

**FLOOD DISASTER PREPAREDNESS AND IMPACTS ON  
RURAL HOUSEHOLDS: A COMPARATIVE STUDY OF  
MWANDI DISTRICT OF ZAMBIA AND EASTERN  
ZAMBEZI REGION OF NAMIBIA**

**by**

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## PREFACE

The research contained in this thesis was completed by the candidate while based in the Discipline of Agricultural engineering, School of Engineering of the College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa. The research was financially supported by WaterNet, National Commission on Research Science and Technology (NCRST) of Namibia and Namibia Students Financial Assistance Fund (NSFAF).

The contents of this work have not been submitted in any form to another university and, except where the work of others is acknowledged in the text, the results reported are due to investigations by the candidate.

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## **DECLARATION OF PLAGIARISM**

I, Monde Patrina Mabuku, declare that:

- (i) the research reported in this dissertation, except where otherwise indicated or acknowledged, is my original work;
- (ii) this dissertation has not been submitted in full or in part for any degree or examination to any other university;
- (iii) this dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons;
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  - a) their words have been re-written but the general information attributed to them has been referenced;
  - b) where their exact words have been used, their writing has been placed inside quotation marks, and referenced;
- (v) where I have used material for which publications followed, I have indicated in detail my role in the work;
- (vi) this dissertation is primarily a collection of material, prepared by myself, published as journal articles or presented as a poster and oral presentations at conferences. In some cases, additional material has been included;
- (vii) this dissertation does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the References sections.



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Signed: Monde Patrina Mabuku

Date: 9<sup>th</sup> December, 2019

## DECLARATION OF PUBLICATIONS

My role in each paper and presentation is indicated. The \* indicates corresponding author.

### Chapter 3

1. Mabuku, M. P.,\* Senzanje, A., Mudhara, M., Jewitt, G.P.W., & Mulwafu, W. 2018. Evaluating the impacts of floods in Zambia and Namibia: A Propensity Score Matching Approach. This paper is in preparation. The paper is based on the data I collected from household survey, interviews and observations. I designed the survey questions, collected, analysed the data and wrote the paper.

### Chapter 4

2. Mabuku, M. P.,\* Senzanje, A., Mudhara, M., Jewitt, G.P.W., & Mulwafu, W. 2018. Rural households' flood preparedness and social determinants in Mwandu district of Zambia and Eastern Zambezi Region of Namibia. *International Journal of Disaster Risk Reduction*, 28, 284–297. <http://doi.org/10.1016/J.IJDRR.2018.03.014>. This paper is an analysis of data collected using the data instruments such as household surveys, focus group discussion and observations. I designed the questionnaire, collected, analysed the data and wrote the paper. The paper, was presented at the 16<sup>th</sup> Waternet/WARFSA/GWP-SA symposium on Integrated Water Resources Management and Infrastructure planning for water security in southern Africa - 28 to 30 October 2015, Mauritius. The presentation was awarded the Best Young Scientist Award under Water and Society theme. The presentation was done by Mabuku PM.

### Chapter 5

3. Mabuku P.M.,\* Senzanje, A., Mudhara, M., Jewitt, G. P. W. & Mulwafu, W. O. (2019). Strategies for coping and adapting to flooding and their determinants: A comparative study of cases from Namibia and Zambia. *Physics and Chemistry of*

*the Earth, Parts A/B/C*, (October 2018), 0–1. <http://doi.org/10.1016/j.pce.2018.12.009>. The paper was presented at the 17<sup>th</sup> WaterNet/WARFSA/GWP-SA Symposium on Integrated Water Resources Management: Water Security, Sustainability and Development in Eastern and southern Africa held on 26<sup>th</sup> -28<sup>th</sup> of October 2016, Gaborone, Botswana. The paper is an analysis of data collected through a survey. The paper was published in the *Journal of Physics and Chemistry of the Earth*. I designed the questionnaires, collected, analysed the data and wrote the paper. I also presented part of this paper at the European Geosciences Union (EGU) General Assembly held on 24<sup>th</sup> - 28<sup>th</sup> of April 2017 in Vienna, Austria. The title of the presentation was “The influence of gender and age on the choice of flood adaptation strategy: The Case study of Namibia and Zambia”.

## **Chapter 6**

4. Mabuku, M. P.,\* Senzanje, A., Mudhara, M., Jewitt, G.P.W. & Mulwafu, W. 2018. A framework for measuring rural households’ flood disaster resilience in Mwandu District of Zambia and Zambezi Region of Namibia. This paper work is an analysis of data collected through survey and focus groups and observations. I designed the questionnaire, collected data and analysed the data. The paper will be submitted to the *Journal of Global Change*.

## **ABSTRACT**

The Zambezi Basin is considered vulnerable to climate variability as evidenced by the recurrent floods. The increased occurrence and severity of floods in recent years in areas previously not flooded has inundated parts of Eastern Zambezi Region of Namibia and Mwanzi District of Zambia. The magnitude and frequency of these floods, coupled with poor disaster preparedness and lack of effective adaptation strategies, is believed to have negative impacts on rural households. Therefore, a cross country case study was carried out in order to assess the impacts of floods on income, crop production and livestock ownership; to determine the level of flood disaster preparedness; to assess coping and adaptation strategies undertaken by the rural households, and to develop a Household Flood Disaster Resilience Framework (HFDRF). Furthermore, the factors influencing the choice of different adaptation strategies and preparedness level were determined. Data were collected through structured and semi-structured questionnaire survey, focus group discussions, literature reviews and observations. The results indicated that floods had statistically significant impacts on income, crop production and livestock ownership of flooded rural households in both Namibia and Zambia. Rural households depended on both short-term coping and long-term adaptation strategies in order to minimize the negative impacts of floods and flood disasters. Households coped with floods through charcoal production, sale of firewood, sale of grass and reeds, collection of wild food and receipt of food aid. Long-term adaptation strategies included planting trees, fish farming, and flood water harvesting, temporary relocation to higher ground, and changing planting dates, among others. A majority of the households were well prepared (52%) for flood hazards in Namibia, whilst a minority were well prepared (9%) in Zambia. Furthermore, flood preparedness was influenced by sense of community, risk perception, self-efficacy, responsibility efficacy, outcome expectancy, education level, marital status, access and size of land. The study concludes that a variety of factors influence level of flood preparedness and adaptation strategy choices. For policy purposes, this suggests that relevant stakeholders' interventions should consider these factors in order to enhance the rural households' adaptive capacity to flooding. Furthermore, results on the impacts of floods on rural households could help in targeting the most vulnerable households in

responding effectively to food disasters. This study informs decision makers and practitioners who aim to strengthen disaster risk reduction and management in the two countries and under similar environments, on the status quo of flood impacts, adaptation, and preparedness. The Household Flood Disaster Resilience Framework can be used as a tool for monitoring rural households' flood resilience.

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- My family members and beloved friends who supported me emotionally making sure I stayed sane throughout this emotional journey.

Special thanks to my two sons, Bencious and Thabo for being patient with mom while away for so many years. I love you sons.



## **DEDICATION**

I dedicate this PhD thesis to my nephew Muhali Elvis Mubusisi who died in a car accident at 24 years old. Your untimely death was a painful one. This PhD is for you. May you continue resting till we meet again

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# 1. INTRODUCTION

## 1.1 Rationale for the Research

Since prehistoric times people have lived in flood-prone areas due to desirable geographic environments. Beneficially, seasonal flooding has served to replenish aquatic habitats, restore soil moisture and nutrients that support wildlife and agriculture, and navigation (Douben, 2006; Zambezi Watercourse Commission (ZAMCOM), 2012; Arnall, 2014). However, above normal floods have been and continue to be a threat to lives and property of floodplain residents in the Zambezi basin (Zambezi Watercourse Commission, 2012). In Eastern Zambezi Region of Namibia, there has been an increase in the area inundated by floods, even in the areas that were perceived as higher ground (Mudabeti, 2011; Mabuku, 2013). Similarly, in Western province of Zambia where Mwanzi District is part, the inundated areas are increasing and the timing shifting, causing increased property damages, reduced food production and income generation, as a result some coping mechanisms are becoming less effective (Cai *et al.*, 2017).

Worldwide, river flood risk is expected to increase in riverine areas with consequent devastating effects on human society and the environment (Ceola *et al.*, 2014). Globally, frequency, intensity and magnitude of flood increased in the last three decades (Doocy *et al.*, 2013). In Africa, La nina<sup>1</sup> and El nino<sup>2</sup> such as the one experienced in 2009, were associated with wet conditions in the south and dry conditions in the east. During 2009, major flooding in Zambia left thousands homeless and Namibia experienced flooding reported to be the worst in more than 50 years (Le Comte, 2010).

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<sup>1</sup> La nina is the positive and cold phase of the El Niño–Southern Oscillation, and is associated with cooler-than-average sea surface temperatures in the central and eastern tropical Pacific Ocean.

<sup>2</sup> El nino is a periodic warming in sea-surface temperatures across the central and east-central equatorial Pacific. An El Niño event increases the risk of heavy rainfall and flooding in some parts of the world, while in others, it increases the risk of drought through reduced rainfall (FAO, 2018).

In southern Africa, climate change and variability is a major problem for many rural communities where the majority of the population still lives, and are directly and indirectly dependent on rain-fed agriculture (Gwimbi, 2009). An example is the widespread flooding due to Cyclone Eline in 2000 in Mozambique, South Africa, Zimbabwe, Malawi, Botswana and Namibia (Vaz, 2000). According to Douben (2006) flooding is still the most damaging of all natural disasters. In 2011 and 2012 nearly 200 million people were affected by floods worldwide with a total damage of almost 95 billion U.S. dollars (Ceola *et al.*, 2014).

The Zambezi Basin is considered most vulnerable climate change impacts, particularly flooding and drought. Climate change is posing an increasingly severe challenge to agricultural livelihoods due to increased frequency and intensity of extreme weather events (Arslan *et al.*, 2018). Climate change is likely to exert its greatest impact on natural resources and hence threaten the livelihoods of the majority of people who live in rural areas (Mfune and Ndombo, 2005). These communities at high risk depend on the River for livelihoods but are challenged by climate change and variability (Zambezi Watercourse Commission, 2012). According to Zambezi Watercourse Commission, (2012) floods on the Zambezi River are recurring disasters. Southern African regional and Namibian national level climate change projections suggest that significant climate change-related impacts are likely in the future (Kandjinga *et al.*, 2010). Rain-fed agriculture system on which people's livelihoods depend are particularly vulnerable. Due to the anticipated effects of increasing climate change and variability on long-term agricultural productivity, the Namibian Government identified the need to strengthen and develop the adaptive capacities of smallholder farmers, pastoralists, and natural resource managers as a matter of priority (Mfune and Ndombo, 2005). While Namibians have long coped with extreme climatic conditions, climate change presents a significant challenge, as it will make living in an already harsh environment more difficult (Crawford and Terton, 2011). Warming temperatures, increasingly variable rainfall, rising sea levels, and more frequent and intense weather events threaten to halt, or even reverse, the country's development progress (Crawford and Terton, 2011). The government recognized that addressing adaptation at the local level, i.e., through

community-based adaptation (CBA) key to achieving sustainable development (Kandjinga *et al.*, 2010).

In the rural communities of Namibia and Zambia, particularly the Zambezi Region and Mwanzi District, people are dependent on natural assets that are impacted by floods. The magnitude and severity of these floods are expected to have serious environmental, economic and social impacts of rural people's livelihoods. This is aggravated by the fact that rural households have to cope and adapt to variability in climate considering that their livelihood strategies are dependent on agriculture. In the Zambezi Basin, the adaptive capacity varies from household-to-household, depending on the assets or capital (see page 137-139 for details) at their disposal to pursue livelihoods. However, the more the adaptive capacity and the higher the rural households' preparedness level the better they will respond when a disaster occurs. According to Ellis (2000), "A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities and access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household". This combination gives rise to the household livelihood strategy. The livelihood strategy a household chooses to pursue may vary and takes the demographic and socio-economic considerations into account. Globalisation and Livelihood Options of People living in Poverty GLOPP (2008) suggested that livelihoods can only be sustainable if they can maintain or enhance their capabilities, assets, entitlements and cope/adapt with the shocks without compromising the natural resource base of the area. It is therefore important that the livelihoods of rural households remain sustainable despite the continuous negative impacts of floods.

## **1.2 Problem Statement**

Riverine rural communities rely on the resources that floods bring, such as rich agricultural soils and fish, to construct their livelihoods, and almost universally incorporate the annual cycle of flooding into their crop production strategies (Arnall, 2014). These resources are the main reasons why these communities moved to flood plains in the first place. However, climate change poses an increasingly severe

challenge to agricultural livelihoods due to increased frequency and intensity of extreme weather events (Arslan *et al.*, 2018). The impacts from floods and drought include among others; loss of life, crops and livestock, as well as displacement and damage to infrastructure (Funder *et al.*, 2018). Responding to these natural disasters is, therefore, a matter of priority.

The Eastern Zambezi Region in Namibia and Mwanzi District of Zambia experience annual seasonal flooding. This is because they are part of the Zambezi Basin, which is considered to be most vulnerable to the impacts of climate change, particularly flooding and drought (Nhubu, 2015). Long *et al.* (2014) reports that the study area recently has witnessed the resurgence of severe flooding. The hydrology of the Zambezi Region in Namibia is characterized by the presence of four perennial rivers, namely the Kwando and Zambezi whose catchment lie in Angola and Zambia, and the Chobe and Linyanti. Furthermore, It is reported that changes in land use and a land cover, coupled with the meteorological dynamics in the region, contribute to the severity and frequency of floods in Eastern Zambezi Region of Namibia (Nhubu, 2015). According to Cai *et al.* (2017), the timing of the floods in the Western Province of Zambia has also changed with both delaying and early onset happening more frequently. These changes cause increasing difficulties to using indigenous knowledge for forecasting and preparing for floods, therefore creating greater damages to crops, livestock, and houses (Cai *et al.*, 2017). The current floodplain management system is inadequate and new interventions are needed to help manage the floods in a systematic manner (Cai *et al.*, 2017).

Widespread flooding due to Cyclone Eline in 2000 over Mozambique, South Africa, Zimbabwe, Malawi, Botswana and Namibia was reported (Vaz, 2000). Furthermore, the decade 2001 to 2010 had increased flooding frequency, with floods occurring in 2004 and 2008 and the near-record water levels of the 2009 flood (Government of Namibia, 2009). The floods affected approximately 23,000 people, twenty-five percent of the population in the Zambezi Region of Namibia. The 2009 flood came after Namibia had experienced several years of low impact flooding after the frequent flooding of the 1960s and 1970s (Mutelo *et al.*, 2013). The upper Zambezi swelled over its banks causing much destruction to property and killing people and animals. Lake

Liambezi through the Bukalo channel received the floodwaters from the Zambezi after a long period since its drying up in the 1990s (Inambao, 2009). The floods affected 90% of the Kabe population who were relocated resulting in reduced harvest in the floodplains, inaccessibility of social service institutions such as clinics and schools during the floods. In addition, the floods resulted in outbreaks of water-borne diseases.

At present, there is a dearth of information on the quantification of the rural household impacts of flooding, the level of flood preparedness and the adaptation in Eastern Zambezi Region of Namibia and Mwanzi District of Zambia. Knowledge on the impacts and preparedness of the flooding in Eastern Zambezi and Mwanzi District of Zambia becomes a necessity for the planning and development of mitigation, adaptation and coping strategies. There have been few published flood-related studies in Eastern Zambezi Region of Namibia and Mwanzi District of Zambia. Nyambe and Belete (2013) carried an assessment of climate risk factors on rural households that practice small-scale agriculture with the aim of improving the incomes of farming households in the flood-prone areas of the Zambezi Region. They revealed that climate risk factors, especially flood, exacerbate the opportunity cost for obtaining a good harvest and thus exposed farming households to income risk and food insecurity.

Long *et al.* (2014) delineated the extent of flooding in the Chobe floodplain in the Zambezi Region of Namibia using remote sensing data. Similarly, Mutelo *et al.* (2013) carried out a study to understand the variations in the area extent of Lake Lyambezi in Zambezi region. The inundation and recharge of the lake was found to be driven by the Zambezi River floods. Furthermore, De Groeve (2010) also carried a study on flood monitoring and mapping using passive microwave remote sensing in Namibia. Another study was carried out to estimate the contribution of water from various sources and the magnitude of changes in the flooding extent in the Chobe watershed between 1985 and 2010 (Pricope, 2013). The results indicated that between 12% and 62% of the basin is flooded on an annual basis and that the spatial extent of the flooding varies throughout the year as a function of the timing of peak discharge in the two larger basins (Pricope, 2013). Mashebe *et al.* (2016) examined the impact of floods on the livelihoods of the community of the Luhonono area in the Kabbe constituency in the Zambezi Region of

Namibia. This study concluded that flooding impacted on the livelihood assets of the community in the Luhonono area, and also stimulated the likelihoods of famine (food insecurity). Furthermore, Lwando (2013) carried out a study on climate variability and gender in Sesheke District. In the study, assessments of the flood impacts were analysed qualitatively. The study did not critically look at the level of preparedness, adaptation strategies and factors influencing the choice of these adaptation strategies. Other research carried out in the study area include that of Saasa *et al.* (2015) who looked at the perceptions, husbandry and disease management practices amongst cattle owners of Mwandu District, Zambia. The vast area of wetland along the Zambezi River flood plains and river banks is important for cattle grazing, and Kamwi *et al.* (2018) looked at livelihood activities and skills in rural areas of the Zambezi Region of Namibia and the implications for policy and poverty reduction.

There is limited knowledge on impacts of floods on income, crop and livestock production, level of flood preparedness and adaptation strategies for floods in the study sites. There is a need for a deeper understanding of flood impacts, flood preparedness and adaptation strategies of households together with the socio-economic factors influencing their choices. Studies focusing on exploring these impacts and the rural households' level of preparedness could give scientific insight on these developments considering the debate on whether rural households are adapting to flooding or not. For Sub-Saharan Africa, Cai *et al.* (2017) concluded that robust identification of adaptation strategies and attribution of hydrological change is severely limited. Therefore it is necessary to incorporate impact assessment and preparedness in flood studies. This is necessary for the design of effective implementation of sustainable adaptation livelihood strategies through policy formulation, extension support and mitigation measures. This in return will assist households to adapt and prepare for future flooding events or disasters. Furthermore, assessing the impacts of floods on income, crop, and livestock in a rural community is an essential step in determining the vulnerability of the community to floods. As a result, this will assist in dealing with the impacts related to flooding and address such impacts through well-informed decisions-making.



### **1.3 Aims and Objectives**

The main aim of this study is the assessment of the impacts of floods on income, crop and livestock production at household level and flood disaster preparedness in order to formulate appropriate household resilient framework for sustainable livelihood. In addition, the different socio-economic and socio-cognitive factors that influence adaptation and flood preparedness is assessed.

The objectives of the thesis is to:

- (i) Assess the impacts of floods on rural households' income, crop and livestock production (Chapter 3, Paper 1),
- (ii) Evaluate rural households' level of flood preparedness (Chapter 4, Paper 2),
- (iii) Determine the factors that influence flood disaster preparedness (Chapter 4, Paper 2),
- (iv) Determine the coping and adaptation strategies to flooding adopted by rural households (Chapter 5, Paper 3),
- (v) Determine the socio-economic factors influencing the choice of adaptation strategies (Chapter 5, Paper 3) and
- (vi) Develop a Household Flood Disaster Resilience Framework (HFDRF) for assessing rural households' flood disaster resilience (Chapter 6, Paper 4).

### **1.4 Research Questions**

This research aimed to address five key research questions:

- (i) What are the impacts of floods on rural households' income, crop and livestock production?
- (ii) What is the level of flood preparedness at the household level?
- (iii) What are the socio-cognitive factors influencing the level of rural households' flood preparedness?
- (iv) What are the adaptation strategies adopted by households in face of floods?
- (v) What are the socio-economic factors influencing the choice of these adaptation strategies?

- (vi) What framework would best assess flood resilience of rural households in the study area?

## **1.5 Outline of the Dissertation Structure**

This dissertation is written in a paper format. Each chapter is mostly self-contained, containing an abstract, introduction, literature review (some literature review is included within the introduction as recommended by the reviewers of the published articles), materials and methods, results and discussion (one section), limitation and conclusions. Chapter 1 introduces the theme of the research, provides the rationale for the study and points out the significant knowledge gaps on flood impacts, preparedness, adaptation and resilience. This chapter also lists the research aims and objectives. Chapter 2 reviews the literature on flood occurrence at different scales, impacts of floods and different models to assess impacts, the general disaster preparedness components and factors influencing disaster preparedness of different communities, and the adaptation strategies in place. It also reviews disaster resilience as assessed by different authors. This paper aims to assess whether a disaster flood resilience framework is needed, which aims to help assess and monitor the resilience of rural communities in Namibia and Zambia study sites. Chapter 3 assesses the impacts of floods on income, crop production and livestock ownership in the study area. This chapter explores the use of Propensity Score Matching (PSM) approach in assessing the impacts of floods. This is done through a comparison of the flooded and non-flooded households and comparing the differences in income, crop production and livestock ownership. Chapter 4 is a case study on adaptation strategies adopted by rural households in the study area. These adaptation strategies include the short term (coping strategies) and the long term adaptation strategies, furthermore, the factors influencing the choice of adaptation strategies were identified. Chapter 5 examines the level of flood disaster preparedness in Mwandji district of Zambia and East part of the Zambezi region of Namibia. It further identifies factors determining the level of floods disasters preparedness in two study sites. This can help policymakers to introduce programs that will enhance flood preparedness that are user specific. Chapter 6 proposes a framework which is envisaged to help the local community, especially at the household level to

prepare for flood disasters taking into account different factors. The final chapter, Chapter 7, integrates the work, provides conclusions and documentation of the contributions of this research. The recommendations for policy and further research are also discussed.

## **1.6 Contributions of the Study**

The study contributes to new knowledge in the field of Disaster Risk Reduction in Zambia and Namibia in a number of ways. Firstly, it is the first to develop a Household Flood Disaster Resilience Framework envisaged to assess the level of resilience in the study sites. Secondly, the study assesses the impacts of floods on income, crop and livestock production using a Propensity Score Matching (PSM), this approach allows for assessing impacts without a need for baseline information. Thirdly, the study will identify coping and adaptation strategies to flooding in two countries. The analysis of flood impact coupled with preparedness and adaptation will give insight on whether the households are resilient considering that they continue to live in the flood plain. Fourthly, the study also identifies problems, such as inconsistencies or gaps in the literature. Finally, the study takes into account the importance of lack of studies that consider trans-boundary aspects, hence the inclusive of Namibia and Zambia cases. This study focuses on the analysis of impacts of floods on income, crop and livestock production, flood disaster preparedness and adaptation strategies. Analysis of meteorological and hydrological data and causes of floods are out of the scope of this study. Furthermore, this study focuses on floods only, it does not in any way address drought.

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## **2. LITERATURE REVIEW**

The literature review focuses on floods and their impacts, flood preparedness, adaptation and resilience. Some specific aspects in the literature review are covered within the individual case chapters.

