to illuminate different facets of the public experience of risk. They argued that what was needed was a comprehensive approach, one that integrated the cultural, social and individual response structures of people's experience of risk. A conceptual framework, based along the processes of signal amplification defined in communications theory, acted as the structural backbone to their theory on the social amplification of risk (Kasperson et al., 1988). The generation of 'signals,' their receipt and amplification (or attenuation), and the secondary effects elicited by the signals were observed to occur through a chain of interconnected social processes that included the generation of 'signals,' their reception and amplification (or attenuation), and the secondary effects elicited by the signals (Kasperson et al., 1988).

The process of social amplification of risk acts in either initiating or delaying risk reduction adjustments (Kasperson et al., 1988). Different mechanisms influence and define how a danger is absorbed and amplified (or attenuated) as well as the actions taken (Kasperson et al., 2004). Examples of mechanisms that influence the social amplification or risk include: information mechanisms (aspects of information flow: volume, disputed, extent of dramatization, and symbolic connotation) and response mechanisms (heuristics

& values, social group relationship, signal value, positive feedback related to the risk itself, and stigmatization) (Kasperson et al., 1988).

2.2 Importance of studying flood risks

Flood risks are natural disasters and have devastating impacts on cities around the world (Liao, 2012, Anilan & Yuksek, 2017). The degree of vulnerability to natural disasters particularly to flooding is high in developing countries which tend to force the poor to occupy the foremost vulnerable areas. On the opposite hand, the vulnerability of developed countries to flooding increase with economic processes and the accumulation of wealth in flood plain areas. Moreover, about seventy percent of all disaster incidences are related to hydro-metrological occurrences particularly flooding which is the second highest natural disaster in the world in damaging losses. Every year thousands of individuals displaced from their homes and a million of people died because of flood damages (WMO (2009) cited in Sinafikish, 2013).

Floods displaced 2.5 million people in Africa in 2009 and more than a million in 2007. In addition to this, Besides, Overall African flood fatalities raised by a factor of ten from 1950 to 2009 and over 15,000 people died during the decade 2000-2009. On the other hand, the settlement in flood prone areas additionally raised by constant amount and therefore the frequency and severity of floods in most parts of African country has increased significantly (WMO (2009) cited in Sinafikish, 2013).

Flooding in Ethiopia is mainly linked with the national topography of highland mountains and lowland plains with natural drainage systems formed by the principal river basins. On

the other hand, most floods in the country occur due to the overflowing of rivers that causes runoff and inundation along their banks in lowland plains (Sinafikish, 2013).

By 2020, in Ethiopia; 151,828 people were affected by recent floods (July and August), including 100,176 people displaced as of mid-August, including 40,731 people displaced in Afar, 20,868 people displaced in Somali, 1,125 people displaced in Oromia (excluding the 141 people displaced by landslide in East Wollega zone), 25,703 people displaced in SNNP and 11,749 people displaced in Gambella due to flooding. (Retrieved on October 2020,https://reliefweb.int/sites/reliefweb.int/files/resources/ethiopia_flood_update_no.3_18_august_2020.pdf).

Since many Ethiopian Cities are vulnerable to flooding risks, we need to have disaster resilient cities which can save life, property and infrastructures. In connection to this, several cities defend the challenges of flood through flood protection mechanisms notably extensive flood-control infrastructures, such as levees, dams, and channelization. Hence, cities resilience to flooding is essential to adjust social, economic and physical damages. More importantly, to develop capacity to prevent deaths and injuries caused due to flooding. Furthermore, the resilient city can withstand flooding and much more variation in socioeconomic situations, resulting in a broader basin and consequentially greater urban resilience to floods (Liao, 2012).

2.3 Basic concepts of flooding

The term flood is multifariously defined counting on the considerations of its user. To all, it's an overflow of a stream channel that exceeds sure limits. To the flood-plain manager, these limits area are unit those at that life and property area vulnerable. To the

hydrologist, the bounds area unit every which way outlined on the idea of magnitude-frequency studies of stream flow. The geo-morphologist and geologist view floods relative to the natural options related to the stream or watercourse. Clearly, the assessment of floods and the mapping of their potential incidence need multi-disciplinary (Wolman, 1971). Floods are usually explained as excess flows beyond the transporting capability of watercourse channel, lakes, ponds, reservoirs, system, dam and the other water bodies, whereby water inundates outside water bodies areas (Aris, 2003). Flood is a continuous natural and repeated event in floodplains of monsoon rainfall areas like Ethiopia, wherever over eightieth of annual precipitation falls within the four wet months (Sanyal, 2005).

2.3.1 Causes, types, and consequences of floods

The flooding will be caused by, heavy rain, snow melt, land subsidence, rising of groundwater, dam failures. The natural disaster related to the weather system variability, world global climate change, and environmental degradation are oftentimes influencing people and their impacts appear to possess greatly enhanced in recent decades (Vincent, 1997).

Mwango (2010) mentioned river and flash flooding typically result from abnormally high downfall over a relatively short period: Hours for flash floods; Days for stream floods. Fast snow soften will bring a lot of water into the hydrological system than are typically adequately drained; leading to what is usually known as spring floods. Deposit of stream beds and deforestation of water structure areas will exacerbate conditions leading to stream depression floods. Deforestation and paving land will

considerably increase the chance of flash floods. Building flooding plains or in environmentally degraded areas, or ever-changing the natural avoidance systems, will considerably increase the danger of flood injury. Typically, stream floods are outlined in terms of a river's water level or discharge. Furthermore, Mwango (2010) attempted to put types, duration and characteristic impacts of flooding. The types of flooding are: 1) predictable regular flooding that takes three months, 2) Increased size of regular flooding that stays up to six months, 3) Flash flooding that stays a few days to weeks, 4) Urban flooding that stays a few days to weeks, 5) Coastal flooding that stays a few days, and 6) Slow-onset from sustained rainfalls that takes three to six months.

Relevant to this assessment are flash and urban flooding. Flash flooding can be rapid cresting typically with very little warning and its high speed flood flows will destroy infrastructure and population displacement typically localized. On the other hand, urban flooding can be rapid-onset, typically returning flash floods in urban rivers or from saturation or blockage of urban emptying systems. Potential for infrastructure harm poignant larger spot and population displacement typically localized (McCluskey, 2001 cited in Mwango, 2010).

Pielke and Downton (2000) mentioned the weak relationship between hydrological and damaging floods: notwithstanding we all know a lot of concerning hydrological floods during a bound space, we tend to could grasp very little concerning damaging floods. Damaging floods result from a mixture of physical and social group processes. The decisive role of social group processes is reflected within the definition of disasters, e.g. given by ISDR (2004) as "... a big disruption of the

functioning of a community or a society inflicting widespread human, material, economic or environmental losses that exceed the power of the affected community or society to cope victimization its own resources".

In step with U.S. Water Resources Council, 1968, it's a well-known incontrovertible fact that, despite vast public expenditures for flood protection, flood losses remains substantial, doubtless cost accounting a median of $2billion per annum across the nation. Presumptuous established trends inside the enhanced use and development of dangerous flood plains, this figure can increase to $5 billion by 2020. In 1966 the calculable annual flood injury for Texas Rivers debilitating quite 250,000 acres, exclusive of the Rio Grande, was $28.2 million (U. S. Water Resources Council, 1968). An increasing share of the annual national flood loss is that the results of alleged harmful floods (Holmes, 1961), i.e., floods that either (1) have a comeback amount of a hundred years or additional, or (2) cause failure of a flood protection project by surpassing the project style flood. The calculable $3 billion injury made by cyclone Agnes flooding within the eastern United State throughout the summer of 1972 might represent the pattern for many future flood losses.

Flooding hazard has much impact on urban residents on household level. Harm to and deterioration of buildings, damage of houses, Water springing from the ground into rooms, lack of potable water, displacement from homes, loss or damage to household property, prevalence of malaria and other diseases, income loss due to sickness and medical expenses are among the common consequences caused due to flooding risk (Unaegbu, 2014).

The same author mentioned flood preventive measures and coping strategies. Use of structural measures to limit floodwater entering houses, construct drains in front of houses; renovate buildings; build high walls to prevent floodwater from entering houses, relocate moveable property outside the community; keep property above flood level, self-medication; use of mosquito nets and insecticide sprays are considered as the major preventive measures. Some coping strategies considered are: filling roads with sand using sandbags; putting wood shavings on roads; relocate to neighbor's or relative's house; raise household property to higher levels; raise floor levels with sand/sawdust; and repair or replace damaged property (Unaegbu, 2014).

2.3.2 Perception of flood risk

Perception is how individuals and communities understand flood risk, and that they are born out of data and experiences of those events (Fatti & Patel, 2013). Renn et al. (1992), cited in Fatti & Patel) posit that "events on hazards interact with psychological, social, institutional, and cultural processes in ways during which can either heighten or attenuate individual and social perceptions of risk and shape risk behavior". This means that people's responses to disaster risk are shaped by their individual experiences, knowledge, and perceptions of this risk, and thus aren't homogenous across or within communities.

Raaijmakers et al. (2008) specify the definition of flood risk perception as a mixture of three specific factors of risk—awareness, worry and preparedness. Individual experiences of disasters influence perception of future risk, which successively influences responses and management of future risk. For instance, a community that has recently been suffering from a flood is more likely to require preventative action against future

flooding, than a community that has never experienced a flood. As a result, anticipatory adaptation efforts, on a community level, tend to be best once they are supported the community's perceptions and priorities, as community members can take ownership and responsibility for these actions (Fatti & Patel, 2013).

Researchers mentioned that there's a linkage between risk perception and individual experience. More specifically, individual experience and risk perception of floods, droughts, and wildfires have an immediate relationship during which one affects the opposite (Brody and Zahra 2008; Diggs 1991; Hamilton and Keim 2009; Spence et al. 2011; Woudenberg et al. 2008, cited in Bonevac, 2019). Social, economic, demographic, and ideological factors highly impact perceptions of flooding (Bonevac , 2019).

2.3.3 Relationships between flood risk characteristics

Risk perception is that the relationship among the risk characteristics (worry, awareness and preparedness). Having awareness would lead to increased worry and in effect higher preparedness. In other words, in a community where there is high awareness, there is a higher chance of worry and in consequence there appear higher preparedness. Also, decreased worry may guide to a decrease in awareness. But, awareness will not necessarily lead to worry, and worry not necessarily to preparedness (Raaijmakers et al., 2008).

2.3.4 Factors determining flood risk perception

Studies indicate various factors generally influencing the perception of flood risk or its individual elements. Tobin and Montz (1997) distinguished the perception of risk and its major components (awareness, worry, preparedness). These are the physical location

reflecting proximity to a hazard (the probability of the occurrence of flood); the character of the flood (since a violent mountain flood is perceived differently to a lowland flood that's long-term in nature and will be predicted beforehand); the extent of the effects; the experience; the extent of hazard awareness and thus the degree of its uncertainty; socio-economic and demographic factors of the population (gender, age, education, income, number of children); the residence characteristics (owning a house, quite a building, presence of a ground floor, cellar); the cultural-historical context; voluntary/involuntary nature; the group of people influenced by the flood (individuals can perceive a risk differently, depending on whether they are directly influenced themselves, their families are influenced or it regards people they are not connected to emotionally).

Wachinger et al. (2013) suggest some other division of flood risk perception in their literature review in which four groups of factors responsible for determining risk perception and natural hazards: (1) Risk factors (scientific characteristics of a risk, perceived probability of the occurrence), (2) Informational factors (the source and level of information), (3) Personal factors (gender, age, education, occupation, personal knowledge, personal disaster experience, trust in authorities, trust in experts, confidence in several risk reduction measures, world views and religiousness), (4) Contextual factors (economic factors, vulnerability indices, home ownership, family status, country, area of living, closeness to the waterfront, size of community, age of the youngest child).

