ASSESSMENT OF HOUSEHOLDS' VULNERABILITY TO FLOOD AND DROUGHT RISK IN GARASHI WARD, KILIFI COUNTY, KENYA

BY

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DECLARATION

This research project is my original work and has not been submitted to any other university for an academic award

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DEDICATION

To my parents Mr. Moses Litoroh and Mrs. Rosemary Litoroh, and my sister Miriam Litoroh, for their constant encouragement and prayers throughout my studies. To God, for His wisdom that He bestowed upon me to successfully complete this study.

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ABSTRACT

Over the past five years, the coastal parts of Kenya have experienced a combination of extreme droughts and flood incidences. This has left a huge negative effect with regards to the social, financial, health, and ecological well-being of the affected population. To successfully manage possible risks of natural hazards occurring in an area, it is necessary to understand how vulnerability is generated, how it builds up and how it intensifies. The aim of this study was to assess the vulnerability of rural households to floods and droughts risks using Garashi Ward in Kilifi County as a case study.

Data were collected from a stratified random sample of 96 households from Mikuyuni, Masindeni and Singwaya administrative units of Garashi Ward. The methods employed to collect data include a household survey questionnaire, in-depth interviews, key informant interviews, and from relevant secondary data and publications. Findings revealed that the study area is highly vulnerable to floods and drought risks. This is depicted by the flood and drought vulnerability index value of 0.82 and 0.81, respectively. Furthermore, the area is more sensitive to floods and droughts compared to exposure and capacity, since the sensitivity index value for both hazards is 1. This value denotes the highest level of vulnerability to hazards. Generally, the effect of floods and droughts on households in Garashi area will worsen if sustainable multi-sectoral interventions are not put in place to prepare and mitigate the vulnerability of these households to natural disasters.

The study recommends that the national and county government should invest in disaster preparedness to achieve effective disaster risk reduction in disaster-prone areas. This includes conducting risk and vulnerability assessments at national, community and household levels. Consequently, the government should build the capacity of all stakeholders in the vulnerable regions focusing on sustainable strategies for coping with droughts and floods. Lastly, future researchers should adopt an inductive and participatory approaches to assess vulnerability.

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CHAPTER ONE: INTRODUCTION

1.1 Background to the Study Problem

Natural hazards affect all areas on the globe. They usually happen unexpectedly, are seemingly unavoidable and have a disastrous impact. In recent years, natural hazards have caused a global increase of climate-related disasters such as floods, droughts, storms and heat waves (Thomas and Lopez, 2015), with destructive natural events occurring globally between 2004 and 2015 (IFRC, 2016). Recent global flood occurrences include the Asian tsunami that resulted in 230,000 casualties across 14 countries in 2004; flooding in Pakistan that affected over 20 million people in 2010 and continued to displace a considerable number of people each year; and a storm surge in the United States of America that caused extensive damage on the urban rail system from New York all the way to New Jersey in 2012 (Rios *et al*., 2017).

Examples of global drought occurrences include severe drought events in Ukraine between 2000 and 2010 that resulted in losses of around €3 billion in grain production (Adamenko, 2017); the 2015 drought in Washington D.C. that resulted in economic damages ranging between $633 million to $773 million dollars across the state (WSDA, 2017); and severe drought across ten countries in the Caribbean that caused loss of crops, low water supply, decreased crop production, health-related problems, and increase in food prices (FAO, 2016a).

In Africa, floods affected approximately 38 million people and caused roughly 13,000 deaths from 1981 to 2014 (Tiepolo, 2014). Recent examples include roads and bridges being closed in Gauteng, South Africa, following heavy floods; disruption of transport in Nairobi, Kenya, following flash floods in March 2018; torrential rains and flooding leading to 20 deaths and 250 displaced families in Dar es Salaam, Tanzania; close to 125,000 people displaced in Belet Weyne region of Somalia following flash floods; and 2,500 people left homeless near Bujumbura, Burundi, following devastating floods in April 2018 (UN-OCHA, 2018).

In 2011 and 2012, most parts of Africa were hit by what was termed as the most severe drought in the region in 60 years. Close to 12 million people living in the Horn of Africa were affected (IFRC, 2016). In Lesotho, the 2014/15 drought left 38% of the rural population at risk of survival and livelihood deficit even in the presence of safety nets. On the other hand, South Africa was turned into a net-food importer following the 2015/16 drought in the country, which also resulted in substantial water scarcity and increased unemployment in the region (Baudoin *et al*., 2017). In East Africa, drought resulted in an extreme food crisis that threatened the lives of close to 9.5 million people in Ethiopia, Somalia, Djibouti and Kenya (UN-OCHA, 2011). Furthermore, the 2015 drought in Ethiopia had the highest impact in the country's history (Philip *et al*., 2015).

1.2 Statement of the Research Problem

In Kenya 89% of the landmass is covered by arid and semi-arid lands that are susceptible to natural disasters like drought and famine (slow-onset), floods, landslides and disease outbreaks (rapid-onset) (GOK, 2015). The drylands which host nearly 39% of Kenya's population are more prone to droughts, while low-lying and coastal regions are regularly affected with floods (GOK, 2015). Kenya flood data show that the 2016 floods were widespread and affected more people compared to floods recorded in 1961/62 and 1997/98 (UNDP, 2016). Between March and May 2018 alone, floods in Kenya displaced over 271,000 people and killed another 118 persons (UN-OCHA, 2018). It is estimated that each year, approximately 3.2 million people are affected by floods and droughts in the country (Guha-Sapir *et al*., 2012). The financial loss to Kenya's economy due to natural disasters occurring between 2008 and 2011 was around 12.1 billion USD, which is almost 9% of the country's Gross Domestic Product (GOK, 2011). Extreme droughts have also dried up water resources in half of the 47 counties in Kenya and as a result, close to three million people in the country lack access to clean water (UN-OCHA, 2017).

Kilifi County is classified as a high hazard probability area of droughts, floods and conflict (WESCOORD, 2013). Since 1981, Kilifi County has shown changes in climate with the first wet season experiencing a two degrees Celsius rise in average temperature and a 20% decreasing order of rain fall. This implies increased drought risk in the first season

(January-June) and increased flood risk in the second season (July-December). This combination of extreme climate-related hazards compromise productivity and food security in Kilifi County and have the potential to cause future challenges if left unchecked (GOK, 2016). Specifically, Magarini sub-County in Kilifi was the most affected area with close to 50,000 people being displaced when their houses were submerged (UN-OCHA, 2018). In 2015, close to 3,000 people in Kilifi County had been affected by what was termed as the worst flood event in the county in 20 years (GOK, 2016). A recent study (KRCS, 2018) indicates that over 25% of the households in Garashi Ward, Magarini sub-County in Kilifi County were rendered inhabitable by floods in April 2018, and residents had to seek temporary shelter in formal and informal camps.

In the past, governments have resolved to a more reactive approach when dealing with natural disasters by providing emergency response in the form of food, shelter and incentives. This approach is important in saving lives in the short-term but is not sustainable. There is need for a more pro-active strategy based on principles of reducing risk and building stronger resilience of societies to floods and droughts risks (FAO, 2016c). To successfully manage possible risks of natural hazards occurring in an area, it is necessary to understand how vulnerability is generated, how it builds up and how it intensifies (Cardona *et al*., 2012).

Several studies have been conducted on the susceptibility of communities to impacts of environmental hazards in various parts of Kenya (Omedo, 2008; Murambi, 2009; Karisa, 2010; Wachira, 2010; UNDP 2004; Okello, 2016; DI, 2017; Gitonga, 2017; Tarbuck, 2018). These studies focus on the environmental aspects of flooding, addressed vulnerability to natural disasters at the community or national level, and have mainly focused on urban households. There is need for more knowledge on vulnerability to disaster risks at household level, especially in the rural areas. This study is an assessment of rural households' vulnerability to floods and droughts risk in Garashi Ward in Magarini sub-County, Kilifi County.

1.3 Research Questions

1. What factors influence vulnerability to floods and droughts risk in Garashi Ward?
2. How are households in Garashi Ward affected by the occurrence of floods and droughts?
3. How do households use their knowledge about vulnerability to adapt to and cope with flood and drought risks?
4. What are the flood and drought vulnerability indices of households in Garashi Ward?

1.4 Research Objectives

1. To determine the factors that influence household vulnerability to floods and droughts risk in Garashi Ward.
2. To determine how households in Garashi Ward are affected by the occurrence of floods and droughts.
3. To evaluate ways that households use their knowledge about vulnerability to adapt to and cope with floods and droughts risks.
4. To determine the flood and drought vulnerability indices of households in Garashi Ward.

1.5 Justification of the Study

Natural hazards occur all over the world and are not harmful on their own. However, when they interact with vulnerable people, ecosystems or property they lead to disasters. The extent of the damages caused depends on the vulnerability of the individuals, households, their communities or dependable sources of income. If the main source of livelihood in an area is rain-fed agriculture or natural resources, then the impact is greater, and people take longer to resume their normal lives (Peduzzi *et al*., 2009).

Vulnerability is an underlying factor that disrupts a regional system's sustainable development. Vulnerability assessments entail determining, measuring and focusing on the susceptible factors in a system. Efforts to re-adjust vulnerable systems are beneficial for

the system to achieve its optimal function, lessen disturbances, modify its environment and develop further (Flax *et al.,* 2002).

Evaluations of vulnerability are contributing to the prevention, early warning and eradication of unusual disasters (Tehrani, 2014), and this will be the basis of this analysis of Garashi area, which is prone to frequent alternating flooding and drought events. The area being remote, marginalized and with the highest poverty index in Kilifi County, self-rescue is more important in this area, compared to other wards in the county. Data on floods and droughts is utilized by a wide range of users in different fields such as managers of water resources, hydrologists, planners, agronomists, researchers, climatologists and decision-makers in the government and private sectors. Areas that are becoming more exposed to floods and droughts in Kenya could be mapped and form part of continuous floods and droughts assessments in the country.

Disaster risk reduction is in line with Sustainable Development Goals #1: end poverty in all its forms everywhere; #2: end hunger, achieve food security and improve nutrition; and #13: take urgent action to combat climate action and its impact. These goals address the importance of integrating environment into development ambitions. Environmental sustainability is a pre-requisite for lasting socio-economic development, food security, poverty eradication and resilient communities. Furthermore, to achieve Kenya's Vision 2030, it is necessary to mitigate the impacts of natural disasters. This will enhance preparedness in disaster-prone areas and improve capacity for adaptation to global climatic change (GOK, 2007).

1.6 Scope of the Study

This assessment focuses on floods and droughts occurrences in Kilifi County. The types of droughts considered in this study are agricultural and hydrological drought, while the types of floods under study are river (fluvial) floods. The unit of analysis is the household, and the focus will be on Garashi Ward, Magarini sub-County in Kilifi County. The variables under study include exposure, sensitivity and capacity.

This study adopted a deductive approach that uses indicators to assess household vulnerability. Indicators for vulnerability assessment are usually selected depending on their suitability to the hazard, definitions in the theoretical framework and availability of data (Balica, 2012b). Although some indicators were suitable for this study, their data was not easily available and hence they were omitted. These were mainly indicators of exposure such as flood depth and velocity in reference to floods, and crop yield and soil moisture deficit in relation to droughts.

Furthermore, not all drivers of vulnerability as specified in different studies were included in the study (Chambers, 1989; Birkmann, 2007; Jean-Baptiste *et al.*, 2013; Vojinovic, 2015). Vulnerability assessments include the social, economic, environmental, physical and attitudinal aspects. This study omitted the physical and attitudinal drivers of vulnerability. The physical drivers include human settlements, their spatial arrangements and materials used to construct these settlements that could affect their vulnerability to hazards. Attitudinal drivers focus on the perceptions and cultural beliefs of populations towards hazards and their risks.

1.7 Operational Definitions and Concepts

Adaptive Capacity: The strengths, resources and knowledge that households have acquired over time to prepare for and mitigate the adverse effects of floods and droughts, while also exploiting opportunities that could be beneficial in the long run.

Coping capacity: The strengths, resources and knowledge that households have to address, manage and overcome adverse conditions that occur suddenly in their area. These are the short-term strategies employed only after the disaster and could either be discarded once normal life is resumed or adapted for long-term preparedness against floods and droughts impacts.

Exposure: The situation of households and their assets in areas that are flood-prone, low-lying, or water-stressed, hence making them unprotected and open to the danger of suffering losses in the event of floods and droughts.

Mitigation: To reduce or limit the possibility of floods and droughts to cause undesirable effects on households in a given area.

Natural hazard: A natural process or phenomenon that occurs either slowly or abruptly and it negatively affects households, their assets and could also hinder their access to services and lifelines, hence disrupting normal activities.

Resilience: The capacity of households to absorb, adopt to and recover from the negative effects of a natural hazard, in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions.

Risk: The possibility of floods and droughts occurrence multiplied by the expected loss experienced by households in an area.

Sensitivity: The extent to which households and the systems they are dependent on are exposed any harm after the occurrence of floods and droughts.

Vulnerability: The prevailing household conditions in relation to the economic, physical, and social factors that increase or lower that household's vulnerability to effects of floods and droughts.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents the reviewed literature relevant to the understanding of the research problem. The first section describes the concept of vulnerability in the context of flood and drought risk by first defining the vulnerability concept and then giving an overview of vulnerability vs. risk. This is followed by a discussion on the factors influencing floods and droughts risk on households. The third section highlights how households use their knowledge about vulnerability to defend themselves against floods and droughts risks, and the fourth section presents households' vulnerability to the impact of flood and drought. Research gaps are highlighted in section five, while the last two sections present the theoretical and conceptual frameworks, respectively.

2.1 Vulnerability in the Context of Flood and Drought Risks

2.1.1 Definition of Vulnerability

For the past five decades, specifically between 1980 and 2000, studies in the population and social sciences fields have contended that the effect of natural hazards does not only rely on the ability of the physical environment to withstand the impact but also on the capability of people to adapt and cope with the stress (Keinberger, 2007). The focus has shifted from natural factors influencing disasters towards different levels of vulnerability. Efforts to reduce vulnerability began as the main approach to mitigate disaster impacts, but this proved tenuous to execute (Keinberger, 2007).

The description formulated by the International Strategy for Disaster Reduction (UN/ISDR) is the most common and defines vulnerability as the circumstances brought about by ecological, physical, financial and social aspects that increase the defencelessness of a system to the effects of hazards (UN/ISDR 2004). One major issue of vulnerability is the view of a forthright and policy-supporting variable. Other studies suggest that vulnerability should have predictive characteristics and is purportedly a way of idealizing what may happen to a specific population under circumstances of particular risk and hazards (Canon, *et al*., 2003).

2.1.2 Vulnerability versus Risk

The terms *vulnerability* and *risk* are generally used to express the likely harmful effects of a change in climate or severe climatic deviations on a specified system unit, including region, economic sector, ecosystem, community, infrastructure or social group (Tehrani, 2014). Although both terms are appropriate in a broad context, it is necessary to differentiate the two in a scientific context, and in particular for their use in quantitative assessment (Tehrani, 2014). Risk is defined as possibility multiplied by the realized or anticipated loss (of lives, persons injured, property damaged, and economic activity disrupted) due to a particular hazard for a given area and reference period, where the hazard here is a threatening event, or the probability of occurrence of a potentially destructive phenomenon within a given time frame and region (Adger *et al.,* 2004). This definition is similar to the type of vulnerability referred to in some literature as "physical" or "biophysical vulnerability", which is dependent on exposure, hazard, and sensitivity (Adger *et al*., 2004). On the contrary, "social vulnerability" (also known as "inherent vulnerability") is defined as the natural characteristic of a system that exists within the system and is independent of external exposure (Adger *et al*., 2004). Poverty, inequality, access to resources, marginalization, housing quality and health are some of the factors that are used to examine the social vulnerability of a system (Tehrani, 2014).

The vulnerability assessment for climate variation and change should, to some extent, integrate both physical and social vulnerability, since this type of vulnerability is the result of the interaction between both physical processes and the human dimension. For example, vulnerability to flood and drought is measured as the scope to which a system is predisposed to droughts and floods based on exposure, in conjunction with the system's capacity to absorb the short-term or permanent negative effects of these hazards (Balica and Wright, 2009).

2.2 Factors Influencing Vulnerability of Households to Floods and Droughts Risks

2.2.1 Climatic Factors

In recent years, climate change has become a major concern worldwide. Even slight changes in average temperatures are predicted to add to the magnitude, type and occurrence of severe events such as flood and drought over the coming years (Meehl *et al*., 2007). Drought and floods projected for the 21st century show a significant increase compared to those in the 20th century. However, projections show that developing countries will be most affected by impacts of climate change (Parvin *et al*., 2016).

Increased rainfall and decreased evapotranspiration are projected to cause an increase in river discharge globally, resulting to an increase in flooding frequency (Parvin *et al*., 2016). Between 1980 and 2010, there was a 25% increase in exposure to floods among developed countries; 50% increase in upper-middle-income countries; 75% increase in lower-middle-income countries; and a 125% increase in low-income countries (UN/ISDR, 2011). Climate change has also resulted in increased frequency and extent of flooding (Reynard *et al.* 2001).