### **2.1 Introduction**

Floods are basin-wide phenomena that do not respect administrative, political, or other humanly devised borders, whether they are national, regional, local, or institutional (Bakker, 2009) . A flood is defined as the presence of water in areas that are usually dry while a “flood disaster” is a flood that significantly disrupts or interferes with human and social activity (Jonkman and Kelman, 2005). Floods can be differentiated according to their spatial and temporal scale (Menne and Murray, 2013). Examples of floods include; slow-onset riverine flood (fluvial), Flash flood (rapid onset), Pluvial or surface water flood affecting sewers and urban drainage and groundwater flood. River floods results in a slow rise of water level as well as gradual inundation of large areas through water spilling over river banks and are caused by excessive rainfall not necessarily in the flooded area but upstream of the river (Jonkman and Kelman, 2005; Keoduangsine and Goodwin, 2012). Extensive, long-lasting floods (plain floods) often result in flooding of larger areas. They are almost invariably caused by rainfall lasting several days or weeks, associated with prior soil saturation. Flash flood is defined as a “fast and extreme movement in high level of water into a usually dry area” the duration of a flood is short and frequently associated with severe damage (Menne and Murray, 2013). These occur after high-intensity local rainfall leading to a quick rise of water levels affecting the lives of inhabitants (Jonkman, 2005). River floods are the most common floods type occurring in the Eastern Zambezi region of Namibia and Mwandia district of Zambia.

The Zambezi basin is considered to be most vulnerable to the impacts of climate change particularly flooding and drought. Changes in hydrological systems have become one of the contentious issues in the global climatic negotiations because it is as a result of the changes in climate. These changes also influence the livelihoods of communities,

particularly those who are dependent on natural resources for their livelihood. Globally, in the last three decades flood increased in frequency, intensity and magnitude (Doocy *et al.*, 2013). According to the World Bank (2005), in Africa, floods and drought are the major natural hazards threatening people's livelihoods. On the other hand, in southern Africa, climate variability is a major problem for many rural communities where the majority of the population still live and are directly and indirectly dependent on rain-fed agriculture (Gwimbi, 2009). An example is the widespread flooding due to Cyclone Eline in 2000 over Mozambique, South Africa, Zimbabwe, Malawi, Botswana and Namibia (Vaz, 2000).

The communities in the eastern Zambezi of Namibia and Mwandia district of Zambia have long dealt with floods but evidence suggest that their long-term methods of coping and adapting to floods may no longer suffice in the context of climate change. Hence the importance of understanding how they have adapted in the past, how they are coping in the present, so as to understand the adequacy of their preparedness in relation to future extreme events. In Eastern Zambezi (Caprivi), there has been an increase in the area inundated by floods, even in the areas that were perceived as higher ground (Mudabeti, 2011; Mabuku, 2013). The current floodplain management system is inadequate and new interventions are needed to help manage the floods in a systematic manner (Cai *et al.*, 2017).

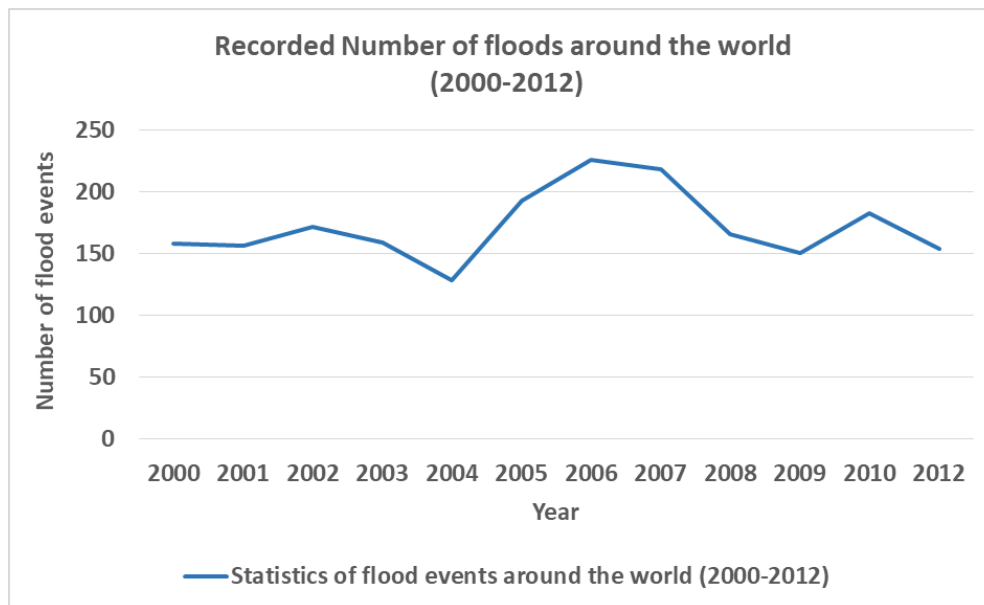
In the Zambezi basin, the adaptive capacity varies from household to household and depends on the assets or capitals at their disposal to pursue a particular livelihood strategy. However, the more the adaptive capacity and the higher the preparedness level of the households the more resilient the households will be better likelihood that rural households will respond when a disaster occurs.

## **2.2 Floods and their impacts on rural households**

A flood is a natural phenomenon which affects people around the world and leads to financial, environmental and human losses (Keoduangsine and Goodwin, 2012). The statistics on flood events indicate a significant increase in impacts over the last three



decades (Kourgialas and Karatzas, 2011). Over the same period, McMichael and Schneider (2011) reported that 57 nations have been affected by catastrophic floods where 29 of these nations were in Africa, 19 (Asia) and 9 (Latin America). According to statistics, more than 3,300 floods and droughts occurred across the globe, between 1991 and 2005 (Preston *et al.*, 2011). More flood events are recorded between 2004 and 2010 as shown in Figure 2.1. The affected population by these disasters was estimated at 3.4 billion. This indicates 98% of the global total population affected by natural disasters during the same period (Lei, 2009). Due to their geographic and climate conditions, some regions are more vulnerable to severe floods and droughts than others (World Bank, 2005). Asia, for example, leads all other continents in terms of the number of floods and droughts which all amount to nearly 40% of the world total (World Bank, 2005). However, regions and countries differ in their ability to successfully prepare, respond as well as adapt to their impacts of floods. Because of this variation, the statistics of people negatively impacted by flood differ by region or country.



**Figure 2.1 Statistics of floods documented between 2000 and 2012 globally (After UNISDR, 2012)**

Xiao (2011) reported several losses in the capital in nations affected by disasters. The impact of flooding on agriculture differs significantly according to tolerance of a specific crop, frequency, duration and seasonality of the disaster (Reser and Morrissey, 2009). In Bangladesh, Kahn (2005) found that most farmers cultivate in the low land. Rice as the main crop grown was damaged by flash floods due to unavailability of controlling measures. In another study in Bangladesh, Banerjee (2010) found that large areas are cultivated and that agricultural productivity (crop yield) is greater in the flood-prone districts. When floods are extreme crop yield amount decrease, however, crop productivity rises during normal floods and in the few months after floods (Banerjee, 2010).

In Africa, it is reported that floods and drought are the main natural disasters causing threats to people's livelihoods (Kenna, 2008). The recurrent floods appear to correlate with the El Nino phase of ENSO events and generate significant economic and human losses (Kundzewicz *et al.*, 2014). Floods and drought disasters in Africa affect millions of individuals and increase the hunger to these individuals (World Bank, 2005). Concentrated and unintended human settling in flood-risk areas contributes highly to the increase in risk of flooding (Kenna, 2008). Several hazards especially droughts and floods have been recorded for many decades in Africa (IUCN/PACO, 2016). In 2007, West Africa experienced the worst floods over the past 30 years with 33 deaths in Burkina Faso, 23 in North Togo, 46,000 displaced people including 26,000 in Burkina Faso and 14,000 in Togo. In the same year, 17,689 ha of flooded crops and a production loss of about 13,500 tonnes were recorded in Burkina Faso (IUCN/PACO, 2016). In Nigeria, it was found that floods in 2010 had negative impacts on the cultivated areas (Adelekan, 2011).

In southern Africa, floods are a common feature and their occurrence poses a threat, which cannot be eradicated but has to be managed (Muhonda *et al.*, 2014). Despite significant achievements in science and technology, rural communities endure the negative consequences of severe flooding in the region (Musah and Akai, 2014). Report by Reliefweb (2017) indicated that in 2017, heavy seasonal rainfall affected southern Africa. It was reported that, in Mozambique approximately 44 people died and about

79,000 people were affected by floods in that year. The risk of vector and water-borne diseases such as cholera and malaria were particularly high. In Malawi, a total of 35,304 people were affected while 7,216 people were displaced and left homeless. Zimbabwe experienced severe flooding across 37 districts of the country, which damaged local infrastructure, livelihoods, transportation routes, and homes. Floods in Botswana resulted in bridges collapsing, roads closed, and health facilities were flooded and some schools were closed to reduce the risk of children drowning.

In Namibia, approximately 23,581 learners from schools in Omusati Region were idling at home as a precautionary measure taken by 67 schools which were flooded by the incessant heavy rains (Reliefweb, 2017). In the north-western provinces of Angola, floods resulted in several people missing and destroyed properties (Reliefweb, 2017). In a study by Lwando (2013), floods in Sesheke and Mwandu districts of Zambia negatively affected 70% of the rural households. Similarly in Namibia, Eastern Zambezi region of Namibia, almost 80% of the rural households are negatively affected by these floods (Mabuku, 2013).

However, in certain instances, floods have positive impacts. Some of the positive impacts include the source of abundance water required for crop productivity, groundwater recharge and support fish production (Banerjee, 2010). Soil fertility augmentation through the growth of Nitrogen-fixing algae is also reported (Hofer and Messerli, 2006). The combination of the above factors result in improved agricultural production and reduce the cost of irrigation and fertilization. Skidmore and Toya (2002) found that sometimes disasters may foster acceptance of innovative technology, rising productivity, and enhance financial development. Reduction in the unemployment rate and increases in earnings in nations affected by disasters have been reported too (Ewing *et al.*, 2005; Belasen and Polachek, 2009).

### **2.3 Climate variability, Climate Change and Flooding**

Climate change refers to a “change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an

extended period, typically decades or longer” (IPCC, 2014). Climate change may be attributed to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014). On the other hand, Climate variability is defined as the variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events (IPCC, 2014). Variability may be due to natural internal processes within the climate system), or to variations in natural or anthropogenic external forcing. Many long-term inhabitants in Africa agree that floods recently inundate areas not flooded two decades ago (ActionAid, 2006) and attribute this to climate change. There have been several observed climatic trends, which shows that climate change is linked to floods (Kundzewicz *et al.*, 2010).

Floods have existed for as long as water has been on Earth and are likely to be of major concern in the future especially with the larger population living near water such as coasts of rivers (Amoako and Frimpong Boamah, 2015). Some people believe that they originate from natural causes while other people believe their occurrence is mainly dependent on human factors. According to Nhubu (2015) causes of floods can be grouped into three categories: meteorological factors such as rainfall; hydrological factors which include soil moisture level, groundwater level, infiltration rate; human factors which include land-use activities, occupation of the floodplain obstructing flows, structural flood control measures such as embankments in the upstream, decrease in conveyance of the river channels owing to build up of river debris, mining and other industries, altered water regimes, greenhouse gas emissions which may affect climate change and frequency and magnitude of precipitation events. Unabated loss of forests may increase or exacerbate the number of flood-related disasters, negatively impact millions of poor people, and inflict trillions of dollars in damage in disadvantaged economies over the coming decade (Knowler and Bradshaw, 2007). Land degradation, deforestation of catchment areas, increased population along river banks, inadequate and poor land use planning induce floods (Amoako and Frimpong Boamah, 2015; Nhubu, 2015). In addition, IUCN/PACO (2016) reported that most flood-related

damages occurred in areas where natural ecosystems were destroyed by human settlement and activities

## **2.4 Impact Assessment Challenges and Approaches**

There are numerous studies undertaken to study the financial effects of natural disasters that lead to human and economic loss (Xiao, 2011). According to Xiao (2011), natural disaster impact research follows a common route: a simulation modelling method and an experimental assessment method. On one hand, the simulation modelling method depends on models that capture main socio-economic interactions. Disaster events are regarded as shocks and impacts are evaluated from the simulated results. This line of research includes impact valuation based on an input-output (IO) framework. For example, models based on computable general equilibrium (CGE) by Rose and Liao (2005), and Rose *et al.*, (2007) and regional econometric models by Chang and Falit-Baiamonte (2002).

On the other hand, the experimental assessment method, evaluates disaster impacts through direct observations, using descriptive or econometric analysis such as the use of Propensity Score Matching (PSM), switching regression, Difference-in-Difference or Double Difference and Heckman two-stage models. Research demonstrates that at national level, economically there is resilience in absorbing shocks caused by natural disasters (Worthington and Valadkhani, 2004). Contrary, research conclusions at local level are reported to be inconsistent (Xiao, 2011).

Estimation of the impact of floods on households grounded on non- experimental approach is the main methodological challenge because of the selection bias problem, and the problem of missing data for the counterfactual (Bundel and Costa, 2000; Wooldridge, 2003). Selection bias is related to the problem of identifying the appropriate counterfactual benchmark or baseline against which to compare the impact of flooded households and non-flooded households (Mmbando *et al.*, 2015). Each individual is either under the intervention being assessed or not and therefore the individual cannot be in both. Outcomes are only observed in one state (affected or non-affected); the counterfactual is unobservable. Households who are affected may have

different characteristics from the ones who are not-affected (Smale *et al.*, 2012). The implication of this is that the use of standard regression techniques (ordinary least square (OLS) to estimate the parameters of the equation would result in biased and inconsistent estimates (Mmbando *et al.*, 2015). Therefore, PSM can be used in evaluating the impacts of floods on rural households.

The Propensity Score Matching (PSM) method is a systematic procedure of estimating counterfactuals for the unobserved values to estimate impact estimates with no (or negligible) bias (Mulugeta and Hundie, 2012). The validity of the outputs of the PSM method depends on the satisfaction of two basic assumptions namely: the Conditional Independence Assumption (CIA) and the Common Support Condition (CSC) (Becker and Ichino, 2002). According to (Mulugeta and Hundie, (2012), CIA (also known as Unconfoundedness Assumption) states that the potential outcomes are independent of the treatment status. The CIA ensures that, although treated and untreated groups differ, these differences may be accounted for in order to reduce the selection bias. This allows the untreated units to be used to construct a counterfactual for the treatment group. The common support condition involves the existence of sufficient overlap in the characteristics of the treated and untreated units to find adequate matches (or common support). According to Khandker *et al.*, (2010) the following are the advantages of using a PSM;

- If selection bias from unobserved characteristics is likely to be negligible, then PSM may provide a good comparison with a randomized estimate,
- the use of PSM does not necessarily require a baseline or panel survey, and
- PSM is also a semi-parametric method, imposing fewer constraints on the functional form of the treatment model, as well as fewer assumptions about the distribution of the error term.

## **2.5 Systems Approach to Disaster Management**

A new consensus has emerged that the best way to address both the causes and consequences of disasters is through a more systems-based approach, one that treats Disaster Risk Management (DRM) as a transversal issue, cutting through public

policies from a variety of sectors, and integrated under a comprehensive strategy (Pelling and Holloway, 2005). In particular, it incorporates research on the threat of disaster, vulnerability assessment, and strengthening of governance systems, while more closely linking DRM with development processes overall (O'Donnell, 2010). The theoretical proposal for this more systems-based approach emerged in the 1990s. It was in the 2000s when the theory began to be applied. In many regions, the shift from the more response-based approach to a more systems-based approach has been quite gradual (Watanabe, 2013). The systems approach places an emphasis on processes and instruments that facilitate interdisciplinary cooperation between distinct actors in order to embed DRM within existing development spheres. It entails strategies that address each of the phases within the cycle of disasters: prevention, preparedness, response and recovery (O'Donnell, 2010). A systems approach focuses on interactions among the elements of a system and on the effects of these interactions, it recognizes multiple and interrelated causal factors and emphasizes the dynamic character of processes involved (Simonovic, 2015). A system approach allows a wider variety of factors and interaction to be taken into account as opposed to the traditional view which assumes linear, cause and effect relationship at a particular time (Simonovic, 2015).

### **2.5.1 Conceptual Frameworks related to Disasters Management**

There are a number of conceptual frameworks in disaster management proposed by researchers and agencies. This section summarizes some frameworks or models relevant to disaster management developed by researchers and agencies. Most commonly is the ‘Sustainable Livelihood Framework’ by DFID (1999) which serve as an important source and checklist for other approaches or frameworks aimed at identifying susceptibility and coping capacity for hazards of natural origin. The framework can also be linked to categories used in the disaster risk community such as hazard, exposed and susceptible elements, driving forces/ root causes, and potential outcomes and responses. More details on this approach is described in 5.3.2 of this thesis. Borgadi *et al.* (2004) developed the “onion framework”, which defines vulnerability with regard to different hazard impacts related to the economic and the social spheres. The impact of a disaster and the vulnerability it reveals is illustrated by

the example of floods. According to this framework, the more comprehensive concept of social vulnerability should incorporate the monetary dimension (likelihood of economic harm) as well as “intangibles” like confidence, trust and fear as potential consequences of the flood. One more framework for measuring vulnerability has been developed by Bogardi *et al.* (2004), is known as “The BBC<sup>3</sup> framework”. This framework addresses various vulnerabilities in social, economic and environmental sphere. It also focuses simultaneously on vulnerabilities, coping capacities, and potential tools to reduce vulnerabilities.

The pressure and release model (PAR model) is a framework generated by Wisner *et al.* (2004). The framework views disaster as the intersection of two major forces: those processes generating vulnerability, on the one hand, and on the other, the natural hazard event. The PAR approach underlines how disasters occur when natural hazards affect vulnerable people (Blaikie *et al.*, 2005). The approach stresses the fact that vulnerability and the development of a potential disaster can be viewed as a process involving increasing pressure on the one hand and the opportunities to relieve the pressure on the other.

Schüttes (2004) framework has two facts: external and internal. Internal side relates to cope with, resist and recovers from the impact of a hazard while the external aspect involves the exposure to risks shocks. It describes exposure to hazards as key component of vulnerability. The framework also emphasizes that the transforming structures in the governmental system or private sector and respective processes (laws, culture) influence the vulnerability context, and determine both the access to and major influences on livelihood assets of people. Turner *et al.* (2003), have introduced another framework. The vulnerability framework defines exposure, sensitivity, and resilience (as coping response, impact response and adaptation response) as part of vulnerability. The framework also explains the responsible factors and linkages that affect the vulnerability of human and environmental system in a space. The conceptual framework also takes into consideration the concept of adaptation, which is viewed as an element that increases resilience. However, some questions remain, such as whether



the distinction between drivers and consequences in this feedback-loop system is appropriate (Birkmann, 2006).

Despite these efforts by researchers and agencies, the process of forming different models or frameworks has been criticised throughout history and new approaches have been developed and each of them has been criticised, considering the historic events. The design of most of the models revolves around the four main phases of disaster management: prevention, mitigation, response and recovery. In other words, these models are not designed to cover all aspects of disaster management, such as hazard assessment, risk management and their sub-components. Furthermore, there is no model or approach that can encapsulate main and major activities of disaster management within a framework.

**Table 2. 1 Selected Conceptual frameworks in Disaster management**

<b>Disaster related conceptual frameworks or models</b>	<b>Authors</b>	<b>Explanations</b>
Crunch cause model	Asian Disaster Preparedness Centre (2000)	This is a causal model that provides a framework for understanding the causes of disasters. Its structure is formed by the equation: Disaster Risk = Hazard * Vulnerability.
Weichselgartner integrated model	Weichselgartner (2001)	The overall objectives of this model are the assessment of probable damage and the planning of future measures to reduce this damage.
Manitoba model	Manitoba Health Disaster Management (2002)	Advantage and feature of this model is establishing a balance between preparation and resilience, in order to respond to the specific needs of the disaster.
BBC conceptual framework	Borgadi <i>et al.</i> (2004)	Addresses various vulnerabilities in the social, economic and environmental sphere
Onion framework	Borgadi <i>et al.</i> ( 2004)	Shows that a flood event could affect the economic sphere and cause flood damage, while if the impact of the flood caused huge additional disruption in the social sphere, a disaster would occur
Pagoda model	Okada (2004)	City has been considered as a vital five-stage system in this model.
Pressure and release (PAR) model	Wisneret <i>et al.</i> (2004) Blaikie <i>et al.</i> (2005)	Unlike the Crunch model and using preventive measures, try to reduce the disaster risk.
Integrated model of Moe and Pathranarakul	Moe and Pathranarakul (2006)	Shows the importance of proactive and reactive strategies in natural disasters management.
Risk management proactive model	Australian Development Gateway (2008)	This model tries to combine logical and integrated model.
Disaster risk management framework (DRMF) model	Baas <i>et al.</i> (2008)	The model has the following three steps: risk reduction, emergency response and recovery
Wheel-shape disaster management model	Rowshandel Arbatani, Purezzat and Qolipoor (2008)	Based on the life cycle of disaster and crisis, as well as its various stages. Also, it is formed by combination of logical and integrated models.

McEntire et al. integrated model	McEntire <i>et al.</i> (2010)	An integrated approach for modelling the vulnerability should consider social science research, engineering and physics simultaneously.
Prevelant vulnerability Index	Cardona <i>et al.</i> (2010)	Assesses predominant disaster vulnerability conditions by measuring exposure in prone areas, socioeconomic fragility and lack of social resilience
Risk management model	BPDMP (2013); Zimmermann and Stössel (2011)	The objective of this model is increment of community resilience and risk reduction using combination of logical and integrated models.
Octopus model	Shi <i>et al.</i> (2011)	As disasters have complex systems, mutual risk management should be based on multidimensional system for achieving success from policy-making viewpoint. This model is proposed based on this viewpoint.
Statoil model	Statoil (2013)	This model is a reactive model because it starts the activities after the occurrence of disaster and lasts until returning the condition to the pre-disaster normal condition.
Saldana-Zorrilla model	Saldana-Zorrilla (2015)	This model provides a set of policy suggestions for integrating risk management and increasing risk reduction measures and planning.
Integrated system-oriented model	Meshkati and Tabibzadeh (2016)	The main feature of this model is its attention to the emergency response.
ANDRI	Parson. (2016)	This framework distinguishes a set of capabilities which are coping and adaptive capabilities.
Monitoring and evaluating model of disaster risk management	Scott <i>et al.</i> (2016)	This model is a unique framework for monitoring and assessment of disaster risk management plans for use by disaster risk management programmes to track the outcomes of their interventions and ultimately raise standards in this area.
Institutional model for collaborative disaster risk management	Tau, <i>et al.</i> (2016)	The model combines the theoretical, political and technical dimensions of collaboration to enhance buy-in for the disaster risk management and reduction function of governments.
Household Livelihood Resilience Approach (HLRA)	Quandt (2018)	Measure resilience and effectiveness of agro-forestry in building this resilience

## 2.6 An Overview of Resilience

A multi-strand approach to minimize losses as the results of disasters has been implemented globally by the UN since the 1960s. During the World Conference on Disaster Reduction that was held in 2005 in Kobe, Hyogo, Japan, and adopted the present Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. The Conference provided a unique opportunity to promote a strategic and systematic approach to reducing vulnerabilities and risks to hazards. It underscored the need for and identified ways of, building the resilience of nations and communities to disasters (UNISDR, 2005). Resilience is becoming an increasing part of disaster studies and related disciplines (Manyena, 2014). This has become particularly prevalent after the adoption of the Hyogo Framework for Action in 2005 (Manyena, 2014). The concept of disaster resilience has gained a wider interest and has become more popular among academic researchers and practitioners (Irajifar *et al.*, 2013). It is being institutionalized in many countries under new laws for civil protection and risk management (International Federation of Red Cross/ Red Crescent Societies, 2006). Resilience is defined as the capacity of systems to reorganize and recover from change and disturbance without changing to other states, systems that are “safe to fail. Community resilience is defined as the ability of a community to maintain its status and perform its intrinsic functions in the context of disasters (Fan *et al.*, 2018).