2.3.5 Response to flooding and coping mechanism

So as to reduce the damages caused by flooding risk, vulnerable people respond against it. People take some positive action to reduce losses, and a couple of

preventive action much beforehand of the hazard event, and others choose an outsized number of adjustments. This might be to differences in what people realize hazardous events, how they perceive them, and thus the concepts they use to classify their experiences and make decisions accordingly (Eyob, 1999). Adjustments vary tremendously, by hazard and society, but are universally found (Kates, 1978). It has also been emphasized that for sort of African countries, adaptation is an option not by choice but by compulsion.

Historically, all communities living flooding plains have always co-existed with floods and much of studies identify such communities to possess a typical flood culture, characterized by adjustments to mitigate flood damage. Because of frequency of long history of flooding, it's possible to hunt out collective action patterns and cognitive patterns which are adjusted to the hazard situation; through the elimination of doubt, thus making things predictable (Kates, 1978). Social capital e.g. reciprocal support among neighbors, support from immediate relations and wider kinship networks, could also be an important safe net for people in handling recurrent flooding (ProVention, 2008).

The most basic coping mechanism is that of the family. Kinship could also be a robust bond and in times of need people will first search to their families and relatives for support (Wijkman, 1984). Del Ninno et al. (2000) as an example reports on how borrowing and selling belongings and reducing food consumption became short term economic coping mechanisms for poor families affected by the acute Bangladesh flooding of 1998. Community level action strongly suggests that response at this level could even be of key importance in influencing public health. One crucial area in terms of public safety is warning and evacuation, that community based activities, may provide

the key to survival (Few et al., 2004). Religious/ social institutions help individuals to cope during emergency periods. They provide leadership, shelter, emotional support and help with burials. In some areas, churches are also called upon to form sure emergency aid is distributed equitably. Internal political/ economic organizations function point through which the government can provide assistance to the victims. International logistic assistance groups like agricultural cooperatives and labor unions provide leadership also as some extent of monetary support (Wijkman, 1984)

Response to flood risks that involves a change in action or policy is mentioned as adaptation, and thus the power of people and systems to cause such changes is mentioned as adaptive capacity (Few et al., 2004). Like coping capacity, adaptive capacity of people and systems is made by social, economic and political processes (Adger et al., 2003).

2.4 Empirical literature review

There are certain empirical works on flood risk perception. (Urcan, 2012) surveyed flood hazards perception on peoples who live on different areas of flood vulnerability and the study considered perception on the basis of the location of households, the previous flood experience, the age and the education level of the respondents.

Bradford et al. (2012) investigated that the roles of public perception in developing flood risk communication strategies in Europe. In their study, "risk perception can be characterized as a combination of awareness, worry and preparedness. Findings of this study, however, indicate that worry is not the central link between awareness and preparedness."

According to Raaijmakers et al. (2008) who made an exploratory research on flood risk perception and multi-criteria analysis, awareness, worry and preparedness are the three basic elements that categorize peoples to show their extent of ignorance, perceived security, perceived control or desired risk reduction. And hence; the study put land use policy as a key to solve flood risk reduction of the people.

Lechowska (2018) in his work of a review of factors and relation between its key elements (awareness, worry and preparedness) attempts to respond to what are the determining factors to flood risk perception? He further noted that the knowledge of factors that affect flood risk perception is vital in tackling problems of people's overlooking flood risks. However, the above mentioned review could not put a clear relationship among awareness, worry and preparedness.

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Oruonye (2013) in his assessment of flood risk perception and response in Jalingo Metropolis Taraba State, Nigeria; attempted to identify the level of individual flood risk perception and behavioral response. The study revealed that many people who were residing along flood prone areas used to leave their homes and shops due to flooding risks. Despite the fact that there was a high flood risk perception, individual's response to flood risk was very poor.

Bonevac (2019) made an investigation on how members of the U.S. public perceive and understand flash flood risks, how they interpret and anticipate responding to flash flood alerts, and what factors influence their warning responses studied aiming to improve flash flood warning communication and responses. Thus, protective action intentions in response to a warning were, however, higher for respondents who said they had made preparations for flash flooding, such as planning an evacuation route or creating a household plan. Protective action intentions were also higher for respondents who

perceived a greater likelihood of people being killed if a flash flood hit Boulder and those who believed they were less safe from flash flooding.

Fatti & Patel (2013) assessed that the way the local people and the municipality responds to flood risk and suggested flood risk perception should be considered while flood decision making process and can be helpful for effective flood management.

Overpopulation and indiscriminate dumping of solid waste, poor drainage system and negligence by government are perceived causes of floods (Unaegbu, 2014). Similarly, rainfall, proximity to the river, and low acreage are the perceived causes of flooding. And "educational level of respondents did not influence respondent's awareness level of flooding and that people's perception of flooding was influenced by factors other than respondent's literacy level" (Oyatayo et al., 2016).

With reference to response to flooding low level of preparedness as a results of low perception of risk, inadequate recognition of preparedness and mitigation measures by affected population, highly vulnerable properties are more susceptible to preparedness, lack of risk communication can affect preparedness and recovery; early response and warning are pre-requisites and financial incapability are often an enormous barrier to preparedness and recovery (Bhattacharya & Lamond, 2014).

Selamawit (2018), on her study on urban households' vulnerability to flooding hazard in Addis Ababa around Ginfile stream; has attempted to explain peoples' perception about flood risk. She made detail discussion on the perception of environmental and ecological impacts, health and psychological impacts of the Ginfile River. She has also acknowledged that flooding in Ginfile catchment and its adverse impacts are caused due

to urbanization which changed the vegetation cover in to buildings and industries as most of the time manufacturing industries built along the riverside. According to the same author, upgrading the infrastructure within the area in terms of building durable flooding barriers within the catchments or capacitating the prevailing barriers and having drainage plan are considered as essential for mitigating the matter.

Specific studies on Adama city by Mulugeta (2016), Dejene et al. (2017) and Merid (2017) have tried to ascertain the flooding risks from different perspectives. Mulugeta (2016) argued that fast urbanization and specifically construction of buildings and roads, water has no thanks to enter in to profile which successively caused more rapid runoff, higher peak discharges and bigger volume of runoff, which has high chance to make flooding hazard. He added that intensive rainfall might be the most cause for flooding.

Dejene et al. (2017) on his contribution, attempted to seem in to varied dimensions of flood risk level in Adama City using multi-criteria approach. His assessment revealed that 10.4% of total area of the town is inside high flood hazard zone; 32,670 inhabitants spread over 8 Kebeles live flooding risk area; 867.6 ha of land operating for different land uses situated at different parts of the town indicates significant economic risk. Moreover, 167.73 ha of land with erosion potential found at southern a part of the town shows ecological flood risk of the City. Flooding is caused by low drainage density, low elevation, and impervious surfaces due to urban land use. On top of this, closed/obscured existing storm drainage lines have significant contribution for flood risk level within the City. However, the study didn't specialize in preparedness, response and recovery mechanisms of flood risk reduction.

Merid (2017) has attempted to spot peak flood and recommend mitigation options supported the environmental and geological situation of the world which will be suffering from extraordinary floods.

All the reviewed empirical literatures in Ethiopia et al. indicate that the researchers have made a detail assessment on the various aspects of flooding risk. However, some studies have checked out the flooding situation in Ethiopia but studies on flood perceptions of and response to flooding have received little or no attention and thus the relevance of this study.

2.5 Conceptual Framework of the Study

The framework shown in the figure below is designed to reflect the study objectives and used in data collection and shape the analysis of the findings to provide the overall understanding the perception of and response to flooding risk in Adama City. Thus, based on the framework, the researcher surveyed and analyzed data collected from selected *kebeles* of sample households, observation and key informants.

The conceptual framework utilized for this study is aimed to show how different variables are interrelated and could affect one another. This framework indicates major factors that determine flood risk perception. These factors are: 1) demographic characteristics such as sex and age; 2) socio-economic characteristics (income and education); 3) worry, experience, knowledge and information; and 4) Flood-prone areas (high, medium and low flood prone sites).

Perceived causes mainly heavy rainfall, poor urban drainage structures, absence of protective or retaining construction, topographic location, unplanned human settlement

and deforestation are directly influenced by the determining factors of flood risk and perception and which in turn affect response measures of flood risk. Besides, major perceived impacts such as; damage of properties, loss of infrastructures, disease and loss of life have come due to inappropriate coping mechanisms and response measures employed by every household and the government bodies.

Moreover, the conceptual framework has put how perception and response to flooding risk in Adama city is based on the determinants, perceived causes, perceived consequences, and preparedness and response measures.

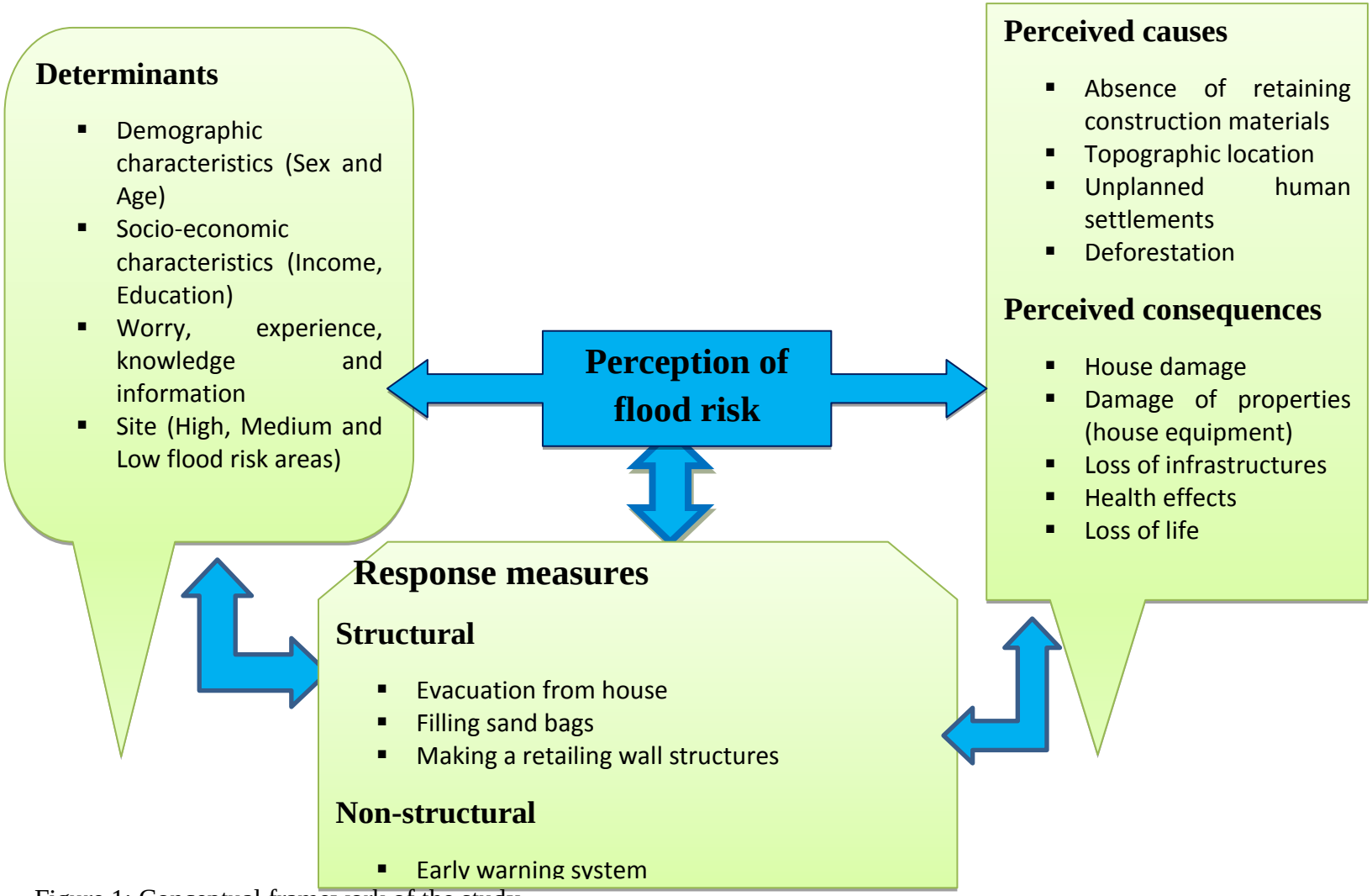

Figure 1: Conceptual framework of the study

Source: own trial

CHAPTER III: DESCRIPTION OF THE STUDY AREA AND THE RESEARCH METHODS

3.1. Description of Adama City

3.1.1. Historical overview of Adama

Adama was set up in 1917. It is located on flat landscape characteristics; mountainous and ridged features and surrounded by plateaus, along Addis Ababa to Harar road at distance of about 96 km (Dejene et al. (2017). Mulugeta (2016) described Adama City's name was inferred from Afaan Oromo "*Adami"* (cactus) which was to mean heavily dominated by cactus trees; *Adaamii* means Euphorbiacandelabrum, a tree of the spurge family, while *hadaamii* would mean Indian fig. In 1946 Adama became the capital seat of *Yerer and Kereyu Awraja.*

The Adama City Administration (ACA) is the result of the historical origin of Adama as urban center started with the Ethio-Djibouti railway that was built in 1894–1917. In 1950, the City got municipal status and now is a first grade urban local government in Oromia regional state (Mulugeta, 2016).