In relation to drought, there has been an increasing warming trend, since the late 20th century, leading to extreme drought events across various regions globally (Chou *et al*., 2018). Climatic conditions that favour drought conditions include precipitation deficiency in relation to timing, intensity and amount, high temperatures, greater sunshine, less cloud cover, high winds, low relative humidity, and increased evaporation and transpiration. Also, decreased precipitation levels in an area for a prolonged period causes a decline in streamflow, inflow to reservoirs An area's soil type also determines the available soil water moisture, due to its water retention capacity and ability to support crop growth, as well as the underlying permeable rock. Soil water deficiency results in plant water stress and low plant biomass and yields.

The frequency and severity of drought is difficult to predict, due to the complexity of the impacts. However, the use of global models (hydrological and climatic) to simulate drought

occurrence shows a possible increase in the global severity of drought (Prudhomme *et al*., 2013).

Climate change is an added stress to already threatened ecosystems in Africa. This combined with human-induced pressures exposes populations, their assets and livelihoods to risks posed by natural hazards such as flood and drought (UNFCC, 2008). Different models and scenarios show that drought risk is expected to increase across Africa in coming decades at various intensities. Although countries in Africa are predicted to experience an exasperating drought hazard, the highest drought risk ratio is estimated across countries in Central Africa. This is due to an increasing population and vulnerability of the region (Ahmadalipour *et al*., 2019). Furthermore, in sub-Saharan Africa, 501 damaging flood events were reported between 1980 and 2010 (Bischiniotis *et al.*, 2018).

In Kenya, the phenomenon of shifting climate is already escalating at an alarming rate as is obviously seen from countrywide temperature rises and irregular, as well as intensified rainfall. Examples include the La Nina drought and frequent occurrences of El Nino events across the country. Temperature trends in Kenya shows that vast areas in the country experienced a general increase in temperatures between 1960 and 2010. However, the coastal region experienced different changes, with a decrease in temperatures over the 50-year period, indicating increased rainfall in these areas (GOK, 2010).

Past impacts of climate hazards in Kilifi County have resulted in increased temperatures and a decrease in the area's annual precipitation. Heat stress, drought and dry spells greatly contribute to agricultural risk in the county. A combination of rains starting late, ending early or the complete absence of rain has made crop failure a recurring hazard in Kilifi (GOK, 2016). Future projections imply that in thirty years, temperatures will increase by 0.5^{o}C, causing tremendous changes in the first wet season. Also, consecutive days of moisture stress are expected to increase in the first and second season, from around sixty-five days per season to over seventy-five days of moisture stress. On the other hand, excessive amounts of rainfall affect harvests and thus household food security is compromised (GOK, 2016).

2.2.2 Socio-economic Factors

Disaster risks occur when three components interact: the hazard, the population at risk and the community's adaptive capacity (Thomas *et al*., 2013b; Peduzzi *et al*., 2009). Globally, floods and droughts are known to have a significant negative impact on populations, including loss of income, limited access to services, and internal displacement of households (UNFCC, 2008).

Effects of flooding caused by climate change are not felt equally by all social levels in the community. Studies show that disasters have an unequal impact on the poor. It has been determined that low-income households suffer the most and experience the worst impacts of any disaster (Johnson, 2006; Parvin and Rajib, 2013; UN, 2009; UN/ISDR, 2005; UN/ISDR, 2013; Yodmani, 2001). Consequently, it is expected that low-income households will be worst hit by flood impacts in the near future. These are households that lack sufficient resources to safeguard themselves against disasters and have minimum adaptive capabilities to survive with loss of livelihoods and property (Brouwer *et al*., 2007).

Short-term effects of drought on households include reduced crop production, poor growth of pasture and availability of crop residues for livestock. Prolonged drought on the other hand may lead to an outbreak of water-borne diseases, reduced family income and even internal displacement. Countries dependent on rain-fed agriculture in Africa, Asia and South-Central America are most likely to suffer from food insecurity (Carrao and Parbosa, 2015). However, drought impacts on a region depends on the households' disaster preparedness and political stability, where governments are willing and capable of investing in early warning systems and building resilience of communities.

In most low-income countries, high level disaster risks are often associated with the communities' livelihood activities. In these countries, regions that are susceptible to risks such as flood lowlands attract more people to settle there because of the high potential for food production (Jinadu, 2014). Empirical studies have established that there is a correlation between exposure to hazards and access to income sources (Brooks, 2003; Gwimbi, 2009). As such, disasters might have a negative impact on people, their assets and

livelihoods. For instance, studies have shown that there is a link between drought, its management and poverty (Sen, 2005; Krishna, 2006; Elbers *et al*., 2007; Oyundi, 2011; Cole *et al*., 2013). These studies imply that drought events have consistently over the years pushed vulnerable households to poverty. In addition, exposure to chronic drought reduces people's incentive to save and invest. The studies argue that the possibility of losing livestock after a drought or crops being washed away during floods discourages households from investing in agriculture-based livelihoods.

In Kenya's arid and semi-arid areas, there has been a recent escalation in disaster threats and these have manifested in socio-economic and environmental losses like destruction of communal facilities, reduced livelihood sources, degradation of water quality and a decline in natural resources. Specifically, drought disaster risks remain the single prime challenge to development in Kenya's arid and semi-arid lands (WESCOORD, 2014).

In terms of social impacts, water scarcity during drought seasons in arid and semi-arid lands of Kenya forces women to walk for long distances to look for water and men spend more time looking for water and pasture for livestock. These changes have resulted in social disturbances and family instabilities (GOK, 2016). Men move to towns in search of more stable jobs as women remain at home looking after the children. Additionally, the uncertainty of food and livelihood security created by extreme weather events leads to an increased rate of school dropouts as children look for work to supplement their families' meager income (GOK, 2016).

2.3 Households' Coping and Adaptive Strategies to Impacts of Flood and Drought

Different hazards have varying impacts, and households respond differently with each impact. Studies have shown that households respond differently to rapid-onset hazards such as floods, compared to slow-onset hazards like drought (Motsholapheko *et al*., 2011; Roncoli *et al*., 2001). In relation to climate-related hazards occurring in rural areas, it is argued that understanding of farmers' adaptation strategies will allow for more targeted and suitable climate adaptation policies (Adger and Vincent, 2005).

The Sustainable Livelihoods Framework (SLF) is now being regularly used to understand how rural sources of income have been diversified as a plan to handle shocks (Ellis, 1998). For instance, rural households can change from farm to non-farm supplies of income (Paavola, 2008), adopt new crop varieties that are better suited to withstand the shock (Deressa *et al*., 2010), or move to new settlements as a way of adjusting to stress (Konseiga, 2007). Other strategies employed by rural households to cope with hazard impacts include spending of family savings, consumption of food reserves and sale of livestock to supplement income (Thornton *et al*., 2007; Chuku and Okoye, 2009; Oyekale and Gedion, 2012).

In Kilifi, unpredictable weather conditions have discouraged farmers to plant maize since the crop rarely grows to maturity and even if it does, the yields are very low. Farmers have therefore shifted to other drought resistant crops like cassava, sorghum, chili and millet. However, drought and floods also affect production of these seemingly resistant crop varieties. Consequently, farmers have adopted early maturing crops like pigeon and cow peas, dryland hybrid maize (PH4, DH04, DH02) and green grams (GOK, 2016).
In cases of extreme drought and flooding impacts, there is total crop failure and/or damage and loss of livestock as well, leading to serious issues of food insecurity and loss of livelihoods in the county. Individuals have therefore resorted to seeking employment in urban areas to diversify their household income (GOK, 2016).

2.4 Early Warning and Emergency Response

Due to the rising intensity and frequency of floods and drought, governments across the globe have invested in the development of disaster risk reduction models (Raikes et al., 2019). However, there are factors that limit the successful implementation of crisis management models such as the lack of clear legislative and policy frameworks, complacency in decision-making, separating human development and disaster response, and countries leaning more towards privatization of risk management by shouldering the disaster responsibility to land owners (Raikes *et al*., 2019).

Studies have shown that early warning models for droughts are structured the same way as those of floods (Sivakumar *et al.*, 2014; Finnessey et al., 2016; Stein et al., 2016). These models are often complex, and the challenge is to optimize them in a way that will minimize and mitigate risk to individuals, households, and communities (Finnessey et al., 2016).

In developed countries, emergency response models are developed to respond more to floods and less on drought, hence there is less literature on drought management models compared to those on floods (Raikes et al., 2019). These are therefore more prepared to respond to flood emergencies than drought. In Africa however, there is more literature on drought response compared to floods because the incidents of drought in the region has been more frequent compared to floods in the past, although this is quickly changing (WESCOORD, 2013).

2.5 Households' Vulnerability to the Impact of Flood and Drought

A society is considered to be vulnerable if its conditions and characteristics make it prone to the harmful effects of a risk (Kidokoro, 2008). Vulnerability and risk are dynamic concepts and need to be measured against several factors, based on the short and long-term impacts (Wisner *et al*., 2004). These concepts can be assessed based on three socio-ecological aspects: the existence of hazards, characteristics of individuals and community-level variables. The proposed two-step approach for deriving regional drought and flood vulnerability adopts the concept that 1) households need a variety of "(semi-)independent" aspects to achieve positive resilience to impacts; and 2) no single factor is sufficient to yield all the various livelihood products that households need to survive (Parvin and Rajib, 2013).

Poverty contributes to people's vulnerability to flooding and drought. Frequent flood and drought impacts lead to increased poverty (ADPC and USAID, 2005; Weis *et al*., 2006). Studies on individual characteristics at household level are based on physical, social, economic and environmental factors. They show that employment status, type of occupation, income and education level, inadequate protection of assets and poor design

and construction of houses can increase or decrease a person's vulnerability to hazards (Cutter *et al*., 2003; Thomas *et al*., 2013a). For example, rural residents have low literacy levels and are more likely to occupy houses made from sub-standard materials that could make them vulnerable to hazards like flooding and storms (Johnson, 2006).

Various studies reveal that the risks of rural areas to disaster vulnerability are specific to different levels and types of vulnerability (Alston, 2007; Brennan and Flint, 2007; Mason, 2011; Saenz and Peacock, 2006). Rural households are constrained by access to resources needed to withstand disasters and recover from them whenever they happen. Also, characteristics of most rural areas like low income and literacy levels and a high dependency on resource-based livelihoods increase these areas' vulnerability to disaster impacts (Prelog and Miller, 2013). Furthermore, other studies have shown that being exposed to risks and having low survival capabilities make rural households very vulnerable and less protected against the shocks of disasters (Foster *et al*., 2008; Gwimbi, 2009).

Social vulnerability is usually manifested after the occurrence of a hazard among different groups of people (Cutter *et al.*, 2003). While all people living in a hazard-prone area are vulnerable, social impacts are often felt by poor households, children, disabled persons and the elderly. These groups are often the least prepared for an emergency, possess the least resources to prepare for a hazard and reside in the highest-risk locations in below standard houses. They also lack knowledge of available resources that they could use to help them cope and recover from a disaster within a short time (Dunning, 2009; NRC, 2006).

Kilifi County is classified to have a very high vulnerability index in relation to shocks and hazards, which include floods and droughts, and has a poor water infrastructure (WESCOORD, 2013). The main livelihood sources in the county include growing of cash crops, dairy, marginal and mixed farming, subsistence farming, formal employment, business and casual employment in processing zones (KIRA, 2014). During floods, dairy cattle can get infected by worms near flooding water. Small-scale dairy farmers are hence vulnerable when it floods, especially those who own an average of three cows per

household and have a lower capacity to invest in feed supplements, veterinary services, vaccines and artificial insemination. Farmers growing cash crops are also vulnerable to drought and floods since crop harvests are usually lower than usual leading to losses (GOK, 2016).

2.6 Research Gaps Emanating from Literature Review

Studies have focused on emergency response (reactive approach), where governments and stakeholders respond to disaster impacts by providing food aid, temporary shelter and material support as a way of supporting affected households to cope with the losses and changes (Alston, 2007; Brennan and Flint, 2007; and Cutter *et al.*, 2003). Other studies have focused on the disaster preparedness aspect (proactive approach) at regional level, where the focus is on early warning systems and effective communication before the occurrence of natural hazards, hence mitigating the impacts (Maina, 2009; Muchunku, 2010; Kimeli, 2016).

Other local studies have mainly focused on vulnerability of urban informal settlements to floods (Omedo, 2008; Okello, 2016). Also, studies have mostly focused on only one aspect of vulnerability; either the social, environmental, or economic aspect, (Cutter *et al*., 2003; Thomas *et al*., 2013a) rather than assessing these interdependent aspects jointly.

Therefore, there is a gap when it comes to addressing vulnerability to floods and droughts at household level, especially in rural areas, while putting into consideration the environmental, social and economic aspects.

2.7 Theoretical Framework

Vulnerability has three aspects: 1) characteristics that influence vulnerability continuously change in time and space; 2) vulnerability is dependent on the unit of analysis (national, household or individual); and 3) vulnerability is multidimensional and varies from one physical context to another. Regarding the third aspect, five components need to be measured when assessing vulnerability. These are the physical components, the economic components, the social aspect, the environmental aspect, and the political or institutional characteristics.

A more recent definition of vulnerability as described by UNU-EHS is that: *"Vulnerability is the intrinsic and dynamic feature of an element at risk (community, region, state, infrastructure, environment etc.) that determines the expected damage/harm resulting from a given hazardous event and is often even affected by the harmful event itself. Vulnerability changes continuously over time and is driven by physical, social, economic and environmental factors,"* (Thywissen, 2006). The UNU-EHS definition is further conceptualised through the Bogardi, Birkmann and Cardona Framework, which views vulnerability as embedded in the hazard-vulnerability chain (section 2.5).

The Expert Working Group on Vulnerability led by the United Nations University – Institute for Environmental and Human Security spearheaded the publication of different synthesis reports which compile diverse approaches and results (Adger 2006, Birkmann 2006, Gallopín 2006, Thywissen 2006, Villagran 2006). Although there is a consensus on the conceptual basis, to link and integrate various aspects from different scopes, sectors and spatial scales makes the assessment of a system regarding its vulnerability a tough and frequently complex task (Keinberger, 2007).

The practical challenge is to come up with a reporting framework on vulnerability that incorporates quantitative and qualitative data, while permitting the communication and visualization of vulnerable areas and dimensions to relevant stakeholders and decision-makers. Also, the identification and definition of a set of vulnerability indicators is another challenge. Indicators of vulnerability should be used to assess adaptive strategies and measures, as well as serve as the baseline for monitoring development processes.

In past years, scholars have proposed various models that aim at coming up with methods of measuring vulnerability. These include the Bogardi, Birkmann and Cardona (BBC) Conceptual Framework (Bogardi and Birkmann, 2004; Cardona, 1999/2001); the Pressure and Release Model (Wisner *et al*, 2004) that describes risk as a function of hazard and vulnerability; the Double Structure Conceptual Framework (Bohle, 2001) which indicates that vulnerability cannot adequately be considered without considering coping and

response capacity; Vulnerability in the Global Environment Change Community (Turner, 2003) where vulnerability is defined to include resilience, sensitivity and exposure; and the Holistic Approach to Risk and Vulnerability (Carreno *et al*, 2007)) where vulnerability is based on three factors namely: lack of resilience to recover and cope, socio-economic instabilities, and physical exposure and sensitivities.

The theoretical framework considered in this study is the BBC Framework since it best answers the research questions and objectives outlined in sections 1.3 and 1.4 above. In this framework, vulnerability is defined through the scope of exposed and susceptible elements on one side, and coping capacities of affected entities (e.g. social groups) on the other hand. This model is based on the understanding that vulnerability goes beyond valuation of damage caused by the disaster, towards continuously assessing vulnerability as a combination of economic, environmental and social elements, then linking them to risk mitigation and sustainable development (Green *et al.*, 2000).

The framework further emphasizes that it is important to address potential intervention tools that could help reduce vulnerability in the social, economic and environmental spheres (Birkmann, 2006). The BBC model argues that there are two opportunities to reduce vulnerability; one before the disaster strikes (being prepared for the disaster) and one after the disaster strikes (reactive measures).