Namibia and Zambia have endorsed the Hyogo Framework for Action (HFA) which seeks to develop the resilience of nations and communities to disasters and to assist countries to move away from the approach of emergency response to one of integrated disaster risk reduction (Elina *et al.*, 2013). During the World Conference, countries also restated their commitment to address disaster risk reduction and the building of resilience to disasters with a renewed sense of urgency, and to integrate both disaster risk reduction and the building of resilience into policies, plans, programmes and budgets at all levels and to consider both within relevant frameworks (Elina *et al.*, 2013).

Ten years after the adoption of the Hyogo Framework for Action, disasters continued to undermine efforts to achieve sustainable development. The Sendai Framework for Disaster Risk Reduction 2015-2030 was then adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015 (UNISDR, 2015). The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters. The Sendai Framework is built on elements which ensure continuity with the work done by the different countries and other stakeholders under the HFA and introduces a number of innovations as called for during the consultations and negotiations.

## **2.7 An Overview of Disaster Preparedness**

Preparedness is defined as the knowledge, capabilities and actions of governments, organizations, community groups, and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions''(UNISDR, 2009). Furthermore, Edward (1993) defines disaster preparedness as making sure the society is ready for any disaster likely to occur, through taking preventive measures and reacting to a disaster. However, preparedness is not fixed in nature, it changes. It requires regular amendments and transformation as social circumstances changes (Perry and Lindell, 2003). In line with this, Paton, (2003) developed a model describing the developmental process of preparation that starts with factors that encourage individuals to prepare, advances to the creation of intention and ends in taking a decision to prepare for disasters.

The perception of preparedness denotes a sequence of self-protective behaviours to alleviate the negative impacts that emanate from a disaster (Faupel *et al.*, 1992). There are different measures that can be undertaken to prepare for flood disasters. One general method of examining preparedness at the household level is to survey the number of emergency supplies on hand (Levac *et al.*, 2012). Mulilis *et al.* (1990) indicated the following as some of the measures of preparedness; having a flashlight and a radio, first-aid kit, food and water, information seeking on how to act during and after a flood, attending gatherings in order to prepare for floods, reading materials and listening to

messages meant for flood preparedness. In previous research, disaster preparedness is examined as either as a general concept or with some sub-categories. According to Malkina-pykh (2013), disaster preparedness is classified into three categories or components: Material preparedness which includes strong alterations of the home and possession of numerous tools valuable throughout a disaster such as, food and water supplies, fire extinguisher or first aid kit; Planning activities involves locating a safe place for temporal relocating or finding a gathering place externally; and knowledge and skills which refers to what people know about the disaster and how to prepare for such disasters e.g attending a first aid course or reading material based on disaster preparedness. Table 2.1 shows the different categories on which researchers have been able to assess the level of disaster preparedness. These components were used in this study to assess the level of flood preparedness.

**Table 2.2 Different categories on which researchers have been able to assess level of preparedness**

Author	USIDR (2005)	Rustam Khairi <i>et al.</i> (2013)	Ainuddin <i>et al.</i> (2012)	Mishra <i>et al.</i> (2010)	Luna (2001)	Rachmalia <i>et al.</i> , (2010)	Miceli (2008)	Doocy (2013)
location		Malaysia	Pakistan	India	Phillipines	Indonesia	Italy	Uganda
Disaster type		Tsunami	Earthquake	Flood	All disasters	Tsunami	Flood	Floods and Landslides
Methodology		3-point Likert scale based survey	Key informants and group discussions	5-point Likert scale based survey	In-depth interview	5-point Likert scale based survey	Stratifies cluster survey	Survey
Components of disaster preparedness	Vulnerability assessment			✓		✓		✓
	Planning		✓					
	Institutional framework				✓			
	Information system	✓		✓	✓	✓	✓	
	Resource base		✓	✓	✓		✓	✓
	warning systems	✓	✓	✓		✓		
	response mechanisms		✓			✓	✓	✓
	Education and training	✓	✓		✓		✓	✓
Rehearsals	✓			✓				
Preparedness level		High	Low	Moderate		Moderate	Fairly	Low

It is known that disasters can be unpreventable and commonly unpredictable (Levac, 2012). However, with significant disaster preparedness, there is a higher possibility of reducing losses of life and property. According to Morrissey and Reser (2003), disaster preparedness reduces psychological pain associated with the likelihood of the occurrence of these disasters. Therefore if a person gets prepared for a possible future disaster, the physical and psychological impact will be reduced. Finally, disaster preparedness reduces the traumatic stress associated with flood occurrences (Morrissey and Reser, 2003).

### **2.7.1 Socio-economic Factors Influencing Household Flood Disaster**

#### **Preparedness**

A number of factors influence disaster preparedness. Below are some of the factors influencing preparedness and include risk perception, critical awareness, and outcome expectancy, sense of community, self-efficacy and responsibility efficacy. Kinateder *et al.* (2015) define risk perception as the belief an individual has of a forthcoming threat to own life and health. However, despite the acceptance that a given disaster can pose a threat to own life, this perception may be moderated by other factors (Paton *et al.*, 2000; Paton *et al.*, 2003). The risk perception of an individual rises after the occurrence of the event (Jackson, 1981). Critical awareness is the degree to which individuals think and talk about a specific source of danger or threat in their environment (Paton, 2003). Effectiveness in preparedness may be hindered by individual low-risk awareness (Scolobig, 2012). It is assumed that households with low-risk awareness have low disaster preparedness (Scolobig, 2012). This, as a result, creates insufficient adaptation to disasters. These findings are consistent with Grothmann and Reusswig (2006), Miceli *et al.* (2008) and Terpstra *et al.* (2009). These researchers have also shown that disaster preparedness is positively related to the feeling of worry concerning the risk. Therefore, the higher the household level of risk awareness the higher the possibility of households taking protective measures (Floyd *et al.*, 2000; Neuwirth *et al.*, 2000). Preparedness is, therefore, becoming a key issue to be considered for effective adaptation to disasters.



Paton (2003) define Outcome expectancy as the perceptions of whether personal actions will effectively mitigate or reduce a problem. In a study undertaken by Paton (2005) on bushfire preparedness, it was found that positive outcome expectancy had a direct influence on both intention and preparing whilst negative outcome expectancy was the driver of non-preparation. Self-efficacy is the belief regarding personal capacity to act effectively (Encyclopaedia of Adolescence, 2011). Self-efficacy is regarded as a precursor of adjustment adoption and resilience in natural hazard contexts (Bishop *et al.*, 2000; Lindell and Whitney, 2000). According to Paton (2003), self-efficacy is strongly linked to the number and quality of preparedness action undertaken, the amount of persistence and effort invested in risk reduction (Levac, 2011). The more confident people are about their capability to successfully respond to an emergency, the more likely they are to engage in preparedness behaviours (Bandura, 1998). If peers and families have the means to create self-efficacy; people are more likely to prepare if those around them believe in preparedness (Levac, 2011). A sense of community is defined as the feelings of attachment for people and places (Paton, 2006). It is known to influence adjustment decisions. People with a high sense of community have a higher possibility of converting intentions into actual preparedness (Paton, 2006). Perceived responsibility is the belief that someone has responsibility for self and others. This will determine whether an individual will be prepared for a disaster or not. Ballantyne *et al.* (2000), states that if people have a perception that others are responsible for their safety there is less possibility of converting intentions into actions. If people believe they have a responsibility to safeguard their life and others, there is the likelihood that they will convert intentions to actions (Paton, 2006).

The literature on factors that hinder household emergency preparedness is inconclusive. In a study by the Institute for Catastrophic Loss Reduction for the Red Cross, 78% of respondents indicated that there were no barriers preventing them from taking part in emergency preparedness activities (Falkiner, 2008). The remaining 22% suggested that their efforts were deterred by time pressures (33%), lack of information (29%), and lack of financial resources (26%). In another study by Diekman *et al.* (2007) two main barriers identified were used, expired, or misplaced supplies and lack of

communication. Other reasons for lack of household preparedness included ignorance for emergency preparedness, not enough time to prepare a kit, lack of knowledge and skills to prepare for disasters, believing that a disaster will not affect household's members, lack of efficacy expectations, lack of critical of awareness

## **2.8 Climate Change Adaptation**

It is reported that Africa is not a major driver of climate change, but is a victim (Conway, 2005). Despite that, the weather is becoming progressively unpredictable (Cross, 2001). According to El-Raey (2004) analysis of long-term rainfall records in Africa shows more variability in climate from year to year. Floods events will increase due to the variability in climate which in return will increase the level of population exposure to more flooding (Few, 2003). This exposure have impacts on agricultural production of households. According to Few (2003), the exposure of population requires intensive research and interventions intended to strengthen local capacity to adapt to flooding, especially for the poor in developing countries. IPCC (2007) defines adaptation as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”.

De Bruin (2011) report that a number of categories exist for adaptation to disasters. De Bruin (2011) also acknowledged different groups of adaptation strategies to climate change. They can be grouped into autonomous or private and planned or public sector adaptation strategies (De Bruin, 2011). On one hand, private adaptation strategies include action taken by non-state agencies such as farmers, communities or organisations and or firms in response to climate change. Agricultural adaptation strategies may involve switching crops, shifting crop calendar, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies(De Bruin, 2011). On another hand, public adaptation involves actions taken by local, regional and or national government to provide infrastructure and institutions to reduce the negative impact of climate change. For example, public agricultural adaptation strategies include development of new

irrigation infrastructure, transport or storage infrastructure, land use arrangements and property rights, watershed management institutions (World Bank, 2010).

According to De Bruin (2011), adaptation strategies can be either proactively /anticipatory or reactive. Proactive adaptation strategies are engaged in anticipation of climate change while reactive adaptation strategies address the effects of climate change after they have been experienced. In crop production, reactive adaptation strategies include control of soil erosion, construction of irrigation dams, improving soil fertility, development of new varieties, shifting planting and harvesting time among others. Anticipatory adaptation strategies, on the other hand, involve the development of tolerant cultivars, research development, policy measures on taxation and incentives. Gbetibouo (2009) suggested that smallholder farmers can adapt to climate change by changing planting dates and diversifying crops, practicing soil and water conservation measures and planting trees (Yesuf *et al*, 2008). In southern Malawi, studies conducted by Nangoma (2007) and EAD (2006) on household adaptation strategies to climate and weather variability, identified improved varieties, irrigation farming, shifting cropping dates and crop diversification as some of the household adaptation strategies to climatic and weather variability.

In a study that was done by Bird *et al.* (2013), many factors were found to hamper or promote the adoption of flood adaptation strategies. These factors include:

- Flood experience – people with previous flood disaster experience have reported to experience pain, inconvenience and stress. These people had a desire to reduce the impacts through adaptation.
- Positive outcome expectancy – the need to protect family members, belongings and assets and, a desire to have peace of mind, were positive drivers in changing household's behaviour to reduce flood risk.
- Proper communication and information sharing – proper channel of communication and sharing information understood by the victims prior to and during the flood, promote the implementation of adaptation strategies. For example, inadequate information and misinterpretation of message may reduce households' adaptive capacity (Yesuf *et al.*, 2009).

- Insurance – slowness of obtaining insurance payouts have been seen to act as a barrier to recovery. Settling in disaster-prone areas results in paying more insurance, reduces the exposure to disaster-prone areas.

Other factors include formal and informal institutions, accessibility to credit and information, land tenure, gender and size of the farm significantly influence household choice when adapting to climate change (Nhemachena and Hassan, 2008; Deressa *et al.*, 2009; Yesuf *et al.*, 2009; Shongwe *et al.*, 2014). Several studies have been carried out in Sub Sahara Africa on climatic and weather variability, adaptation strategies and agricultural production. However, most studies have concentrated on the impacts of climatic variability on crop production and less on the factors that influence the household choice of adaptation strategies (Nhemachena and Hassan, 2008; Akpalu *et al.*, 2011).

Maddison (2007) revealed that education, gender, extension services or information and experience significantly influenced households in adapting towards climatic change. It was found that formal education and gender (males) increased the probability of adoption of adaptation strategies by 0.03% and 6%, respectively. Study findings recommended that education and extension services should be emphasised to appropriately adapt towards changes in climate. Furthermore, lack of appropriate seed, credit accessibility, security of tenure and market accessibility were some of the barriers to household adaptation. In a similar study, Deressa *et al.* (2009) employed a Heckman model to assess the determinants of household adaptation to climate change in Ethiopia. The study found that household size and gender (males), availability of credit and temperature had a positive influence on household adaptation to climate change. For instance, credit accessibility and climatic information increased the household likelihood of adopting adaptation strategies by 48% and 37%, respectively.

ActionAid (2011) assessed farmers' adaptation towards climatic change and variability in the southern part of Malawi. It was found that most households in Malawi did not have sufficient capacity to cope with challenges posed by climatic change and variability. Deressa *et al.* (2009) used the multinomial logit (MNL) model to investigate the factors influencing household choices of climate change adaptation methods. The

results from the study indicated that household characteristics such as education, farm and nonfarm incomes which could be enhanced through policy intervention have a significant impact on adaptation to climate change. The study further revealed that households adopted soil conservation measures, use of different crop varieties, tree-planting, and changing planting dates. Irrigation was applied to farms to reduce the negative impacts of disasters. Those who did not adapt mentioned lack of information on adaptation methods and financial constraints to using any of the adaptation methods.

## **2.9 Discussions and Conclusions**

The literature review has cited different types of floods in Africa and beyond. These can either be river, coastal or flash floods. Flood disasters are increasing in magnitude and frequencies. The increase in the magnitude and frequency is due to inappropriate land-use, population growth, deforestation and rainfall. This is in line with who identified climate change, river channel modification and land-use landcover change as possible drivers of changes in flooding frequencies and magnitudes. There is a greater likelihood that climate variability will negatively impact on nearly every aspect of the wellbeing of the communities because of high variability of rainfall in time and space, scarce water resources and vulnerability due to regional low adaptive and mitigation capacities. Despite the negative impacts cited, these floods have some positive impacts on income and agricultural production. Positive impacts of floods include reducing the cost of fertiliser as most floods deposit nutrients which helps in the growth of crops, therefore enhancing yield. Negative impacts, on the other hand, include; reduction of income sources which results in a reduction of rural household's income and destruction of homes, increasing the cost of reconstruction or relocation.

However, quantifying or assessing these impacts has proved to be challenging for researchers. This is because, in most areas, there is a lack of baseline studies. In areas where the baseline is available, the variables or parameters that are required to be measured may be different. Moreover, literature has shown that there are different econometric models of assessing impacts. These econometric models may be used in

the absence of baseline information. One of the commonly used methods is the Propensity Score Matching (PSM). This method will be applied in this study.

Although floods are increasing in magnitude and frequency, and have negative impacts all over the world, many people still fail to prepare. There are many factors why people fail to prepare for flood disaster thus a need to examine these factors applicable to the study area. Studies related to disaster preparedness and factors will then provide information to disaster managers for disaster risk reduction. Since socio-cognitive factors are factors related to the behaviour or perception of people, it is a starting point in implementing flood disaster preparedness measures. For example, risk perception and response capability depend on an individual's understanding of the hazard (Miceli *et al.*, 2008). For people to take action, they must believe the hazard is a threat, believe they have the ability to more effectively manage it as it is normal and believe that there is a positive outcome in taking preventative actions (Damon *et al.*, 2010). There is a higher possibility for these individuals to take up preventative measures. Evaluation of one's resources is also an important factor in risk perception (Mulilis *et al.*, 2000). When people perceive that their available resources are enough to avoid a threat, risk perception is reduced. The perceived likelihood of a threat turning into an actual event is another important factor in emergency preparedness (Pennings and Grossman, 2008). Certain attributes such as the predictability, duration and pattern of an event, the number of casualties or the degree of damage, and the availability of prevention or treatment, act as risk or protective factors which determine psycho-social effects and perception of risk (Lemyre *et al.*, 2005). People will only adopt preventative action if they believe the hazard to be important to them (Paton, 2003b) or if they have caregiving responsibilities for children or older adults (Olympia *et al.*, 2010). Results from Mulilis *et al.* (2000) suggest that property owners are generally more prepared than renters, who in turn are more prepared than student renters.

Access to media as a primary source of emergency information and warning is another motivating factor of disaster preparedness (Reddick, 2011). However, a clear, constant and reliable message that is well understood and interpreted by people with lower literacy levels, is vital during the entire phases of disaster preparedness (Paton and

Johnston, 2001). For example, Cretikos *et al.*(2008) found that radio was the most commonly accessed source for information during natural disasters. Balluz *et al.* (2000) on the other hand, identified television bulletins and warning sirens as the most successful means of issuing tornado warnings.

Different adaptation to climate change and variability exists. Adoption of adaptation strategies by rural households should be encouraged, therefore a need for assessment of the adaptation strategies and their effectiveness evaluated. According to Kapucu (2008) awareness interventions are the first step to encourage the public to adopt proper disaster preparedness activities as well as adapt to floods. In eastern Zambezi of Namibia and Mwanzi district of Zambia, little is known about the impacts of floods, level of flood preparedness and adaptation strategies adopted in view of floods, therefore this research is aimed at filling this knowledge gap.

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### **3. EVALUATING THE IMPACTS OF FLOODS IN ZAMBIA AND NAMIBIA: A PROPENSITY SCORE MATCHING APPROACH**

#### **3.1 Abstract**

In both Namibia and Zambia climate variability has resulted in the frequent occurrence of floods. These floods have had an impact on both individuals and communities, and have social, economic, and environmental impacts. Most of the impacts of floods, both negative and positive, are felt more on the agriculture-dependent rural households. This study was carried out to determine the impacts of floods on households' income, crop production and livestock ownership in the eastern part of the Zambezi region of Namibia and Mwanzi district of Zambia. The study tested the null hypothesis that there is no statistically significant difference in the mean income, livestock owned and crop produced between the flooded and non-flooded households. The study applied a Propensity Score Matching (PSM) approach and a t-test in determining the impacts of floods on rural households' income, livestock owned and crop production. A total of 447 households were sampled in flooded and non-flooded households within the study area. Furthermore, observations and six focus group discussions were conducted among the flooded households. Results in Eastern Zambezi region of Namibia show that non-flooded households had higher mean income derived from the sale of crops ( $p < 0.05$ ), the sale of livestock ( $p < 0.1$ ) and remittances and gifts ( $p < 0.1$ ) than the flooded households. On the contrary results from Mwanzi district of Zambia show that flooded households had higher mean income from the sale of livestock ( $p < 0.01$ ), the sale of crops ( $p < 0.01$ ) and sale of fish ( $p < 0.1$ ) than the non-flooded households. Furthermore, there was a statistically significant difference in mean crop production between flooded and non-flooded households in Eastern Zambezi region of Namibia ( $p < 0.01$ ). On the contrary, results from Mwanzi district show that there was no statistically significant difference in mean crop production between flooded and non-flooded households ( $p > 0.1$ ). There was a statistically significant difference in the mean number of livestock owned between flooded and non-flooded households in Mwanzi ( $p < 0.01$ ). Non-flooded households had a higher mean number of livestock than the flooded households. It is concluded that the floods had both negative and positive impacts on income, crop and

livestock production. These indicators and outcomes should help in targeting flood-affected households in order to reduce the impacts of floods. Applying the Propensity Score Matching approach will inform researchers and other disaster management to apply this method in disaster impact assessment to reduce bias.

**Keywords:** *Flood impacts, rural households, Propensity Score Matching, Namibia, Zambia*

### **3.2 Introduction**

Since ancient times people have lived in flood-prone areas in Namibia and Zambia due to favourable geographic conditions which facilitate economic growth, such as accessibility (transportation) and food production (fertile land) (Douben, 2006). However, worldwide, riverine areas are expected to increase in river flood risk with consequent devastating effects on human society and the environment (Ceola *et al.*, 2014). According to Douben (2006), flooding is the most damaging of all natural disasters. For instance, in 2011 and 2012 nearly 200 million people globally were affected by floods with total damage of almost US\$95 billion (Ceola *et al.*, 2014). Similarly, in the period between 1996 and 2005, floods have had devastating effects on the continent of Africa, Asia, and the Americas (Satterthwaite *et.al.*, 2007). It is reported that, during that period, there were 290 flood-disasters in Africa alone, which left 8 183 people dead and 23 million people affected, and caused economic losses of US\$1.9 billion (Nick, 2012). Estimates suggest that over the next century, sea-level rise resulting from global warming will also increase the probability of floods (Solomon *et al.*, 2009).

Sub-Sahara Africa is considered the most vulnerable to climate variability including flooding. Floods have impacts on rural households' agriculture production, which in turn impact negatively on their income. In March 2009, heavy rains caused widespread flooding in Angola and Namibia, affecting 120 000 people in Angola; washed away roads and bridges leaving approximately 30 000 people isolated; and families were left homeless after 4 720 houses were destroyed (Davis and Vincent, 2017). In Namibia

130 000 people were at risk of flooding, a few hectares of crops were submerged and small livestock was lost (Davis and Vincent, 2017).

Due to its geographical vulnerability, the Zambezi region in Namibia and Mwanzi districts in Zambia experience frequent floods almost every year. The magnitude and severity of floods in the area have an impact on both individuals and communities and have social, economic, and environmental impacts. Most of the impacts of floods, both negative and positive, are felt more on the agriculture-dependent rural households. This is aggravated by the fact that rural households have to cope and adapt to variability in climate considering that their livelihood strategies are dependent on agriculture.

Communities in the eastern part of the Zambezi region especially in Kabbe and Katima Mulilo constituencies adapted well to flooding. According to Mudabeti (2011), the decade 2000 had witnessed a new trend of an increased annual intensity of floods even in areas perceived as higher ground. These floods have had an impact on income, crop production and livestock production. Agriculture-based livelihood systems that are already vulnerable to food insecurity faced immediate risk of increased crop failure, new patterns of pests and diseases, lack of appropriate seeds and planting material, and loss of livestock (Mabuku, 2013). As a result of the floods, the governments of Namibia and Zambia spent millions of dollars to rescue or provide aid to the affected households. For instance, in 2011, the Government of Namibia allocated US\$4.4 million to respond to the flood emergency. Food assistance was provided to an estimated 20,000 people displaced in several relocation camps in the six most flood-affected regions of Namibia (Mushabati, 2014). About 90% of the population in Kabbe constituency were relocated in previous years due to floods and this resulted in victims enduring the negative impact of floods such as: reduced harvest in the floodplains, inaccessibility to a number of health and education facilities during the period of the floods, damage to homesteads and infrastructure, loss of humans and domestic animals through drowning, and increased outbreak of water-borne diseases. Furthermore, wild animals such as crocodiles, hippos, snakes and elephants leave flooded territories to occupy dry and forested shelter in the floodplains posing danger to the households (Mushabati, 2014).