3.1.2 Location

The city is situated along the main road that links Addis Ababa to Djibouti in which an enormous number of trucks travel to and from the seaports of Djibouti. Additionally, the new Addis Ababa-Djibouti Railway runs through Adama. The city has an area of almost 136.65km2 positioned between 08°30′29″N-$8^0$35'58''N latitude and $39^0$15′08″E-$39^0$20'15''E longitude, at the western edge of the Great East African Rift Valley (Mulugeta, 2016). The normal rise of the built up area is almost 1,620m.a.s.l with most

extreme distinction of 70 m between the most elevated and least areas (Merid & Agizew, 2016).

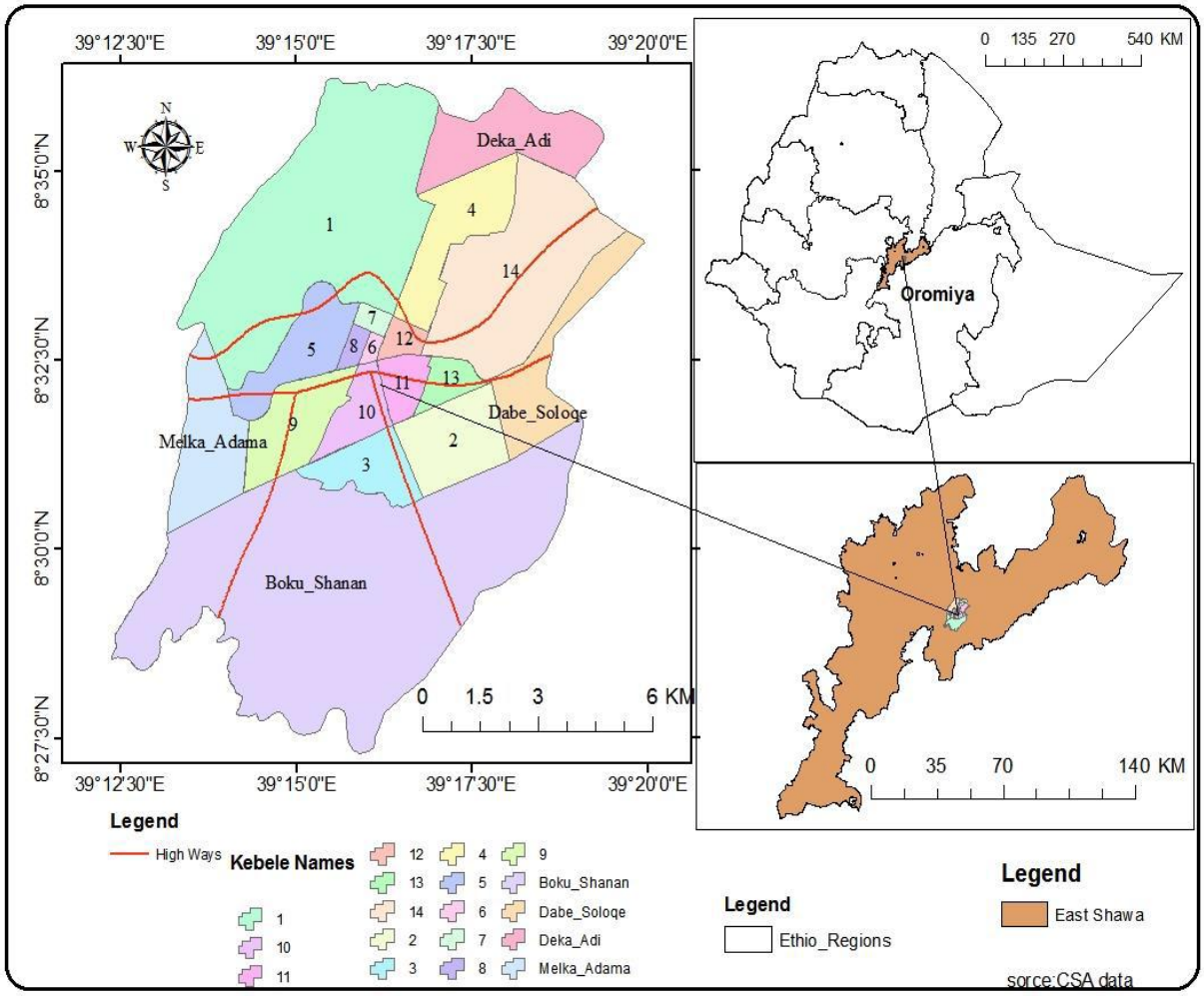

Figure 2. Map of the study area, Adama city

Source: CSA data

3.1.3 Socio- economic Activities

The geographically strategic location and favorable climatic situations of Adama have contributed to the rapid expansion of the city as commercial, residential and recreational center. In this respect, the contribution of Awash valley and its economic potential in

addition to the recreational role of the rift valley, particularly, the role of Sodare hot spring at a distance of 10 km from the city makes Adama one of the tourist attraction centers in the country. Adama has a great development potential, and is also expected to play a major role in the integrated development of the nearby urban and rural areas due to the fact that the city is located at the junction of major routes to Addis Ababa, Arsi/Bale, Harar, and other hinterland areas of economic importance besides on outlet to Djibuti. Adama City Administration has two macro watersheds these are Awash and Migira macro watershed and agro-climatically they are categorized under Kolla agro-climatic zone (ASTU, 2016)

3.1.4. Geology setting

The city lies on Quaternary volcanic rocks and sediments that are formed in association with the formation of the rift. The sediments that dominate the floor of the city are alluvial and lacustrine deposits. (Alula and et al., 1992) The volcanic products from the Boku volcano can be grouped as alkaline and per alkaline rhyolite lava domes, flows, and pyroclastic falls, which cover the floor complex ignimbrite deposits. The major products are rhyolite lava flows, obsidian flows, pumice falls, and spatter cones with associated basaltic lava flows. After the emission of these products, the caldera has been collapsed and given rise to post-caldera (intra-caldera) products such as scoria cones with associated basaltic lava flows. The Boku ridge forms the maximum peak in the area rising from 1600 m above sea level to 1800m above sea level. The major tectonic lines, which are aligned in NE-SW direction in the Rift floor, form numerous local graben and horst structures (Rift-in-Rift structures). Consequently, the city is bounded by NE-SW aligned tectonic lines and lies within the graben structure .The faults are younger than the

outcropping volcanic rocks and are grouped as Wonji Fault Belt. The central volcanoes are rooted along these tectonic lines and are characterized by collapsed calderas, among which the Boku caldera occupies the southern part of Adama in the main Ethiopian Rift (Alula, 1990).

3.1.5. Soil

The soil development in the Adama catchments is mostly due to the physical disintegration and decomposition of volcanic rocks, deposition of alluvial and ashes. The weathering products are either remain in places and form residual soils or transported and deposited in the lowland central and southern parts driven by overland flow (ASTU, 2016). Although there is significant difference in the degree of weathering on the slopes of ridges, the soils formed there will be rapidly eroded and result in thin soil cover. In the localities where the topography is plain to gentle, the soil has thick profile. The type of parent material and the length of time to which the parent material is subjected to weathering, control the variation in the thickness of soil. Generally, the soil deposited on the plainly land of Adama is reworked alluvial sediment and has longer deposition time. As can be deduced from the well log data of boreholes drilled in the City, the depth of the soil reaches up to 20 meters around Melka Hida (ASTU, 2016).

3.1.6. Climate and Hydrology

Rainfall

In general, there are three seasons at Adama; *Kermt* (main rainy season), *Bega* (dry season) and *Belg* (small rains). The rainfall recorded at Adama for the past eleven years (2010-2020) indicated that the average annual rainfall is about 913.9 mm. The maximum monthly average rainfall is about 293.9 mm. Utmost of the rain come about in summer

season (June to September). The wettest months are July and August. The average amount of rainfall in July and in August is about 245.2 mm. The proportion of the precipitation in these two months is about 52% of the annual total. The rainfall intensity data recorded at the nearby station of Bishoftu, Kulumsa and Methara is sometimes considered; accordingly, the average maximum rainfall intensity in the three stations for the past eleven years (2010-2020) is about 39.7mm/hr NMA (2021).

Table 3.1: Average monthly total rain fall of Adama (in mm) 2010-2020

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	5.6	13.9	54.2	58.9	54.4	73.1	293.9	196.5	139.6	26.4	22.8	5.7

Source: NMA (2021)

Temperature

Adama and its environs lie on various climatic zones *Weina-Dega* (sub-tropical) or *Qolla* (tropical) climate zones describe the area according to traditional altitude and temperature classifications. The mean annual temperature is between 19 and 22°C. It can be classified as semi-humid to semi-arid climate, which characterizes the altitude range between 1300 to 1800m a.s.l. The Maximum temperatures usually occur between March and May; the maximum temperature in this period can exceed 30^{o} C. The temperatures are at their lowest in November (NMA, 2021).

Wind

Greater evaporation loss and lower runoff occur when wind velocity and temperature are high. According to NMA statistics from the last five years (2016-2020), the average wind velocity at 2 meters above ground level varies from 1.08 meters per second in September to 2.12 meters per second in March. This shows the wind speed at Adama is high (NMA, 2021).

3.1.7. Natural hazards

Landslides

Rockslides are common features observed around the city of Adama especially along the ridges exploited by quarrying activity. Small-scale rock fall at fault escarpment and continuous slump at valleys and stream channels are common. The city is endowed with the presence of many fault escarpments, loose alluvial deposit and internal tectonic. In the city of Adama landslide prone areas are those located along ridges where quarrying activity is taking place (Alula, 1992). The city and its environs are characterized by deep gullies called inverse gullies that are deep up stream and shall owing downstream that cut through loose tuff deposits. Since the nature of gullying is deep around the town, there is serious risk of sliding along the gullies that cause gully widening. Such activity consumes farmland by increasing soil erosion. The areas affected by erosional gullies are located around Boku, north of Adama (around cemeteries), and behind Migira ridge on the way to Wolenchiti (ASTU, 2016).

Flooding

In Adama city, flooding is a significant natural hazard ascribed to its position within the f lat lying rift. The main causes of flooding are heavy rain, high water table, and culvert damage or blockage (ASTU, 2016).The city is exposed to different problems such as soil and water conservation, which led to severe flooding problems. Urbanization (horizontal expansion) of city, industrialization, road construction and negative human intervention has fueled the flooding hazardous though out the city and the surroundings rural. The threat of the flooding is increasing from season to season (ASTU, 2016).