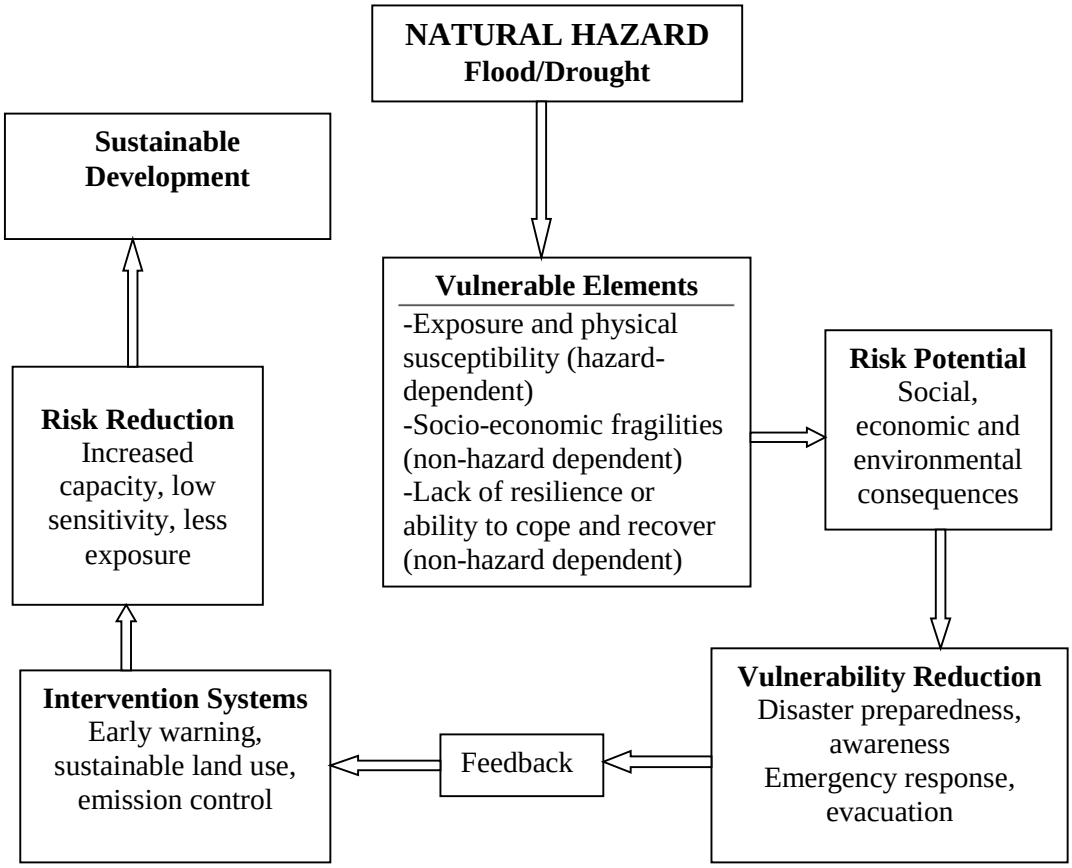
2.8 Conceptual Framework

Understanding the pattern of vulnerability in an area is important in the management of disasters (Cutter, 1996). However, frameworks on vulnerability vary in scope and thematic focus. It is therefore apparent that different vulnerability frameworks are suited for specific disciplines. There is no one-size-fits-all model that is general to all themes of study (Ciurean *et al*., 2013). Consequently, this study adopted different concepts from the BBC theoretical framework.

According to the conceptual model (Figure 2.1), there is a high likelihood of risk being realized if a natural hazard occurs in a vulnerable community. If disaster occurs, then it can

be reduced through emergency response (reactive measure). Disaster can also be mitigated or prevented from happening (preparedness). Feedback on the disaster impact and mitigation can be used to develop early warning systems to reduce the vulnerability of households to disaster risks.

Figure 2. 1: *Conceptual framework*



Source: Adopted from Birkmann (2006)

Vulnerability in this context is regarded as the combination of susceptible elements and coping capacity. Assessment of vulnerability goes beyond determining the extent of damage caused by the hazard, to the continuous evaluation of a combination of social, economic and physical components and links them to reduction of risk and sustainable development.

According to the BBC framework, risk is conceptualized as the interaction between a disaster and vulnerable elements. Disaster risk can be actualized if there is no vulnerability

reduction measures such as disaster preparedness and awareness. Disaster management measures then must be put in place to mitigate impacts of the disaster through emergency response. Intervention systems such as early warning systems and sustainable land use practices can reduce risks and consequently lead to sustainable development.

CHAPTER THREE: RESEARCH MEHODOLOGY

This chapter presents the study methodology in terms of the target population and sampling, sources and techniques of collecting data, and the approaches used in data analysis. The chapter starts by giving an overview of the physical and human characteristics of the study area.

3.1 The Study Area

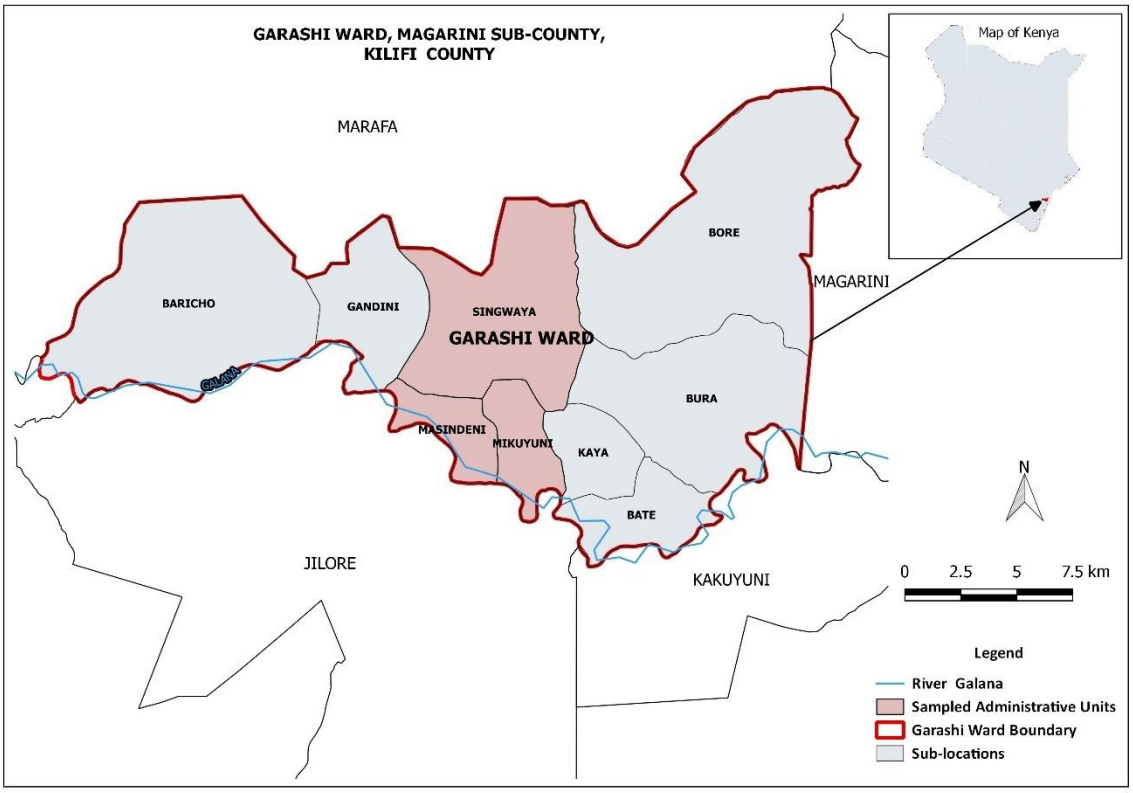
3.1.1 Location and Topography of the Study Area

The study area is Garashi Ward, which is one of the six wards in Magarini sub-County in Kilifi County, Kenya (Figure 3.1). Kilifi is one of the six counties in the Coast region of Kenya. Garashi Ward covers an area of around 347.7km^2. Garashi is bordered by Marafa Ward to the North, Magarini Ward to the East, Baricho Ward to the West and Kakoneni Ward to the South (GOK, 2018). Garashi Ward has nine administrative units, namely Kaya, Bura, Bate, Mikuyuni, Masindeni, Singwaya, Baricho, Bore and Gandini (KNBS, 2017). Garashi Ward falls within the Nyika plateau, which has an elevation of about 100 to 340 metres above sea level, and it covers about two thirds of the western side of Kilifi County. The plateau is marked by few inhabitants, little crop cover, and a gently undulating terrain. This forms the arid and semi-arid region of the county, which is fit for raising livestock herds (GOK, 2018).

3.1.2 Ecology and Climate

Garashi Ward falls in two of the five agro-ecological zones of Kilifi County. These are the Livestock-Millet Zone and the Lowland Ranching zone. The Livestock-Millet Zone can only support little farming activities, with annual rainfall varying from 700mm to 900mm. This zone is apt for dry land farming that supports crops that can withstand long periods of drought and livestock keeping. The Lowland Ranching Zone varies in altitude between 90m to 300m with an annual mean temperature of 27^o Celsius, and a yearly rain fall of 350mm to 700mm. Wildlife and ranching are the main activities in this area (GOK, 2018).

Figure 3. 1: *Administrative Wards of Magarini sub-County*



Source: http://www.kilifi.go.ke (Accessed on 18th June 2018).

Garashi Ward is in the hinterland area of Kilifi County, which receives an annual precipitation of approximately 300m to 900mm. The short rains are experienced in the last quarter of the year, while the long rains are from March to May. The most important season for the hinterland, under which Garashi area falls, is the short rains for water recharge and pasture regeneration. The Nyika plateau area experiences the highest annual evaporation rates of up to 220mm. The highest evaporation rates are experienced in the first three months of the year in the county. The annual temperatures range between 30^{o} Celsius and 34^{o} Celsius in the hinterland (GOK, 2018).

3.1.3 Demography

Garashi Ward has 3,734 households with a population of 25,781 people (KNBS, 2009). In the larger Magarini sub-County, males make up 46.5% and females 53.6% of the entire population (GOK, 2018). Magarini sub-County has the least population density in the

county at 34 persons per square kilometer (GOK, 2018). The average household size in Kilifi County is 5.6, which is higher than the national average of 4.4 (KNBS, 2009). The ratio of people depending on one income earner in the county is 101.45% (GOK, 2018).

3.1.4 Socio-Economic Characteristics

Garashi is the poorest ward in Kilifi County, which has a poverty rate of 70.8%. This is higher than the national rate of 45.6% (KNBS and SID, 2013). The main economic activities in the area include agriculture, charcoal production for commercial purposes, fish farming, rural self-employment and wage employment (CRA, 2011). Charcoal production in arid and semi-arid lands of Magarini sub-County has resulted in pollution, soil erosion, land degradation and climate change (GOK, 2018). According to the National Housing Survey (2013), 43.7% of the households in Kilifi County have iron sheets for roofing and 53% have grass/*makuti* roof. One third of households in urban areas use stones/bricks/blocks for constructing houses, while almost a half of the population in rural areas use mud and wattle for constructing walls. 67% of the households have earthen floors, while 30% cement floors, mostly in urban areas.

3.1.5 Land use

A greater area of the land in Garashi is being utilized for farming and herding of livestock. The main crops grown in the area include maize, pineapples, mangoes, sisal, cassava and millet. More than 65% of Kilifi County landmass has a limited supply of water and the households either harvest rainwater in water pans or fetch water from the river for drinking, cleaning and cooking, as well as livestock consumption. These water pans often dry up during the normal seasonal dry spells.

Generally, there is a high demand for water in Kilifi County. There are also very few water harvesting initiatives for irrigation. Households in Garashi mainly depend on irrigation to grow their crops, due to unreliable rainfall patterns in the area. River Sabaki crosses the southern part of Magarini near Mikuyuni village, and it poses a high irrigation potential for households residing near its banks. However, the 2016/2017 drought almost resulted in all the water sources drying up in the county including River Galana which is very expansive.

Consequent periods of droughts and floods in the county provide a unique potential for harvesting large volumes of water that is essential for watering croups during droughts.

3.2 Research Methodology

3.2.1 Target Population and Sampling Procedure

The target population was households in Garashi Ward. Garashi Ward has 9 administrative units, namely Kaya, Bura, Bate, Mikuyuni, Masindeni, Singwaya, Baricho, Bore and Gandini. However, because of the large geographical extent of Garashi Ward, this study was done in Mikuyuni, Masindeni and Singwaya. The choice of the three administrative units was informed by the fact that they are usually the most affected by floods and drought in Garashi Ward. Furthermore, the three administrative units were easily accessible. Proportionate stratified random sampling was used to select 96 households for the study. To determine the sample size, the Fischer's formula was employed,

where,

n = Sample size

Z = Normal deviation at the desired confidence interval (95% with a Z value of 1.96)

P = Proportion of the population with the desired characteristic (0.5 was used)

Q = Proportion of the population without the desired characteristic (1-P)

I^2 = Degree of precision taken at 10% (0.1)

As such, the sample size was n = (1.96) (1.96) * 0.5 (1-0.5) / (0.1) (0.1) = 96.

The target population was stratified into the three selected administrative units of Garashi. These are Mikuyuni, Masindeni and Singwaya. The number of households to be included in the sample in each of the three administrative units was then determined proportionately as summarized in Table 3.1.

Table 3. 1: *Sampling procedure*

Sub-location	No. of households	Sample size
Mikuyuni	432	42
Singwaya	305	30
Masindeni	251	24
Total	**988**	**96**

Source: Researcher, 2018

From each stratum, households to be included in the survey were selected systematically using a sampling frame generated from the areas' administrative Assistant Chiefs through the "*Nyumba Kumi*", disaster management, and relief food distribution lists.

In addition, four key informants were purposively selected for key informant interviews. The first key informant was the County Drought Response Officer at the National Drought Management Authority (NDMA). A representative from NDMA was key to this study because the agency is mandated by the Government of Kenya to ensure that drought does not occur in emergencies, issues early warning bulletins for floods and drought for alertness, and that effects of environmental changes are mitigated across Kenya. The second informant was the Nutrition Program Coordinator, Kenya Red Cross Society (KRCS) who was selected due to being on the forefront of emergency response efforts due to the April 2020 floods in Magarini sub-county. Kenya Red Cross Society implements a disaster risk component in the study area and was the lead in disseminating updates on the flood response activities by partners, hence provided data on extent of damages by floods on households, including pictures used in this study. The third key informant was the Assistant Chief of Masindeni sub-Location. The researcher, area Chief and three assistant chiefs from Masindeni, Singwaya and Mikuyuni held a consultative meeting where the assistant chief from Masindeni was selected because he had been actively taking part in emergency response efforts in the community and would therefore provide the most accurate information for this study. The fourth key informant was Program Coordinator for UNDP-funded projects at NDMA and he was selected because of his extensive background knowledge of flood and drought monitoring in the study area.

3.2.2 Sources and Methods of Data Collection

Table 3.2 gives a summary of the sources and methods of data collection by objective. Generally, both primary and secondary sources of data were used. The collection of primary data was largely through household interviews using a standardized pre-coded questionnaire. In addition, there was in-depth interviews, key informant interviews and direct field observations. On the other hand, collection of secondary data involved reviewing and utilization of existing literature and publications relevant to the study problem. Two enumerators were trained to help in the household interviews (Plates 3.1 and 3.2), while the researcher participated in both household and key informants' interviews (Plate 3.3).

Table 3. 2: *Sources and methods of data collection*

Research objective	Data sources	Methods of data collection
Trend of flood and drought occurrence	• Head of households • Officials from NDMA, KRCS & UNDP • Area Chief • Press reports	• Household interviews • Key informant interviews
The impact of flood and drought to households	• Head of households • Officials from NDMA, KRCS & UNDP • Area Chief • Press reports	• Household interviews • Key informant interviews • Observation
Households' coping and adaptive strategies to flood and drought impacts	• Head of households • Officials from NDMA, KRCS & UNDP • Area Chief • Press reports	• Household interviews • Key informant interviews
Households' vulnerability to flood and drought risk	• Head of households • Relevant literature	• Household interviews

Source: Researcher, 2018

During the process of data collection, the researcher took into account the following ethical issues: voluntary participation, confidentiality of information and informed consent on the respondent.

Plate 3.1: *RA 1 Household interview in Garashi*

Source: Field work

Plate 3.2: *RA 2 Household interview in Garashi*

Source: Field work

Plate 3.3: *Key informant interview in Garashi*

Source: Field work

3.2.3 Data Analysis

The filled questionnaires were checked and subjected to a close scrutiny for inconsistencies and errors before data entry, cleaning and analysis. Descriptive statistics were then generated for quantitative data. The qualitative data was analyzed through content analysis. Table 3.3 gives a summary of the methods of data analysis by research objective.

Table 3. 3: *Data analysis methods for each objective*

Research Objective	Data Analysis Methods
Trend of flood and drought occurrence	• Content analysis
The impact of flood and drought to households	• Descriptive statistics • Content analysis
Households' coping and adaptive strategies to flood and drought impacts	• Descriptive statistics • Content analysis
Households' vulnerability to flood and drought risk	• Vulnerability Index

Source: Researcher, 2018

Vulnerability is dependent on capacity, exposure and sensitivity (IPCC, 2012b). This is expressed as V= f (E, S, C), where V = Vulnerability, E = Exposure, S = Sensitivity, C =

Capacity. Based on this, six exposure indicators, seven sensitivity indicators, and six capacity indicators were used to calculate the vulnerability index (Table 3.4).

Table 3. 4: *Vulnerability variables and indicators*

Variable	Indicators
Exposure	1. Household size 2. Recent frequency of drought/flood 3. Previous frequency of drought/flood 4. Number of income earners in household 5. Number of men in household 6. Female-headed households
Sensitivity	1. Main source of income 2. Dependency ratio 3. Damage to agricultural assets 4. Damage to non-agricultural assets 5. Socio-economic disruptions 6. Access to lifelines 7. Health impacts
Capacity	1. Level of education of household head 2. Level of preparedness for impacts 3. Diversified sources of income 4. Availability and circulation of emergency plans 5. Knowledge on ways to improve resilience 6. Ability to resume normal livelihood activities after disaster

Source: Researcher, 2018

The indicator-based vulnerability assessment is recognized as a suitable method for evaluating population groups at national, regional, community, household and individual levels (UN/ISDR, 2005).