Evaluating the impacts of floods quantitatively is a methodological challenge. Most previous studies had used the mean comparison evaluation method. The application of propensity score matching (PSM) can create a more refined and reliable estimate of flood impacts by removing the selection bias as compared to the mean comparison evaluation methodology. Propensity score matching has been applied in many fields of studies such as education, public health, criminology, psychology and social science (Thoemmes and Kim, 2011). In health literature, several studies have attempted to take advantage of the matching approach, but very few of them are convincing (Johar, 2009). Some studies that applied PSM include those of Galiani *et al.* (2005), who estimated the effect of privatisation of water system on children's mortality in Argentina. Hudson *et al.* (2014a) evaluated the effectiveness of flood damage mitigation measures in the German households living along the Elbe and Danube rivers in response to floods occurring in 2002, 2005, and 2006. Noy and Vu (2010), undertook a province-level analysis to examine the impact of natural disasters on annual output growth in Vietnam. While Deryugina (2013) looked at the impacts of hurricanes on US counties. The study used PSM to find a control group of counties with equal hurricane risk and then uses a difference-in-differences approach and an event study approach. Strobl (2011), looked at the impact of landfalling hurricanes between 1970 and 2005 on county growth rates in the United States. Strobl (2011) developed a hurricane destruction index based on monetary loss, local wind speed, and local exposure variables to use as an explanatory variable in a county fixed-effects model with a spatial autoregressive error term. However, in Namibia and Zambia, there are no known published studies that have applied PSM in impact assessment. Some studies in Namibia and Zambia that assessed impacts of floods quantitatively failed to control for many correlated covariates, therefore, creating bias in the assessment (Lwando, 2013; Mashebe *et al.*, 2016; Shifidi, 2016, 2014).

Therefore, this study was carried out to determine the impacts of 2015 flood on mean income, crop production and livestock ownership of rural households in Mwandia district of Zambia and Eastern Zambezi region of Namibia. The study tested the following hypotheses:

- **H<sub>0</sub>:** There is no statistically significant difference in the mean crop production between flooded and non-flooded households
- **H<sub>0</sub>:** There is no statistically significant difference in the mean income between the flooded and non-flooded households
- **H<sub>0</sub>:** There is no statistically significant difference in the mean number of livestock owned between the flooded and non-flooded households

Flood impact assessments can serve a variety of purposes. Firstly, it guides governments, non-governmental organisations (NGOs) and development agencies in decisions around investment programmes, for example determining what and where to implement relevant projects. Secondly, it can assist the governments in Namibia and Zambia on where to pay attention when dealing with impacts. For example, local or national governments may use the results in decision making and risk management by anticipating food crises through early warning systems. Insurance and reinsurance companies may use flood impact assessments to understand the value of assets at risk and to price their policies accordingly. The study will contribute to knowledge that will permit policymakers and researchers to assess the impacts of floods in any location using this method.

### **3.3 Literature Review**

The following section gives an overview of the literature on the impacts of floods.

#### **3.3.1 Impacts of Floods**

Flooding is a normal function of most river systems and, in a normal year, helps to sustain the wetland ecology (Smith, 1993). Agricultural production depends on the renewed soil fertility associated with silt deposition and the flushing of salts by annual floods (Smith, 1993). Furthermore, the abundance in flood water supports irrigation and fish farming. This is the reason people settle along or near the river systems. Despite the positive effects, floods are among the major challenges which rural communities in southern Africa face, which occur every three to five years resulting in crop failure (Muhonda *et al.*, 2014). The available evidence, although imperfect, suggests that flood

losses are increasing in many countries (Smith, 1993). Wabanhu (2017), has reported that various studies in the past related to climate change have shown that flood frequency has increased leaving people in the flood plains more vulnerable. In Rwanda, Asumadu-Sarkodie *et al.* (2015) reported that flooding was the most frequent extreme event. About 183 people out of almost 82,000 people lost their lives from 1900 to 2015 due to flood events (Asumadu-Sarkodie *et al.*, 2015).

In 2000 - 2001, approximately 491,000 people were displaced and 700 died due to floods in Mozambique (Christie and Hanlon, 2001). In Mozambique, large-scale inundations were a threat to lives and livelihoods either directly or indirectly. Direct impacts were through destroying people's crops and possessions and, indirectly, through the trauma and inconvenience of displacement, or the spread of water-borne diseases and malaria (Arnall, 2014). In Zimbabwe, the 2000 - 2001 flood and drought caused 800 deaths and affected almost 2 million people, of which about 1 million needed emergency food supplies (Bola *et al.*, 2014). More than 300 000 people were displaced by the floods while agricultural land was covered with water (Bola *et al.*, 2014). While in Malawi, during the 2014 - 2015 growing season, severe flooding affected large numbers of farmers across the country (McCarthy *et al.*, 2018). Consistent with the global and regional evidence on the increased frequency and severity of extreme weather events, evidence from Malawi also suggests that the frequency of both flood and drought events is increasing, and likely to increase further with climate change (Chinsinga, 2012; Venäläinen *et al.*, 2016).

According to World Meteorological Office (WMO), the 2015 - 2016 El Niño was one of the strongest on record, comparable with the 1997 - 1998 and 1982 - 1983 events (Bath, 2016). During this period, flood events were recorded in several African countries. For instance, in Malawi, about 21 700 people were affected by storms and floods while 10 000 people were displaced by floods in Angola's Benguela Province. Furthermore, floods were reported in Tanzania, Mauritius and in northern Mozambique where 22 000 people were affected, with 3 500 homes damaged and 1 500 destroyed (Bath, 2016).

### **3.3.2 Causes of Floods in Eastern Zambezi Region of Namibia and Mwandia**

#### **District of Zambia**

Floods have existed for as long as water has been on earth and are likely to be of major concern in the future especially with a larger population living near the banks of rivers (Nhubu, 2015). Some sections of society believe that they emanate from natural causes, mainly extreme rainfall events, while others believe their occurrence is largely dependent on human factors, which increase runoff generation and the bursting of the stream banks (Nhubu, 2015). The main drivers contributing to floods in the study sites include; meteorological factors such as upstream and local rainfall, hydrological factors such as river characteristics and human factors such as land-use and land-use cover change (Burke *et al.*, 2016; Zimba *et al.*, 2018). According to Madamombe (2004), land degradation, deforestation of catchment areas, increased population along river banks, inadequate and poor land use planning were among the factors inducing floods.

### **3.3.3 Impact Assessment**

Numerous studies examined the impacts of natural disasters and the environmental hazard events that lead to economic or human losses. According to Xiao (2011), natural disaster impact studies take two general directions: a simulation modelling approach and an empirical assessment approach. On one hand, the simulation modelling approach relies on models that capture key socioeconomic relationships. Disaster events are introduced to the system as shocks and impacts are assessed from the simulated outcomes. This line of research includes impact assessment based on an input–output (IO) framework such as models based on computable general equilibrium (CGE) by Rose and Liao (2005) and Rose *et al.* (2007) and regional econometric models by Chang and Falit-Baiamonte (2002). On the other hand, the empirical assessment approach, examines disaster effects through direct observations, using descriptive or econometric analysis such as the use of Propensity Score Matching (PSM), switching regression, Difference-in-Difference or Double Difference and Heckman two-stage models. The Propensity Score Matching (PSM) method is a systematic procedure of estimating

counterfactuals for the unobserved values to estimate impacts with no (or negligible) bias (Mulugeta and Hundie, 2012). It is a statistical technique in which a treatment case is matched with one or more control cases based on each case's propensity score. This matching can help strengthen causal arguments in quasi-experimental and observational studies by reducing selection bias. The validity of the outputs of the PSM method depends on the satisfaction of two basic assumptions namely: the Conditional Independence Assumption (CIA) and the Common Support Condition (CSC) (Becker and Ichino, 2002). According to Mulugeta and Hundie (2012), CIA (also known as Unconfoundedness Assumption) states that 'the potential outcomes are independent of the treatment statuses. The CIA ensures that, although treated and untreated groups differ, these differences may be accounted for in order to reduce the selection bias. This allows the untreated units to be used to construct a counterfactual for the treatment group. On the other hand, CSC entails the existence of sufficient overlap in the characteristics of the treated and untreated units to find adequate matches (or common support). According to Khandker *et al.* (2010), the following are the advantages of using a PSM;

- If selection bias from unobserved characteristics is likely to be negligible, then PSM may provide a good comparison with randomized estimate,
- the use of PSM does not necessarily require a baseline or panel survey, and PSM is also a semi-parametric method, imposing fewer constraints on the functional form of the treatment model, as well as fewer assumptions about the distribution of the error term.

### **3.4 Materials and Methods**

#### **3.4.1 Study Area**

##### **3.4.1.1 Eastern part of the Zambezi region in Namibia**

Zambezi region is one of the 14 regions of Namibia which used to be known as Caprivi until August 2013 (Steytler, 2014). It lies between 24° and 25° longitudes East and 15° and 17° latitudes south. It was named after the Zambezi River that runs along its border



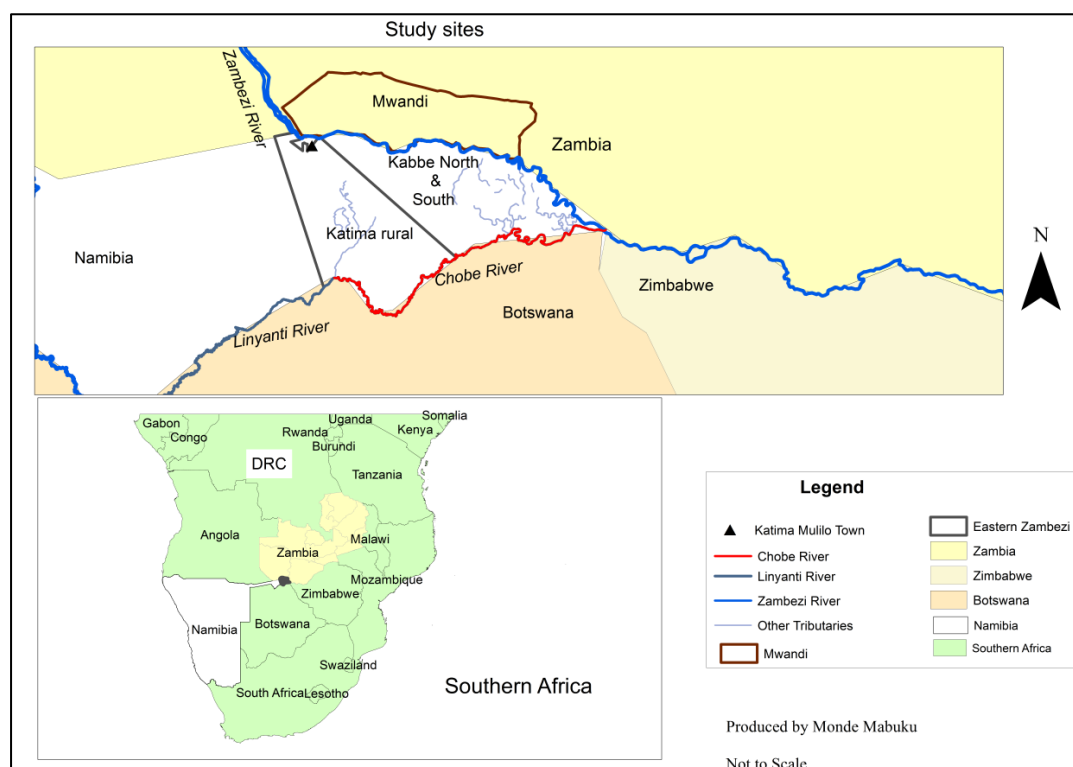
and the region covers an area of about 14 500 km<sup>2</sup>, accounting for 1.8% of the total land area of Namibia. The region borders with Zambia in the north; Angola in the northwest; Botswana in the east and south and Zimbabwe in the east. Average rainfall in Zambezi region ranges between 600-700 mm per year and increases gradually from south to north. The rainfall occurs from October to March. The frequency of rainfall is more than 60 days as an annual average, with a rainfall variability of less than 20-25%. Evaporation rate is between 2400-2600 mm per annum and the average temperature is between 7<sup>0</sup> C and 35<sup>0</sup> C.

This study area (Eastern Zambezi region) covers a total area of 4106.9 km<sup>2</sup>. It was selected because the study area is often greatly affected by floods in Namibia. It has a population of 30 917 people and 5 265 households while the population density is three people per square kilometre. The people in Eastern Zambezi region derive their source of income from business activities (excluding farming), wages and salaries, farming, old age pension, cash remittances, retirement fund, and orphan grant (Steytler, 2014). The abundance of water is a distinctive feature that differentiates the Eastern Zambezi region from the other parts of the Zambezi basin. Of the four permanently flowing rivers in Zambezi region, three are in the Eastern part of the Zambezi region: the Chobe, Linyanti and Zambezi. The Zambezi River in the northeast (Zambezi Region) occasionally overflows into the flood plain to the Chobe River west of the Kasane border with Botswana, causing a reverse flow in the Chobe in the southwest direction toward Lake Liambezi. The sources of water in the northern river systems are the rains in southern Angola that reach up to 1000 mm per annum.

#### **3.4.1.2 Mwandi District of Zambia**

In the Western province of Zambia, Mwandi district is selected as the second study area. Mwandi district was part of Sesheke District until November 2013, when it was declared a district on its own (Provincial and District Order, 2013). It is situated at the South end of Western Province. It lies between 23° and 26° longitudes East and 15° and 18° latitudes South and shares borders with Sesheke, Kazungula and Kalomo districts of the Southern Province (Lwando, 2013). It also borders with Kaoma,

Shangombo and Senanga districts. The district consists of 6 248 households and 27 922 inhabitants (Central Statistics Office, 2012). It falls under Kazungula-Mwandi plain (zone 7A) food economy zone. According to the Zambia Vulnerability Assessment Committee (2004), this livelihood zone has a generally semi-arid climate, with periodic drought and flooding. The main economic activities include crop and livestock production, formal employment, trading, curios (related to tourism), fishing and sale of wild fruits. The vast area of wetland along the Zambezi river flood plains and river banks is important for cattle grazing (Saasa *et al.*, 2015). Figure 3.1 shows the location of the study area



**Figure 3.1 Study areas: Mwandi district of Zambia and Eastern Zambezi region of Namibia.**

### 3.4.2 Propensity Score Matching Approach

Estimation of the impact of floods on households based on non-experimental observations is a major methodological challenge because of the selection bias problem, and the associated problem of missing data for the counterfactual. Selection bias is

related to identifying the appropriate counterfactual benchmark or baseline against which to compare the impacts of flooding on households. There is a problem of missing data because it is not possible to measure the impact on the same individuals as at each moment in time each individual is either under the intervention being evaluated or not and thus he or she cannot be in both (Khandker *et al.*, 2009). Outcomes are only observed in one state (affected or non-affected); the counterfactual is unobservable. Households who are affected by floods may have systematically different characteristics from the ones who are not affected by floods. The implication of this is that the use of standard regression techniques (ordinary least square (OLS)) to estimate the parameters of the equation would result in biased and inconsistent estimates. Therefore, PSM can be used to address the above econometric challenges in evaluating the impacts of floods on rural households.

A propensity score can be defined as the probability of study participants receiving a treatment based on observed characteristics (Austin, 2011). The propensity score can be expressed as:

$$e(x) = P(Z = 1 | \mathbf{X}) \quad (3.1)$$

Where  $e(x)$  is the abbreviation for propensity score,  $P$  a probability,  $Z=1$  a treatment indicator with values 0 for control and 1 for treatment, the "|" symbol stands for conditional on, and  $\mathbf{X}$  is a set of observed covariates. In other words, the propensity score expresses how likely a household is to select the treatment condition given observed covariates, e.g. household characteristics. This score is useful because it can be used to match participants from the treatment condition (flooded households) to participants from the control condition (non-flooded households) who have a very similar estimated propensity score. This matching process creates a balance between the flooded and non-flooded participants on the propensity score and more importantly, is also expected to create balance on the covariates that were used to estimate the propensity score. This balance property is a key aspect of propensity score methods because a balanced pre-test covariate cannot be a confounder anymore, i.e., cannot bias

the treatment effect estimate (Thoemmes, 2012). We apply this method to flooded households (treatment) and non-flooded households (control).

### **3.4.3 Data**

#### **3.4.3.1 Survey Description**

For each country, non-flooded and flooded households were drawn from the list provided by the local community members who had knowledge about the area. From the list, villages were selected at random and the households were randomly sampled with the head of the household as the unit of measure. Where the head of the household was not available, an effort was made to interview any adult household member who was knowledgeable about the general livelihood of the household. A structured questionnaire was administered to each of the sampled households. FAO (2010) and Beaman and Dillon (2009) define a household as a group of people living together, making common arrangements for food and other essentials for survival and acknowledge the authority of a man or women who is the head of household.

Data collection comprised of the household survey, observations and focus group discussions. A household questionnaire was divided into the following sections; (i) demographic characteristics, (ii) income of household derived from different sources, (iii) kilograms of crops harvested in 2014 – 2015 agriculture year, and (iv) total number of livestock owned in the same agriculture year. Before the main household survey was conducted in July 2015, a pre-testing of the questionnaire was conducted as part of the pilot study. A questionnaire survey of 445 randomly sampled households was conducted in the study area, where 220 households were interviewed in the eastern part of the Zambezi region of Namibia and 225 in Mwanzi district of Zambia. All households within the study area had an equal chance of being sampled. Eight enumerators of which four were from Zambia and four from Namibia were trained for two days to carry out data collection. The enumerators were all conversant in speaking English and one of the spoken local languages in each country. The household survey was supplemented by six focus group discussions, consisting of between 6 and 8

participants each. The questionnaire was written in English, but it was translated into Silozi and Subia languages during the interview. These are the languages respondents are conversant within Zambia and Namibia, respectively.

#### **3.4.4 Ethical Consideration**

Ethical clearance was granted by the University of KwaZulu-Natal, South Africa (Ethical Clearance Number: HSS/0596/015D). Informed consent was obtained from all the participants in the study. The respondents were required to sign a participation declaration indicating that they understood the nature of the research and their willingness to participate in it. Respondents were free to withdraw from the study at any time if they so wished. The reporting of results would ensure no individuals were identified by name.

#### **3.4.5 Data Analysis Framework**

Data were entered in MS Excel and further analysis was done in IBM SPSS statistics 22. The analysis applied the Propensity Score Matching approach to match flooded households with non-flooded households based on their propensity scores. To run Propensity score matching in SPSS a plugin called “R” was installed. The “psmatching” program performs all analyses in R through the SPSS R-Plugin and makes use of the R code by Thoemmes (2012). The following were the steps involved in propensity score matching approach in SPSS.

##### **3.4.5.1 Identifying the Appropriate Data and Defining the Treatment**

Propensity score matching approach required data collected from flooded households and non-flooded households. In this case, flooded households were the treated and non-flooded households were the control. The aim was to compare the means in the outcomes between the flooded and the non-flooded households.

### **3.4.5.2 Selecting the Covariates**

This step involved identifying and measuring as many covariates as possible based on the theory and prior research. There is a lack of consensus in the literature as to which variables one should include in the propensity score model (Austin, 2014). However, Steiner *et al.*, (2010) suggested that scholars may measure a rich set of covariates if there was no prior theoretically or empirically sound guidance for the covariates selection (e.g., the research question is very new). In this case study covariates such as age, marital status, gender, formal employment, family size, educational level, duration of stay in the community, flood duration, land size were selected. Age, gender, marital status, education level, formal employment and land size were used in estimating the propensity scores after they were found to be statistically significant in influencing treatment ( $p < 0.1$ ).

### **3.4.5.3 Estimating the Propensity Score**

After selecting the observational covariates that passed the threshold, propensity scores were estimated. This was done by computing the probability of an individual flooded or non-flooded using logistic regression based on the covariates for every household in the database. A logistic model was run using a treatment dummy (whether an individual was flooded or not flooded) as the dependent variable and the aforementioned covariates (as the independent variables).

### **3.4.5.4 Matching**

In matching the flooded and the non-flooded households, nearest neighbour matching was applied in this study. The propensity score matched sample was constructed using greedy nearest neighbour matching with a matching bandwidth or caliper of 0.25 recommended by (Stuart, 2010). According to Caliendo and Kopeinig (2005) Nearest Neighbour (NN) matching faces the risk of bad matches, if the closest neighbor is far away. Tolerance level on the maximum PS distance known as caliper or bandwidth is imposed to avoid bad matches. This avoids bad matches and enhances the matching quality. Applying caliper matching means that those households from the non-flooded

group are chosen as matching partners for flooded households that lies within the caliper (propensity range) and is closest in terms of the propensity score. The households were matched 1:1, which means that one household in the flooded group was matched to one household in the non-flooded group based on their propensities. The matching algorithm sorts the observations in the flooded group by their estimated propensity score and matches each household sequentially to a household in the non-flooded group that has the closest estimated propensity score (Rudner and Peyton, 2006). The units outside the area of common support (defined as the region of the distributions of estimated propensity scores in the flooded and non-flooded group for which units in both groups are observed) were discarded (Thoemmes, 2012). All households that fell outside the region of common support were discarded. A new set of data with all matched data were created and further analyses were carried out.

#### **3.4.5.5 Checking for Balance**

After matching was completed, a series of model adequacy checks were performed. The main reason was to check whether balance on the covariates was achieved through the matching procedure. This was done by comparing several statistics of the flooded and non-flooded group before and after matching, most often the standardized mean differences and the variance ratio. The standardized mean difference of covariates should be close to “0” after matching, and the variance ratio should be close to “1” after matching. Rubin (2001) suggests the standardized difference in the mean propensity score between the two groups should be near zero (standard deviation difference,  $d < 0.20$ ).

#### **3.4.5.6 Estimating Treatment Effects (ATE)**

Once matching was completed, the treatment effect was estimated by directly comparing outcomes between flooded households and non-flooded households in the matched sample. Paired t-test was used to establish if there was a significance difference between the outcome variables of flooded and non-flooded households. The outcomes in this regard were the income from different sources per month. The income sources from livestock, the sale of crop, the sale of fish, casual labor, the sale of reeds

and grass, part-time job, business, remittances and gifts were recorded into dummy variables (low and high). Low income represented those households whose monthly mean income from that particular source was between (N\$0 - N\$110) while high income represented (N\$111 - above). The kilograms of crops harvested (maize, sorghum and millet) and livestock owned were continuous variables. After running a t-test we further estimated the average treatment effect (ATE) on the population using nearest neighbor, propensity score and regression adjustments estimators (see Table 3.4).