3.1.8 Demographics

According to the 2020 CSA population projection statistics, Adama's total population is predicted to be 414,240 people. Males make up 202,747 of the total population, while females make up 211,493 (CSA, 2020).

The city is home to a diverse range of ethnic groups and population kinds. The Oromo ethnic group accounts for 39.02 percent of the population in Adama, followed by the Amhara (34.53 percent) and Gurage ethnic groups (11.98 percent) and finally the Silte (5.02%). All other ethnic groups constitute 9.45% of the city's population. In terms of religion, around 63.62 percent of the population is Orthodox Christian, 24.7 percent is Muslim, and 10.57 percent is Protestant (ACA, 2020).

3.2. Research design and aapproach

Based on the purpose and the predetermined objectives of the study, this research was carried out using cross-sectional study design with mixed approaches (quantitative and qualitative). Since, the two approaches have their own limitations, researchers felt that biases inherent in any single approach could neutralize or cancel the biases of other approaches. On the other hand, triangulating data sources a means for seeking convergence a cross qualitative and quantitative methods (Creswell, 2009). A mixed method approach was utilized in the present work, a techniques that combines quantitative and qualitative approach sequentially. The qualitative data was used to support interpretation of the findings of the quantitative approach. As such, a mixed methods approach was applied with the assumption that the quantitative data collected through questionnaire supported by the qualitative data gathered through interview, observation and document review to enhance the reliability of the findings of this study.

3.3 Sources of data

The study used both primary and secondary data sources. The primary data collected from the selected household heads living along flood prone areas in Adama, Adama City Administration, Adama municipality, Boku Shenen, Migira Lugo sub-cities experts, elders and sample kebeles. Similarly, National Metrological Agency (NMA) was the most important source for meteorological data (such as temperature and rainfall data) while Central Statistical Authority (CSA) of Ethiopia was used for demographic data of Adama City.

3.4. Sampling design

Adama City was purposely selected for it is one among urban centers prone to flooding risk in Ethiopia. In a follow up, stratified random sampling technique was used to select three *Kebeles* based on the level of risk to flooding. In the City, the level of flooding risk varied from low to high. From within each level of risk areas one *kebele* was selected: namely, High risk (*kebele* 02 around Migira area); medium risk *(Kebele* 03 around Tikur Abbay) and little/low risk *kebele* (*kebele* 04 around OBN and Adama University).

The stratification was done to capture maximum variability of the problem under investigation. Households within the selected *Kebeles* were selected using systematic random sampling at an interval of 5 households. Thus, a combination of sampling techniques was employed to select household heads for interview. For qualitative data, samples were selected based on the informants' knowledge and direct relevance on the issue under investigation. Thus, 6 individuals who are unit heads and experts from the Municipality, and 4 purposely selected individuals from sampled *Kebeles* who have deep insight were taken as participants of the study.

3.5 Sampling procedures and sample Size

In order to determine the sample size of the study area, the researcher considered the following concepts. Target population refers to the population for which the conclusion will be made. In this study, the flood vulnerable households around Adama city will serve as a target population. Sampling frame is the actual set of household lists from which samples will be drawn. Since the list of households of the selected *Kebeles* was incomplete, we used local guides to delineate the administrative boundaries. Therefore, households were the primary sampling units on which our data collection was based and analysis was conducted using the responses of households.

For this study, the sample size was determined using (Cochran, 2007) Sampling Techniques for Data analysis was employed. The formula is shown here under:

$$n = \frac{Z^2}{d^2}\, p(1-p) \times Deff$$

$$n = \frac{1.96^2}{0.05^2} \times 0.884(1-0.884) \times 2 \approx 312$$

Where, $\boldsymbol{n}$ is the sample size,

$\boldsymbol{Z}$ is the 95th percentile value of a standard normal distribution

$\boldsymbol{d}$ is margin of error which is assumed to be 5% which is common in social science research

$\boldsymbol{p}$ is proportion of flooding risk perception among households (88.4% taken from a study conducted in Nigeria (Oyatayo et al., 2016))

Deff refers to design effect. In the present study, a design effect of 2 was assumed as the sampling design used was a combination of stratified for clusters and systematic random sampling for households.

3.6 Instruments and procedures of data collection

In order to achieve the objectives of the study, primary data was collected through structured questionnaires, key informant interviews. Primary data was gathered from households. In an effort to augment the primary data and make this research work more valid and worthy, all relevant secondary sources pertinent to the study were reviewed. Accordingly, different written documents both published and unpublished books, journals, research works, reports etc, in relation to the issue under consideration.

3.6.1 Structured Questionnaire

In this study a structured questionnaire was designed using literature as a basis. The researcher prepared the questionnaire for sample of 312 households of three selected *kebeles*. The researcher prepared scaled questions (Likert and rating scales) as well as multiple and open ended questions which were used to judge the feeling, attitude and perception of the households. The questionnaire consisted of households' flood experience, knowledge, information, levels of preparedness and protection measures and confidence in officials and institution to tackle flooding problems in the study area *(For details see Appendix A).*

The following questions were used to measure perception and worry. Every respondent is given score based on these questions. Every respondent is scored on the each of the 4 perception questions so as small scores correspond to less level of perception and higher

scores refer to desirable perception. Similarly, scores of the level of worry were based on 6 non-spatial risk factor questions where smaller scores on the scale refer to absence of worry and larger scores indicate a higher level of worry. Ideally, the scores for the level of perception and worry range from 0 to 10 and 0 to 24, respectively.

Table 3.2: Major measuring questions for perception and worry

SN	Perception Questions	Minimum	Maximum
1	Is the location of your residence vulnerable to flooding?	0	1
2	Level of risk of flooding in your area	0	4
3	Is level of risk of flooding reducing, same or increasing in Adama City?	0	2
4	How likely is the risk of flooding in the broader area of your residence in the future?	0	3
	Sum	**0**	**10**
	Worry Questions (Non-spatial factors)		
1	I think about flooding a great deal	0	4
2	I am concerned about the possibility of major storm	0	4
3	Major flood is likely to occur in the next 10 years	0	4
4	Major flood is likely to cause property damage	0	4
5	My community is vulnerable to the risk of major floods	0	4
6	People in my community have a great dread of major floods	0	4
	Sum	**0**	**24**

3.6.2 Key Informant Interviews (KII)

Regarding the key informant interview, the investigator developed some guiding items related to perception of and response to flooding risk in Adama City with specific reference to the households of three *kebeles* of different risks residing along flood prone areas. Since interview is a source of data that can provide peoples' experience, opinions, aspirations and feelings (Kitchin and Tate, 2000) cited in Selamawit, 2018), a total of ten persons of whom 6 individuals who are unit heads and experts from the Municipality, and

4 purposely selected individuals from sampled *kebeles* who have deep insight were interviewed for the study *(For details see Appendix B).*

3.6.3 Field observation

Since Field observation is a method where people can observe real location and situation, the researcher had a chance to see the actual condition of the flood prone areas particularly the ecological and other effects of flooding hazard in the study area. Pictures were taken, passions of the respondents were high, and the researcher even had an actual flooding encounter in Migira area during the data collection *(For details see Appendix D, E, F& G)*

3.7 Data collection and processing

A Computer Assisted Personal Interview (CAPI) technique with KoBoCollect application software was used to gather data from selected households. Five trained data collectors that have at least BSc degree were recruited for the data collection. A one day briefing was given to the data collectors on the purpose of the research, the tools and art of posing questions. The overall data collection process was supervised by the researcher on site. Data collection started on July 28/2020 and completed on July 31/2020. Data cleaning was performed on daily basis and feedback was given to data collectors every morning before starting their daily data collection routine. The collected data finally was exported to Microsoft excel for further analysis. Besides, qualitative data were collected during the month of August 2020.

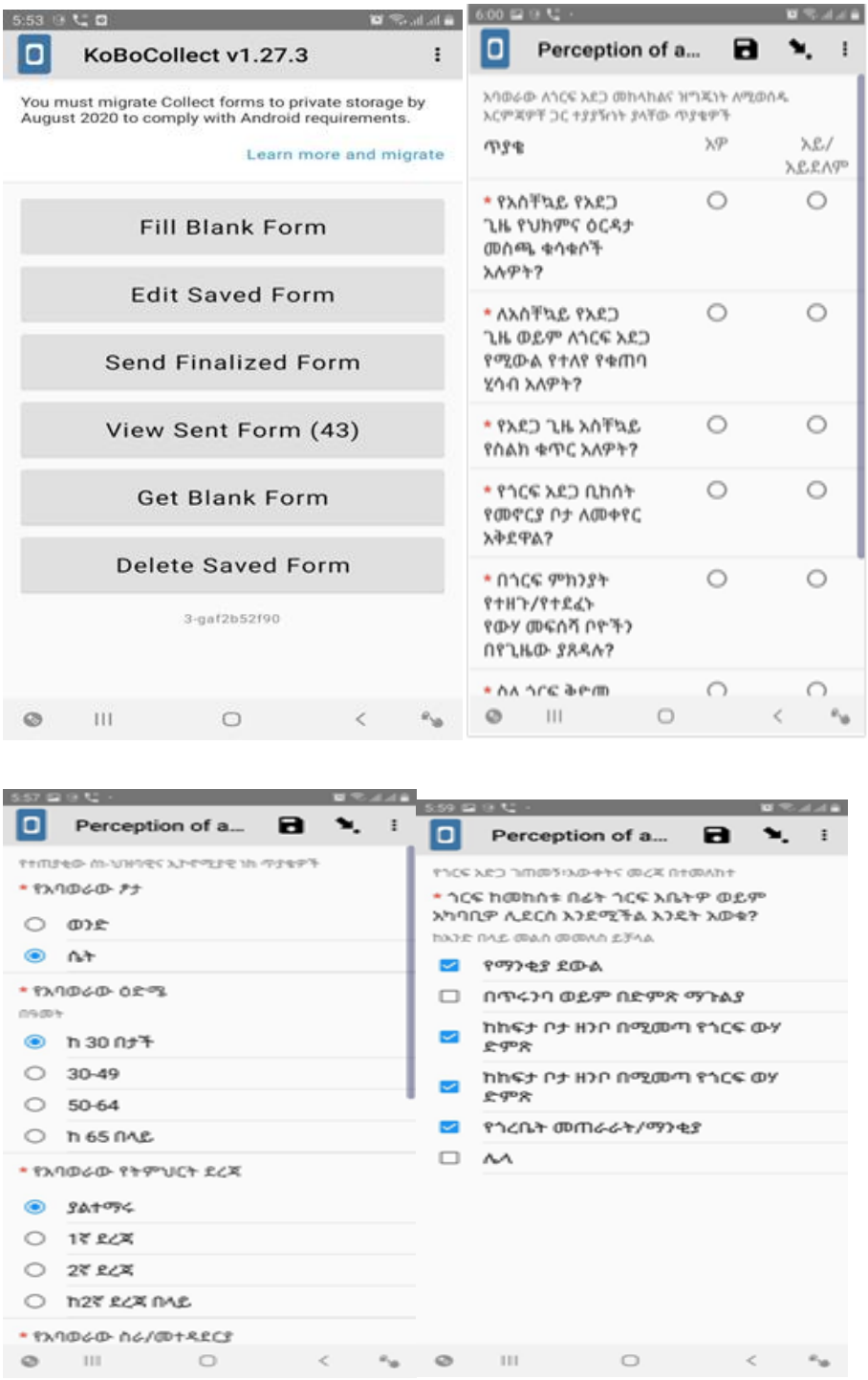

Figure 3: Picture of mobile app which shows while data were in it.