A five-point Likert Scale was applied to evaluate the respondents' responses to the indicators (data variable measurement). The scales include 1) very high; 2) high; 3) moderate; 4) low; and 5) very low. Weights varying from 0.2 to 1 were assigned to each response, where 0.2 is the lowest level of household vulnerability and 1 is the highest vulnerability level (Table 3.5).

Table 3. 5: *Level of data variable measurement*

Disaster Risk Component	Levels of Measurement using Weights				
	1	**0.8**	**0.6**	**0.4**	**0.2**
Exposure	Very High	High	Moderate	Low	Very low
Sensitivity	Very High	High	Moderate	Low	Very low
Capacity	Very High	High	Moderate	Low	Very low

Source: Researcher, 2018

The Weighted Average Index (WAI) for each data variable (exposure, sensitivity and capacity) was then computed using the formula below:

$$\text{WAI} = \frac{W_1 + W_2 + \ldots\ldots W_i}{\text{n}} = = \sum_i^n \frac{W_i}{\text{n}}$$

Specifically, for each index (exposure, sensitivity, and capacity), the weighted sum of all the wights was divided by the total number of weights in that index as shown below:

$$EI = \frac{\sum_i^n EWi}{n}, \qquad SI = \frac{\sum_i^n SWi}{n}, \qquad CI = \frac{\sum_i^n CWi}{n}$$

The Vulnerability Index (VI) was then calculated for both floods (FVI) and drought (DVI) using the Exposure Index (EI), Sensitivity Index (SI) and Capacity Index (CI). That is, FVI = EI x SI/CI and DVI = EI x SI/CI. This methodology was selected because it distinguishes various identified characteristics at each scale, and hence offers a more in-depth analysis and interpretation of local indicators (Balica, 2012b).

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter presents the results of the study based on the four specific objectives to: 1) establish the trend of flood and drought occurrence in Garashi Ward; 2) determine the impact of flood and drought to households in Garashi Ward; 3) assess the households' coping and adaptive strategies to flood and drought impacts; and 4) analyze the households' vulnerability to flood and drought risk.

Responses were scaled as very high, high, moderate, low and very low, in terms of vulnerability to floods and drought (Table 4.1). Each scale was then weighted as follows: very high = 1, high = 0.8, moderate = 0.6, low = 0.4 and very low = 0.2; where 0.2 is the lowest level of household vulnerability and 1 is the highest vulnerability level.

Table 4. 1*: Determinants of scales used to weight indicators of vulnerability*

Indicator	**Determinants**
Exposure: Household size	• 11+ (very high); 8-10 (high); 5-7 (moderate); 2-4 (low); 1 (very low) • The higher the household size the more vulnerable it is to disaster impacts
Recent frequency of drought/flood	• Less than 3 months ago (very high); 3-6 months ago (high); 7-11 months ago (moderate); 1-2 years ago (low); 3+ years ago (low) • The more recent the occurrence the more vulnerable the household is to disaster impacts
Previous frequency of drought/flood	• Within past 6 months (very high); 7-11 months ago (high); 1-2 years ago (moderate); 3 years ago (low); 4+ years ago (very low) • The shorter the duration between two disaster events the more vulnerable the household is to disaster impacts
Number of income earners in household	• 0 (very high); 1 (high); 2-4 (moderate); 5-7 (low); 8+ (very low) • The more the income earners the less vulnerable the household is to disaster impacts
Number of men in household	• 0 (very high); 1 (high); 2-4 (moderate); 5-7 (low); 8+ (very low) • The more the number of men the less vulnerable the household is to disaster impacts

Indicator	Determinants
Female-headed households	• All the female-headed households were considered as very vulnerable to disaster impacts • All the male-headed households were considered as having low vulnerability to disaster impacts
Sensitivity: Main source of income	• If the main source of income is natural resource-based then the household is very vulnerable to disaster impacts
Dependency ratio	• 10:1 (very high); 10:3 (high); 5:1 (moderate); 5:2 (low); 2:1 (very low) • The higher the dependency ratio the more vulnerable the household is to disaster impacts
Damage to agricultural assets	• The more the impacts mentioned by household the more vulnerable the household is to disaster impacts (loss of all livestock, crops and food reserves = very high)
Damage to non-agricultural assets	• The more the impacts mentioned by household the more vulnerable the household is to disaster impacts (loss of all household property, including housing structure = very high)
Socio-economic disturbances	• The more extreme the disturbances the more vulnerable the household is to disaster impacts (very long average disturbances to water sources, reduced/lost income for an extended period = very high)
Access to lifelines	• The more limited the access to lifelines the more vulnerable the household is to disaster impacts
Damage to health	• The more life-threatening the impact is, the more vulnerable the household is to disaster impacts
Capacity: Level of education of household head	• no education (very high); ECD (high); primary (moderate); secondary (low); tertiary (very low) • The more educated the household head the less vulnerable the household is to disaster impacts
Level of preparedness for impacts	• The more sustainable methods employed by household the less vulnerable the household is to disaster impacts
Diversified sources of income	• The more the sources of income the less vulnerable the household is to disaster impacts
Availability and circulation of emergency plans	• The more the sources of information on disaster preparedness the less vulnerable the household is to disaster impacts
Knowledge on ways to improve resilience	• The more frequent the household receives information on disaster occurrence, the less vulnerable the household is to disaster impacts

Indicator	Determinants
Ability to resume normal livelihood activities after disaster	• The longer it takes for a household to resume its normal activities after disaster, the more vulnerable the household is to disaster impacts

Source: Researcher

4.1 Factors Influencing Vulnerability of Households to Floods and Droughts

The research findings identified three broad categories of factors influencing the vulnerability of households to floods and drought risks. These are 1) alternating flood and drought experience by households; 2) characteristics of heads of households (gender and education level); 3) household characteristics (household size, number of men in the household, number of income earners, main and secondary sources of income, and dependency ratio of household size to income earners).

4.1.1 Alternating Flood and Drought Experience by Households

4.1.1.1 Households' Flood Experience

Respondents were asked to state the last time they experienced floods in their village. All the households responded that they had experienced floods in the last three and six months before the survey. Before this occurrence, they had experienced another set of serious floods more than five years ago.

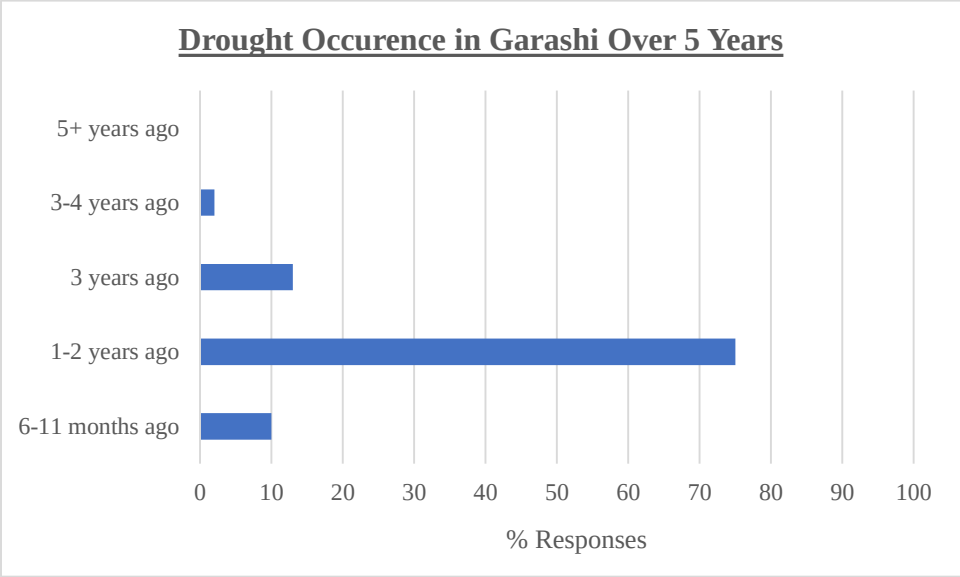
Respondents reported that the April 2018 floods were among the worst records of flood occurrences in the area since the El nino floods in 1997. They added that although the area is prone to flooding when it rains, the water volume is usually low; people, livestock and property are not usually affected; and the inundated areas dry up within two weeks. According to the respondents, the recent floods had a high velocity and volume; transported silt from the riverbank to their farms and homes; swept away property and livestock; and that some areas were still inundated in August 2108, five months after the floods.

In reference to table 4.1 above, the recent frequency of floods in Garashi area was less than three months ago, indicating a very high vulnerability of households in Garashi to flood risks. However, prior to this flooding event, the previous incident was more than 3 years ago, which is a determinant of low household vulnerability to flood risks.

4.1.1.2 Households' Drought Experience

Respondents were also asked to state the last time they experienced drought in their village. The recent flood experience was between six and 11 months prior to the study according to 10% of the respondents (Figure 4.1). Also, 80% (72) of the households reported that they had experienced drought in the last one and two years prior to the recent incident.

Figure 4. 1: *Drought occurrence in Garashi Ward*



Source: Researcher, 2018

The Assistant Chief of Masindeni sub-location reported that the study area experienced prolonged drought for close to five years prior to the flooding experience. He added that this resulted in very low crop yields compared to around seven years ago prior to the onset of drought. According to an official from the National Drought Management Authority, Kilifi County experienced severe drought for two months in 2016. In 2017 the situation further worsened with drought extending for seven months. There was an improvement in 2018 when the county experienced moderate drought.

The recent drought experience of between six and eleven months prior to the study is a determinant of a high vulnerability of households to drought risks. Also, the finding that there is a short duration between the recent and previous drought experience by households indicates a very high vulnerability to drought risks in the area.

These findings on drought and flooding experiences in Garashi area were corroborated by an official from NDMA who reported that the organization collects information on early warning in Kenya for all counties, through remote sensing for biophysical indicators and sentinel data for socio-economic data. He further said that this information is collected daily at the households and continuously using satellite placed at University of Boku, Austria. The information is used to map drought and flood occurrences in the specific area, in this case Kilifi County. An official coordinating UNDP-funded projects at NDMA added that although the organization's focus is drought, it is highly related to floods since they are all climate-related hazards. This means the satellite imagery collects all information related to drought and floods in the area.

An analysis of the satellite imagery information for Kilifi County shows that in 2015, the early warning stage was normal with a stable trend (NDMA, 2015). The situation deteriorated in 2016 when the county experienced drought for two months. The early warning stage for that year was consequently classified as alarming, with a deteriorating trend (NDMA, 2016). In 2017, the situation further worsened, with Kilifi County experiencing drought for seven months. Extreme drought was recorded for the first five months (January to May), but the situation improved in June and July (NDMA, 2017).

There was improvement in early 2018 when the county experienced moderate drought. However, in mid-2018, above normal wet conditions were recorded in the county indicating flooding conditions (NDMA, 2018).

This data from satellite images of Kilifi County collected by NDMA between 2015 and 2018 corroborates with data collected during this study in August 2018, which shows that Garashi area was experiencing drought between 2014 and early 2018, followed by an onset of floods in the area in mid-2018. An official from KRCS also adds that the organization collects information on hazard occurrence, but this is done depending on the occurrence and is informed by the need. This information is collected during periodic field visits and forums such as community review meetings, stakeholder platforms like County Steering Groups, monthly reports (NDMA bulletin) and weekly sitreps (24 to 72-hour emergency forms that feed into the situational analysis).

An official from UNDP further reported that some areas like Garashi that were not previously mapped to have a very prevalence to drought or floods have now become more vulnerable to these hazards, and the maps need to be revised to include these areas. He further adds that coming up with a system that triggers a warning when there is a disaster is challenging because hazards are highly unpredictable.

In Kilifi County, some areas receive annual rainfall of less than 500mm, hence resulting in periodic drought in the region. Since 1981, the county has shown changes in climate with the first wet season experiencing a two degrees Celsius increase in mean temperature and a 20 percent decreasing order of precipitation. Future projections to the years of 2021-2065 predict extreme precipitation and prolonged moisture stress in the county. This implies increased drought risk in the first season (January-June) and increased flood risk in the second season (July-December) (GOK, 2016).

Further literature indicates that clear trends should not be expected when it comes to natural disasters due to the high level of unpredictability (Thomas & Lopez, 2015).

4.1.2 Characteristics of Heads of Households

4.1.2.1 Gender of Heads of Households

62% of the sampled households were headed by a male while 38% were headed by a female. All the female-headed households were considered as very vulnerable to disaster impacts while all the male-headed households were considered as having low vulnerability to disaster impacts.

Gender plays a significant part in determining who is affected by disasters. In the event of a disaster, households headed by females are 1.6 times more likely to be food insecure compared to those headed by males (FAO, 2014). However, if both men and women are included in disaster resilience trainings, then the household resilience can be improved (UN/ISDR, 2015). Women are the ones who take care of those affected, like the injured, elderly and sick. Women's vulnerability is also increased when they become the bread winners and are more likely to experience post-disaster stress which is mainly attributed to various factors (WHO, 2002).

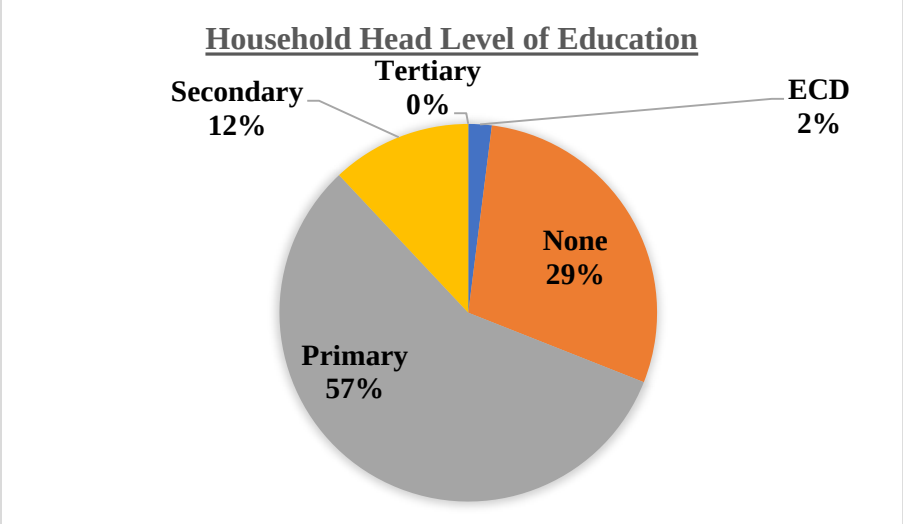
Women have less physical strength compared to men when it comes to re-construction and repair of damaged shelters. Also, women lack skills such as tree climbing and swimming that are traditionally taught to men (IFRC, 2010). This will reduce their adaptive capacity and lengthen the period it takes for them to recover from disaster impacts. Also, women living in communities where cultural practices exclude them from decision-making are at a higher risk of being left out of post-recovery planning process (UNDP, 2010).

This often results in their needs being unmet, further aggravating the impact of the disaster. For instance, women may refuse to relocate to the displacement area because they do not feel it is secure or private enough in terms of bathing or sleeping areas. Their families may end up staying in worse conditions for a longer period, hence at a greater risk of developing post-disaster stress (FAO, 2016b).

4.1.2.2 Education Level of Heads of Households

57% of the household heads had attained a primary level education, 29% had attained no formal education, 12% had attained secondary education, while 2% had attained ECD education (Figure 4.2). Furthermore, none of the household heads had attained a tertiary level education. This could complicate the possibility of building the capacity of households on disaster risk reduction through formal training.

Figure 4.2: *Education level of household head*

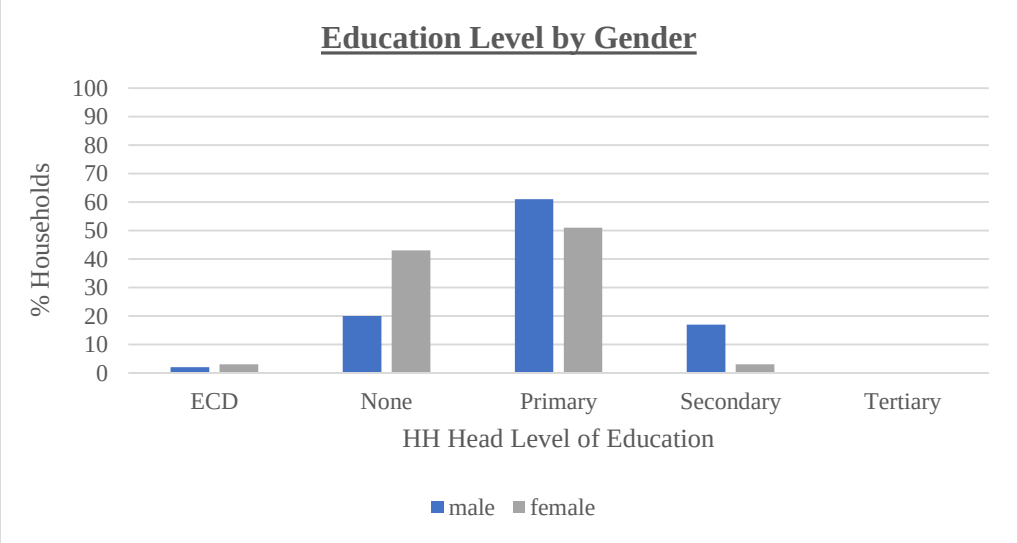


Source: Researcher, 2018

The more educated the household head, the less vulnerable the household was to floods and droughts risks. In instances where the household head has attained tertiary level education, then the household was considered to have a very low vulnerability to floods and droughts risks, hence none of the households in the study area had a very low vulnerability to floods and droughts in relation to this indicator. However, 29% of households where the head had not received any formal education were considered to have a very high vulnerability to households.