### **3.5 Results and Discussions**

#### **3.5.1 Overall Sample Characteristics of the Matched Households**

Out of the total 220 households in Namibia, about 53 non-flooded and 101 flooded were matched. On the other hand, out of 225 households in Zambia, about 49 non-flooded households and 82 flooded households were matched. This means the matched households had similar characteristics based on the selected covariate age, gender, marital status, education level, land size and formal employment status.

The sample survey result indicated that an average rural household in the study area consists of five people in both Namibia and Zambia. In Zambia, household heads were dominated by males in both flooded and non-flooded households while female-headed households dominated Non-flooded households in Namibia. Tables 3.1 and 3.2 below show the covariates used for matching the flooded and non-flooded groups. These are covariates selected after they passed the threshold of the significant level ( $p < 0.1$ ).



**Table 3.1 Overall sample characteristics of the matched households in Namibia**

<b>Variables</b>	<b>Measures</b>	<b>Non-flooded</b>		<b>Flooded</b>		<b>p-value</b>
		<b>Frequency</b>	<b>%</b>	<b>Frequency</b>	<b>%</b>	
<b>Age</b>	<20 years	0	0	2	2.0	0.1
	21 to 40 years	13	24.5	42	41.6	
	41 to 60 years	18	34.0	30	29.7	
	>61 years	22	41.5	27	26.7	
<b>Gender</b>	Male	25	47.2	57	56.4	0.274
	Female	28	52.8	44	43.6	
<b>Education</b>	Grade 1-4	3	5.7	2	2.0	0.435
	Grade 5-7	13	24.5	23	22.8	
	Grade 8-10	13	24.5	32	31.7	
	Grade 11-12	13	24.5	27	26.7	
	Tertiary	0	0.0	4	4.0	
	Adult literacy	1	1.9	2	2.0	
	Never attended	10	18.9	11	10.9	
<b>Land size</b>	Less than 0.5 ha	1	1.9	1	1.0	0.442
	0.5 ha to 1 ha	0	0	3	3.0	
	1 ha to 2 ha	3	5.7	10	9.9	
	2 or more ha	49	92.5	87	86.1	
<b>Formal employment</b>	Employed	3	5.7	4	4.0	0.849
	Unemployed	48	90.6	92	91.1	

**Table 3.2 Overall sample characteristics of the matched households in Zambia**

<b>Variables</b>	<b>Measures</b>	<b>Non-flooded</b>		<b>Flooded</b>		<b>P-value</b>
		<b>Frequency</b>	<b>%</b>	<b>Frequency</b>	<b>%</b>	
<b>Age</b>	<20 years	1	2.0	2	2.4	0.756
	21 to 40 years old	27	55.1	42	50.6	
	40 to 60 years	17	34.7	27	32.5	
	>60 years	4	8.2	12	14.5	
<b>Gender</b>	Male	31	63.3	49	59.0	0.631
	Female	18	36.7	34	41.0	
<b>Education</b>	Grade 1-4	1	2.0	5	6.0	0.05
	Grade 5-7	8	16.3	30	36.1	
	Grade 8-10	25	51.0	31	37.3	
	Grade 11-12	9	18.4	13	15.7	
	Tertiary	5	10.2	1	1.2	
	Adult literacy	0	0.0	1	1.2	
	Never attended	1	2.0	2	2.4	
<b>Land size</b>	Less than 0.5 ha	11	22.4	11	13.3	0.322
	0.5 ha to 1 ha	2	4.1	7	8.4	
	1 ha to 2 ha	5	10.2	5	6.0	
	2 or more ha	31	63.3	60	72.3	
<b>Formal employment</b>	Employed	4	8.2	5	6.0	0.670
	Unemployed	45	91.8	77	92.8	

### **3.5.2 Balancing and Common Support**

The results indicate that after matching a considerable amount of bias was reduced and the covariates were balanced in both groups (flooded and non-flooded). The standardised mean differences after matching were close to zero, showing that after matching both categories of rural households (flooded and non-flooded) were very similar to each other. The balancing property of the PSM was satisfied, which means that households with the same propensity scores had the same distributions of all covariates. The flooded and the non-flooded households were more before matching and reduced after matching as shown in the summary of balance for matched data section of Table 3.3. The standardised mean difference in family size between flooded and non-flooded households reduced to -0.02; it was -0.09 before matching. The standardised mean difference in age of the household between flooded and non-flooded reduced to -0.10; it was -0.31 before matching. Finally, the mean difference between flooded and non-flooded households in terms of marital status reduced to 0.06; it was 0.02 before matching. In short, after matching, the flooded and non-flooded households were very similar in terms of age, formal employment, marital status, gender and family size. Before matching, the flooded and non-flooded were on average larger than after matching. Table 3.3 shows the means and standard deviation, standardised mean differences between the flooded and non-flooded groups.

**Table 3.3 Standardised mean difference before and after matching**

Variables	Detailed balance before matching				Detailed balance after matching			
	Means flooded	Means non flooded	SD non-flooded	Std. Mean Diff.	Means flooded	Means non flooded	SD non-flooded	Std. Mean Diff.
Propensity scores	0.63	0.56	0.14	0.61	0.61	0.59	0.11	0.18
Age (years)	44.72	49.69	17.09	-0.31	46.87	48.45	16.63	-0.10
Gender (dummy)	1.41	1.51	0.50	-0.19	1.43	1.50	0.50	-0.14
Marital status (Formal employment (dummy))	2.34	2.25	1.51	0.06	2.22	2.25	1.51	-0.02
Education level	2.01	2.00	0.18	0.02	2.01	2.00	0.19	0.03
Family size (number)	3.23	3.20	1.25	0.02	3.18	3.23	1.26	-0.04
	4.81	5.06	3.24	-0.09	4.97	4.87	2.76	0.03

Note: Treated are all the flooded households sampled and control are the non-flooded households. Std mean diff. is the standardised mean difference between the flooded and non-flooded, and SD is the standard deviation.

### 3.5.3 Impact of Floods on Income, Crop Production and Livestock Ownership in the Study Area

#### 3.5.3.1 Impacts of Floods on Crop Production

In evaluating the impacts of floods on crop production we tested the hypothesis ( $H_0$ ) that there is no statistically significant difference in crop production between flooded and non-flooded households. Results of the focus group discussion indicated that floods in both study areas had positive and negative impacts on crop production. Related to positive impacts, households indicated that during a normal or disaster flood there was abundant food such as water potatoes, fish and some wild vegetables. These floods were reported to deposit nutrients into fields enabling cultivation without the application of fertilisers. However, when the magnitude of the flood was reported higher than normal (flood disaster), households reported damage to crops before harvesting time. Maize, sorghum, millet as the main three crops grown could not respond well in fields with

high moisture. Most households did not attain their targeted production, translating to losses due to lost production. Maize, which is the main staple food among households recorded particularly lower actual yields compared to the expected yields.

Crop production was reported higher among flooded households than non-flooded households in Eastern Zambezi region of Namibia (see Table 3.4). The results of ATE in Table 3.6 below showed that flooded households reported mean crop production of 1624 kg while non-flooded households reported 214 kg. These results were statistically significant different ( $p < 0.1$ ). The average effect of crop production indicates that flooded households harvested 1278 kg more than the non-flooded households. In this case, we reject the null hypothesis that there is no statistically significant difference in crop production among flooded and non-flooded households. Despite the fact that the size of land cultivated was not statistically significantly different between flooded and non-flooded households ( $p < 0.01$ ) crop production was different. However, Mabuku *et al.*, (2018) reported that Eastern Zambezi region of Namibia experienced more floods than Mwandia district of Zambia. Since more flood deposit nutrients in the fields, this could be the reason why more households in flooded areas had higher production than those in non-flooded households. It was reported that during normal/low floods, in which this study was carried, households in flood plain had a good harvest as fields had considerable moisture. This allowed them enough time to cultivate and harvest before the next flood. However, during a higher flow, negative impacts are more pronounced. In Luhonono village of Eastern Zambezi region in Namibia, Mashebe *et al.* (2016) reported crops and animal farming practices severely affected by floods. Livelihoods of the flood victims deteriorated over the years (Mashebe *et al.*, 2016) due to flood disasters. Increased flood disasters in the Zambezi Region of Namibia led to more agriculture land lost for longer periods, shorter growing periods and lower crop productions (Ministry of Lands and Resettlements, 2015). Increased normal floods will lead to increased fertility of the floodplains as sediments and organic matter are carried by the floods (Ministry of Lands and Resettlements, 2015). However frequent flood disasters have an implication for farm-based livelihoods resulting in reduced crop production and higher incidence of crop failure (Ministry of Lands and Resettlements, 2015).

However, in Mwanzi district of Zambia, the t-test results in Table 3.5 show that non-flooded households harvested on average 1064 kg of different crops and non-flooded households 993 kg in 2014/2015 agriculture year and the results were not statistically significant. Gichere *et al.* (2013) reported that differences in expected yields among households could be attributed to factors like the size of land under cultivation. Floods disasters can damage crop production coupled with a decrease in cultivated area and crop yield, which leads to income loss (Garbero and Muttarak, 2013). Similarly, in this study, there was no statistically significant difference in the land cultivated between the flooded and non-flooded households ( $p < 0.05$ ) in Mwanzi district. In this case, we accept the null hypothesis that there was no statistically significant difference in crop production between flooded and non-flooded households in Mwanzi.

### **3.5.3.2 Impact of Floods on Livestock Ownership**

In evaluating the impact of floods on livestock ownership we tested the hypothesis ( $H_0$ ) that there is no statistically significant difference in the average number of livestock owned between the flooded and non-flooded households in the study area. In Namibia, flooded and non-flooded households owned an average of 107 and 97 number of livestock as shown in Table 3.4. These results were not statistically significantly different. We accept the null hypothesis that there is no statistically significant difference in the mean number of livestock owned between the flooded and non-flooded households in Eastern Zambezi region. This could be explained by the fact that households in non-flooded areas especially those that were relocated permanently from flood plain still take their livestock to flood plain for grazing during dry periods in the higher ground.

Contrary to Eastern Zambezi region results, in Mwanzi district of Zambia, there was a statistically significant difference in the mean number of livestock owned between flooded and non-flooded households ( $p < 0.05$ ) (see Table 3.5). The Flooded households owned a mean number of 32 livestock compared to non-flooded households who owned 61 livestock. We reject the null hypothesis that there is no statistically significant

difference in the average number of livestock owned between flooded and non-flooded households.

During focus group discussions households indicated that livestock drowned during the flood period. Insufficient food for livestock was also reported since most of the grazing areas were flooded and the carrying capacity was exceeded during the relocation period. In most cases, livestock was relocated to higher land before the onset of floods. This process of relocating livestock came with costs of finding good pasture upland and returning after the water has receded. Since grazing areas were flooded during the flood period, livestock death and illnesses were reported in the study area. As a result, households opted to sell off their livestock during impending floods to alleviate losses from livestock deaths or transferring the livestock to safer areas during flood events thus, pre-empting or reducing any losses (Gichere *et al.*, 2013). When grazing land was frequently flooded households kept limited livestock and this could explain why flooded households owned less livestock than the non-flooded households in Eastern Zambezi region of Namibia.

### **3.5.3.3 Impact of Floods on the Income of the Rural Households**

In evaluating the impact of floods on income we tested the null hypothesis ( $H_0$ ) that there is no statistically significant difference in income between the flooded and non-flooded households. The results show that there was a statistically significant difference in the mean income obtained between the flooded and non-flooded households from livestock sale, sale of crops, sale of reeds and grass, and remittances and gifts received from families and friends ( $p < 0.05$ ) in both Eastern Zambezi region of Namibia and Mwanzi in Zambia. As opposed to the results in Namibia, flooded households in Zambia, had higher income obtained from livestock, the sale of crops and fish compared to the non-flooded households. There were statistically significant differences ( $p < 0.1$ ) in income derived from the sale of thatched grass and reeds, and remittances and gifts between flooded and non-flooded households. It should be noted that one household may obtain income from all the different income sources while another may obtain from one income source.

### **3.5.3.4 Income from Livestock Sale**

Livestock farming and cropping are some of the most important contributors to the subsistence livelihood income for residents of the Zambezi region (Mashebe *et al.*, 2016). Ministry of Lands and Resettlements (2015) reported that 29% of people in Eastern Zambezi region farm with livestock. In Eastern Zambezi region of Namibia, non-flooded households had higher income from the sale of livestock than the flooded households ( $p < 0.01$ ). The ATE results from the nearest neighbour, regression adjustment and propensity score show negative coefficients of -0.18 ( $p < 0.05$ ), -0.0260 ( $p < 0.01$ ), -0.22 ( $p < 0.1$ ) which were statistically significant. In order to reduce the carrying capacity of an area that was flooded, flooded households in Namibia sold more of their livestock reducing the large numbers of livestock likely to die during relocation. During flooding period animal diseases such as foot and mouth (Saasa *et al.*, 2015; Venkateswaran, 2014) and death were also reported common in the study areas. Selling of cattle reduced the risk of livestock deaths due to an outbreak of these diseases. In both flooded and non-flooded households in Namibia households also obtained income from other sources such as social grants (Mabuku *et al.*, 2018). Predictions claim that there will be an increased reduction in primary productivity and carrying capacity, and more frequent and intense floods (Ministry of Lands and Resettlements, 2015).

On the contrary, flooded households had higher mean income from the sale of livestock than the non-flooded households in Mwandu district ( $p < 0.05$ ). ATE results obtained from the nearest neighbour, regression adjustment and propensity score showed coefficients of 0.27 ( $p < 0.01$ ), 0.27 ( $p < 0.01$ ), 0.31 ( $p < 0.01$ ) which were statistically significant. The results mean that flooded households obtained higher income from selling livestock than non-flooded households.

### **3.5.3.5 Income from Sale of Crops**

Overall crop farming was the dominant agriculture activity in the Zambezi region of Namibia (Ministry of Lands and Resettlements, 2015). The main crops cultivated were maize, millet and sorghum. The result of t-test in Table 3.4 show that in Namibia's study area, non-flooded households had higher mean income from the sale of crops than



the flooded households and the results were statistically significant ( $p < 0.01$ ). The ATE results from the nearest neighbour, regression adjustment and propensity score estimators in Table 3.6 show negative coefficients and statistical significance of -0.29 ( $p < 0.01$ ), -0.26 ( $p < 0.01$ ), and -0.24 ( $p < 0.05$ ). We reject the null hypothesis that there is no statistically significant difference in the income obtained from the sale of crops. These differences mean that there were negative impacts of floods on income from the sale of crops. Contrary to Namibia, results in Zambia show that flooded households had higher income from the sale of crop and results were statistically significant ( $p < 0.01$ ) as shown in Table 3.5. The ATE results from nearest neighbour, regression adjustment and propensity score estimators in Table 3.6 show positive coefficients and statistical significance of 0.17 ( $p < 0.01$ ), 0.14 ( $p < 0.01$ ), 0.18 ( $p < 0.01$ ). A positive coefficient means that there is a positive impact of floods on the flooded households. Similar to Namibia, we reject the null hypothesis that's there is no statistically significant difference in the income obtained from the sale of crop between the flooded and non-flooded households in Mwandu district of Zambia.

### **3.5.3.6 Income from Sale of Reeds and Grass**

Households harvested grass and reeds for subsistence and commercial use. In Zambia and Namibia indigenous construction methods both in flooded and non-flooded area made use of reeds for fencing and elephant grass for roofing. Mostly reeds were harvested near the river banks and tributaries. In Namibia, non-flooded households reported higher mean income obtained from the sale of reeds and grass than the flooded households. The results from t-test indicate that there was a statistically significant difference in the income obtained from the sale of grass and reeds between the flooded and non-flooded households ( $p < 0.01$ ). The null hypothesis in Namibia was rejected. However, in Zambia, the null hypothesis was accepted since there were no statistically significant differences in the income from the sale of grass and reeds between the flooded and non-flooded households.

### **3.5.3.7 Income from Remittances and Gifts**

Households in Zambia and Namibia reportedly received remittances and gifts in the form of money and goods from friends and families. These remittances were received monthly or occasionally. The result of t-test in Table 3.4 shows that in Namibia's study area, non-flooded households had higher mean income from remittances and gifts than the flooded households and the results were statistically significant ( $p < 0.01$ ). The ATE results from the Nearest neighbour, regression adjustment and propensity score estimators in Table 3.6 show negative coefficients and statistical significance of -0.28 ( $p < 0.01$ ), -0.22 ( $p < 0.01$ ), and -0.22 ( $p < 0.1$ ). We reject the null hypothesis that there is no statistically significant difference in the mean income obtained from remittances and gifts between the flooded and non-flooded households in Eastern Zambezi region of Namibia. In Namibia, remittances from family employed or involved in diverse business activities in urban areas contribute to rural household income (United Nations World Food Program, 2008). Since flooded households in Namibia are more vulnerable to floods compared to Zambia their family members and friends send money monthly to assist during a flood and flood disaster and for recovery.

Contrary to the results from Namibia, results of t-test in Zambia show no statistically significant differences in income from remittances and gifts between flooded and non-flooded households as shown in Table 3.5. We accept the null hypothesis that there is no statistically significant difference in the mean income obtained from remittances and gifts between the flooded and non-flooded households in Mwanzi district of Zambia. The severity of floods between Zambia and Namibia explains why Households in Namibia received more remittances and gifts than those households in Zambia.

### **3.5.3.8 Income from Sale of Fish, Part-Time Job, Casual Labour and Business**

Households obtained income from sale of fish, part time jobs and owning small business like a shop. Results of t-test did not show any statistically significant differences in the income obtained from casual labour, part-time jobs and business between flooded and non-flooded households in Eastern Zambezi region of Namibia and Mwanzi district of Zambia. We accept the null hypothesis that there were no

statistically significant differences between flooded and non-flooded households income obtained from above income sources.

The results indicated that flooding had both a positive and negative impact on the income of the households in both Namibia and Zambia's study areas. However, households in Namibia's flooded area had lower income in most of the sources. This could be attributed to the severity of floods experienced in Eastern Zambezi region of Namibia as reported in Mabuku *et al.*, (2018). Namibians experience flood disasters more often and severely than the Zambian. Venkateswaran, (2014) reports that floods of all magnitudes greatly impacted households and communities living along the Zambezi River basin.

**Table 3.4 Statistical significance differences in the outcome variables between flooded and non-flooded households in Eastern Zambezi region of Namibia**

Outcome variables	Matched sample paired t-test			p-Value
	Non-Flooded mean	Flooded mean	Difference	
Formal employment	0.377	0	0.0377	0.0498**
Sale of livestock	0.1020	0.0120	0.0899	0.0163**
Sale of crops	0.5094	0.2376	0.2718	0.0006***
Sale of fish	0.0754	0.0198	0.0556	0.0910*
casual labor	0.0377	0.0198	0.0179	0.5094
Sale of grass and reeds	0.3396	0.1287	0.2109	0.0018***
Part time job	0.2452	0.13260	0.1066	0.0994*
Business	0.0943	0.039	0.0547	0.1711
Remittances and gifts	0.3773	0.1485	0.2272	0.0012***
Farming land cultivated	0.9245	0.9207	0.0037	0.9350
Crop production	214.2	1624.3	-1410	0.0623*
Livestock owned	96.9	107.28	-10.32	0.7522
Number of livestock sold	12.5	12.15	0.3797	0.9084

**Note:** The significant level test was at 1% \*\*\*, 5% \*\*, 10% \*.

**Table 3.5 Statistical significance differences in the outcome variables between flooded and non-flooded households in Mwandia district of Zambia**

Outcome variables	Matched sample Paired t-test			
	Non-flooded mean	Flooded mean	Difference	<i>p</i> -Value
Formal employment	0.1020	0.0120	0.0899	0.0163**
Sale of livestock	0.0612	0.3253	-0.264	0.0004***
Sale of crops	0.0204	0.1566	-0.1362	0.0139**
Sale of fish	0.0816	0.2409	-0.1593	0.0218**
Causal labor	0.06122	0.0244	0.0368	0.2906
Sale of grass and reeds	0.06122	0.0722	-0.0110	0.8093
Part time job	0.1428	0.1686	-0.0258	0.6979
Business	0.2040	0.2289	-0.0248	0.7415
Remittances and gifts	0	0	0	0
Farming land cultivated	0.632	0.5975	0.0350	0.6929
Crop production	1064	993	71	0.8482
livestock owned	60.65	32.43	28.2	0.0021***
Number of livestock sold	6.18	7.4	-1.2982	0.5750

Note: The significant level test was at 1% \*\*\*, 5% \*\*, 10% \*

**Table 3.6 Impacts of floods on outcome variables from different matching methods**

<b>Average Treatment Effect for Eastern Zambezi region of Namibia (N=154)</b>				
<b>Outcome variables</b>	<b>Measure</b>	<b>Nearest neighbor</b>	<b>Regression adjustment</b>	<b>Propensity Score</b>
Crop production	Number of kg harvested	1320.5 (0.002)***	1266.7 (0.005)***	1278.7 (0.003)***
Income from livestock	Dummy 1 high or 0 low	-0.18 (0.043)**	-0.26 (0.002) ***	-0.22 (0.050)*
Income from crop sales	Dummy 1 high or 0 low	-0.29 (0.003)***	-0.26 (0.001)***	-0.24 (0.042)**
Income from fish sales	Dummy 1 high or 0 low	-0.11( 0.024 )**	-0.07 (0.144)	-0.06 ( 0.276 )
Income from remittances	Dummy 1 high or 0 low	-0.28 (0.002)***	-0.22 (0.004)***	-0.21 ( 0.067)*
<b>Average Treatment Effect of Mwanzi district of Zambia (N=132)</b>				
Income from livestock sale	Dummy 1 high or 0 low	0.276 ( 0.001 )***	0.27 (0.000)***	0.31 (0.0001)***
Income from crop sale	Dummy 1 high or 0 low	0.17 ( 0.001)***	0.14 (0.001)***	0.18 ( 0.0001 )***
Income from fish sale	Dummy 1 high or 0 low	0.11 ( 0.087 )*	0.17 (0.003)***	0.11 (0.087 )*
Livestock ownership	Number of cattle, sheep and goats	-21.83( 0.074)*	-26.87 (0.004)***	-29.17 ( 0.003)***

Notes: Average Treatment Effects showing the coefficients of different estimate effect methods applied in the study. In the parentheses are the p-values indicating the significant difference between the non-flooded households (control =0) and flooded (treated =1) outcome variables. The significant level test was at 1% \*\*\*, 5% \*\*, 10% \*. Due to the small sample size, categorical outcome variables were recoded (0, 1). The value 0 indicating low income per month and value 1 indicating high income

### **3.6 Limitation of the Study**

During focus group discussion some households reported residing in the flood plain having fields or livestock in higher ground and the opposite was also true. The estimate on the impact may have been overestimated since respondents obtained income or harvested crops from both flood plain and higher ground. Some non-flooded households were resettled from flood plain to higher ground but were still cultivating in the floodplain. Further studies may distinguish between the income obtained from flood plain (flooded areas) and from higher ground to provide the true impacts of floods. This could be achieved by designing questions in such a way that distinguishes the crops harvested in the flood plain or higher ground.