(Source: Own, July 2020)

3.8 Data analysis

After data has been cleaned, analysis was conducted using STATA 14. Simple descriptive analysis including tables and graphs were produced. To identify determinants of flooding risk perception, a multiple linear regression model was fit. A 5% level of significance was used to declare statistical significance in this study.

Analysis for qualitative data gathered through interview guideline and direct observation in relation to flooding risk perception and response were made through concept clarification and opinion discussion in line with the data gathered through questionnaire. In this study, the qualitative data was presented together with the quantitative data so that triangulation was possible.

3.9 Ethical consideration

Efforts were made to make the research process professional and ethical. To this end, the researcher has attempted to communicate the respondents about the purpose of the study i.e. purely for academic. As it was introduced in the introductory part of the questionnaire, respondents and informants assured that, confidentiality would be protected. In addition, participants of the study were involved in the study based on their consents. The researcher also did not personalize any of the response of the respondents during data presentation, analysis and interpretation. Furthermore, all the materials used for this research have been duly acknowledged.

CHAPTER 4: RESULT AND DISCUSSION

The purpose of this study was is to assess perception of and response to flooding risk in Adama City with specific reference to the households residing along flood prone areas. This chapter dealt with presentation, analysis and interpretation of the data gathered via the structured questionnaire from households, Key Informants interviews from the residents and heads and experts of Adama City Administration and Field observation employing descriptive and inferential statistics.

4.1. Background characteristics of respondents'

Three different flood risk areas, namely; high risk, middle risk, and low or risk free areas were covered. In each of the sites, equal numbers of households were interviewed and the background characteristics were displayed in Table 4.1 below. Overall, an almost equal number of male (49.0%) and female (51.0%) respondents were interviewed. However, when disaggregated by site, while more women were interviewed from the high risk area (61.5%), an exceedingly high number of women were interviewed in the medium risk (61.5%) and low risk (52.9%) areas. Large numbers of the respondents were from the age group 30-49 years old and elderlies contribute to only 8.0% of the sample. Nearly a quarter of the sample (23.1%) constitutes young individuals of age less than 30 years. A large portion of the respondents from high risk (47.1%) and medium risk (53.8%) had a primary level of education; however, in the little/no risk area, a little more than two in five (43.3%) of the respondents had an above secondary level of education (Table 4.1).

With regard to occupation of respondents, 8.0% constituted government employees, 11.5% in the risk free and 4.8% in high risk areas. Nearly three in ten (28.5%) were

unemployed and half (50%) were engaged in own business, trading, farming, or working as a daily laborer. On average, five family members reside among the interviewed households; which is also similar across study sites. The average duration of residence in the area for the respondents was 13 years and the average monthly income of households of the study area was 3,000 Birr. The result also indicate that households residing in medium and high risk areas had lower monthly income (2000 Birr) as opposed to households of little/no risk area (5000 Birr). Moreover, the little/no risk areas are new residential area on the main, with an average duration of residence in the area of 8 years while households found in the medium (13 years) and high risk areas (20 years) are older and informal settlements around the periphery of Adama city (Table 4.1).

Table 4.1: Background characteristics of respondents by risk of residence, Adama City July 2020

Characteristics and categories		Risk Area						Total	
	High Risk			Medium Risk		Little/No Risk			
	No.		Percent	No.	Percent	No.	Percent	No.	Percent
Sex	Female	40	38.5	64	61.5	55	52.9	159	51.0
	Male	64	61.5	40	38.5	49	47.1	153	49.0
Age	Below 30	16	15.4	18	17.3	38	36.5	72	23.1
	30-49	52	50.0	61	58.7	38	36.5	151	48.4
	50-64	23	22.1	18	17.3	23	22.1	64	20.5
	65+	13	12.5	7	6.7	5	4.8	25	8.0
Education	No formal schooling	21	20.2	9	8.7	15	14.4	45	14.4
	Primary	49	47.1	56	53.8	12	11.5	117	37.5
	Secondary+	21	20.2	21	20.2	32	30.8	74	23.7
	Above secondary	13	12.5	18	17.3	45	43.3	76	24.4
Occupation	Civil servant	5	4.8	8	7.7	12	11.5	25	8.0
	Daily laborer	14	13.5	12	11.5	3	2.9	29	9.3
	Farmer	6	5.8	1	1.0	-	-	7	2.2
	Merchant	15	14.4	15	14.4	17	16.3	47	15.1
	Others*	16	15.4	15	14.4	11	10.6	42	13.5
	Self-employed	22	21.2	23	22.1	28	26.9	73	23.4
	Unemployed	26	25.0	30	28.8	33	31.7	89	28.5
Total	**104**		**100.0**	**104**	**100.0**	**104**	**100.0**	**312**	**100.0**
		Median		**Median**		**Median**		**Median**	
Family size		5.0		5.0		5.0		5.0	
Monthly income		2000		2000		5000		3000	
Duration of residence		20.0		13.0		8.0		13.0	

* **Others include housewife and pensioner**

4.2 Flood experience, knowledge and information

Overall, more than half of the respondents (53.8%) had an actual flooding experience. When disaggregated by risk area, the magnitude of actual experience by households shows an exponential increase across risk area; almost none-existent among households in no/little risk area (4.8%), three in five in medium risk area (59.6%) and almost all in high risk area (97.1%) (Figure 4). The damage it caused to households of different risk area was also disproportionate. While high to complete damages were reported by households residing in high risk area, moderate and slight damages were recorded by households of medium and little/no risk areas, respectively.

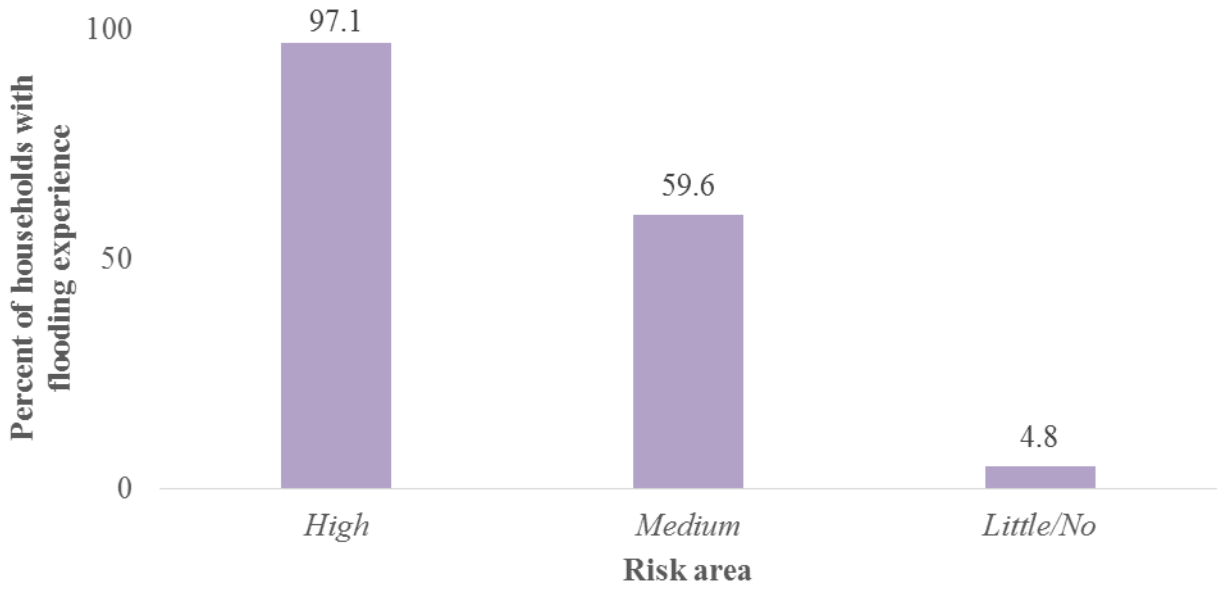

Figure 4: Flooding experience of households by risk area, Adama City, July 2020

Despite high damages encountered, people decided to continuously reside in medium and high flooding risk areas for many reasons. The popular reason stated by respondents for

staying in the areas for long were: 1) lack of an alternative (50.0%), 2) to maintain ties with family, social institutions and friends (35.6%), and 3) attachment with the area as they stayed in the area for a long time (35.6%). Low cost of land and housing (19.2%) along with proximity to work or business location (8.6%) were also mentioned as reasons but to a lesser degree. Absence of a proper early warning system is also a challenge that households residing in medium and high flood risk areas encountered. Households calling each other verbally via door-knocking (68.3%), sound of runoff from upper catchment (35.1%) and rainfall intensity (31.7%) were the main mechanisms that inhabitants use as an early flooding warning system (Table 4.2). However, the information obtained from key Informants revealed that there was no responsible body for Early Warning System from government side and no body warned them to protect themselves and their property ahead of flood occurrences.

Table 4.2: Reasons of attachment to residence and flooding warning systems among households in medium and high flooding risk areas, Adama City July 2020

Reasons for continuously residing in the area*(n=208)	No.	%
Lack of an alternative	104	50.0
To maintain ties with family, social institution and friends	74	35.6
Stayed in the area for a long time	74	35.6
Low cost of land and housing	40	19.2
Proximity to work or business	18	8.6
Area is not crowded	4	1.9
Warning systems*(n=208)		
Neighbors calling each other	142	68.3
Sound of runoff from the upper catchment	73	35.1
Rainfall intensity	66	31.7
Other	17	8.2

Percent do not sum to 100 as these are responses of multiple response questions

Information and knowledge are precursors to flooding risk perception of households and the level of preparedness and protection measures against flooding taken by households. About three quarters (78.8%) of households of high flooding risk areas reported of having a regular discussion held with government authorities regarding flooding risk. While about half of the respondents in medium risk area (54.8%) reported of having the same discussion, the discussion is less prevalent and uncommon in areas that are little affected (4.8%). The most popular source of information for extreme weather particularly flooding is TV (77.2%) followed by internet (19.6%) which is common specifically in the affluent areas of the City. Radio (17.0%) and community elders (12.2%), however small the magnitudes are, were also used as a source of information for extreme weather by households (Table 4.3).

It is only a handful of households that check extreme weather and flooding information regularly (14.4%). About a quarter of the households (27.6%) reported of checking extreme weather information occasionally. The majority of the households check information on extreme weather and flooding less frequently or not at all (58.0%). It is also observed that there are fatalistic individuals that believe flooding is a wrath of God (10.9%). Many understand that flood is a natural hazard (56.1%), a relatively high flow of water that oversteps the natural channel provided for runoff (42.0%), and natural response of rivers/streams to excess water (41.7%) (Table 4.3).

Table 4.3: Information and knowledge of households on flood, Adama City July 2020

Discussion about flooding with authorities	No.	%
High risk area (n=104)	82	78.8
Medium risk area (n=104)	57	54.8
Little/No risk area (n=104)	5	4.8
Source of information for extreme weather and flooding*(n=312)		
TV	241	77.2
Internet	61	19.6
Radio	53	17.0
Community elders	38	12.2
Awareness about flood*(n=312)		
A natural hazard that causes destruction	175	56.1
A relatively high flow of water that oversteps a natural channel for runoff	131	42.0
Natural response of river/stream to excess water	130	41.7
Wrath of God	34	10.9
Frequency of checking extreme weather and flooding information (n=312)		
No	52	16.6
Rarely	129	41.4
Sometimes	86	27.6
Regularly	45	14.4

* Percent do not sum to 100 as these are responses of multiple response questions

4.3 Perceived causes and effects of flooding

Respondents were asked to state the origins of flooding in their area. According to their response, they indicate that the main causes of flooding in the area were heavy rain (98.1%), lack of protective or retaining construction (84.6%) and its maintenance (84.3%), and poor urban drainage structure (79.8%). Overflowing rivers, topographic location, unplanned human settlement, and deforestation were mentioned as second order causes of flooding in the area. The most notable effects of flooding in the area were also stated. The leading effects were a) damage house (91.1%) and destroyed household equipment (90.1%), b) loss of infrastructure (52.0%) and c) health concerns (40.4%) (Table 4.4).