A further analysis by gender revealed that female heads of households tend to be less educated than their male counterparts (Figure 4.3).

Figure 4. 3: *Household heads' level of education by gender*



Source: Researcher, 2018

A case study of Vietnam shows that the education level of the family head has a significant impact on both flooded and non-flooded households (Le, 2015). Having a family head with a higher education level (secondary or tertiary) can contribute to increased income per capita of a household, while household heads with a primary level education or lower worsens the level of income earned in the household. This is because well-educated family heads have a higher chance of acquiring better paying jobs or skills to generate more income, hence improving the living standards of the family. This increase the family's

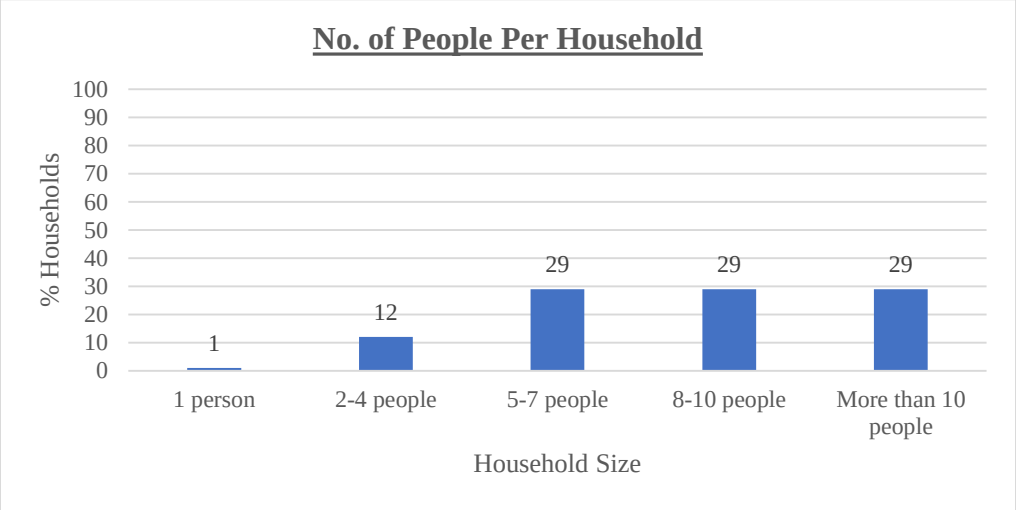
capacity to recover from impacts of floods within a shorter period compared to families without adequate resources required to cope with the floods (Le, 2015).

4.1.3 Household Characteristics

4.1.3.1 Household Size and Number of Men per Household

Figure 4.4 reveals that the sampled households have generally large household sizes. About 90% of the households have five or more members, while the rest have between one to four household members. Furthermore, about 90% of the households have two or more adult males, while only two percent of households lack an adult male.

Figure 4. 4 *Household size*



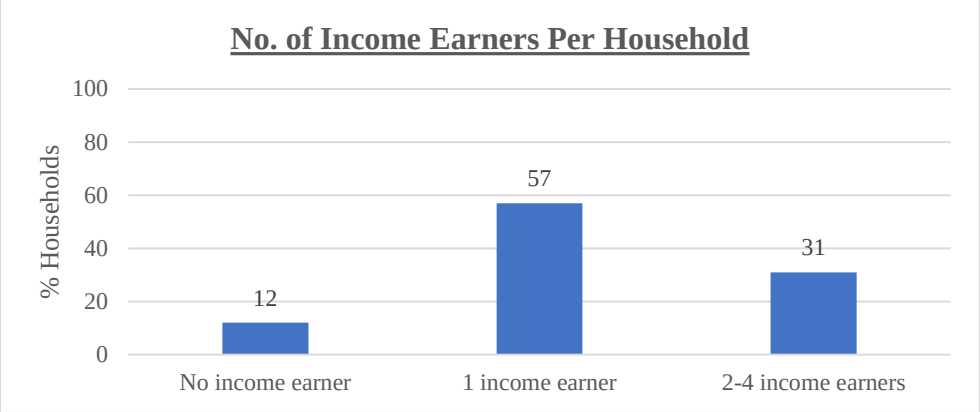
Source: Researcher, 2018

The higher the household size, the more vulnerable the household is to flood and drought risk. 29% of households have more than 10 people indicating a very high vulnerability to flood and drought risks. Only 1% of households have 1 person, indicating a very low vulnerability. The higher the number of men in a household, the less vulnerable the household is to flood and drought risk.

4.1.3.2 Household Income Earners

Figure 4.5 shows that 12% of the households did not have an income earner, 57% had one income earner, while 31% had an average of three income earners.

Figure 4. 5: *Household income earners*



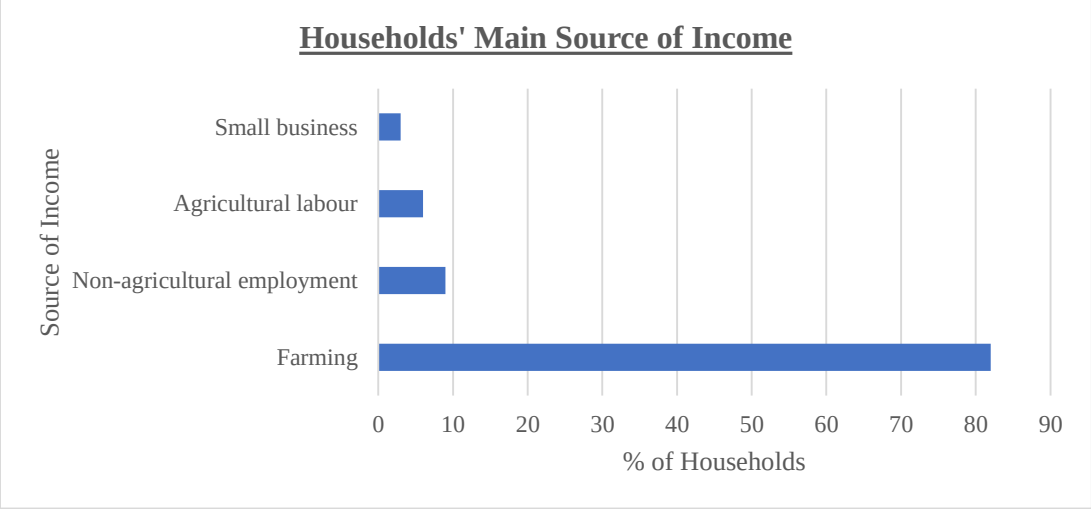
Source: Researcher, 2018

The more the income earners, the less vulnerable the households are to floods and drought risks. 12% of the households with no source of income have a very high vulnerability while the vulnerability of 31% of households is moderate. Households comprising of more members and few income earners have a higher rate of expenditure thus increasing their likelihood of poverty. This makes the households less resilience and hence suffer a greater loss in the event of a disaster (GREDEG, 2015).

4.1.3.3 Household's Main Source of Income

The main source of livelihood for households in the study area is subsistence agriculture, where households grow crops and rear few livestock for food (Figure 4.6).

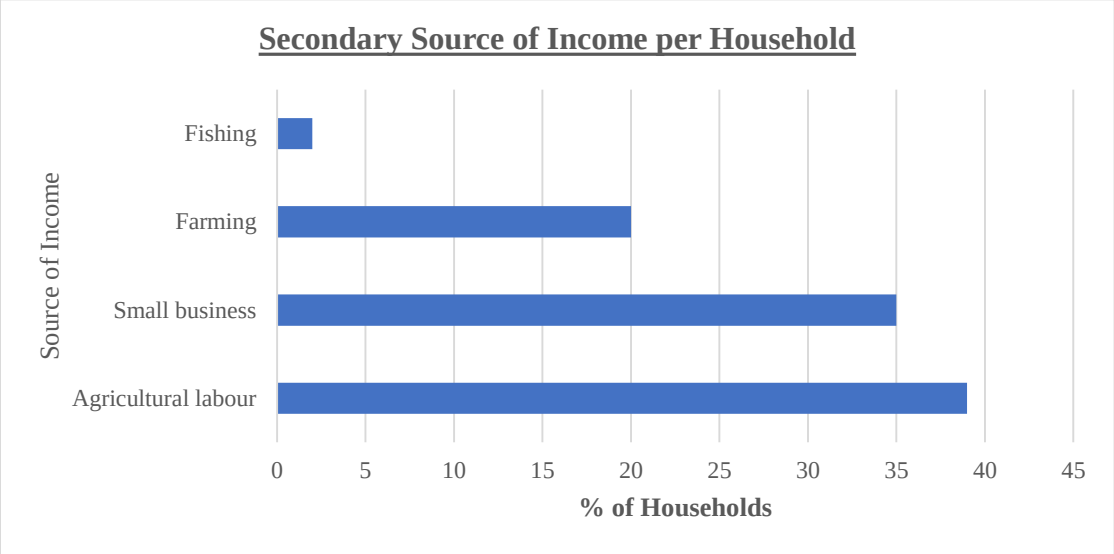
Figure 4.6: *Household's main sources of income*



Source: Researcher, 2018

The secondary source of income for most households is agricultural labour in other people's farms (Figure 4.7). The high dependency on farming as a main and/or secondary source of income increases the vulnerability of these households to the impact of floods and drought.

Figure 4. 7: *Household's secondary sources of income*

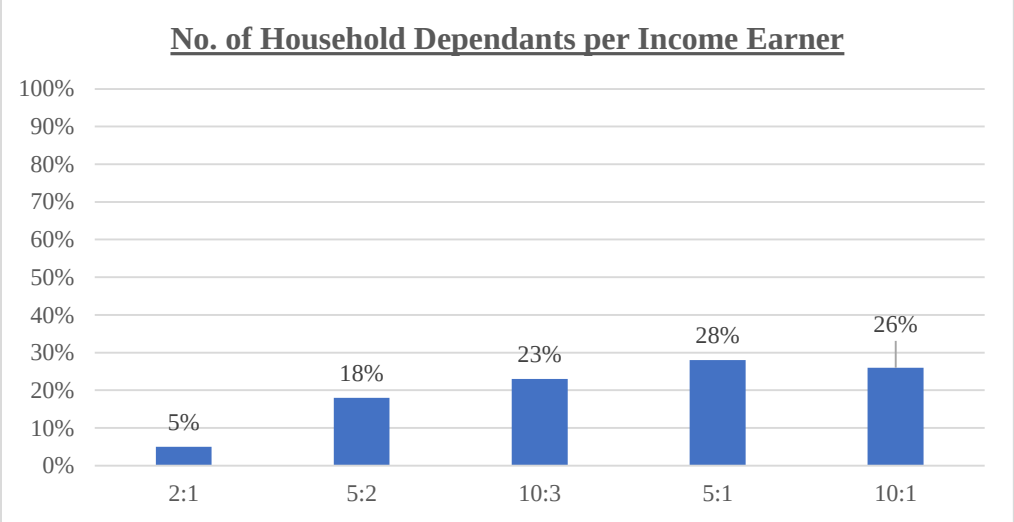


Source: Researcher, 2018

4.1.3.4 Dependency Ratio of Household Size to Source of Income

Figure 4.8 presents the dependency ratios of household size to source of income. 26% of the households have a dependency ratio of 10:1, implying that there are ten people depending on one person's source of income in these households. This indicates that these 26% of households have a very high vulnerability to households (table 4.1). Only 5% of the households in the study area have a dependency ratio of 2:1, indicating a very low vulnerability to flood and drought risks. High dependency ratios could exacerbate the length of time taken by households to recover from flood and drought. This is especially where families lose the main source of livelihoods due to flooding or drought events, and have to rely on relief aid, or alternative sources of income for survival.

Figure 4. 8: *Dependency ratios of household size to sources of income*



Source: Field work

A study sampling 157 rural households in India shows that high dependency rations make households more vulnerable to disasters (Sam *et al*., 2015). This is because high levels of dependency contribute to poverty, which is a major risk factor to vulnerability. Poverty reduces the adaptive capacity of households, hence increasing the time taken by households to recover (Verner *et al*., 2018, 2016; FAO, 2016a).

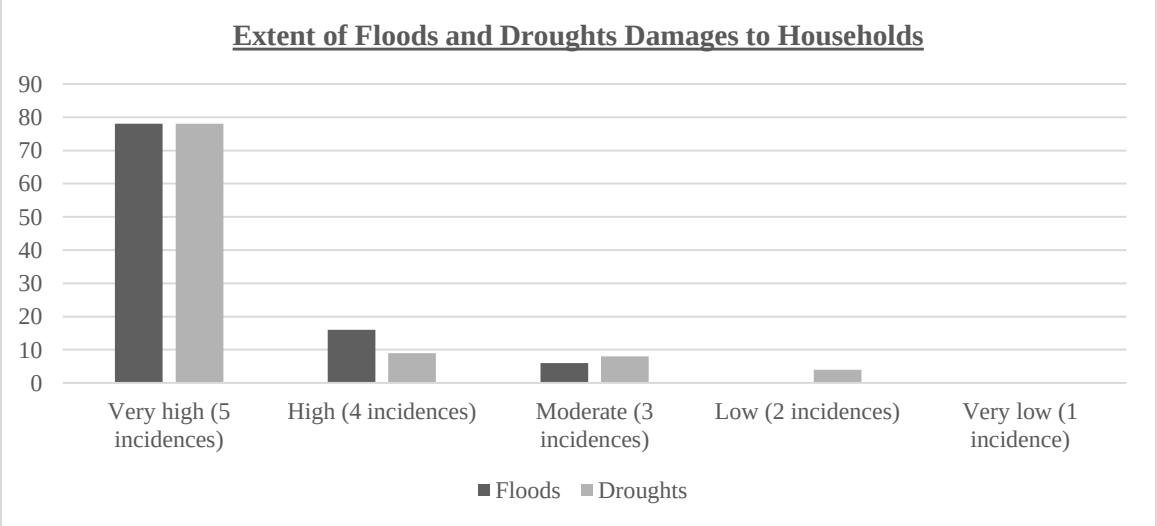
Another study shows that poor people are the most affected with the harmful effects of floods and drought because they lack the capacity to prepare and cope with the consequences of the disturbances (Oxfam, 2010). The study further equates poverty and vulnerability as two sides of the same coin, because limited access to natural resources and low standards of living exposes households, hence making them more vulnerable to floods and droughts risks.

Further literature shows that social factors such as education, poverty and health are key causes of vulnerability (Fothergill *et al.*, 1999; Adger *et al.*, 2004; Vincent, 2004; Brooks *et al.*, 2005) because they are related to distribution of resources (Blaikie *et al.*, 1994). Social diversity, in the availability of and access to resources, makes certain groups more exposed to risk and less capable of adapting (Adger *et al*., 2004, Smit and Wandel, 2006).

4.2 Consequences of Floods and Droughts in Garashi Ward

The research findings identified four broad categories of consequences of floods and droughts to households in the study area. These are 1) damage to agricultural assets (crops, crop yields, livestock, food reserves and agricultural land); 2) loss and reduction of household income and livelihood sources; 3) disruption of normal life and access to lifelines, including school disruption; and 4) spread of diseases, human weakness and loss of lives. Additional losses specific to floods that were identified include 5) damage to houses and household property. In the instance where a household reports all the above categories, then this is interpreted as a very high extent of losses caused by floods and drought to the household. Over three quarters of respondents reported a 'very high' extent of losses to their households, livelihood and well-being by both floods and droughts (Figure 4.9).

Figure 4. 9: *Extent of damages caused by floods and droughts to households*



Source: Researcher, 2018

4.2.1 Damage to Crops, Crop Yields, Livestock, Food reserves and Agricultural Land

Generally, the respondents mentioned that their livestock were swept away or drowned in flood waters; crops were either submerged or swept away; agricultural equipment was lost or damaged and farmland was submerged in water or covered with silt hence rendered

uncultivatable (Plates 4.1 and 4.2). Food reserves for most households were also damaged and/or swept away by floods.