Households were hesitant to provide information on income, during a pilot study, the majority of respondents could not give the total amount, however during data collection income was grouped into four categories instead of continuous values. This might not give an exact income obtained but an estimate within a range.

It is important to highlight that this study did not cover a full range of impacts (such as health, education), as a result, the flood impact assessment is incomplete and may contain methodological biases and omissions such as unverified crop yield and lack of ground truthing. The collection of more data would be highly valuable to build upon as a research basis. Since the application of PSM discards some of the households, more samples from the non-flooded group would be collected to account for those samples that will be excluded from the study. It is not clear how big a sample is needed and needs further study (Luellen *et al.*, 2005). However, Lane, (2011) suggested that 300 sample size may be too small for matching when the prediction of group assignment is high. PSM relied on matching households on the basis of observable characteristics linked to the predicted likelihood of being flooded. In cases where there are any 'unobserved' characteristics that affect treatment (flooded or non-flooded) and which change over time, the estimates may be biased and thus affect the observed results. This

study attempted to apply PSM, it is beyond the scope of this paper to discuss all possible variations and their implications for interpreting statistical results.

### **3.7 Conclusions**

We conclude that indeed flood had positive and negative impacts on rural households in the study area. It was established that flooded rural households in Mwanzi and Eastern Zambezi region practiced mixed farming (crops and livestock), however, crop farming was more favoured over livestock farming which is highly susceptible to flood events. Crop farming was preferred more because it was convenient (reduced agriculture inputs such as fertilisers and labor saving) and didn't require attention since it was seasonal compared to livestock farming requiring attention throughout the year. Impact assessment results show that normal floods had a positive impact on flooded household's crop production in Namibia. More flooded households reported higher production than the non-flooded households in Eastern Zambezi region of Namibia. We conclude that normal floods are beneficial for flooded households in Namibia. Contrary to results from Namibia, there was no statistically significant difference in mean crop production between flooded and non-flooded households in Mwanzi district of Zambia.

Focus group discussion indicated that households opted to cope with these floods through the sale of their livestock before a flood struck thus reducing losses due to livestock deaths. Another way was to transfer the livestock to safer grounds during a flood disaster. Thus reducing any losses resulting from deaths. Impact findings indicate that flood disasters in Eastern Zambezi region of Namibia had negative impacts on the flooded households' income derived from the sale of crops, the sale of fish, the sale of livestock and remittances and gifts. While flooded households had higher mean income from the sale of livestock, sale of crops, and sale of fish, the sale of livestock and remittances and gifts than the non-flooded households in Mwanzi district of Zambia. In Eastern Zambezi region of Namibia, flooded households and non-flooded households were not statistically significantly different in the mean number of livestock owned. As opposed to Namibia, In Zambia flood disasters had a negative impact on

flooded households' livestock ownership. Non-flooded households had a higher number of livestock than flooded households.

There is a need for advocacy on coping and mitigation strategies against adverse floods impacts in relation to income, livestock ownership and crop production. For policy implication, PSM method is an impact assessment method that can help policymakers in evaluating impacts in areas with missing baseline data. Evaluating the impacts would help decision makers in targeting the most impacted areas and sectors with negative impact. PSM is an evaluation methodology which can be applied to all areas of natural disaster risk research that use survey data in order to evaluate the impacts of disasters. However, in carrying PSM, the larger sample size is recommended as more non-flooded households are discarded during matching. Furthermore, data can be collected at different flood events to account for the differences in the outcomes. The inclusive of many possible confounders in estimating propensity scores is highly recommended.

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## **4. RURAL HOUSEHOLDS' FLOOD DISASTER PREPAREDNESS AND SOCIAL DETERMINANTS IN MWANDI DISTRICT OF ZAMBIA AND EASTERN ZAMBEZI REGION OF NAMIBIA**

### **4.1 Abstract**

In rural communities of Zambia and Namibia as in other parts of the world, floods are one of the most potentially destructive natural hazards to impact rural livelihoods. This makes it necessary to mitigate their negative impacts through rural households' disaster preparedness. In Zambia and Namibia, very few studies have empirically investigated the rural households' preparedness to flooding and how social capital influence disaster preparedness. The purpose of this case study was to examine the level of flood preparedness and how rural households' social capital and characteristics influence flood preparedness in the study sites. A questionnaire survey of 207 randomly sampled households was conducted in the flood-prone areas of eastern Zambezi region of Namibia and Mwandu district of Zambia. The study employed several additive scales to measure different social capital and flood preparedness. Independent t-test results showed that Namibians had higher flood preparedness levels than Zambians ( $p < 0.05$ ). Tobit Model result indicated that flood preparedness was influenced by a sense of community, risk perception, self-efficacy, responsibility efficacy, outcome expectancy, education level, marital status, access and size of land. It is concluded that flood preparedness differs from one household to the other and is influenced by various social and demographic factors. It is therefore recommended that education and training should be aimed at changing perceptions that are more likely to impact preparedness behaviour. This, in turn, will improve the households' response to floods, planning for floods and preparedness knowledge resulting in improved awareness of flood hazards.

**Keywords:** Flood preparedness, rural households, social capital, Namibia, Zambia.

### **4.2 Introduction**

Natural hazards have historically resulted in financial and psychological damage to society [1]. In recent decades, changes in climate have caused impacts on natural and

human systems on all continents [2]. Climate change is projected to be a dominant stressor on socio-economic systems and exacerbate the potential magnitude and frequency of flood disasters. For example, climate change is projected to cause an average global sea-level rise of between one and two meters by 2100, depending on the green gases emissions scenario[3,4]. Therefore, over the next century, sea-level rise resulting from global warming will increase the probability of flood disasters [5]. Worldwide, riverine areas are expected to face an increase in river flood risk with devastating effects on human lives and the environment [6]. According to Douben [7] flooding is still the most damaging of all natural disasters. For example, in 2011 and 2012 nearly 200 million people worldwide were affected by floods with a total damage cost of almost US\$95 billion [6]. The 2000 Connie and Eline cyclones hit southern Mozambique, isolated Maputo and resulted in damage to thousands of homes as well as 700 deaths and 250,000 displaced people [8]. Despite these adverse impacts people have and continue settling in flood-prone areas due to favourable geographic conditions such as accessibility (transportation) and food production (fertile land), which facilitate economic growth[7].

At the UN World Conference on Disaster Risk Reduction [9], 187 member states signed the Sendai Framework for Disaster Risk Reduction 2015-2030. This global agreement on national action for Disaster Risk Reduction (DRR) replaced the Hyogo Framework for Action 2005-2015 (HFA) [10]. Priority 4 of the Sendai Framework calls for states to enhance disaster preparedness for effective response and to “build back better” in recovery, rehabilitation and reconstruction at all levels [9]. To answer this call rural households are expected to make adjustments to prepare for any impending threats, including household flooding.

Preparedness is defined as the “knowledge, capabilities and actions of governments, organizations, community groups, and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions”[9]. Preparedness is an important part of community resilience [11]. Households’ disaster preparedness is important because it can reduce losses of life and property [12]. It is a well-known fact that floods are unavoidable and unpredictable

[13], but one way to avoid losses is through disaster preparedness. Disaster preparedness can reduce psychological pain and traumatic stress associated with the likelihood of the occurrence of these hazards [14]). Therefore, if individuals or households are prepared for future floods, the physical, social, economic and psychological impact will be reduced.

Making adjustments in response to flooding can be affected by different factors. Among these include risk perception, sense of community, critical awareness, perceived responsibility efficacy, outcome expectancy, and self-efficacy [12,15–17].

The main objective of this study was to determine the level of flood preparedness and determine the household factors that influence flood preparedness. The study looked at measuring components of the ideal preparedness as stated in the Hyogo Framework for Action and items derived from disaster studies in other countries. The study was carried out to answer the following questions: What are the levels of flood preparedness in the eastern Zambezi region of Namibia and Mwanzi district of Zambia, and what are the social factors influencing flood preparedness level?

At present, there are no known studies in the eastern Zambezi region of Namibia and Mwanzi district of Zambia that measured flood preparedness, and at a household level. This necessitated the need to include the above study sites. Even though many studies have attempted to measure the level of flood preparedness at the household level, these studies have been carried out on other continents and other African countries. Moreover, these studies focused more on other hazards. Although the study sites are faced with many hazards such as drought and fire, this study focused on flood hazards only. The results from this transboundary study would help draw lessons from both countries that would allow authorities to enhance flood preparedness at the household level. The results of the study will be useful in the design of appropriate disaster risk reduction strategies. The methodology of this work can be transferred to other rural settings aiming at measuring household level of flood preparedness.



### **4.3 The Scope of the Study**

This study focused on flood preparedness as measured by items on the flood preparedness scale. Furthermore, the study concentrated on the socio-cognitive factors that influenced flood preparedness, which included risk perception, sense of community, outcome expectancy, responsibility efficacy and demographic factors such as gender, age, marital status, land access and size. Examining other economic factors was beyond the scope of the study. The study did not examine the determinants of social capital.

### **4.4 Literature Review on the State of Art of Disaster Preparedness**

This section gives an overview of disaster preparedness in general and the factors influencing preparedness.

#### **4.4.1 Overview on Methods and Measures of Disaster Preparedness**

Disaster preparedness is ensuring the readiness of society to disasters, taking precautionary measures and responding to an impending disaster [18]. Preparedness is not static in nature, but dynamic, requiring revisions and modifications as social contexts change [19]. The goal of preparedness is to ensure that households, government, business and communities develop for when disaster occur [20]. It ensures that resources needed to effectively respond to the impending disaster are in place prior to a disaster [20]. There are different measures that can be undertaken to prepare for disasters. For example, Nakagawa & Yamamoto [21] has indicated the following as some of the measures of earthquake preparedness; having a flashlight, radio, childcare items, stocks of food and water, getting information about what to do in case of a disaster, planning and evacuation route and participating disaster drills and so on. Levac *et al.* [22] has indicated that one common method of analysing a household's emergency preparedness is to examine the amount of emergency supplies on hand. Malkina-Pykh [23] classified disaster preparedness into three categories or components; material (food, water etc), planning (e.g identifying a meeting place) and knowledge and skills (first aid course). The Hyogo Framework for action 2005-2015,

classified disaster preparedness into nine components, these are; vulnerability assessments, planning, institutional framework, resource base, warning systems, response mechanisms, public education, training and rehearsals [24]. Most studies measuring disaster preparedness, have measured it based on one or more of the components mentioned in the Hyogo Framework for Action. None of the studies of disaster preparedness had exhausted all the components of disaster preparedness as outlined in the Hyogo Framework for Action 2005-2015.

A number of studies in disaster preparedness have examined preparedness through questionnaire survey, focus group discussions or key informants interviews as data collection methods. For example, Rustam *et al* [25] used a three-point Likert Scale survey to measure tsunami preparedness in Malaysia. The scale contained items on information and warning systems, education and training and rehearsal. The study found low level of tsunami preparedness for both community and government. In another study, using key informants and group discussions in Pakistan, Ainuddin & Routray [26] found low level of earthquake preparedness for both community and government. Earthquake preparedness questions were based on resource availability, warning system, response mechanism, and education and training.

In Africa, particularly in Uganda, Doocy *et al* [27] measured flood and landslide preparedness using questionnaire surveys focusing on education and training, response mechanism, resource base and vulnerability assessment. Low levels of flood and landslide preparedness were found among communities. Similarly in Kenya, Okayo *et al* [28] used a questionnaire survey to measure flood preparedness. The questionnaire was based on the 'Yes' or 'No' responses, focusing on response actions taken after people received flood warnings.

#### **4.4.2 Factors Influencing Disaster Preparedness**

A number of factors exists that influence household disaster preparedness. They include socio-cognitive (psychological) (risk perception, sense of community, etc), demographic characteristics (age, gender, marital status etc), physical (land access) and

financial (income etc). Sense of community is defined as “a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together” [29]. Mishra *et al* [30], found place attachment as one of the factors influencing flood preparedness in India. It is defined as the feelings of attachment for people and places and is known to influence adjustment decisions. The study concluded that there is a need in understanding emotional connection to place and belonging as it influences flood preparedness. People with high place attachment may be unwilling to change their deep-seated views about the environment, to move, or to take protective action[30]. People with a strong feeling of belonging to a place may be more likely to convert intentions into actual preparedness [31]. Another factor influencing disaster preparedness is critical awareness, the extent to which people think and talk about a specific source of adversity or hazard within their environment [31]. Critical awareness measures the extent to which people perceive hazard issues as important and to think and discuss with others [32]

Risk perception also influences disaster preparedness. Risk perception is the subjective assessment of the probability of a specified type of accident happening and how concerned one is with the consequences [33]. For instance, as low household risk awareness may hinder effective preparedness [34], this should be a key consideration for effective emergency planning and management. A widely held belief is that low household risk awareness is among the main causes of low levels of preparedness, which in turn generates inadequate adaptation to hazards. This assumption is supported by several scientific studies such as [35][36] and[37]. These studies have shown that disaster preparedness is positively associated with the feeling of worry about the risk. Similarly, the willingness to adopt precautionary measures is positively related with the households' level of risk awareness [34,35]. This research indicates that disaster preparedness is positively associated with the feeling of worry about the risk.

Paton [40], found that positive outcome expectancy directly influenced both preparedness intention and actual preparedness whilst negative outcome expectancy was the driver of non-preparation. Outcome expectancy is defined as the perceptions of

whether personal actions will effectively mitigate or reduce a problem [41]. Self-efficacy is the individual's belief in his capacity to perform a given behaviour when faced with a variety of challenges [42]. Furthermore, self-efficacy is regarded as a precursor of adjustment adoption and resilience in natural hazard contexts [38, 39]. The number and quality of actions undertaken, the amount of perseverance and effort invested in risk reduction is strongly dependent on self-efficacy [41]. The more confident or self-efficacious people are about their ability to successfully respond to a given situation such as an emergency, the more likely they are to engage in preparedness behaviours [45]. Perceived responsibility efficacy is the belief that someone has responsibility for self and others. This will determine whether an individual will be prepared for disaster. If people believe they have responsibility to safeguard their life and others, there is the likelihood that they will convert intentions to actions.

Otayo [28] found that flood preparedness was significantly dependent on other factors such as distance, household composition, income, occupation of the household and social network type one belonged to. Education level was found to be insignificant in flood preparedness. Reynaud *et al* [46], found that socio-economic variables characterizing households play only a minor role in flood protective behaviours [46]. Educational level, income and age were found to be insignificant in influencing flood protective behaviour.

Furthermore, in a study for the Red Cross by the Institute of Catastrophic Loss Reduction, the majority of respondents indicated that there were no barriers preventing them from taking part in emergency preparedness activities [47]. The remaining respondents suggested that their efforts were deterred by time, pressure, lack of information, and lack of financial resources. In another study by Diekman *et al* [48] two main barriers identified were used, expired, or misplaced supplies and lack of communication.

The literature on factors that hinder household emergency preparedness is inconclusive. However, the role and significance of disaster preparedness and their factors for disaster

risk reduction is very important and cannot be underestimated. The need for disaster preparedness is a vital part of all disaster management models and frameworks.

#### **4.5 Study Sites**

The study was undertaken in the Mwandu district, situated in Western province of Zambia and the eastern Zambezi region of Namibia. The Zambezi region, formerly known as Caprivi region, is one of 14 regions of Namibia [49]. The Zambezi region covers an area of about 14,500 km<sup>2</sup> and accounts for 1.8 per cent of the total land area of Namibia. The region borders Zambia in the north; Angola in the northwest; Botswana in the east and south and Zimbabwe in the east. Average rainfall in the Zambezi region ranges between 600-700 mm per year, occurring from October to March and increases gradually from the south to the north. The evaporation rate is between 2 400-2 600 mm per annum and the average annual temperature range is between 7<sup>o</sup> C and 35<sup>o</sup> C.

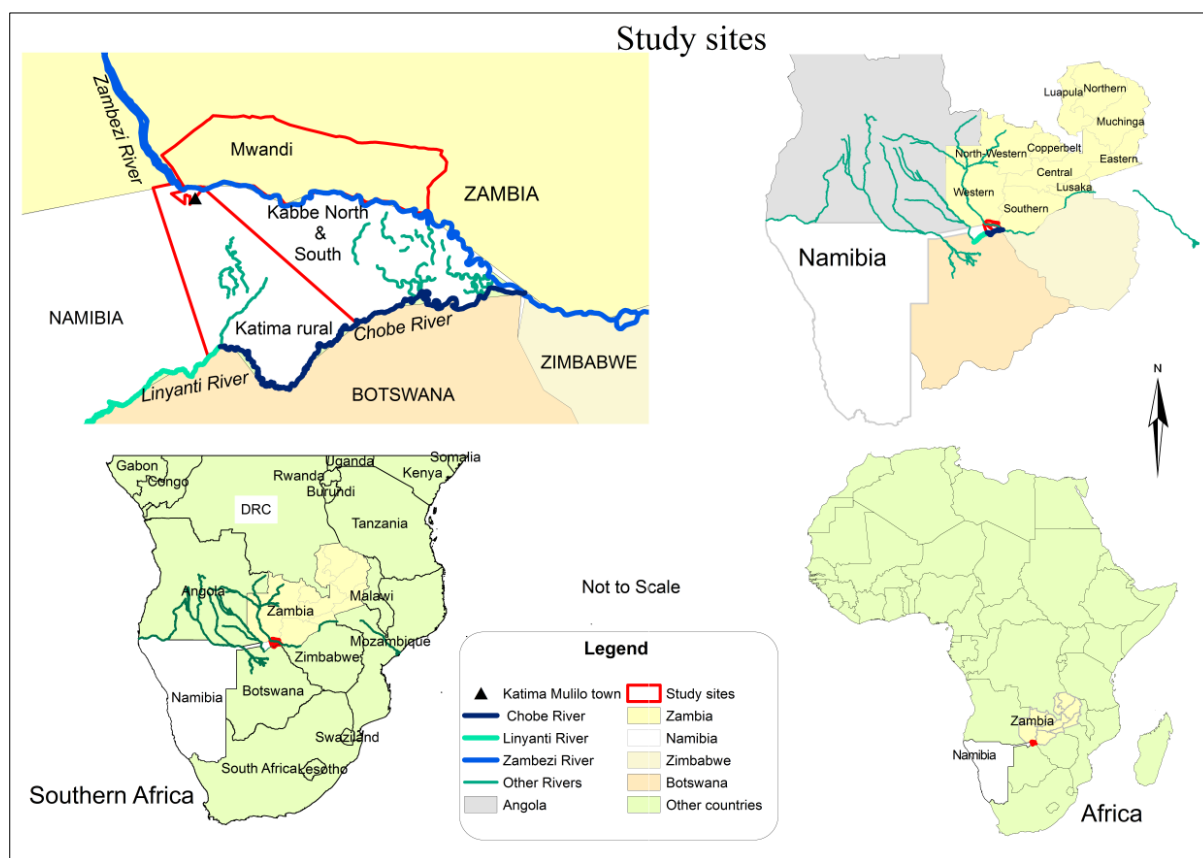
The study sites consist of three constituencies namely Kabbe North, Kabbe South and Katima Mulilo rural. It covers a total area of 4 106.9 km<sup>2</sup>. The study sites were selected as it is one of the flood prone areas in Namibia. The population for the study sites was 30 917 people and 5 265 households in 2011 [49]. The population density was three persons per square kilometre. The people in eastern Zambezi region derive their income from; business activities (excluding farming), wages and salaries, farming, old-age pension, cash remittances, retirement fund, and orphan grants [49].

The abundance of water differentiates the eastern Zambezi region from other riparian parts of the region. Of the four rivers that permanently flow in the Zambezi region, three are in the Eastern Zambezi region; the Chobe, Linyanti (Kwando) and Zambezi. The Zambezi River in the northeast (Zambezi Region) occasionally overflows into the flood plain to the Chobe River west of the Kasane border with Botswana, causing a reverse flow in the Chobe in the southwest direction toward Lake Liambezi. The sources of water in the northern river systems are the rains in southern Angola that reach up to 1 000 mm per annum [50].

Mwandi District, situated in Zambia's Western Province was selected as the second study area. It was part of Sesheke District until the 15<sup>th</sup> November 2013, when it was declared a district on its own [51]. It is situated in the southern portion of Western Province. It lies between 23° and 26° longitude east and 15° and 18° latitude south, and shares borders with Kazungula and Kalomo districts of Southern Province [52]. Within the province, the district borders with Sesheke, Kaoma, Shangombo and Senanga districts. The district consists of 6 248 households and 27 922 inhabitants [53]. It falls under Kazungula-Mwandi plain (zone 7A) food economy zone. According to the Zambia Vulnerability Assessment Committee [54] this livelihood zone has a generally semi-arid climate, with periodic drought and flooding. The main economic activities include crop and livestock production, formal employment, trading, curios (related to tourism), fishing and sale of wild fruits. Figure 4.1 and Figure 4.2 below shows the study sites location. A summary of the study sites characteristics is shown in Table 4.1.

**Table 4.1 Characteristics of the study sites**

Characteristics	Namibia	Zambia
Study sites	Eastern region	Zambezi Mwandi district
Region/province	Zambezi region	Western Province
Population size	30917	27922
Estimated number of households	5265	6248
Average annual rainfall	700	674
Study sites size	4106	1820
Livelihood activities	Farming, old age pension, cash remittances, retirement funds, orphan grants, etc.	Crop and livestock production, formal employment, trading and fishing, sale of fruits, etc.



**Figure 4.1 Study sites: Eastern Zambezi Region, Namibia and Mwandi District, Zambia**

#### **4.5.1 Spatio-temporal Characteristics and the Impacts of Floods in the Study Sites**

The eastern Zambezi region of Namibia and Mwandi districts of Zambia are prone to flooding due to the presence of wetlands and floodplains. These areas experience annual floods reportedly with increased frequency and intensity, inundating areas considered to be higher grounds [55,56]. The eastern Zambezi region experiences annual flood pulses that last between five and eight months, depending on the amount of regional precipitation and river runoffs in the Zambezi and Kwando Rivers [57]. The floods occur due to local rainfall and floodwaters emanating from upstream in Angola [57,58]). In Sesheke district in which Mwandi district was part of, during the period 2010 and 2011, 70% of households were reported to have been affected by floods [52].

These floods led to widespread damage to crops and loss of livestock. Floods resulted in social, economic as well as environmental consequences on people's rural livelihoods and this reduced the adaptive capacity of the natural resource dependent communities [52]. Considering that the majority of the population in Namibia (54%) and Zambia (60%) live in rural areas [59], a significant part of the population experienced the negative impacts of floods.

Similarly, the eastern Zambezi region of Namibia is negatively affected by floods. Communities in flood-prone area of the Zambezi region have, for years, depended on government relief aid [60]. These seasonal floods are experienced annually due to the nature of the area. These annual floods were normal floods with no or less negative impacts on people's livelihood, because despite these floods people would carry out their normal activities during that season. However, from 2000, the study sites have been witnessing the recurrence of severe flooding after a long dry period in the 1990s [61]. For example, in February and March 2009, torrential rains increased water levels in Zambezi and Chobe Rivers, which resulted in a 40 year flood. The 2009 flood came after Namibia had enjoyed several years of low negative impact flooding after the frequent flooding of the 1960s and 1970s [62]. The spatial extent of these flooding events has also increased inundating areas regarded as higher grounds [56].