Table 4.4: Causes and effects of flooding in the study area, Adama City July 2020

Causes and effects of flooding	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Heavy rain	-	0.6	1.3	**4.5**	**93.6**
Overflowing rivers	16.4	27.6	2.2	6.7	47.1
Lack of protective construction/ retaining structure	1.6	10.3	3.5	**10.6**	**74.0**
Lack of maintenance of protective/retaining structure	1.3	10.6	3.8	**10.9**	**73.4**
Topographic location	6.4	18.0	5.8	12.5	57.4
Poor urban drainage structure	1.9	15.1	3.2	**10.9**	**68.9**
Unplanned human settlement	7.7	27.6	3.8	10.6	50.3
Deforestation or lack of vegetation	3.8	28.5	4.5	9.9	53.2

Effects of flooding* (n=312)	No.	%
Destroyed my house	275	91.1
Destroyed household equipment	272	90.1
Loss of infrastructure	157	52.0
Health concerns	122	40.4

*** Percent do not sum to 100 as these are responses of multiple response questions**

Qualitative data from KII and the researcher field observation supplement that flooding in Adama has frequently had disastrous consequences on people, animals and properties. The following figure can illustrate how properties are flooded. It further show us that the residence and properties with in and the surrounding drainage lines and infrastructures are flooded and the flooding risk/hazard significantly impacted the socio-economic activities as a result.

Figure 5:Image showing flooded house and properties.

(Source: Own, July 2020)

4.4 Flooding risk perception

The flooding risk perception of residents showed a marked difference over the different flooding risk areas. Respondents residing in a medium and high flood risk areas had a remarkably high magnitude of flooding risk perception than respondents residing in little/no flooding risk area. Although the average flooding perception of respondents living in medium and high flooding risk areas are higher, a t-test indicates that the averages are significantly different (P-value=0.001) putting respondents of high flooding risk area at advantageous position (Figure 6).

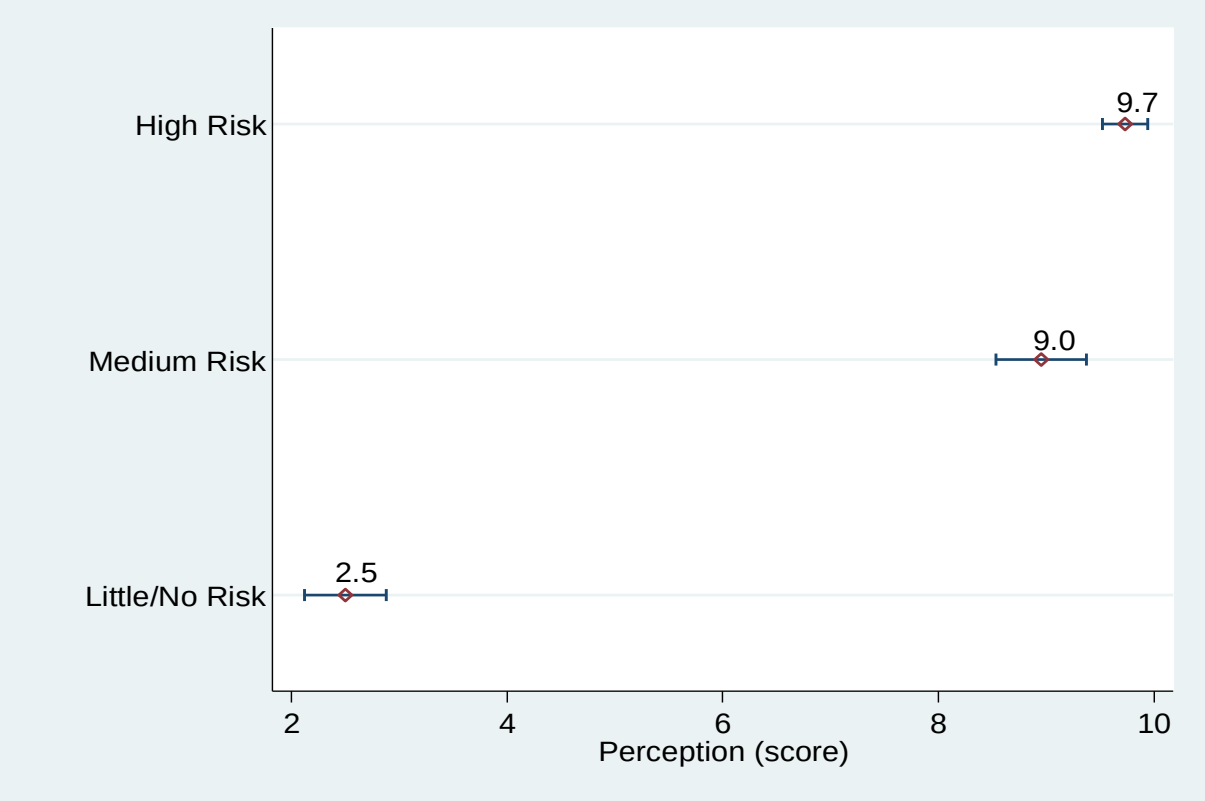

Figure 6: Flooding risk perception-mean score and 95% confidence interval plot-by risk area, Adama City July 2020

Householders, particularly medium and high flood affected areas, were greatly worried or concerned about future flood occurrences, 81.7% and 93.3%, respectively. Despite the elevated flooding risk perception and worry of future occurrence of flooding, the majority of households were not aware of information issued by local authorities on extreme weather (71.2%). Moreover, the confidence on public officials for protection against flooding hazards are very shaken, 59.6% and 86.6%, respectively, among households of high and medium flooding risk areas (Figure 7).

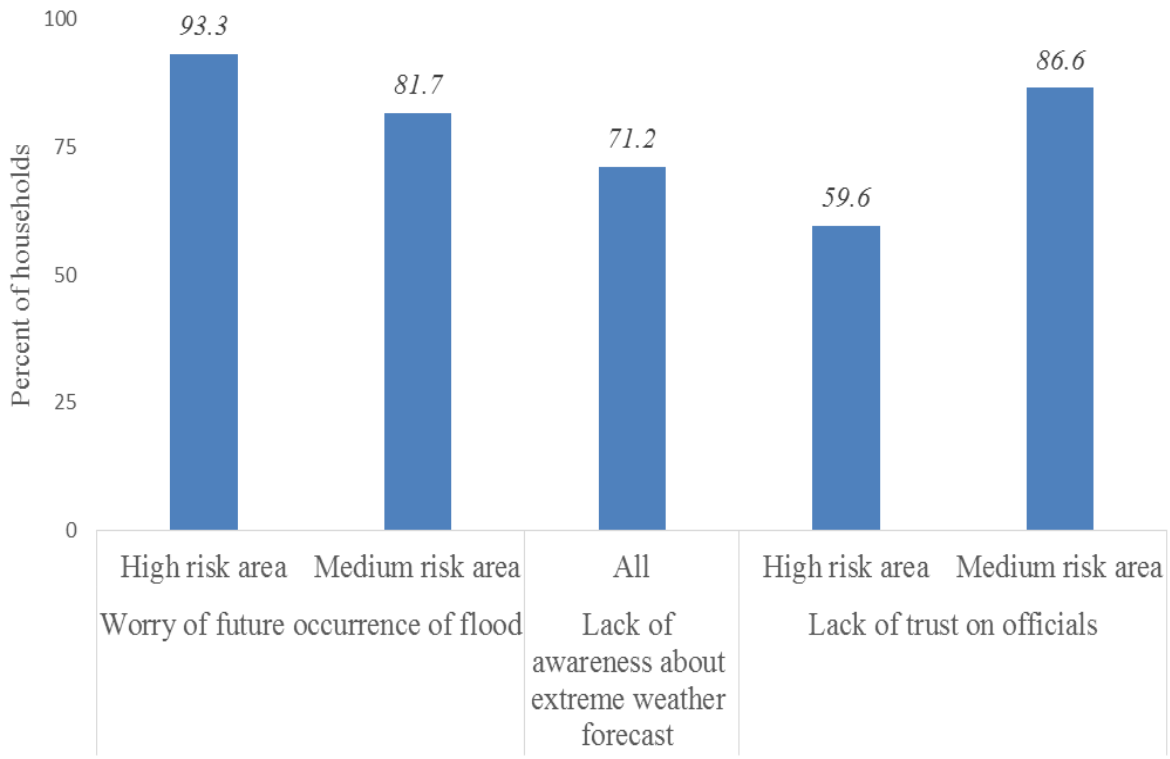

Figure 7: Worry, awareness and trust on officials, Adama City July 2020

Besides, the key informants told me that they have great anxiety of flooding incidence particularly in high and medium risk areas. Some informants genuinely reported that the

government authorities took no notice of flooding problem around Migira and Lugu Kebeles. Hence, there is lack of trust on government officials and institutions.

4.5 Preparedness and response measures

Respondents have a strong belief that residents should take measures to protect themselves or their property from flooding (93.0%). However, it is about two in five (42.3%) of the households that had a plan that has been implemented to prevent the household from flood before its happening, during the event and post hoc. It is only in a quarter of these households (24.2%) that the coping strategy was effective. A coping method most often employed by households when flood occurs stated by the respondents in order of magnitude were: a) filling sand in bags and placing around the edges of the premise (83.3%), b) diverging the water way to other parts (28.8%), c) evacuate sand from blocked drainage (21.2%), d) moving to higher ground (19.6%), and evacuating from premise (9.9%) (Table 4.5).

Table 4.5: Preparedness and response measures of households against flooding, Adama City July 2020

Residents should take measures to protect themselves against flooding (n=312)	No.	%
Strongly disagree	222	71.1
Agree	68	21.8
Difficult to decide	18	5.8
Disagree	1	0.3
Strongly disagree	3	1.0
Have a strategy to prevent flooding (n=312)	132	42.3
Coping strategy was effective (n=132)	32	24.2
Coping strategies usually employed by households* (n=312)		

Residents should take measures to protect themselves against flooding (n=312)	No.	%
Filling sand in bags and place around the edges of the premise	260	83.3
Diverging the water way to other parts	90	28.8
Evacuate sand from blocked drainage	66	21.2
Moving to higher ground	61	19.6
Evacuate from the premise	31	9.9

*** Percent do not sum to 100 as these are responses of multiple response questions**

Figure 8: Shows sandbags as a blockage of flooding water.

(Source: Field Photograph, July 2020)

Figure 9: Image showing a retaining wall-like structure with a hollow block to defend flooding.

(Source: Field Photograph, July 2020)

From figure 8 and 9, one can understand that during or before the flooding season, the flood-plain households employ different strategies so as to minimize the harm caused by flooding hazard and some householders during our discussion reported that during rainy season they always forced to leave their residence and rent houses where there are little or no damages of flooding.

The householders place sand bags across doorways and cover all drainage holes and floor drains to stop back flow of flooding water as a mechanism for flood protection (Figure 8). Besides, during rainy season, the residents make a retaining wall-like structure with a hollow block to defend flooding hazard. Such walls are essential for holding soil and preventing erosion. They can also deter flood water by directing the water toward the

street. That means according to the householders understanding retaining water can protect their property from flood damage (Figure 9).

A quarter of the respondents (26.0%) attested that authorities were willing to take necessary measures to reduce flood damages. Similarly, the support provided from government and non-government organization to prevent flood before, during and after happening (12.2%) was limited. The actions that government authorities usually take in combating the risks of flooding were: a) Early warning (75.3%), b) cleaning and maintaining drainage system (36.9%), and c) facilitating evacuation (12.8%) (Table 4.6).