Plate 4.1: *Submerged crops in Masindeni area*

Source: Courtesy of KRCS, August 2018

Plate 4.2: *Partially submerged livestock in Mikuyuni area*

Source: Courtesy of Wish FM on Twitter, 24 April 2018

According to some of the respondents:

> *"I lost 14 goats, 20 chicken and 10 ducks. Also, I had grown maize, cowpeas, green gram, banana trees, brinjals and green pepper on my farm and all these crops were swept away by the floods. To make it worse, two thirds of the farm is covered by*

water so I cannot even grow more crops" – Female respondent, Mwananyamala village, Mikuyuni.

"I lost 4 cattle, 11 goats and more than 200 chickens. All the food that I had stored was washed away as well as the crops I had grown on our farm which include coconut trees, maize, tomatoes, brinjals and mango trees" – Male respondent, Zhongwani village, Mikuyuni.

"Four acres of our farmland now forms part of the river due to the floods. I cannot cultivate crops anymore. The remaining part of the farm is covered in soil, so it has been rendered useless now. I also lost 11 ducks, 5 chicken and 10 goats as they were swept away by the floods" – Female respondent, Kadzitsoni village, Singwaya.

Drought on the other hand resulted in crop failure due to insufficient rainfall and extremely high temperatures for a period of nearly five years (Plate 4.3). According to some of the respondents:

"All crops dried up and hence were not edible, for example bananas, so food was really scarce" – Male respondent, Mwananyamala village, Mikuyuni.

"The drought caused all crops and pasture to dry up" – Female respondent. Kadzitsoni village, Singwaya.

Plate 4.3: *Crop failure at Bora Imani*

Source: Courtesy of Daily Nation, 24 February 2018

Furthermore, prolonged drought led to water sources drying up and a sharp decrease in pasture for livestock. Consequently, livestock were malnourished and in extreme cases, died of starvation and dehydration (Plate 4.4). According to some of the respondents:

> *"We lost 40 cows due to lack of pasture during drought"* – Male respondent, Singwaya village, Singwaya.

> *"There was food scarcity, since there is a shortage of water to grow crops. The water is also not enough for our livestock and pasture dried up, so most of the herd died of starvation"* – Male respondent, Mikanangweni village, Masindeni.

> *"Drought has affected us for the past six years, and crops die due to lack of rainfall. As a result, there is lack of grass for livestock. Even the food residues that cows feed on are not enough due to crop failure"* Female respondent, Kadzitsoni village, Singwaya.

Plate 4.4: *Effect of drought in Garashi*

Source: Courtesy of Baraka FM, 2 February 2017

A study on the impact of floods and droughts on rural livelihoods in Malawi reveals that the most immediate impact of sudden and intense floods and reduced precipitation is on crop production (Devereux, 2006). Floods and droughts weaken crop yields and harvests, and this reduces availability of food in the household, depending on the extent that the family relies on agricultural income. The study further shows that more diversified households are less vulnerable to these impacts of floods and droughts, as long as their secondary sources of income are not dependent on rainfall, or indirectly reliant on agriculture (Devereux, 2006). 80% of the households in Garashi practice farming as their main source of income (figure 4.7). The alternative source of income for more than 50% of the households is still agriculture-dependent (figure 4.8). This implies a high vulnerability of the families in the study area to impacts of floods and droughts. In the long run, the existence of risk lowers the productivity of rural economies by reducing the households' returns to investment. This discourages households to invest in agriculture because the returns are low, and the farmers have become risk averse. These risks posed by floods and drought lead to agriculture stagnation and rural poverty in countries that are hugely dependent on rain-fed agriculture (Dorward and Kydd, 2002).

4.2.2 Loss and Reduction of Household Income

Since the main source of income for most households is farming, the loss of livestock, low crop yields and harvests resulted in reduced and loss of household income. Respondents mentioned that the floods washed away or destroyed farm equipment, and this has led to an increase in cost of production, resulting in a reduction of household income. Farmlands that were rendered uncultivable led to a decline in income opportunities for households that mainly relied on agricultural labour. In addition, respondents who are formally employed or run small businesses reported that the time spent in relocating and waiting for flood water to subside resulted in loss of productive time that could have been used in generating more income for their households.

Even though Garashi is a low-lying area that is susceptible to floods, it is inhabited by a high number of households. Studies have shown that flood plains attract human settlements due to the high potential for agriculture (Jinadu, 2014). The types of losses mentioned by the respondents in this study resonate with studies on the impact of downstream flood disasters (Foster *et. al.*, 2008; Gwimbi, 2009), which have shown the negative effects to include soil degradation, damage to crops, destruction of property, and poor health. Furthermore, households comprising of more members and few income earners have a higher rate of expenditure thus increasing their likelihood of poverty. This makes the households less resilience and hence suffers a greater loss in the event of a disaster (GREDEG, 2015).

Damages caused by drought on agricultural assets led to a decline in household income and livelihood sources for households depending mainly on agriculture-based resources. Respondents reported that crops had lower yields; animals weighed less hence fetched lower prices at the market; employment opportunities on farms were scarce due to unproductive farms; and children had to drop out of school to look for work to supplement the household income. According to some of the respondents:

> *"We experienced drought for the past five years and this led to a loss in jobs on farms since crops could not grow. The household income was low because the livestock were malnourished hence cannot be sold at the market. The crops all dried*

up so we had none to sell or eat. This led to long periods of hunger for the family, and we had to depend on wild fruits to survive" – Female respondent, Nuru village, Mikuyuni.

"Drought increased the level of poverty for our family since crops don't grow due to water shortage. We lost our livestock, and this means lost income because we don't have any cattle to sell" – Male respondent, Mtsungutsunguni village, Singwaya.

"We lost our livestock that were the main source of income when we sell milk or calves at the market. The household income was low, and the children had to drop school to look for work so the money can substitute the little money we get" – Female respondent, Kadzitsoni village, Singwaya.

Farmers who produce substantially fewer crops to sustain the family often resort to alternative sources of income, mostly non-farm employment to supplement the main source of income (Devereux, 2006). Furthermore, the impacts of floods and droughts on small businesses are usually negative in rural labour markets. This is because the disposable household income has reduced hence services such as barbershops and grocery shops do not get many customers. This argument is supported by a study that introduced the concept of derived destitution, which illustrates how shocks such as drought endanger the livelihoods of households whose main source of income is indirectly dependent on agriculture (Sen, 1981).

Since most farms cannot be cultivated during droughts and floods, work that is available on farms is no longer available; the labour supply goes up while the demand goes down. Also, since there are reduced crop yields and harvests, food prices go up resulting in more household expenditure on food, which is a necessity (Devereux, 2006). Livestock farmers are especially most affected during drought since the cattle they sell or exchange for food stuffs is worth only a small fraction of the price they would have fetched prior to the drought (Swift and Hamilton, 2001). Garashi area has experienced prolonged periods of drought and this could aggravate the area's poverty rate of 70.8% which is already higher

than the national rate of 45%. If left unchecked, the increasing poverty levels will reduce the capacity of households to cope and adapt to impacts of floods and droughts.

4.2.3 Disruption of Normal Life and Access to Lifelines

During the flooding season, households in Garashi area were filled with water and the supporting structures were either damaged or swept away. Displaced households were forced to relocate to the nearest displacement camps set up in their area (Plate 4.5). The prolonged inundation of flood water resulted in limited access to water, toilet amenities and means of transport to different regions. The respondents reported that floods destroyed toilets and water storage facilities. In addition, most of the fresh water sources were contaminated with wastewater transported by the flash floods and was not fit for human or livestock consumption. In most areas, flood water was very deep and therefore hindering movement, especially when someone needed urgent medical help (Plate 4.7). The flooded water also disrupted school activities since children could not access the school premises. According to some of the respondents:

> *"The nearest school is flooded, and all classrooms are destroyed by the heavy rains. Children have to walk long distance to school which poses a challenge to children under seven to attend. School performance also goes down since they are psychologically affected by the harsh conditions they are facing"* – Male respondent, Mikanangweni village, Masindeni.

Plate 4.5: *A temporary camp in Garashi Secondary School*

Source: Courtesy of KRCS, August 2018

Plate 4.6: *Flooded road in Garashi*

Source: Courtesy of Daily Nation, 17 March 2018

According to one of the respondents,

> *"Our family was displaced, and we moved to the Chief's camp where we are getting shelter, food and clothing. The children missed school for three months and when we moved, they had to join another school. The teachers here now force them to repeat class and it has really affected them. They don't have the joy of going to school or working hard in their studies"* – Male respondent, Mtsungutsunguni village, Singwaya.

Drought on the other hand caused a very high social disturbance in 48 percent (46 out of 96) of the sampled households. The disturbances include women walking for long distances in search of relief food (Plates 4.7) and water; men leaving their families to search for alternative sources of income in urban areas; change in gender roles since women now take on roles formerly perceived to be men's such as digging trenches and building roads due low returns from agricultural; and children dropping out of school for lack of fees.

Plate 4.7: *Walking to a food distribution center in Magarini*

Source: Courtesy of Daily Nation, 27 February 2018

According to some of the respondents:

> *"During drought, food is scarce, and we always depend on donations. Water is also scarce, and women have to walk for long distances get water from the river"* – Male respondent, Vugulani village, Mikuyuni.

> *"The long dry spell made women take on jobs previously perceived to be done by men. Women now dig trenches and build roads. Majority of women are enrolled in the ACK program of constructing roads. This enables our wives to support the family's income"* – Male respondent, Mtsungutsunguni village, Singwaya.

> *"There was lack of food and the family stays for days without eating. There is also lack of clean water for drinking. Women have to walk for long distances to look for water and relief food, and this make them weak"* – Female respondent, Mwananyamala village, Mikuyuni.

Several studies have defined social vulnerability as the ability of people to cope, survive, adapt and recover from the impacts of natural hazards such as floods and droughts (Wisner *et al*., 2004; Blaikie *et al.*, 1994; Canon *et al*., 2003). Emergency situations such as sudden

flooding and drought can be extremely disruptive, stressful and traumatic time for those affected. Entire communities can be relocated, family and friends divided, homes, livelihoods and, most likely, lives can be lost. In the outcome of such events, families may experience a range of physical, behavioural and psychological responses that, while entirely natural, can considerably affect their ability to cope with the condition (ARC, 2015). This therefore increases their social vulnerability to floods and droughts risks. Social impacts happen over a long period of time and are difficult to determine, because they could be at times perceived as a way of life.

4.2.4 Spread of Diseases, Human Weakness and Loss of Life

Additional consequences of floods in the study area was spread of diseases. Due to the prolonged inundation of water after flooding, there was an outbreak of water-borne diseases such as cholera, malaria and typhoid. Young children were mostly affected although many households mentioned that the entire family was affected by the disease outbreaks. Respondents further reported that loss of food reserves, livestock and crop damage led to food scarcity, threatening food security in the households. This exacerbated the cases of malnutrition among young children that had been caused by extreme hunger during the drought period.

Furthermore, children were also psychologically affected due to the displacement by floods and had to adjust to living in the temporary shelters before eventually moving to their newly re-built homes. Loss of school uniform, textbooks and exercise books also disoriented children mentally, as this was an abrupt change they had to deal with. According to some of the respondents:

> *"All our children were infected by malaria due to the stagnant water surrounding our house. This is a good breeding place for mosquitoes and since the area has remained flooded for long, there are so many mosquitoes everywhere"* - Female respondent, Matesho village, Mikuyuni.

> *"There was an outbreak of disease like cholera due to the poor sanitation in the area after the floods. There was also food scarcity since all our crops were washed*

away by floods and the children were hungry all the time" – Male respondent, Masindeni North Village, Masindeni.

Prolonged drought in Garashi area triggered food security in most households. Respondents mentioned that crop failure and loss of livestock led to increased food insecurity and participants could stay for an average of two days without food. This led to malnutrition especially among young children, who were mainly depending on wild fruits for their daily nutrient supply.

Drought also affected the health of most household members in Garashi. Extreme heat resulted in a lack of soil moisture and there was a lot of dust in the area for many months. This led to the prevalence of a chronic dry cough among the household members. Children were also psychologically affected since they had to walk in the scorching sun to school on a hungry stomach, yet they were supposed to perform well in their studies. Respondents mentioned that the children kept crying due to hunger, thirst, illness or due to the harsh conditions. According to some of the respondents:

"Food was scarce during this period. The lack of food to sustain the body caused it to be weak hence vulnerable to many diseases. Children have to go to school without food and this affects their performance. The family could even stay for three days without food. We were often sick and weak, and often sought medical help" – Male respondent, Mporojoni village, Mikuyuni.

"The food scarcity caused children to go to school without food for even two days. Children also had to drop from school to look for employment. This affected them psychologically, because they are missing school. Those who remained in school could also not concentrate because they were hungry," – Male respondent, Mikanangweni village, Masindeni.

In general, floods and droughts have a negative impact on the health and nutrition of the affected population (WHO, 2002). Consequences of these emergencies in an area depend on the pre-disaster situation of the health system, the public health conditions and disease

pattern of the area before the crisis, displacement of people, effectiveness of the disaster response in the area (WHO, 2002). Common consequences of floods and drought include disability, illness, death, psychological trauma due to displacement, death and illness (WHO, 2009).

In 2009, countries in the southern parts of Africa such as Malawi, Zambia, Botswana, Angola, Namibia, Mozambique and Zimbabwe experienced severe floods that resulted in cholera outbreaks, acute watery diarrhea and loss of lives. Close to 150,000 people were affected by the diseases and approximately 4,600 deaths were reported during this period (WHO, 2009).

The health sector has in the past mainly focused on response and recovery from flood and droughts consequences. This strategy is now shifting to a more proactive approach of mitigation and prevention through strengthening the capacity of communities to provide timely and effective recovery and response to floods and droughts (WHO, 2011). Health systems that are resilient and founded on primary health care at community level can lessen underlying vulnerability, protect health facilities and services, and scale-up the response to meet the diverse health needs in disasters (WHO, 2011).

4.2.5 Damage to Houses and Household Property

Damages to non-agricultural assets were specific to floods only and they include entire houses being swept away; houses filled with sand or destroyed by floods; loss of household property; and loss of important documents (Plates 4.8 and 4.9). According to some of the respondents:

> *"All property in the house including important documents like birth certificates was swept away by floods"*– Male respondent, Gogoranamba village, Singwaya.

Plate 4.8 *Submerged houses in Bore-Singwaya area*

Source: (Hartwell, 2018)

Plate 4.9: *House destroyed by floods in Bore-Singwaya area*

Source: (Hartwell, 2018)

"Our three houses were severely destroyed by the flood water, and we have to re-build them again" – Female respondent, Mtsungutsunguni East village, Singwaya.

"All our household property was destroyed and now we don't even have beddings and cooking utensils. Three of our houses were also completely destroyed so we currently lack shelter" – Female respondent, Zhongwani village, Mikuyuni.

The link between changes in climates, occurrence of natural disasters and internal displacement is now unquestionable (UNHCR, 2017). Small-scale flooding events that lead to local displacement are more common than more profound flooding events affecting bigger population sizes. Those that frequently take place in remote, vulnerable or marginalized areas are rarely reported due to limited communication and access to these areas (IDMC, 2019).

Displacement places communities at more risk of poverty and discrimination and creates specific needs among those affected. It also enhances the risks linked with potential natural hazards and makes previously existing vulnerabilities worse. Homes and livelihoods are damaged, social support networks fall apart and displaced people face intensified protection risks such as family separation, gender-based violence and child protection challenges. Frequently displaced populations tend to remain displaced for longer periods, increasing their risks to consequences of flooding (IDMC, 2019).

In Bangladesh, close to 325,000 people were displaced by floods in 2014, in what was termed as the worst flooding event after the extensive flooding in the area in 2007 (Walter, 2015). In such incidences, the rural poor are most affected since they lack capacity and resources needed to help them fully recover in time. Households headed by females, dependent on agriculture or those with no land are the most vulnerable during human displacement by floods (Walter, 2015).

4.3 Household's Coping and Adaptive Strategies to Floods and Droughts Consequences

4.3.1 Coping and Adaptive Strategies to Flood Consequences

The research findings identified six broad categories of coping and adaptive strategies employed by households to mitigate losses caused by floods. They are 1) seeking advice

from extension officers; 2) reinforcement of houses; 3) migration to less flood-prone areas; 4) ensuring an adequate food reserve; 5) saving money for emergencies; and 6) diversification of income and livelihood sources. In the instance where a household reports all the above coping and adaptive strategies, then this is interpreted as a very high level of flood preparedness.

Generally, study findings show that there is a very low level of preparedness among 92 percent of the sampled households to cope with risks associated with floods (Table 4.2). There is also a perception among respondents that floods are unpredictable and there is little one can do to prepare for them. Furthermore, Garashi area had not received intense floods for over 20 years and hence households were not expecting it to happen.

Table 4. 2: *Household's level of preparedness to flood risks*

Level of preparedness	**Frequency**	**Percentage**
Very low (1 strategy or none)	88	92
Low (2 strategies)	4	4
Moderate (3 strategies)	0	0
High (4 strategies)	0	0
Very high (5+ strategies)	4	4
Total	**96**	**100**

Source: Field work

4.3.1.1 Seeking extension services

Some households reported that they attend meetings held by agricultural officers that advise them on the right planting seasons, early maturing crops, and sustainable farming practices. However, there are household heads in the study area that do not see the importance of regularly attending these meetings and hence are not up to date with the flood preparedness messages. They only attend in the event of an emergency. According to some of the respondents:

> *"Since our farms are filled with sand, we cannot cultivate enough crops for the family. We have been advised by government officers on the right crops to plant so they can mature early before the rains. Some people do not come for these meetings but I think they are important*" - Male respondent, Mporojoni village, Mikuyuni.