During 2004, 2008, 2009 and between 2011 and 2013 water levels in the Zambezi River were recorded above normal (4m) and resulted in flood hazards. The upper Zambezi swelled over its banks causing much destruction to property and killing people and animals. Lake Liambezi through the Bukalo Channel received floodwaters from the Zambezi after a long period since its drying up in the 1990s [63]. Some households were relocated during the severe flood and during the relocation period people depended on government aid. People who were relocated to camps harvested little, inaccessibility of social services institutions such as clinics and schools during the flood period [64].

In addition the floods resulted in outbreaks of water-borne diseases. It is for this reason that people needed to cope during these crisis and make some adjustment to adapt to future



floods. Not only do floods have negative impacts, positive impacts are also acknowledged. Some of the positive impacts included *litapa* farming (flood plain farming), abundance of fish during a flood season, and harvesting of water potatoes (abundance of food when water recedes).

## **4.6 Data and Methods**

### **4.6.1 Research Design**

A questionnaire survey of 207 randomly sampled households was conducted in the flood prone areas of eastern Zambezi region (n=114) and Mwanzi district of Zambia (n=93). All flood affected households within the study sites had an equal chance of being sampled. This survey was part of a broader study of 445 households sampled from flood prone and non-flood prone areas. However, for the purpose of this study only households sampled from flooded areas were used. In this case a purposive data collection method was used. Only those villages affected by floods were sampled in both countries. We purposely sampled the 93 households because in Zambia's study sites, the estimated households at risk of flooding in 2012 was estimated at  $\pm 1\ 800$ . While in Namibia's study sites, Reliefweb [65] reported  $\pm 2\ 500$  households to be affected by floods in 2013. The sample size was based on the number of households at risk of flooding as opposed to the total number of households in study sites.

Data collection also included key informants interviews, focus group discussions, observations and informal discussions. A structured questionnaire was administered to each of the sampled households, with the head of the household as the unit of measure. Where the head of the household was not available, every effort was made to interview an adult household member knowledgeable about the general livelihood of the household. The questionnaire was divided into the following sections as shown in Appendix 3; (i) demographic and socio-economic (ii) economic impacts of floods on households (iii) household preparedness and adaptation strategies and (iv) social factors influencing flood preparedness. A pilot study was carried out in January 2015 to pre-

test the research instruments and the main survey was carried out in July 2015. Six focus groups were also conducted in Zambia and Namibia during the same time period.

#### 4.6.2 Research Instruments

This study used seven different scales to collect data as described below.

##### 4.6.2.1 Preparedness Scale

The flood preparedness scale was designed with 47 items or questions. The items on the scale were grouped into six components as indicated in Table 4.2. Items in the scale were derived from authors such as Mulilis *et al.* [25–27,66–68]. A pilot study was carried out that tested the items in the scale. Some of the questions were reworded to allow for easier interpretation in the local language. The 47 items on flood preparedness scale measured the extent to which a person or household is prepared for floods. Respondents indicated the extent of their preparedness with regard to each item on a 3-point scale: 1 = yes, 2=no and 3=I don't know. The questions were then recorded to a dichotomous scale: 1= yes, 0 = otherwise (no and don't know). Sample questions asked included; “Do you keep the following items ready before the flood season?”, “Did you make the radio sets fully serviceable?”; “Did you attend any first aid training in the last two years?”, and “Do you organise yourselves to monitor the water level?” The score is calculated by summing up all the yes responses. The score range is 1 to 47. The inference is that households with higher scores had higher preparedness levels.

**Table 4.2 Definition of components used in the preparedness scale and the list of related items**

<b>Component of flood disaster preparedness</b>	<b>Definition</b>	<b>Preparedness Items</b>	<b>Number of items</b>
Resources availability	Refers to the physical (boats, food, emergency kits) and financial resources (money)	-Have boats available -Keep emergency food and water -Keep emergency blankets -Keep mosquito net	12

<b>Component of flood disaster preparedness</b>	<b>Definition</b>	<b>Preparedness Items</b>	<b>Number of items</b>
	available and households have access to when a disaster strikes.	<ul style="list-style-type: none"> <li>-Save enough money for emergency</li> <li>-Make radio set fully serviceable</li> <li>-Keep torch lights and candles available</li> <li>-Keep a list of emergency phone numbers in case of a flood emergency</li> <li>-Keep first aid kit ready</li> </ul>	
Knowledge	Knowledge and skills households have of flood disaster preparedness and how the knowledge is enhanced	<ul style="list-style-type: none"> <li>-Know of the emergency evacuation centre</li> <li>-Read material on flood disaster preparedness</li> <li>-Listen to messages on flood disaster preparedness on radio or television</li> <li>-Attend meetings for the purpose of flood disaster preparedness</li> <li>-Attended first aid training</li> </ul>	5
Emergency plan	Availability of a household evacuation plan when a flood disaster strikes	<ul style="list-style-type: none"> <li>-Have plan for a safe place during flood disaster</li> <li>-Organise or attend meeting with household members after flood</li> <li>-Member of household involved in planning or coordinating with the government on flood disaster preparedness</li> </ul>	3
Warning system	The existence of an early warning system and the effectiveness of the warning system in place	<ul style="list-style-type: none"> <li>-Households receive flood warning messages</li> <li>-Is the message of the early warning clear</li> <li>-Household respond to the issued warning by keeping valuable items safe</li> <li>-Early warning are the key to reducing impacts of floods</li> <li>-Village organise itself to monitor water level</li> <li>-Households have traditional early warning systems in place</li> </ul>	12

Component of flood disaster preparedness	Definition	Preparedness Items	Number of items
Response mechanism	Availability of assistance during flood disaster	<ul style="list-style-type: none"> <li>-Households have ways to predict the risk of flooding</li> <li>-Assurance of getting a warning before flood</li> <li>-Government has the biggest responsibility to issue warning</li> <li>-A lot can be done by households about early warning</li> <li>-Groups available who help during a flood disaster</li> <li>-Groups help everyone</li> <li>-Household member help another member of the community</li> <li>-Government help during a flood disaster</li> <li>-Red cross available to help during a flood disaster</li> <li>-NGO help during a flood disaster</li> <li>-Other organisations available to help during a flood disaster</li> <li>-Households contacted through radio</li> <li>-Households contacted through TV</li> <li>-Household contacted through headman</li> <li>-Household contacted through newspaper</li> <li>-Household member relocate during floods</li> </ul>	12
Education and training	What is being done to enhance the skills and knowledge of flood disaster preparedness? This could be in the form of meetings, training attended for the purpose of flood disaster preparedness.	<ul style="list-style-type: none"> <li>-Attend any training held by school/NGO/Government for flood disaster preparedness purpose</li> <li>-Teach any member of the household what to do in case of flood</li> <li>-Attended first aid training</li> <li>-Participate in mock drills or rehearsal for the purpose of flood disaster preparedness</li> </ul>	4

#### 4.6.2.2 Perceived self-efficacy scale

The General Perceived Self-Efficacy Scale (GPSES) is the most frequently used scale for measuring perceived self-efficacy, and it has been found to have good psychometric qualities [69]. The GPSES is a 10-item psychometric scale that is designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life as shown in Table 4.3. The scale was based on ten items as developed by Schwarzer, Jerusalem [69]. The scale consists of 10 statements about mastery with four response alternatives: “completely disagree” (0), “disagree” (1), “agree” (2), and “completely agree” (3). The score is calculated by adding up all responses to a sum score. The range is from 0 to 30 points, with a higher score indicating more self-efficacy meaning better flood preparedness. The internal consistency (Cronbach's alpha) of the self-efficacy in a study carried by Nygaard *et al.* [70] was found to be good (0.90). Self-efficacy questions asked were related to respondents’ or households’ flood preparedness and included questions such as: “I find several solutions when confronted with floods”, and “I am able to prepare for floods with invested efforts” and so on.

**Table 4. 3 Principal Component results of Perceived Self-efficacy**

Self-efficacy	Factor loading	
	1	2
Manage to solve flood related problems	0.606	
Find means and ways to prepare for floods	0.759	
Able to stick to aims and accomplish goals meant for preparing for floods	0.756	
Knows how to handle unforeseen situation such as flood disaster able to prepare for flood with invested effort	0.730	
Remain calm during a flood disaster because rely on coping abilities	0.564	0.714
Find several solution when confronted with floods	0.754	
Think of a solution when affected by flood disaster	0.776	
Able to handle whatever comes on way	0.730	

#### **4.6.2.3 Sense of community scale**

In order to measure an individual's sense of community, a modified version of the sense of community index (SCI) based on 23 items as revised by Chavis *et al.* [71] was used. Chavis *et al.* [71] indicated an internal consistence (Cronbach's alpha) of 0.89. The sense of community index is the most frequently used quantitative measure of sense of community in the social sciences [71]. It has been used in numerous studies covering different cultures in North and South America, Asia, Middle East, as well as many other contexts [71]). Results of prior studies have demonstrated that the SCI has been a strong predictor of behaviours. The SCI was based on a theory of sense of community presented by McMillan *et al* [29] that stated that a sense of community was a perception with four elements: membership, influence, meeting needs, and a shared emotional connection. For each of the 23 items, respondents were asked to indicate how well the statements represented the importance they felt about the community they live in, ranging from "not at all important = 1" to "completely important = 4". Finally the total sense of community index was calculated by adding all the scores from the scale. The score ranged from 23 to 92, with higher scores indicating a higher sense of community.

#### **4.6.2.4 Critical awareness items**

Critical awareness was measured by two items. The respondents were asked in regard to what happens in their household, to indicate the extent to which they agree or disagree with each of the following two questions, "I think about a flood occurring and impacts in my household and community" and "I talk about floods problems and issues with others in my community". The questions were coded as 1 = agree to 3 totally disagree. Those with higher scores indicated higher critical awareness about the floods and impacts.

#### **4.6.2.5 Perceived responsibility efficacy**

With regard to perceived responsibility efficacy seven items were used to measure this construct. Respondents were asked to indicate the extent to which they agreed or

disagreed with the items shown in Table 4.4. This seven-item measure produces a robust variable that measures individual perceptions of the responsibility to flood preparedness on a scale from 0 to 3. The scores ranged from 0 to 21, with higher numbers indicating greater responsibility for self and others to flood preparedness.

**Table 4.4 Principal component analysis (PCA) of the eight items of a perceived responsibility efficacy**

<b>Responsibility efficacy</b>	<b>Factor loading</b>
Responsibility to help family and others when a flood occurs	0.521
Right to know what to do during flood event	0.725
Right to contribute to reducing the risk of flood to households	0.592
Aware of emergency procedure when a flood warning is issued	0.646
Responsibility to comply with the evacuation procedures	0.749
Responsibility to warn others when a flood comes	0.735
Responsibility to learn to live with floods if well organised	0.685

#### **4.6.2.6 Risk perception**

There were two domains of risk perception measured in this study. An estimate of the likelihood of a set of risky flood events occurring and the feeling of worry concerning these flood events as in Micheli *et al.* [36]. Respondents were asked to imagine the probability of a flood occurring in the coming year. They were then asked to answer questions related to perceived likelihood and a feeling of worry. Perceived likelihood was measured using five items asking about the likelihood of experiencing floods with negative consequences. On the other hand, feeling of worry was measured with five items asking in regards to the feeling of worry about the same possible outcomes. Responses were categorised from 0 (not at all) to 3 (very much). The sum of the five items ranged from 0 to 15 for each domain. Higher scores indicated high risk perception meaning better flood preparedness.

#### **4.6.2.7 Outcome expectancy**

Outcome expectations reflect beliefs that a given behaviour will produce a specific outcome [17]. This outcome can either be negative or positive. Positive outcome expectancy was evaluated. The outcome expectations for flood preparedness scale

contained six statements rated by participants using a five-point Likert Scale from 1 (completely disagree) to 5 (completely agree) as indicated in Table 4.5.

**Table 4.5 Principal components analysis (PCA) results of outcome expectancy results**

<b>Outcome expectancy statements</b>	<b>Factor loading</b>
Preparing for flood will improve the way of life	0.697
Preparing for flood will improve the value of my house	0.643
Preparing for flood will improve ability to deal with disruptions	0.706
Floods are not destructive if I prepare for them	0.739
Preparing for flood is convenient for my household	0.649
Preparing for a flood is not difficult if I try hard	0.501

#### **4.6.3 Ethical Consideration**

Ethical clearance was granted by the University of KwaZulu-Natal, South Africa (Ethical Clearance Number: HSS/0596/015D as shown in Appendix 1) while informed consent was obtained from all the participants in the study. The respondents were required to sign a participation declaration indicating that they understood the nature of the research and their willingness to participate in it. Respondents were free to withdraw from the study if they so wished at any time. The reporting of results would ensure no individuals were identified by name.

#### **4.6.4 Validity and Reliability**

Validity and reliability of data collection instruments were achieved through adapting existing tools used in similar research. Piloting of the data collection tools was also undertaken. Triangulation of different data sources such as questionnaires and interviews was used to corroborate the data and validate the data collection tools.

#### **4.6.5 Data Analysis**

Data analysis was undertaken using SPSS (version 22) and Stata (version 13) Software. Descriptive statistics (mean, standard deviation) were applied to the analysis of the household flood preparedness and the determinants. Internal consistency reliability



testing was carried out for all the scales. Reliability testing measures the consistency of the questionnaire to determine if the items on the scale measured the same construct. Mohammad-pajooch [72] suggests that the overall internal reliability is good when Cronbach's alpha is greater than 0.60. Based upon the formula;  $\frac{rk}{[1 + (k - 1)r]}$  where k is the number of items considered and r is the mean of the inter-item correlations the size of alpha is determined by both the number of items in the scale and the mean inter-item correlations. George and Mallery [73] provided the following rules of thumb: "> 0.9 – Excellent, > 0.8 – Good, > 0.7 – Acceptable, > 0.6 – Questionable, >0.5 – Poor, and <0.5 – Unacceptable". The scales were validated using Principal Component Analysis (PCA).

In order to determine the level of flood preparedness the sum of all the yes responses were calculated. Since the total items were 47, it was expected that a maximum score of 47 would be obtained. The higher the score the more prepared the households were. Following Mohammed-pajooch *et al.* [72], preparedness was grouped into three levels, namely, well prepared, fairly prepared and poorly prepared. Respondents who answered "yes" to 31 items and above of the 47 items presented to them were categorized as well prepared, those respondents who answered "yes" between 16 and 31 of the 47 items were categorized as fairly prepared, and finally those respondents who answered "yes" to less than 16 items asked were categorized as poorly prepared. In examining the difference between flood preparedness in the two sites, t- test was applied to test for any differences across the two sites.

In determining factors that influences flood preparedness, multivariate analysis using logistic regression (Tobit model) was employed in explaining household preparedness to floods. The confidence intervals for all statistical tests were set at 90%, 95%, and 99%. The Tobit model, also known as a 'censored regression model', is designed to estimate linear relationships between variables when there is either left (censored at a low threshold) or right-censoring (censored at a high threshold) in the dependent variable [74]. This model was employed in this study because preparedness scores were "censored" within a range of "1" and "47". In this case, Tobit model gives more precise

estimates of the associations between the dependent and independent variables than ordinary least square regression [1].

## **4.7 Results and Discussions**

### **4.7.1 Overall Sample Characteristics**

The sample survey results indicated that an average household in the study sites consisted of five people in Zambia and four in Namibia's study sites. In Namibia, minimum and maximum age of respondents interviewed were 18 and 84 years old while in Zambia, the age ranged between 20 and 81 years old. In Zambia and Namibia, male-headed households were 62% and 55%, respectively. In Zambia and Namibia within the households interviewed, the majority of respondents (54% and 57%), respectively, attended secondary level education and were literate as understood by their ability to read and write. With respect to marital status, majority of Zambians (59%) and Namibians (58%), were married. However, there were fewer single-headed households (14%) in Zambia than those in Namibia (31 %) ( $p < 0.05$ ). In Namibia 93% of households had access to land as opposed to 69% in Zambia. From those who had access to land in Namibia, 91% owned the land whilst in Zambia only 59% owned the land. From those who owned the land, 79% of Namibians owned two or more hectares of that land while the figure for Zambia was 65%. Statistically, Namibians had more access to land and owned more land than the Zambians ( $p < 0.05$ ). In respect to length of stay in the flood prone areas, more Namibians than Zambians have stayed all their life in these areas ( $p < 0.05$ ). Summary of the survey and t test results are indicated in Table 4.6.

**Table 4.6 Socio-demographic characteristics of respondents in the surveyed rural communities (n = 207, Zambia = 93, Namibia = 114)**

<b>Variables</b>	<b>Measure</b>	<b>Zambia N (%)</b>	<b>Namibia N (%)</b>	<b>P-value</b>
Age group	≤20	2.4	2.9	0.201
	21-40	47.6	41.3	
	41-60	35.7	28.8	
	≥61	14.3	26.9	
Gender of the household head	Male	58 (62)	63 (55)	0.302
	Female	35 (38)	51 (45)	
Education	Grade 1-4	5 (5)	3 (3)	0.086
	Grade 5-7	32 (34)	26 (23)	
	Grade 8-10	33 (36)	34 (30)	
	Grade 11-12	17 (18)	31 (27)	
	Tertiary	2 (2)	4 (4)	
	Adult literacy	1 (1)	4 (4)	
	Never attended	3 (3)	12 (11)	
Marital status	Single	13 (14)	35 (31)	0.005
	Married	55 (59)	66 (58)	
	Living together	7 (8)	2 (2)	
	Separated	3 (3)	2 (2)	
	Divorced	4 (4)	0	
	Widowed	11 (12)	8 (7)	
Occupation	Employed	5 (5)	5 (4)	0.190
	Unemployed	83 (89)	98 (86)	
	Student	2 (2)	10 (9)	
Length of stay in the community	<10 years	31 (33)	7 (6)	0.001
	11-20 years	19 (20)	10 (9)	
	All my life	(45)	97(85)	
Access to land	No	17(19.8)	1(10.9)	0.001
	Yes	69(80.2)	106(99.1)	

## **4.7.2 Livelihoods, Capital and resources availability in the Surveyed Rural**

### **Community**

Research results indicated that diverse capital and resources exist in the two study sites and were mobilized in response to impending floods. Some households participated in piecework (part time job) such as cattle herding, weeding and housekeeping. Another source of income was livestock sale either as meat or live animal. This income was used to buy food, and pay for children's school uniforms and fees. Most households practiced *matapa farming* (flood plain farming) and dry land arable farming, and during good harvest, crops such as maize, groundnuts, beans are sold. Fishing was another important livelihood activity and income source. Furthermore, remittances and gifts were received in the form of money and goods from friends and families.

Some Namibian citizens and permanent residents received monthly pension grants from the government. A pension grant is given to every Namibian citizen and permanent resident who has attained 60 years of age and above. Besides pension grants and unlike in Zambia, Namibians have the opportunity to obtain monthly social grants. These social grants are given to those whose households have disabled persons, orphans, war veterans, and so on. Other sources of income included sale of thatching grass and reeds. A t test and Chi-square test results indicated that there was a significant difference in all the sources of income derived by households between the two sites ( $p < 0.05$ ) and there was no association among variables. In Namibia since most elders and disadvantaged groups got grants every month, they would respond to flooding better than their counterparts in Zambia who do not receive such grants. This could have contributed to the higher level of flood preparedness of Namibians.

Other livelihood sources depended on floods, the more flood that occurred the more such activities were practiced. For example, fishing and sale of reeds and thatching grass was more common when there were more floods. Flood plain farming is highly dependent on flood occurrence. This is the main reason why people moved into flood plains. Flood plain farming is advantageous since there is no need for fertilisers and irrigation therefore reduces the costs of these agricultural inputs.

In terms of education, the results show that 97% and 89% of the household heads in Zambia are literate. Literate in this study is defined by the ability to read and write [75]. The high literacy rate in both countries may be influenced by the old age policy on education. In both Zambia and Namibia there are programmes designed to encourage school dropouts return to school regardless of their age.

Many households have acquired different skills from attending school, through friends and family members. Skills possessed by households can improve the overall household wellbeing with the skillful individuals having more and diverse opportunities for livelihood earning especially during a flood disaster[76]. A household may have more than one skill at a time. In Namibia, the most prominent skills are beer brewing, hunting, weaving, sewing, carpentry, craft making, woodcarving, traditional medicine, construction, and fishing. In Zambia, the prominent ones are cropping and livestock rearing, construction, weaving, sewing, fishing, gardening, and skills in traditional medicine. There was a significant difference in all the skills possessed between the study sites ( $p < 0.05$ ). Having skills help households to prepare for floods since farming is not the only source of income. Households can use these skills to sustain themselves.

Social capital has implications for societal development and overall livelihood development [76]. In this study household membership to groups or associations were assessed. A number of organizations operated in different sectors of the study sites. These organizations formed groups or committees to involve rural community in the development of their areas, including management of floods and droughts. In Zambia, 28% of households' members belonged to various groups or associations such as health care, Mwandu general contractor, Catholic Relief Services, *zuha mwabuloko* women's group (wake up from your sleep) and Mwandu multipurpose groups. About 28% of household members belonged to cooperative committees such as Mwandu cooperatives. Some 22% of household members belonged to water associations and 21% were members of community forests or conservancy.

In Namibia, 41% of households had at least a family member who belonged to Salambala conservancy. About 21% of the households had a member who belonged to groups such as relief programmes, Red Cross, First Aid, education, HIV and AIDS groups, and 17% of the households had a member who belonged to a water associations such as *malukaka* water point committee. Furthermore, 13% members of households belonged to cooperatives such as Likwama co-operative and 9% of the members belonged to a community forest and conservancy committee. The overall results show that there are active social networks and committees who are responsible for flood disaster management including evacuation and relief aid. These different organisations or groups help during the occurrence of a flood hazard there by reducing the negative impacts of floods.

#### **4.7.3 Internal Consistency Reliability of the Scales**

Principal component analysis (PCA) was run to validate the scale and the results are indicated in Tables 4.7, 4.8 and 4.9 for those scales. A principal component factor analysis of the subset of variables in the scales shows that measures of responsibility efficacy, outcome expectancy, perceived self-efficacy constructs all contribute heavily to or "load" on a single factor, as shown in Table 4.7 to 4.9. The selected measures load at a 0.5 cut-off level. The first principal component of responsibility efficacy and outcome expectancy explains 59% and 52% of the variation. The first principal component of self-efficacy explain 63% of the variation in the data. All the scales were tested for internal consistency (reliability). In brief, results of this test support the view that measures of deterrence in the questionnaire are highly interrelated and do constitute a construct. The results of reliability tests indicated in Table 4.10 show that the scales used were reliable and further analysis on scoring the scales and determinant were undertaken.