Table 4.6: Preparedness and response measures by GOs and NGOs, Adama City July 2020

Items	No.	%
Willingness of authorities to take necessary measures (n=312)	81	26.0
Support from GOs and NGOs to reduce flood damages (n=312)	38	12.2
Actions taken by government authorities* (n=312)		
Early warning the community	235	75.3
Cleaning and maintaining drainage system	115	36.9
Facilitating evacuation	40	12.8

*** Percent do not sum to 100 as these are responses of multiple response questions**

Moreover, during our discussion with KII experts and heads of Adama Municipality unheedingly reported that the City does not have responsible government body that strongly follow up the issue of flooding problems and other natural disasters.

4.6 Factors influencing flooding risk perception

In this section, we will have a description about contributing factors to the flooding risk perception of households. The results of a multiple linear regression are displayed in the

table below and the description below is based on the result displayed in Table 4.7. The predictor variables included in the model were sex, a site of the household, educational level, age, and level of worry. The fit model performs best as is implied by a high value of coefficient of multiple determination (R-squared=0.82).

The results indicate that the flooding risk perception of male and female respondents is similar in the study area. The flooding risk perception of individuals of age less than 30 years is better than older people. On average, the score for young respondents is higher by 0.451 after adjusting the influence of other spatial and non-spatial predictor variables. The level of education of respondents does not have an influence over their flooding risk perception. Moreover, the results portray that the level of worry of individuals is positively and highly correlated with their flooding risk perception after controlling the influence of other factors. In fact, the average score of flooding risk perception increases by 0.210 for each unit increase in the score of level of worry.

Finally, it is observed that the location of respondent's residence had a statistically significant influence over flooding risk perception. Respondents residing in low risk area on average scored 5.169 below the reference category after controlling the influence of other predictor variables. Similarly, respondents residing in medium risk area on average scored 0.676 less than residents of high flooding risk area after the influence of other variables are removed.

Table 4.7: Result of a linear regression analysis for score of flooding risk perception, Adama City July 2020

Predictors	Coef.	Standard Error	t-value	p-value	[95% Confidence Interval]		Sig
Sex [Female (*Ref*)]							
Male	0.085	0.191	0.44	0.659	-0.292	0.461	
Age [30-49 (*Ref*)]							
Below 30	0.451	0.238	1.90	0.059	-0.017	0.919	*
50-64	0.130	0.254	0.51	0.609	-0.369	0.629	
65+	0.117	0.387	0.30	0.762	-0.644	0.879	
Site [High risk area (*Ref*)]							
Medium risk area	-0.676	0.228	-2.96	0.003	-1.124	-0.227	***
Little/no risk area	-5.169	0.343	-15.08	0.000	-5.843	-4.495	***
Education [Above secondary (*Ref*)]							
No formal schooling	0.125	0.360	0.35	0.729	-0.583	0.832	
Primary	0.269	0.262	1.02	0.307	-0.248	0.785	
Secondary	0.139	0.266	0.52	0.601	-0.384	0.662	
Level of worry	0.210	0.023	8.97	0.000	0.164	0.256	***
Mean Perception score		7.061	SD Perception score			3.703	
R-squared		0.822	Number of observations			312	
F-test		139.098	Prob > F			0.000	
Akaike crit. (AIC)		1184.593	Bayesian crit. (BIC)			1225.766	

**** p<0.01, ** p<0.05, * p<0.1*

4.7 Discussion

The level of flooding risk perception in Adama city varied across different background characteristics, social strata, and level of risk of sites. Younger age group and better income predicted enhanced understanding of vulnerability to flooding and future expectation of flood occurrence in their neighborhood and in the city in general. In addition, the study indicated that more than half of the sample population had no plan of protection and even those reported to have plan were unfortunately ineffective.

According to Whitmarsh (2008) direct experience of flooding is fundamental in accepting that flooding poses a genuine personal risk. Flooding experience and associated potential loses have a sound effect on the level of flooding perception and response or protection measures of households (Bhattacharya-Mis & Lamond, 2014; Harvatt et al., 2011). In line with this, we have discovered that the location of respondent's residence and repeated past experience had a substantial influence over flooding risk perception. Our finding corroborates with the finding reported in Slovenia and Nigeria that states peoples' experience with floods and their awareness of flooding varies from one area to another (Brilly & Polic, 2005; U. Unaegbu, 2014).

High risk areas are informal older settlements around the periphery of Adama city and frequently affected by flooding. For instance, key informants discussion showed that among the total households in Kebele 02 (Migira area), 85% of settlements are illegally occupied; where the inhabitants are under big threats of flooding. The area is characterized by absence of a drainage system as a result of which households encounter repeated risks of flooding. A similar finding is reported in a study conducted in Mombasa which identified informal settlements are prone to flooding having a high level of

perception of flooding due to multiple encounters of flooding and its consequence (Okaka & Odhiambo, 2019). In the opinion of Nyakundi et al. (2010) flooding experience had a role in the determination of how individuals perceive and react to future flood events. The result relate to the argument that flooding risk perception is connected with the person knowing that they reside in flood prone areas.

Warning systems are a way of getting information about threatening event of flooding, communicating that information to those who need it, and facilitating good decisions and timely response by people in danger (Kammerbauer & Minnery, 2019). Thus, early warnings are key in stimulating instant response to flooding and develop an effective mitigation measure (Harvatt et al., 2011). However, according to qualitative data result; this study came up with absence of strong early warning system from the government side and considered as a challenge that households residing in medium and high flood risk areas encounter. Households calling each other verbally via door-knocking, sound of runoff from upper catchment and rainfall intensity were the main mechanisms that inhabitants use as an early flooding warning system.

Information and knowledge are precursors to flooding risk perception of households and the level of preparedness and protection measures against flooding taken by householders. A large portion of households from high and medium risk areas had discussions with government authorities about flooding. However, many of the respondents do not trust or have confidence on government officials. TV was the major source of information for flood and extreme weather changes. Consistent with our finding, Krasovskaia et al. (2001) reported local radio as a best information source for the majority, followed by national TV and local newspapers. Besides, local radio was the

most credible source of information about flood forecasts. Internet is probably not so widely used, especially concerning warnings. Thus, radio and TV are much more useful in this sense and were also perceived as such (Brilly & Polic, 2005).

The study revealed a number of perceived causes stated by households residing along flood prone areas. As such, the major perceived causes of flooding in the area were heavy rain, absence of protective or retaining construction and its maintenance, and poor urban drainage structure. Overflowing rivers, topographic location, unplanned human settlement, and deforestation were also mentioned but to a lesser extent as perceived causes of flooding in the area. The result matches with works of different writers that identified low elevation, high intensity rainfall, and poor drainage system were mentioned as causes of flooding (Uneaegbu, 2014, Oyatayo et al., 2016, Dejene et al., 2017).

Major consequences encountered by respondents were damaged house and destroyed household equipment, loss of infrastructure and health concerns. Similarly, Unaegbu (2014) has mentioned in his study that flooding has various impacts notably; damage to, and deterioration of buildings, loss or damage to household property, damage to roads, displacement from homes, prevalence of malaria and other diseases and disruption of movement. In keeping with this finding, Okaka & Odhiambo (2019) also arrived at the conclusion that flooding danger has high impact on the health of households.

It has been attempted to look in to the householders' preparedness and response measures in which almost the majority strongly believed they should take measures to protect themselves or their property from flooding. Households in the study area employed different response mechanisms to protect themselves from flooding. The frequent

protecting methods was filling sand in bags and placing around the edges of the premise as well as making a retaining wall-like structure with a hollow block. But, these mechanisms unfortunately proved to be ineffective in recent years due to the rise in rainfall intensity. Moreover, some dwellers in the study area usually evacuate from their houses (either for rent or for staying with their relatives) before the rainy season begins as a flood defending mechanism. On the other hand, the support provided from government and non-government organizations to prevent flood before, during and after happening was also limited. The default action that government authorities usually take in combating the risks of flooding in the area is early warning the community. But, key informants reported it was not strong. Likewise, the report from qualitative data and KII reveal that Adama has no legal institution that strictly works on flood hazard and other natural calamities.

Flooding risk perception of male and female respondents is similar in the study area. The flooding risk perception of individuals of age less than 30 years is higher than older people. The finding of this study is in contradiction with the study by Kellens and colleagues that reported risk perception is higher with females and when respondents are older (Kellens et al., 2011). The variance could be explained by methodological difference of measuring risk. While our study was based on vulnerability to flooding and current and future flooding risk assessment, Kellens and colleagues work depended on worry, consequences and future expectations. Location is another factor found to influence flooding risk perception of households. Congruent to our finding, Kellens and colleagues reported that higher risk perception was measured in high risk locations (Kellens et al., 2011).

In our study, we found that educational status does not affect the flooding risk perception of people living in a flood plain. Rather, it is the level of worry of individuals that is positively and highly correlated with their flooding risk perception. Consistent with our finding, Oyatayo et al. (2016) reported that the level of education of respondents does not have an influence over their flooding risk perception. Worry is a product of past experience and future expectation of flooding and its consequence. As a result, when worry about flooding is absent, risk perception of flooding of individuals may not exist and hinders them from developing mitigation strategies for future flooding events.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The study assessed perception of and response to flooding risk in the study area. The findings show that the study area particularly the high and medium risk areas are densely populated informal settlement lacking infrastructure including masonry ditch and cut off diversion for overflowing water.

The level of flooding risk perception in Adama city varied across different background characteristics, social strata, and level of risk of sites. The findings revealed a greater level of perception of flood risk in the high and medium risk areas in comparison with the low risk areas.

The major perceived causes for flood vulnerability in the study area were heavy rain, absence of protective or retaining construction and its maintenance, and poor urban drainage structure. Also, major consequences encountered by respondents were damaged house and destroyed household equipment, loss of infrastructure and health concerns. Perception of flood risk is influenced by several variables. Young age, past flooding experiences and high level of worry heightened the perception of flooding risk in the study area.

With regard to response measure, the frequent protecting methods by householders were householders' evacuation from their houses, filling sand in bags and placing around the edges of the premise as well as making a retaining wall-like structure with a hollow block. But, these mechanisms unfortunately proved to be ineffective in recent years due

to the rise in rainfall intensity. Moreover, the finding revealed the support provided from government and non-government organizations in pre and post flood time was poor and this affected trust on government officials and institutions.

With regard to Early Warning System, the main mechanisms that the residents use as an early flooding warning system identified were: calling each other verbally via door-knocking, sound of runoff from upper catchment and rainfall intensity. However, there was absence of strong early warning system from the government side. In addition to this, the City has no responsible institution that follows up the issue of flooding and disaster risks.

5.2 Recommendations

Based on the findings and discussions, the following recommendations are provided.

- In order to reduce flood risks in the City, the Adama City Administration must work on developing forestation in the upper catchments (minimize upcoming runoff), flood proofing of buildings (protect/modify lower floors & use upper floors), developing engineering structures (culvert, ditch, etc) especially in informal settlements of flood risk areas with appropriate capacity of rainfall intensity and protecting natural flows during building and infrastructure development.

- The regional government and the City should show more commitment to address the flooding risk problems in the study area. This includes institutionalizing flooding and flood related disaster risks by a separate legal body or at least by a body/desk that can cover disaster risk management activities; preparation of

drainage master plan and flood preparedness plan. Drainage design should have to be developed and flooded areas should be free from any land use for construction purpose.

- The Adama City administration and non-governmental Organizations along with *kebeles*; ought to raise public awareness on flooding and related disasters before, during and after the flood occurs. Also, provide continuous trainings and equipment for managing future floods in the study area to minimize the impact.

- The existing protecting techniques of the residents should be strengthened based on scientific and sustainable strategies. It should also be noted that householders' efforts in risk management measures can be successful with a proper support and follow up of government authorities on how to durably defend themselves.

- Since flood is a sudden hazard, early warning system (EWS) and flood forecasting on which dissemination of information through variety of media should be considered by all levels of government.