4.3.1.2 Reinforcement of houses

Only a few of the respondents (5 out of 96) reported that they had reinforced their houses to withstand flooding. Although three of the households had used semi-permanent materials like sticks to rebuild their houses, one had used bricks to reinforce their houses' foundations, while the other had plastered their walls to make them stronger. According to some of the respondents:

> *"I have used bricks to strengthen the foundation of my house, since previously it was made of mud. This made it weak and as a result it was washed away by floods"* – Male respondent, Zhongwani village, Mikuyuni.

> *"We re-built the house using bricks and also plastered the walls (kutomea) to make them stronger"* - Male respondent, Matesho village, Mikuyuni.

4.3.1.3 Migration to less flood-prone areas

Majority of households feel that they need to relocate to locations with a higher topography, since they are less likely to be affected by future flood occurrences. However, only a few respondents had made some steps towards this, since most were waiting for support from the government and NGOs to relocate them to different areas and/or support them to re-build their homes. Three households, all in Vugulani village in Mikuyuni, reported that they have bought land in less-flood-prone areas and are in the process of re-building their houses. The heads of these households reported that they are staying at the temporary camps until they complete constructing their houses.

4.3.1.4 Maintaining adequate food reserves

Respondents' strategies to ensure they have adequate food reserves include use of irrigation to grow more crops in the highlands; planting more crops to achieve a higher crop yield; and building more granaries to store food surpluses. However, some families reported that the food reserves are enough to last them only for a month or two, before they can start depending on food aid. According to some of the respondents:

> *"We have a farm in a different area that was not affected by floods because it is a higher region. We used irrigation to grow more crops during the dry season, and*

this ensured we always had something to eat" – Female respondent, Zhongwani village, Mikuyuni.

"We use sack farming to increase food production, since this is more controlled compared to many crops on a farm that may fail or be affected by heavy rains" - Male respondent, Mporojoni village, Mikuyuni.

4.3.1.5 Saving money for emergencies

There are households who reported that when the floods occurred, they had a few savings, and this helped to cushion them against the negative impacts of the flood. Some households use their savings to purchase a plot in higher areas, while others used the savings to cover household expenses. Respondents mentioned that their savings helped them to recover faster from the flood impacts, although for some it was only for a month or two before they started depending entirely of aid from NGOs and the government.

4.3.1.6 Diversification of income and livelihood sources

Respondents mentioned that their main source of income which is farming and agricultural labour was lost or reduced by flood impacts. This means they must resolve to other source of income to cover the household needs. The strategies they use include looking for jobs in urban areas and starting small businesses to generate more income for family.

The impacts of small-scale disasters such as flash floods that are newly emerging in an area are not usually felt nation-wide, but they usually cause serious damage at the community level. These new disaster hotspots make the households very vulnerable since they were not accustomed to such catastrophes (UN/ISDR, 2012). The knowledge by households on how to deal with floods cannot therefore apply to these newly affected areas, since they were taken by surprise. For example, in the event of a flood in East Africa, there are more cases of Malaria reported in newly flooded areas compared to previously known hotspots. Households in the new hotspots are not prepared to defend themselves against malaria resulting in loss of lives in the area (UN/ISDR, 2012).

In Bangladesh, which is a country prone to frequent flooding, households dependent on agriculture resort to reserving all seed types and selling excess poultry and livestock before the floods; harvesting fast-growing vegetables and using hay for feeding cattle during floods; and vaccinating their livestock, releasing the seedlings reserved pre-floods, growing fast-growing vegetables and completing vaccination of livestock after the floods (Emran, 2014).

Furthermore, households in areas experiencing less flooding and are better off socially and financially are more likely to cope with impacts compared to households in regions with high and unexpected flooding (Shitangsu and Jayant, 2009). The households' ability to cope varies with the people's socioeconomic situations such as income, sources of livelihood and education (Shitangsu and Jayant, 2009).

4.3.2 Coping and Adaptive Strategies to Impacts of Drought

The research findings identified six broad categories of coping and adaptive strategies employed by households to mitigate impacts of drought. These are 1) seeking advice from extension officers; 2) ensuring an adequate food reserve; 3) saving money for emergencies; 4) changing the planting season and use of drought resistant crops; 5) adoption of alternative sources of water; 6) selling livestock; and 7) diversification of income and livelihood sources. In the instance where a household reports all the above coping and adaptive strategies, then this is interpreted as a very high level of drought preparedness. Table 4.3 indicates that the level of preparedness for drought is much better than of floods.

Table 4. 3: *Household's level of preparedness to drought impacts*

Level of preparedness	**Frequency**	**Percentage**
Very low (1 strategy or none)	7	7
Low (2 strategies)	65	68
Moderate (3 strategies)	22	23
High (4 strategies)	2	2
Very high (5+ strategies)	0	0
Total	**96**	**100**

Source: Field work

Two households reported high drought preparedness, 22 households reported moderate preparedness, 65 households reported low preparedness, while 7 households reported very low preparedness. Some of the residents do not prepare for drought since they believe it is a common occurrence and one can do little to mitigate it. Unfortunately, such households wait for help from well-wishers, NGOs and churches.

4.3.2.1 Seeking advice from extension officers

Respondents reported that there are agricultural extension officers who either visit individual farms or call meetings in the area during each planting season. Some families attend the meetings frequently, some do so occasionally, while others do not see the need to attend the meetings at all.

4.3.2.2 Ensuring an adequate food reserve

Most of the respondents noted that they are used to the dry season, so they have to grow more crops so as to have more food surpluses. Households irrigate their farms when there is no rain to maintain a constant supply of food for the family. According to some of the respondents:

> *"We just want to use the flood water to irrigate the remaining farms, so we can grow crops and store them. We know the dry season will be here soon"* – Male respondent, Mtsungutsunguni village, Singwaya.

> *"We have built storage houses to store crop harvests for future consumption"* – Female respondent, Mwananyamala village, Mikuyuni.

4.3.2.3 Saving money for emergencies

There are households that save enough money to sustain them for at least two months; others save money to sustain them for at least a month; while others save money that can sustain them for less than a month. However, most of the households (90%) do not save at all. Savings is only done for food and rarely for other needs. According to some of the respondents:

"We save money for food when drought strikes, to cushion us from the hunger that people feel when crops do not grow" – Male respondent, Mporojoni village, Mikuyuni.

4.3.2.4 Changing the planting season and use of drought-resistant crops

This is one of the strategies employed by most households, and it could be as a result of frequent extension services offered in the area, as well farmers' experiences of the highest yielding and resistant crop varieties. The drought-resistant crops mentioned by respondents include sorghum, millet and cassava. According to some of the respondents:

"We start planting early and grow more crops so we can have a reserve for use during the dry season. We also grow drought-resistant crops to ensure we have something to eat even if the sun is scorching and most crops cannot grow" – Female respondent, Zhongwani village, Mikuyuni.

"We plant crop varieties that mature early, so that we can have food when drought strikes again," –Male respondent, Mikanangweni village, Masindeni.

4.3.2.5 Adoption of alternative sources of water

The prolonged drought resulted in scarcity of water. Respondents had to walk for long distance in search of water for domestic and livestock use because nearby water sources had dried up. Households have formed welfare groups where they collectively dig wells or water pans. Through these groups, households have also managed to purchase generators to pump water from River Galana to their farms. Some of the respondents have also started mobilizing members of the community to construct dams that can hold a lot of water. Others have started planting trees because they feel that this will increase the chances of rain and lessen the drought spells. According to some of the respondents:

"We have formed groups to construct a well and water pans to store water during the rainy season, so we can use when it does not rain for a long time. We also live next to River Galana, so we use the water to irrigate our farms" – Male respondent, Kadzitsoni village, Singwaya.

"We bought a generator through our farmers' group, that we use to pump water from the river to our farms, so we can irrigate crops" – Male respondent, Vugulani village, Mikuyuni.

"We plant more trees to attract rain. When people cut trees, the rain became less frequent, so we are now planting more trees so that it can rain frequently, and we will have more water" – Female respondent, Gogoranamba village, Masindeni.

4.3.2.6 Selling livestock

Livestock farming is one of the main sources of livelihood for households in Garashi. Drought resulted in a decline in livestock health, leading to low livestock production and loss of livestock in extreme cases. Respondents mentioned that unproductive livestock do not fetch profitable sales, hence they undergo a loss, compared to the input cost. To prevent this, households have to sell their livestock early enough before they are too unproductive to be sold at the market. Since the supply is higher than the demand, the farmers often incur a loss. According to some of the respondents:

"During drought, we sell most of the livestock so as to get money for food, instead of letting the animal die of starvation" - Male respondent, Mtsungutsunguni village, Singwaya.

4.3.2.7 Diversification of income and livelihood sources

One of the impacts of drought was the loss of household income and livelihood sources. Households reported that they had to diversify their income sources in order to make ends meet. Alternative sources of income reported by respondents include working on other people's farms that are located near the river; looking for work in urban areas; planting cash crops at the riverbank; fishing; and starting small businesses. According to some of the respondents:

"We have started engaging in small business to generate more income, rather than depend on agriculture only. The rains have become unpredictable" – Female respondent, Mtsungutsunguni village, Singwaya.

"During the dry season we go to urban areas to search for jobs so we can save more money for our family to use when there is little food on the farms. We have also built storage houses to store crop harvests for future consumption" – Female respondent, Mwananyamala village, Mikuyuni.

"When income from farming was low, my husband started fishing then I opened a business of selling fish so as to earn extra income for the family" – Female respondent, Mikanangweni village, Masindeni.

Unlike floods that have a rapid-onset, droughts occur over a long period of time, giving people the chance to plan on what measures they will take to think through and address the causal factors such as people's vulnerabilities, poverty, risks posed to household income, lack of early planning strategies, and inadequate institutional capacity and resources (UN/ISDR, 2012). Understanding the underlying causes of drought risks will allow governments and the private sector to undertake effective droughts and floods reduction and preparedness actions (UN/ISDR, 2012). Severe droughts, for instance, can force food-insecure farmers to overexploit common property resources such as community forests, pasture, ponds, riverbanks and groundwater, with negative medium- and long-term consequences for agricultural productivity and food security (Pandey et al., 2007).

Turkana pastoralists in northern Kenya are faced with extreme and frequent drought events that have impacted negatively on their livelihoods. The long-term adaptation strategies they use to cope with droughts include moving around with livestock to track water and forage resources; rearing different livestock types with varying tolerance to drought and diseases and species with diverse productivity to increase chances of herd survival; diversifying sources of livelihood; and educating their children as a long term investment with expected returns from employment (Opiyo *et al*., 2015).

4.3.3 Support to Mitigate Impacts of Flood and Drought

The respondents were asked whether they received any form of support to help them recover from flood and drought impacts. The findings show that 98 percent of the affected

households received support during floods, while 75 percent of the households received support during drought. The support was largely in terms of food supplies, clothing and temporary shelter. Other minimal form of support was in terms of financial assistance, farm inputs, medical services, provision of clean water, provision of mobile toilets, provision of beddings, chlorine for purifying water, household items (cooking utensils and beddings), and psychosocial support.

Support for those affected by floods and drought came from non-governmental organizations (majority of the households), faith-based organizations, the government, friends and relatives. The organizations working in the area include Kenya Red Cross, ADS Pwani, World Vision, Action Aid, Plan International, Anglican Church of Kenya (ACK), Islamic Relief, National Drought Management Authority (NDMA) and Kenya Red Cross Society.

A social analysis of rural communities living along Zambezia River in Mozambique reveals that populations residing near rivers should be resettled, although it is estimated that only about 40% of the newly displaced households were permanently residing on the resettlement sites allocated by the Government (Lorenzetti, 2013). This is because in most instances, the allocated land lacks infrastructure and adequate service provision; families hence tend to return to their initially disaster-prone regions. This decision is especially understandable in economies that heavily rely on agriculture, and farming is the main source of livelihoods for 80% of the households (Lorenzetti, 2013).

4.4 Household Flood and Drought Vulnerability Index

This study employed the vulnerability index to determine the level of vulnerability of households to impacts of floods and drought. The vulnerability index combines multiple components of a system into one value of between 0 and 1. A value of 0 denotes lowest vulnerability, while a value of 1 denotes highest vulnerability (Table 4.4). Three variables were used in this index: exposure, sensitivity and capacity. Each variable had six indicators, adding to a total of 18 indicators in the index. These indicators were the ones used to formulate questions for the household and key informant surveys.

Table 4. 4: *Interpretation of vulnerability index*

Vulnerability	Index value	Description
Very low	<0.01	• The area recovers very fast • Insurances against impacts exist • There is a very high investment in preparedness
Low	>0.01-0.25	• Social, economic, environmental and physical components are occasionally affected by hazards but the recovery process is fast • If area is less developed economically, damages are not so high • High budget exists for preparedness
Vulnerable	>0.25-0.50	• Social, economic, environmental and physical components are affected • The area can recover in months • There is enough investment in preparedness
High	>0.50-0.75	• Social, economic, environmental and physical components are vulnerable to hazards • Recovery process is slow • The area has a low resilience to hazards • Lack of disaster management institutions
Very high	>0.75-1.0	• Social, economic, environmental and physical components are very vulnerable to hazards • Recovery process can take years • Budget for disaster preparedness is scarce

Source: Balica, 2012a

Responses were scaled then weighted as follows: very high = 1, high = 0.8, moderate = 0.6, low = 0.4 and very low = 0.2; where 0.2 is the lowest level of household vulnerability and 1 is the highest vulnerability level. The Weighted Average Index (WAI) for each data variable (exposure, sensitivity and capacity) was then computed using the formula below:

$$\text{WAI} = \frac{W_1 + W_2 + \ldots\ldots W_i}{\text{n}} = = \sum_i^n \frac{W_i}{\text{n}}$$

$$EI = \frac{\sum_i^n EWi}{n}, \qquad SI = \frac{\sum_i^n SWi}{n}, \qquad CI = \frac{\sum_i^n CWi}{n}$$

The Vulnerability Index (VI) was then calculated for both floods (FVI) and drought (DVI) using the Exposure Index (EI), Sensitivity Index (SI) and Capacity Index (CI).

FVI = EI x SI/CI and DVI = EI x SI/CI

4.5.1 Flood Vulnerability Index

Analysis of flood vulnerability index reveal that average normalized value for exposure is the lowest at 71.1, followed by capacity at 82.1 then sensitivity at 91.2 (Table 4.5). This means there is a higher flood sensitivity index compared to the exposure and capacity indices. Indicators that increased the sensitivity of Garashi community to floods was the impact to non-agricultural assets; dependence of household income on agriculture and impact of flood to agricultural assets.

Table 4. 1: *Flood vulnerability variables and weighted indicator values*

	Weighted levels of measurement				
Flood risk component	**1**	**0.8**	**0.6**	**0.4**	**0.2**
Exposure:					
Household size	28	28	28	11	1
Previous flood frequency	0	1	0	82	13
Recent flood frequency	96	0	0	0	0
Number of income earners	11	55	30	0	0
Number of men in household	2	6	54	30	4
Female-headed households	0	0	0	37	59
Total	**137**	**90**	**112**	**160**	**77**
Total Weighted	**137**	**72**	**67.2**	**64**	**15.4**
Average Normalized Values = 71.12					
Sensitivity:					
Main source of income	79	6	3	0	8
Dependency ratio	25	27	22	17	5
Damage to agricultural assets	61	19	14	1	1
Damage to non-agricultural assets	80	8	2	4	2
Disruption of normal life and access to lifelines	21	11	43	20	1
Damage to health	15	2	75	2	2
Total	**281**	**73**	**159**	**44**	**19**
Total Weighted	**281**	**58.4**	**95.4**	**17.6**	**3.8**
Average Normalized Values = 91.24					
Capacity:					
Level of education of household head	28	2	55	11	0
Level of preparedness for floods	7	65	22	2	0
Diversified sources of income	0	10	86	0	0
Availability and circulation of emergency plans	32	1	2	43	18
Knowledge on ways to improve resilience	90	1	3	1	1

Ability to resume normal livelihood activities	27	22	8	28	11
Total	**184**	**101**	**176**	**85**	**30**
Total Weighted	**184**	**80.8**	**105.6**	**34**	**6**
Average Normalized Values = 82.08					

Source: Field work

In summary, the table shows that:

1. Flood Exposure Index = 71.12/96 = 0.74
2. Flood Sensitivity Index = 91.24/96 = 0.95
3. Flood Capacity Index = 82.08/96 = 0.86
4. Flood Vulnerability Index = (0.74*0.95) ÷ 0.86 = 0.82

As such, Garashi area has a very high vulnerability to floods. In addition, the flood vulnerability index computations reveal that the area is more sensitive to floods compared to exposure and capacity. The lowest variable is exposure although it still has a high vulnerability value at 0.74. The indicator that increased the flood exposure index in Garashi area is the recent occurrence of floods.