- The City Administration should put direction to establish and mobilize fund so as to protect, minimize and cope with flooding that in turn will help for flood insurance and compensation. Thus, the City should encourage the residents to have a saving account for flood risk and should initiate short and long term plans to mobilize funds on volunteer basis and through different modalities like sms, and telethon.

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APPENDICES

Appendix A

ADDIS ABABA UNIVERSITY

College of Development Studies

Environment and Sustainable Development

Questionnaire for Sample Households

Dear respondents: the purpose of this questionnaire is to gather information for conducting a study on **perception of and response to flooding in Adama city.**

The information obtained through this questionnaire will only be used for the research purpose. The quality of this study is highly depends on the information provided by you. Whatever information you provide me will be kept strictly confidential. You do not have to write your names. Thus, you are kindly requested to fill in the questionnaire according to the instructions provided. **Thank you in advance for your kind cooperation!!**

General direction: Please read each of the given items carefully and indicate your choice for items with options and circle your response on the provided items.

I. BACKGROUND INFORMATION OF HOUSEHOLD HEAD

1. Sex: A. Male ☐ B. Female ☐

2. Age: A. below 30 B. 30 - 49 C. 50– 64 D. 65 and above

3. Educational status:

A. Illiterate

B. Read & Write

C. Primary (1 – 8)

D. Secondary (9-12)

E. certificate (new educational curriculum)

F. Diploma

G. Degree & Above

4. Occupation:

A. Farmer B. Daily laborers C. Merchant D. Self-employed

E. Unemployed F. Civil servant G. Others

5. **Number of individuals living in the household** _____

6. **Monthly household income**_____

7. **How long you lived continuously in the kebele (years)?** _____

II. QUESTIONS RELATED TO FLOOD EXPERIENCE, KNOWLEDGE AND INFORMATION

---

8. How do you understand flood?

A. Natural response of a river/stream to excess water

B. Excess water found on a normally dry land

C. A relatively high flow which oversteps the natural channel provided for runoff

D. A natural hazard which causes a lot of destruction

E. Wrath of God

9. Do you feel the location of your home/residence is vulnerable to flooding?

A. Yes

B. No

C. Undecided

10. Do you have a flooding experience?

A. Yes

B. No

11. **If Yes to the above question, how do you rate the damage it caused to your household?**

    A. None

    B. Slight

    C. Moderate

    D. High

    E. Complete

12. **Have you ever had a discussion about flooding risk with government authorities?**

    A. Yes

    B. No

13. **Do you think that your residence is under risk of flooding?**

    A. Yes

    B. No

14. **Is flood risk in your kebele increasing, stays the same or reducing?**

    A. Increasing

    B. Stays the same

    C. Reducing

15. **Rate the level of risk of flooding in your area.**

    A. High risk

    B. Medium risk

    C. Low risk

D. No risk

E. Undecided

16. Why do you decide to continuously reside in the area?

A. Low cost of land and housing

B. Area is not crowded

C. Stayed in the area for a long time

D. Proximity to work or business location

E. To maintain ties with family, social institutions and friends

F. Don't have an alternative

G. Undecided

17. Just before the flood, how did you first become aware that flooding might reach your home or neighborhood? (NB: you can choose more than one)

A. Siren

B. Loud Speaker

C. Rain fall intensity

D. Sound of the runoff from the upper catchment

E. Neighbors calling each other

F. Others _____

18. Source of information for extreme weather especially flooding? (NB: you can choose more than one)

A. Internet

B. TV

C. Radio

D. Printed material

E. Community Elders forecast

F. Other sources

19. When do you check extreme weather and flooding information?

A. No

B. Regularly

C. Some times

D. Rarely

20. How likely do you believe is the flood in the broader area of your residence in the next years?

A. Very likely

B. Likely

C. Neither

D. Unlikely

E. Very unlikely

III. QUESTIONS RELATED TO HOUSEHOLD LEVEL OF PREPAREDNESS AND PROTECTION MEASURES AGAINST FLOODING

21. Should residents take measures to protect themselves or their property from flooding?

A. Strongly agree

B. Agree

C. Neutral

D. Disagree

E. strongly disagree

22. Is there any type of plan or strategy from your side that has been done to prevent the flood before happening, during and after?

A. Yes

B. No

23. In your opinion, is your coping strategy effective?

A. Yes

B. No

24. What coping method you usually use when flood occurs? (NB: you can choose more than one)

A. Moving to higher ground

B. Filling sand in bags and placing around the edges of our premises

C. Evacuate from the premises

D. Diverging the water way to other parts

E. Others_____

25. Do you have a medical kit for disaster emergency?

C. Yes

D. No

26. Do you have a separate savings account for flood or disaster emergency?

A. Yes

B. No

27. Do you keep disaster emergency phone numbers?

A. Yes

B. No

28. Do you have a contingency plan for relocation should flood occur?

A. Yes

B. No

29. Do you frequently evacuate sand from blocked drainages?

A. Yes

B. No

30. Are you aware of any flood warning system?

A. Yes

B. No

31. Do you frequently educate your household about flood disaster?

A. Yes

B. No

IV. QUESTIONS RELATED TO THE PERCEPTION OF FLOOD CAUSES & EFFECTS

The way Household heads perceive the causes that generated amplified floods depend on their information, experience and knowledge level. Please indicate the level of agreement to the following items.

No	Items	Level of agreement					
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Strongly Agree**
32	Heavy rain fall run off						
33	Over flowing rivers/ Shortage of planned Storm Water drainage						
34	Lack of protective construction/retaining structure						
35	Lack of maintenance of protective construction/retaining structure						
36	Topographic location						
37	Poor urban drainage infrastructure/ poor solid waste management						
38	unplanned human settlement						
39	Deforestation or lack of vegetation						
40	New development/construction						

41. Do you have worry or fear about future Flood Occurrence?

A. Yes

B. No

42. Please rate the importance of flood hazards on the basis of the feeling of worry or concern that it causes to you

A. Negligible importance

B. Low importance

C. Average importance

D. Important

E. very important

43. Can you Elaborate or mention the effects the flood has on you and others? (NB: you can choose more than one)

A. Physical Infrastructure Loss (Damage the Street, Drainage, Electric and Others)

B. Destroyed My House

C. Destroyed house hold Equipment's

D. Human Life Loss

E. Pet Animal Life Loss

F. Health Effects

G. Others_____

H. None

44. In your Opinion, how much worth of property was destroyed throughout your tenancy?

A. None

B. 500-1000 birr

C. 1000-2000 birr

D. 2000-4000 birr

E. 4000-1000 birr

F. > 10,000 birr

G. Don't know how much worth

45. Are you willing to relocate to other area/region if flooding recurs?

A. Yes

B. No

46. If your answer to the above question is yes, how are you willing to leave your living area?

A. On my own will

B. Only forced by authorities

C. Only if authorities recommended it

D. Prefer to face the flood

IV. QUESTIONS RELATED TO CONFIDENCE IN OFFICIALS AND INSTITUTIONS

47. How would you assess the level of flood forecasting and flood warning by authorities?

A. Very High

B. High

C. Average

D. Low

E. Very low

48. To what degree do you trust the responsible authorities for your protection against flood?

A**.** Very High

B. High

C. Average

D. Low

E. Very low

49. Are you aware of any extreme weather especially flooding issued by authorities?

A. Yes, I am aware

B. No, I am not aware

50. Have you ever received or read any informational material regarding flood, flood risk and flood protection from government body?

A**.** Yes

B. No

51. Authorities are willing to take the necessary measures to reduce flood damages

A**.** Yes

B. No

52. Is there any help that has been done from the government and/or non-governmental institution side to prevent the flood before happening, during and after?

A. Yes B. No

53. If yes, Please specify,

Before (Prepare and Prevent)

_____

_____

_____

_____

During (Coping)

_____

_____

_____

_____

After (Recover)

_____

_____ _____

54. Do authorities undertake actions to prevent flooding?

A. Yes

B. No

55. If yes, please indicate actions that were taken

A. Cleaning and maintaining drainage system/ditch

B. Facilitating People's evacuation

C. Early warning the community

D. Insurance and compensation

IV. QUESTIONS RELATED TO FACTORS OF FLOOD RISK PERCEPTIONS

No.	Spatial factors	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
56	The physical location reflecting proximity to a hazard (the probability of the occurrence of flood) determines flood risk perception.					
57	The nature of the flood affects flood risk perception.					
58	The extent of the effects and experience of flood affect					

	flood risk perception.					
59	The level of hazard awareness and the degree of its uncertainty are important factors of flood risk perception.					
60	Socio-economic and demographic factors of the population (gender, age, education, income, number of children) can determine flood risk perception.					
61	The residence characteristics (owning a house, type of a building, presence of a ground floor, cellar);					
62	The cultural-historical context influence flood risk perception.					
63	Voluntary/involuntary nature of people influenced by the flood (individuals can perceive a risk differently, depending on whether they are directly influenced themselves, their families are influenced or it regards people they are not connected to emotionally).					

	Non spatial risk perception factors	Strongly agree	Agree	Neither agree nor disagree	Disagree	strongly disagree
64	I think about the risk of floods a great deal.					
65	I am concerned about the possibility of a major storm affecting my community.					
66	It is likely that a major flood will occur in my community in the next 10 years.					
67	A major flood is likely to cause major property damage to my community.					
68	My community is vulnerable to the risk of major floods					
69	People in my community have a great					

	dread of major floods.					
70	I am ready to participate through volunteering actions to help prevent flooding through different activities					

Appendix B

KEY INFORMANT INTERVIEW GUIDE

Sex_____

Age_____

Office: _____

Responsibility: _____

Phone number: _____

1. Do you think that flooding is a problem in Adama?

2. If 'yes' please describe in detail

4. Please mention hotspot areas for flooding in Adama

5. What do you think are the major causes of urban flooding in Adama?

6. Is there any specific place that is said to be vulnerable for flooding?

7. If 'yes' please describe in detail

8. Please describe what Adama city administration and its dwellers are doing to protect or respond to flooding?

9. Please mention areas of support/ intervention by the government (before, during and after flooding) against flooding hazards in Adama.

10. What do you recommend to minimize the flooding hazards in Adama? Please mention some

Thank you very much for your time & professional support.

Appendix C

አዲስ አበባ ዩኒቨርሲቲ

በሃገር ልማት ኮሌጅ

የአካባቢና ዘላቂ ልማት ትምህርት ክፍል

ለቃለ ማጠይቅ የተዘጋጁ ጥያቄዎች

ሥም_____

ጾታ_____

ዕድሜ_____

ቢሮ_____

ኃላፊነት _____

ስልክ ቁጥር_____

1. የጎርፍ አደጋ ለአዳማስጋት ነውብለውያስባሉ?

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2. አዎ ከሆነ በደንብ ያብራሩ

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3. የጎርፍ አደጋ የት የት አካባቢ እንደሚፈጠር ይግለጹልኝ

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4. የጎርፍ አደጋ መከሰት መንስኤዎች ምንድናቸውብለውያስባሉ?

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5. የጎርፍ አደጋን የከተማውን ዋሪ እንዴት እንደሚከላከል (ዝግጁነት፣ እንዴት ምላሽ እንደሚሰጥ) ይግለጹልኝ

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6. በከተማ አስተዳደሩ በኩል ለጎርፍ ተጠቂ ለሆኑ አካባቢዎች የሚደረግ ድጋፍ ካላ ቢያብራሩልኝ

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7. የጎርፍ አደጋን ለመከላከል እና ነዋሪውን ከስጋት ለማዳን ምን መደረግ አለበት ይላሉ?

Appendix D

A photograph that shows flooded area around Luguu (Kebele 02)

Source: (Own, July 2020)

Appendix E

A photograph that shows flooded area around Luguu (Kebele 02)

Source: (Own, July 2020)

Appendix F

A picture of drainage inappropriately diverted around Migira pond.

Source: (Key Informant, July 2020)

Appendix G

A Picture of flooded area around Migira

Source: (Key Informant, July 2020)