In coastal areas, flood vulnerability index is used to measure the area's susceptibility to flooding, in relation to the system's physical and socio-economic aspects over a long period of time. This provides decision-makers with an indication of which areas need urgent intervention and provides a wide option of possible adaptation options that can be used locally (Balica *et al*., 2012c).

4.5.2 Drought Vulnerability Index

For drought, sensitivity is the highest variable at 92.88 (Table 4.6). The indicators that had the highest weight in this variable are dependence of household income on agriculture, impact on agricultural assets and social disturbances, indicating that these are the most sensitive variables to flood and drought risks in Garashi area.

In summary, the table shows that:

1. Drought Exposure Index = 71.12/96 = 0.74
2. Drought Sensitivity Index = 92.88/96 = 0.97
3. Drought Capacity Index = 85.52/96 = 0.89

4. Drought Vulnerability Index = (0.74*0.97) ÷ 0.89 = 0.81

As such, Garashi has a very high vulnerability to drought. The area is more sensitive to drought compared to exposure and capacity. The lowest variable is exposure although it still has a high vulnerability value at 0.74. Fewer numbers of female-headed households in the area lowered the level of exposure to drought impacts.

Table 4. 2: *Drought vulnerability variables and indicators*

	Weighted levels of measurement				
Drought risk component	**1**	**0.8**	**0.6**	**0.4**	**0.2**
Exposure:					
Household size	28	28	28	11	1
Previous drought frequency	3	46	12	24	0
Recent drought frequency	10	72	12	2	0
Number of income earners	11	55	30	0	0
Number of men in household	2	6	54	30	4
Female-headed households	0	0	0	37	59
Total	**54**	**207**	**136**	**104**	**64**
Total Weighted	**54**	**165.6**	**81.6**	**41.6**	**12.8**
Average Normalized Values = 71.12					
Sensitivity:					
Main source of income	79	6	3	0	8
Dependency ratio	25	27	22	17	5
Damage to agricultural assets	75	16	1	0	4
Socio-economic disruption	46	28	18	0	4
Access to lifelines	34	28	20	9	5
Damage to health	18	36	23	15	4
Total	**277**	**141**	**87**	**41**	**30**
Total Weighted	**277**	**112.8**	**52.2**	**16.4**	**6**
Average Normalized Values = 92.88					
Capacity:					
Level of education of household head	28	2	55	11	0
Level of preparedness for drought	7	65	22	2	0
Diversified sources of income	0	10	86	0	0
Availability and circulation of emergency plans	64	0	20	8	4
Knowledge on ways to improve resilience	39	33	22	2	0
Ability to resume normal livelihood activities	16	36	26	7	11
Total	**154**	**150**	**231**	**30**	**15**
Total Weighted	**154**	**120**	**138.6**	**12**	**3**
Average Normalized Values = 85.52					

Source: Field work

Studies show that over the past 10 years, the drought vulnerability index has been used a tool to assess vulnerability of households that are dependent on agriculture to drought and climate change globally (Addisu *et al.*, 2016; Panthi *et al.*, 2016; Adu *et al.*, 2018; Oo *et al.*, 2018; Williams *et al*., 2018). This index will provide measures to observe vulnerability over time, determine the activities that lead to vulnerability, focus on approaches for its mitigation and evaluate the effectiveness of these approaches in different social and ecological settings.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusion and recommendations based on the four specific objectives to: 1) determine the factors that influence household vulnerability to floods and droughts risk in Garashi Ward; 2) determine how households in Garashi Ward are affected by the occurrence of floods and droughts; 3) evaluate ways that households use their knowledge about vulnerability to adapt to and cope with floods and droughts risks; and 4) determine the flood and drought vulnerability indices of households in Garashi Ward.

5.1 Summary of Findings

5.1.1 Factors Influencing Vulnerability of Households to Floods and Droughts

This study determined that the two main factors that influence the vulnerability of households to floods and droughts risks include an alternating occurrence of prolonged drought (for around five years) followed by an onset of floods; and the high dependency by households on agriculture-based resources as the main source of income. Factors that had a moderate influence on household vulnerability include large household sizes; low number of income earners per household; high dependency ratio of household size to income earners; and low literacy levels of household heads. Other factors with a significant influence on household vulnerability include presence of female-headed households and a low number of men per household.

5.1.2 Consequences of Floods and Droughts in Garashi Ward

This study established that the two main consequences of floods in Garashi area include damage to non-agricultural assets (houses and household property) and damage to agricultural assets (crops, crop yields, livestock, food reserves and agricultural land. Other significant consequences mentioned by households include. The two main consequences of drought in the study area include damage to agricultural assets and socio-economic disruptions (long walking distances to relief food and water points, shifting gender roles and rural-urban migration in search of alternative sources of income).

5.1.3 Household's Coping and Adaptive Strategies to Floods and Droughts Consequences

Based on this study's evaluation it was established that households with little or no knowledge on how to prepare for the anticipated risks of floods and droughts are more vulnerable to floods and droughts consequences. Although households receive support from the government, non-governmental organizations, and well-wishers to recover from the shocks, the extent of the consequences faced depends on the household's adaptive capacity to respond to these shocks. This study established that there is a low level of preparedness at household level, and this is attributed to the low literacy levels among heads of households, lack of adequate information on disaster resilience at household level and non-effective early warning systems.

5.1.4 Household Flood and Vulnerability Indices

The vulnerability analysis established that Garashi area is highly vulnerable to droughts and floods risks. This is depicted by the flood and drought vulnerability index values of 0.82 and 0.81, respectively. The study area is more sensitive to floods and droughts risks, because the sensitivity index value for both hazards is 1. This value denotes the highest level of vulnerability to hazards.

5.2 Conclusion

Flood and drought are a common occurrence in Garashi area, and this trend is expected to continue in coming years. Households on the other hand are least prepared to cope with the impacts of floods and drought and hence are at a very high risk-potential to flood and drought impacts. Generally, the impact of floods and drought on households in Garashi area will worsen if sustainable multi-sectoral interventions are not put in place to prepare and mitigate the vulnerability of these households to natural disasters.

5.3 Recommendations

5.3.1 National Government

The national government should take lead in conducting periodic identification of natural hazards as well as risk and vulnerability assessments. Information generated from these

assessments will strengthen the capacity of key stakeholders in disaster management. Consequently, this will guide the development of effective mitigation measures for natural hazards at national, county, community, household and individual levels. This also calls for a high investment in disaster preparedness at all levels to achieve effective disaster risk reduction. In this regard, the government should develop a contingency plan that will help reduce disaster impacts caused by natural hazards.

5.3.2 County Government

Based on the identified needs from the national assessments, the county government in collaboration with key partners should identify all stakeholders then conduct trainings targeted at vulnerable regions, to build the capacity of households on disaster risk reduction. The trainings should focus on sustainable strategies for coping with disasters. They should also be participatory and tailor-made for various groups such as female-headed households, children and low literacy individuals. Furthermore, both men and women should be included in the trainings for sustainability.

In addition, the county government and other organizations that offer support to communities in the event of a natural disaster should conduct rapid needs assessments and consultative meetings prior to the intervention aimed at mitigating hazard impacts. This will avoid duplication of efforts and offer more targeted forms of support to affected households.

Although interventions to mitigate hazard impacts should focus on all variables of vulnerability (exposure, sensitivity and capacity), priority should be on the sensitivity component since it has the highest vulnerability index values. This entails providing more livelihood opportunities aimed at diversification of income to reduce dependency of households on agricultural-based resources. Households also need to be sensitized on the relationship between income dependency ratios and duration of recovery from impacts, to increase their adaptive capacities.

5.3.3 International Development Partners

Development action should be coordinated across all partners to avoid duplication of efforts. International partners should complement and strengthen existing government structures and avoid a competitive approach. There is a gap in early warning, hence international partners to prioritize investment in the development of adaptable disaster risk reduction models. Partners should also support multi-sectoral advocacy initiatives to lobby for clear legislative and policy frameworks on risk management.

There should also be a high level of accountability among international partners to ensure that the allocated funds are used for the intended purpose in the areas of intervention.

5.3.4 Future Researchers

The time limitation for this study could not allow the use of inductive and participatory approaches of vulnerability assessment. This involves engaging vulnerable households to identify their own perspective of resilience and vulnerability. The households define natural hazards and their risks based on the people's cultural beliefs and perceptions, then give suggestions for best-suited strategies that should be used to mitigate the hazard and its risks. This is a more subjective approach that offers an in-depth understanding of social vulnerability of households to natural hazards. Combining inductive and participatory approaches with the deductive method of using indicators gives a detailed overview on the capacity needs of each household.

APPENDICES

Appendix A: Household Survey Questionnaire

<table>
<tr><td colspan="2">Questionnaire No: Date of Data collection:</td></tr>
<tr><td colspan="2">A: GENERAL HOUSEHOLD INFORMATION</td></tr>
<tr><td colspan="2">Village/sub-Location</td></tr>
<tr><td colspan="2">Head of Household’s (Respondent) Details:
Name/ID No
Gender: M/F
Age:
Level of education: (none, ECD, primary, secondary, tertiary)</td></tr>
<tr><td>1. How many people live permanently in your household?
□ More than 10 people
□ 8 to 10 people
□ 5 to 7 people
□ 2 to 4 people
□ 1 person</td><td>1.a) How many of these are men?
□ None
□ 1 man
□ 2 to 4 men
□ 5 to 7 men
□ More than 7 men</td></tr>
<tr><td>2. How many people earn an income in your household?
□ None
□ 1 person
□ 2 to 4 people
□ 5 to 7people
□ More than 7people</td><td>3. What is the main source of income for your household? [Select one]
□ Agriculture
□ Livestock
□ Agricultural labour
□ Small business
□ Non-farm employment
□ If other, specify</td></tr>
<tr><td colspan="2">4. What is the secondary source of income for your household? [Select all that apply]
Agriculture - Livestock - Agricultural Labor - Small business - Non-farm employment. If other, specify</td></tr>
<tr><td colspan="2">B: FLOODS</td></tr>
<tr><td colspan="2">5. Have you ever experienced floods in your village? Y/N (if no, skip to Q 10)</td></tr>
<tr><td colspan="2">5.a) If yes, when was the last time you experienced floods in your village?
□ Within the past 6 months
□ 6-11 months ago
□ 1-2 years ago
□ 3-5 years ago
□ More than 5 years ago</td></tr>
<tr><td colspan="2">6. Before the last incidence, had you experienced another occurrence of floods in your village? Y/N (If no, skip to Q 7)</td></tr>
<tr><td colspan="2">6.a) If yes, when did this occur?
□ 6-11 months ago
□ 1-2 years ago
□ 3 years ago
□ 4-5 years ago
□ More than 5 years ago</td></tr>
</table>

7. Have floods ever had an impact on your household? Y/N (if no, skip to Q 10)

7.a) If yes, how have floods affected your household? (Write down all details as mentioned but do not lead the respondent. Use the details to determine the level of impact and then fill in table below):

Example of impacts (not exhaustive)	Very High	High	Moderate	Low	Very Low
Floods threatened food security in household					
Floods caused food scarcity					
Floods caused malnutrition					
Floods caused a disease outbreak					
Floods caused unemployment					
Floods caused reduction in household income					
Floods caused population displacement					
Floods affected schooling of children					
Floods caused hopelessness and sense of loss					
Floods threatened access to clean water					
Floods caused loss of lives					
Floods caused damage to property					
Floods caused damage to house structure					
None					

8. How long does it take your household to recover from flood impacts?
   - ☐ More than 3 years
   - ☐ Between 1 and 2 years
   - ☐ Between 6 months and 1 year
   - ☐ Between 3 and 6 months
   - ☐ In less than 3 months

9. How does your household prepare to cope with impacts of flooding? (Write down all details as mentioned but do not lead the respondent. Use the information given to determine the level of preparedness. Very low level of preparedness will be assigned the 'very high' weight in the table below:

Examples of household means of preparedness	Very high	High	Moderate	Low	Very low	
Changing the planting seasons						
Change to early-maturing crops						
Store crop harvests						
Save more money						
Store crop residues for livestock						
Sell some livestock						
Migrate to a less flood-prone area						
Seek alternative sources of income						
Reinforcing the house to withstand flood water						
Nothing						

10. Have you ever received information on how you can make your household safe/able to quickly recover from impacts of floods? (Y/N) (If no, skip to Q 15)

10.a) If yes, how recently did you receive the information?

- 5 or more years ago
- Between 3 and 5 years ago
- Between 1 and 3 years ago
- Between 6 and 12 months ago
- Within the past 6 months

11. From whom did you receive the information on how to make your household safe from impacts of floods?

- Friends/relatives
- NGOs (Kenya Red Cross etc.)
- Government officials
- Media (TV/newspaper/radio)
- Other (specify)

12. What kind of support has your household received from other people to help you recover from impacts of floods?

- None
- Food supplies
- Clothing
- Financial assistance
- Temporary shelter
- Farm inputs
- Other (specify)

13. Who usually provides the support to enable your household recover from impacts of floods?

- The Government
- NGOs (Kenya Red Cross etc.)
- Friends/relatives
- Faith-based organizations
- Other (specify)

C: DROUGHT

14. Have you ever experienced drought in your village? Y/N (If no, skip to Q 20

15. If yes, when was the last time you experienced drought in your village?

- Within the last 3 months
- Between 3 and 6 months ago
- Between 6 months and 1 year ago
- Between 1 and 2 years ago
- More than 2 years ago

16. Before the last incidence, had you experienced another drought occurrence in your village? Y/N (If no, skip to question

16.a) If yes, when did this occur?

- Between 6 months and 12 months ago
- Between 1 and 2 years ago

- Between 2 and 3 years ago
- Between 3 and 5 years ago
- More than 5 years ago

17. Has drought ever had an impact on your household? Y/N (If no, skip to Q

17.a) How has drought affected your household? (Write down all details as mentioned but do not lead the respondent. Use the details to determine the level of impact and then fill in table below):

Examples of impact (not exhaustive)	Very High	High	Moderate	Low	Very Low
Drought threatened food security in household					
Drought caused food scarcity					
Drought caused malnutrition					
Drought caused a disease outbreak					
Drought caused unemployment					
Drought caused reduction in household income					
Drought caused hopelessness and sense of loss					
Drought caused conflict over clean water					
Drought caused loss of lives					
Drought caused loss of livestock					
Drought caused family instability					
None					

18. How long does it take for your household to recover from drought impacts?
- More than 3 years
- Between 1 and 2 years
- Between 6 months and 1 year
- Between 3 and 6 months
- In less than 3 months

19. How does your household prepare to cope with impacts of drought? (Write down all details as mentioned but do not lead the respondent. Use the information given to determine the level of adaptation. Very low level of preparedness will be assigned the 'very high' weight in the table below:

Adaptation level (not exhaustive – add as mentioned)	Very high	High	Moderate	Low	Very low
Changing the planting seasons					
Change to drought-resistant crops					
Store crop harvests					
Save more money					
Store crop residues for livestock					
Sell some livestock					
Adopt water-harvesting techniques e.g. water pans					
Migrate to a less drought-prone area					
Seek alternative sources of income					
Nothing					

20. Have you ever received information on how you can make your household safe/able to quickly recover from impacts of droughts? (Y/N)
20.a) If yes, how recently did you receive the information? □ 5 or more years ago □ Between 3 and 5 years ago □ Between 1 and 3 years ago □ Between 6 and 12 months ago □ Within the past 6 months
21. From whom did you receive the information on how to make your household resilient to impacts of drought? □ Media (TV/newspaper/radio) □ Government officials □ NGOs (Kenya Red Cross etc.) □ Friends/relatives □ Other (specify)
22. What kind of assistance has your household received from other people to help your household recover from impacts of drought? □ None □ Food supplies □ Clothing □ Financial assistance □ Water supplies □ Farm inputs □ Other (specify)
23. Who usually provides the support to enable your household recover from impacts of floods and drought? □ The Government □ NGOs (Kenya Red Cross etc.) □ Friends/relatives □ Faith-based organizations □ Other (specify)

Appendix B: Key Informant Interviews Questionnaire

The following guiding questions were used to interview the key informants:

Date of Interview: **Organization:**
Name and Position of Respondent:
1. Do you collect any information on drought and flood occurrence in Kilifi County? Y/N 1.a) If yes, what type of information do you collect? 1.b) How frequently do you collect this information?
2. In your opinion, which areas in Kilifi County are most affected by drought and floods?

3. Do you have any prevention measures safeguarding households against any danger or threats of drought and floods in Magarini sub-county? Y/N 3.a) If yes, please explain briefly the prevention measures you have, and how often you implement them:
4. What are some of the mitigation measures that you have in place towards promoting household resilience to impacts of drought and floods in Magarini sub-county?
5. Do you have any capacity-building plans in place to increase household awareness on preparedness and ways to adapt to drought and flood impacts in Magarini? Y/N 5.a) If yes, what type of messages are usually communicated to the households and how?
Do you have any other comments/information you would like to add?

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