**Table 4.7 Principal component analysis (PCA) of perceived responsibility efficacy items**

<b>Responsibility efficacy</b>	<b>Factor loading</b>
Responsibility to help family and others when a flood occurs	0.521
Right to know what to do during flood event	0.725
Right to contribute to reducing the risk of flood to households	0.592
Aware of emergency procedure when a flood warning is issued	0.646
Responsibility to comply with the evacuation procedures	0.749
Responsibility to warn others when a flood comes	0.735
Responsibility to learn to live with floods if well organised	0.685

**Table 4.8 Principal components analysis (PCA) results of outcome expectancy**

<b>Outcome expectancy statements</b>	<b>Factor loading</b>
Preparing for flood will improve the way of life	0.697
Preparing for flood will improve the value of my house	0.643
Preparing for flood will improve ability to deal with disruptions	0.706
Floods are not destructive if I prepare for them	0.739
Preparing for flood is convenient for my household	0.649
Preparing for a flood is not difficult if I try hard	0.501

**Table 4.9 PCA results for perceived self-efficacy**

Self-efficacy	Factor loading	
	1	2
Manage to solve flood related problems	.606	
Find means and ways to prepare for floods	.759	
Able to stick to aims and accomplish goals meant for preparing for floods	.756	
Knows how to handle unforeseen situations such as flood	.730	
Able to prepare for flood with invested effort	.564	.714
Remain calm during a flood because rely on coping abilities	.758	
Find several solutions when confronted with floods	.754	
Think of a solution when affected by flood	.776	
Able to handle whatever situation arises	.730	

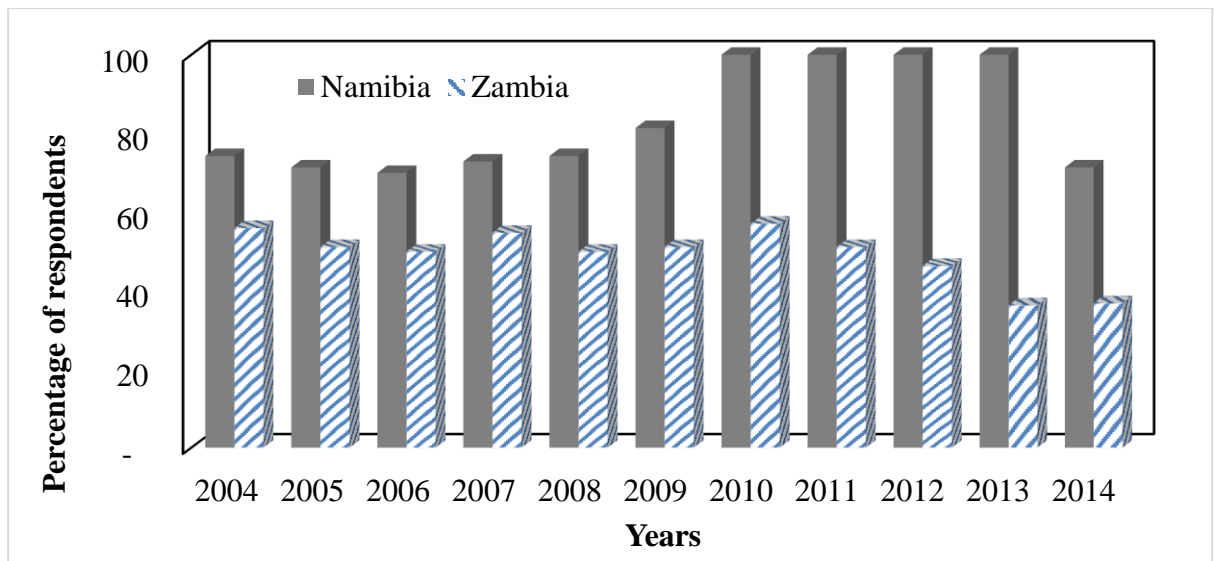
**Table 4.10 Reliability testing results for different scales**

Scales	Internal consistency (Cronbach's alpha)
Preparedness	0.89
Sense of community	0.90
Perceived responsibility efficacy	0.83
Outcome expectancy	0.72
Self-efficacy	0.88

#### 4.7.4 Flood Occurrence in the Study Sites

Responses on the frequency of flooding indicated that every year from 2004-2014, floods impacted both study areas. More respondents in Namibia reported more frequency of floods than those in Zambia. For instance, from 2010 to 2013, 100% of respondents in Namibia were flooded, while less than 50% were flooded in Zambia. Figure 4.2 shows the number of households who experienced flooding between 2004 and 2014. The duration of flooding on average was 4 months in Namibia and 2 months in Zambia. However, in Namibia and Zambia, a maximum of eight and six months flood duration was reported respectively. During this flood period some households were accommodated in relocation camps. Statistically, more Namibians were flooded for longer period than the Zambians ( $p < 0.05$ ). Flood occurrence shows an increased trend in Namibia and decreasing in Zambia. With regard to the length of stay in the community, more Namibians (85%) than Zambians (41%) have lived in flood prone areas all their lives ( $p < 0.05$ ).



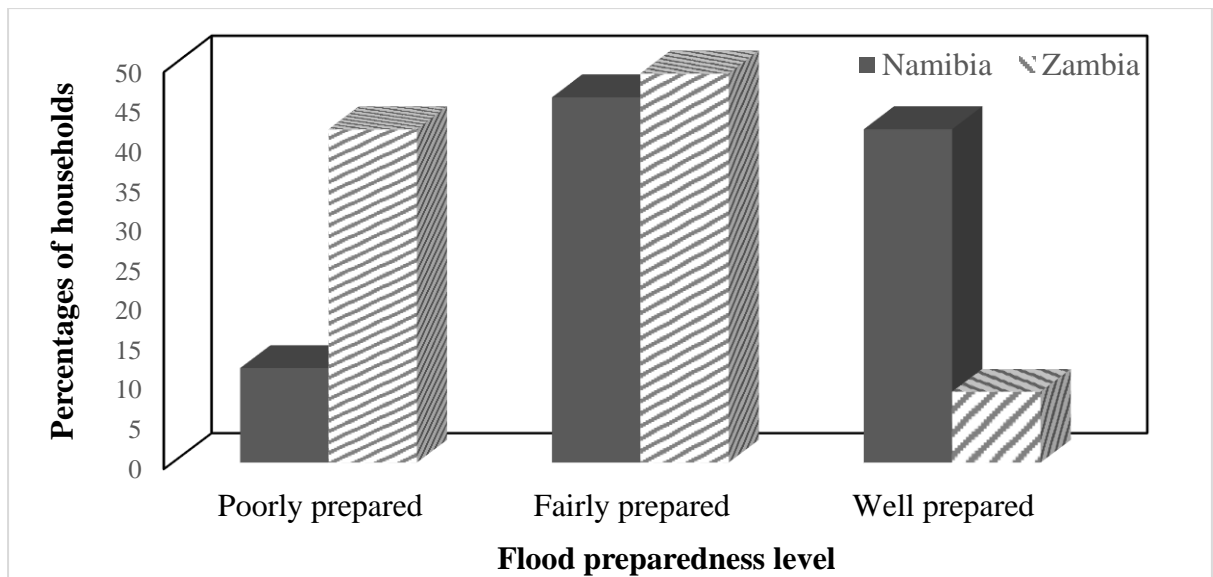


**Figure 4.2 Flood experience of respondents in the surveyed rural communities**

#### **4.7.5 Flood Preparedness in the Surveyed Rural Communities**

Following the groupings as done by Mohammed-pajooch *et al.* [72]), the results indicate that 42% of Zambians were poorly prepared, 49% fairly prepared and 9% were well prepared. In Namibia, 12% of the households were poorly prepared, 46% were fairly prepared and 42% were well prepared for floods. Figure 4.3 presents the results.

An independent samples t-test was conducted to examine whether there was a significant difference in household flood preparedness across the study sites. The test revealed a statistical significant difference between flood preparedness in the two study sites ( $p < 0.05$ ). Households in the eastern Zambezi region of Namibia reported statistically significant higher levels of flood preparedness than households in Mwandia district of Zambia.



**Figure 4.3 Households flood preparedness levels of respondents in the surveyed rural communities**

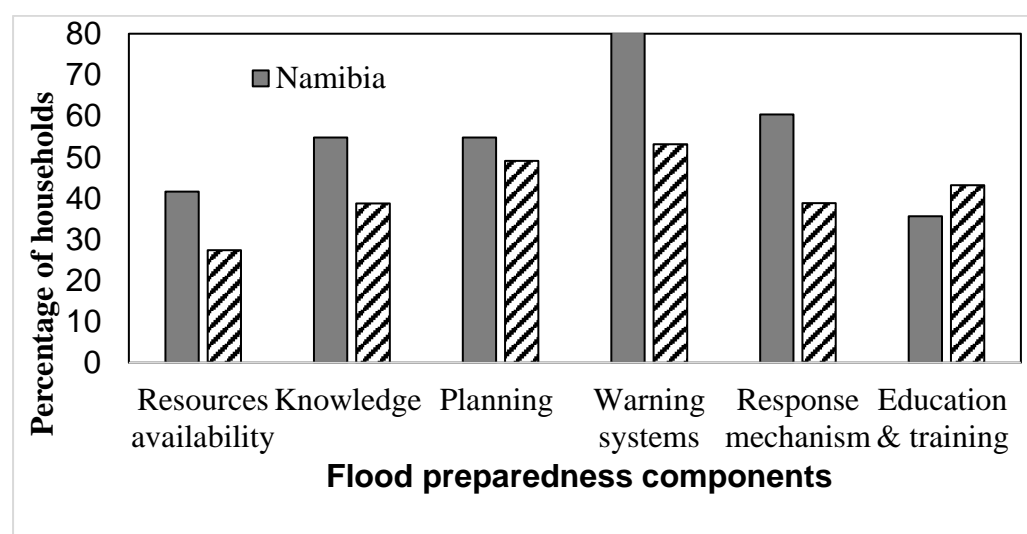
This level of preparedness can be attributed to the frequency and severity of floods experienced in the study sites. Since Namibians reported more flood experience, they were more likely to be prepared for floods than Zambians. Some authors have reported a correlation between past experiences and flood preparedness [77–79]). In Germany, Kreibich *et al* [80], found that the experience of an extreme flood event significantly increased the level of preparedness. However timing of the previous experience played a role, past flood experience has a small influence later in people’s lives than recent flood experience [81]. Takao *et al.* [82] in Japan found that flood preparedness depended on ownership of a home, fear of flooding, and the amount of damage from previous floods. Those who experienced floods more often and severely were more likely to prepare for the next flood hazard [82]. Similar to results in Zambia, a study in Malaysia showed a majority (62%) of respondents were not prepared for floods, 23% were moderately prepared and only 15% were well prepared [72]. Other authors reported low levels of disaster preparedness. In China, Xu [83] found that less than 5% of respondents were well prepared for emergency whilst more than half (52%) were poorly prepared.

In Namibia, more households were prepared in terms of warning systems (80%), response mechanism (60%), emergency planning (55%) and preparedness knowledge (55%). However, few households were prepared in terms of education and training (36%) and resource availability (42%). In Zambia, more households were prepared in warning systems (53%), while less households were prepared in emergency planning (49%), education and training (43%), knowledge (39%) and response mechanism (39%) and resources availability (27%). Figure 4.4 shows the results of participants “Yes” responses per preparedness component. Chi-square test and t test results indicated there was a statistically significant difference in resource availability, flood preparedness knowledge, early warning and emergency responses and between the study sites ( $p < 0.05$ ) as shown in Table 4.8.

In the surveyed rural communities of Namibia and Zambia, more items measuring early warning systems were confirmed to be applicable. More households in both study areas were prepared in terms of warning systems. Households received early warnings through radios (government authorities), headmen, and have expedient ways of measuring water levels especially when they are fishing. Since the floods are slow onset, early warning provided them enough time to prepare for the floods. Respondents received flood warnings from responsible authorities or had ways of knowing when floods were approaching. For example some respondents indicated the presence of certain birds as an indication of approaching floods.

Education and training was the least among the preparedness components households were prepared for in both countries. The majority of respondents reported inadequate knowledge and skills on how to prepare for flooding, uncertainty about the severity of flood, contradicting information among the households as some of the reasons why they were not prepared. Some participants preferred to relocate when the flood struck as had been their culture. Other participants said they were aware of flood occurrence every year and yet were not prepared for these floods. Fishing quotas from the Ministry of Fisheries have also hindered household’s ability to measure water levels. This is because fishing is prohibited from December until March (fish breeding season), meaning households have no reason to go to the river. Some participants rely on

fishermen to warn them about the rise of the water level. This is the crucial time when water level rises. Furthermore, resource unavailability during a flood hindered flood preparedness. Respondents reported lack of resources such as canoes for temporary evacuation to higher ground and the lack of food for human and livestock consumption during flood period. During focus group discussions, participants mentioned lack of land for temporal relocation. Relocating permanently was not an option, since they are not accustomed to the life on the higher ground.



**Figure 4.4 Percentage of participants with “Yes” responses across flood preparedness component in the surveyed rural communities**

**Table 4.11 Test of differences among flood preparedness components across the surveyed rural communities**

Flood preparedness components	T-test- Kruskal-wallis Test		
	Namibia (% households)	Zambia (% households)	p-value
Resources availability	42	27	0.001
Preparedness Knowledge	55	39	0.001
Planning	55	49	0.921
Warning systems	80	53	0.001
Response mechanism	60	39	0.001
Education and training	36	43	0.350

#### 4.7.6 Determinants of Flood Preparedness in the Study Sites

Descriptive statistics show that in both study sites, flood preparedness determinants as listed in Table 4.12 below are higher than the average and that there are statistically significant different scores between the two countries. Only responsibility efficacy and outcome expectancy scores were not statistically significant different between the sites. All the respondents in study sites felt that they had responsibility to safeguard themselves and family members and that the outcome of preparing for floods were rewarding. Since they all had been relocated more than once from their homes they saw the need to safeguard themselves and family members.

**Table 4.12 Descriptive statistics of factors influencing flood preparedness in the study sites**

<b>T-Test results (Namibia (N=114), Zambia (N=93), Degree of freedom =205)</b>					
<b>Scale name</b>	<b>Country</b>	<b>No of items</b>	<b>Mean scores</b>	<b>Standard deviation</b>	<b>Significant (2-tailed)</b>
Preparedness	Namibia	47	25.9	8.9	0.001
	Zambia		17.6	11	
Sense of community	Namibia	23	55.2	10.4	0.001
	Zambia		62.5	11	
Self-efficacy	Namibia	9	17	6.6	0.007
	Zambia		15	5.4	
Risk perception (likelihood)	Namibia	5	11.6	2.9	0.001
	Zambia		10	2.9	
Risk perception (worry)	Namibia	5	12.2	4.2	0.020
	Zambia		11.3	2.9	
Responsibility efficacy	Namibia	6	17	4	0.134
	Zambia		16.1	4.8	
Outcome expectancy	Namibia	8	10.4	2.9	0.526
	Zambia		10.7	3.5	

Note: No of items = total number of questions in each scale

The result of the Tobit model are presented in Table 4.13. The explanatory variables of preparedness were tested at a significant level of 0.1, 0.05 and 0.01 and are presented below.

**Table 4.13 Flood preparedness determinants results from a Tobit model**

<b>Flood preparedness determinants</b>	<b>Coefficient</b>	<b>Standard error</b>	<b>P&gt; t </b>
Risk Perception (likelihood)	-0.24	0.20	0.252
Risk perception (feeling of worry)	0.27	0.16	0.097
Critical awareness (think about flood)	-1.37	0.88	0.120
Critical awareness (talk about flood)	1.22	0.78	0.118
Marital status	-2.80	1.67	0.096
Country	-8.68	1.27	0.001
Sense of community	0.12	0.05	0.013
Self-efficacy	-0.42	0.10	0.001
Responsibility efficacy	0.46	0.16	0.004
Outcome expectancy	0.61	0.23	0.008
Size of land	1.65	0.67	0.014
Land ownership	0.63	0.75	0.402
Access to land	8.33	2.12	0.001
Female household members	0.21	0.27	0.452
Constant	8.49	5.42	0.119

#### **4.7.6.1 Access and size of land**

Access to land in this study means having the right to enter upon and use the land. It is one of the factors that showed a statistically significant relationship with flood preparedness ( $p < 0.01$ ). It has a regression coefficient of 8.33, meaning households who had access to land were 8.33 units more prepared for floods than those without access to land. Apart from having access to land, the size of the land showed a positive relationship with flood preparedness. The coefficient of the explanatory variable is statistically significant at a 5% level and it is 1.65. This indicates that households with larger area of land ( $> 2$  ha) were more likely to prepare for floods than those with smaller land area. In rural areas of Zambia and Namibia land is the most significant provider of employment opportunities [84]. Those without access to land may not have

resources to be prepared for floods. Deressa *et al* [85] reported that land size represents wealth, social status and power, this was emphasized by Knowler and Bradshaw [86] and Nabikolo [87]. This could be the reason why in Namibia and Zambia, those with larger areas of land were more prepared for floods. The majority of the households in Zambia with access to land had small land areas. During focus group discussions households indicated that sometimes the only option to cope with flood was to relocate temporarily or permanently to higher grounds, but due to lack of land household members were forced to stay in the flood plain even when a flood strikes. Furthermore, having a piece of higher ground would allow cultivation during the flood and therefore spread the risk of flooding.

#### **4.7.6.2 Outcome expectancy and perceived responsibility efficacy**

The outcome expectancy variable had a positive coefficient of 0.61 and statistical significant ( $p < 0.01$ ). Households who believed that preparing for floods yielded positive outcome were more prepared for floods than those who believed that preparing for floods yielded a negative outcome. This indicates that an increase in a unit of outcome expectancy led to 0.61 increase in flood preparedness. In a study undertaken by Paton [17], on bushfire preparedness, it was found that positive outcome expectancy had a direct influence on both intention and actual preparedness whilst negative outcome expectancy was the driver of non-preparation for a disaster. Similarly in a study by Zaalberg [88] in the Netherlands and Grothmann [35] in Germany, outcome expectancy was found to positively relate to the adoption of flood preventive intentions. Grothmann [35] found that increments in outcome expectancy increased intentions to perform the risk preventive behaviour.

In this study, the coefficient of responsibility efficacy was statistical significant at a 1% level and positive with a coefficient of 0.46. This shows that households who perceived having more responsibility for themselves and others were more prepared for floods than those with less responsibility by 0.46 units. That means perceived responsibility efficacy factor positively determined the level of a household's preparedness. Some of the respondents interviewed indicated that it is not their responsibility to prepare for

floods, but the authorities' responsibility. Such individuals may not be prepared for future floods. These findings agree with the work of Paton [12]), who states that, if people perceive others as being responsible for their safety they are less likely to convert preparedness intentions to actions. But if people believe they have responsibility to safeguard their life and that of others, there is a likelihood that they will convert preparedness intentions to actions [12]. Contrary to the results from Paton [17], in a study conducted in Netherlands, perceived responsibility was not significantly correlated with flood preparedness intentions [89].

#### **4.7.6.3 Risk perception - feeling of worry**

The Tobit model results indicated that risk perception (feeling of worry) influences flood preparedness. The regression coefficient is 0.27 meaning households who had a feeling of worry about the occurrence of the flood were 0.27 units more likely to prepare for floods than their counterpart. In the two countries, the more worried households were about the damage that the floods would cause to their belongings the more they were prepared for them. Similar results from Raaijmakers *et al.* [90] in Spain and Miceli *et al.* [36] in Italy found that a higher level of worry is more likely to result in a higher level of preparedness. In the Netherlands, risk perception was also positively correlated with preparedness intentions [78]. In the Czech Republic, flood risk perception is particularly important for determining flood prevention measures that are selected and implemented [91]. Unlike Taghizadeh [92] in Iran, the study showed that people in districts with low earthquake risk were more prepared than people living in districts with high earthquake risk. This could be explained by the lower socioeconomic level of people living in the high risk districts. An individual can be aware of a flood risk, however, if the individual is not afraid of this risk, he or she will not take any action to prepare for the disaster. Those who rely excessively on others without taking ownership of the flood risk and responsibility for protecting their own properties are also likely to be less prepared [35,93]. However, the relationship between awareness, worry and preparedness is not clear and conflicting results are often found in the literature [94].



#### **4.7.6.4 Sense of community and self-efficacy**

Sense of community is defined as “a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together” [29]. The coefficient is 0.12 and statistically significant at the 5% level. This shows that households with a high sense of community were more prepared for floods than those with a low sense of community. Every unit increase in the sense of community results in 0.12 increase in flood preparedness. That means sense of community is a positive factor in determining the level of a household flood preparedness in the two countries. In Namibia many people have lived in flood plains all their life and these people have a feeling of belonging and an emotional attachment to these places. This makes them serious about flood preparedness or they have learnt to live with these floods. In a study by Paton [12], it is reported that people with a strong sense of community (place attachment) were reported to be more likely to convert intentions into actual preparedness. This is because place attachments promote healing [95] and increase the likelihood of community rebuilding after a disaster strikes [96]. However, some studies reported a weak relationship between sense of community and preparedness. This is attributed to social fragmentation and limited opportunity to utilise social support networks within the wider community [97]. In a wildfire study by Paton and Johnston [98] sense of community contributed dramatically to individuals' willingness and ability to prepare for and act in a threat situation.

The coefficient of self-efficacy variable is negative and is statistically significant at a 5% level. This indicates that a unit increase in self-efficacy result in a 0.42 reduction in flood preparedness. That means self-efficacy negatively influenced the level of a household preparedness in the two countries. In Zambia and Namibia self-efficacious people may not have enough resources or skills to prepare for flood disasters. This is in contrast to other studies which suggest that the more confident or self-efficacious people are about their ability to successfully respond to a given situation such as an emergency, the more likely they are to engage in preparedness behaviours [45,99]. According to Paton [12], the number and quality of action undertaken, the amount of perseverance

and effort invested in risk reduction is strongly dependent on self-efficacy. Individuals with high self-efficacy are self-confident, willing to take risks, perform accurate self-evaluation, and have sense of accomplishment. On the other hand individuals with low self-efficacy have fear of risk and uncertainty, feelings of failure and impression management. Individual efficacy will vary greatly depending on the nature of the task and context of the event [68]. If peers and families have means to create self-efficacy; people are more likely to prepare if those around them believe in preparedness.

#### **4.7.6.5 Marital status and country**

The result of the marital status was statistically significant ( $p < 0.1$ ). However the coefficient was negative which indicated that single headed households had 2.8 units less flood preparedness. Single headed households were 2.8 units less likely to prepare for flood hazards than others such as the married, widowed or separated respondents. A study in Kenya found that there was a significant relationship between marital status and uptake of precautionary measures to mitigate floods ( $p = 0.016$ )[28]. Of the married category, only 36.9 % did not take precautionary measures. The inference is that the households that have families have huge responsibilities of taking care of other people, other household members (children), or even property in such circumstances as during a flood. Single person may not see the need to take precautionary measures because they do not have any other person other than themselves to care about and may develop 'I don't care attitude' and feel free to do as they please.

Country was also a factor that influenced household flood preparedness. The coefficient of the country is statistically significant at a 5% level and it is a negative (-8.68). A negative coefficient indicated that Namibians were 8.68 units more prepared for flood disaster than Zambians. The reason for higher preparedness in Namibia is due to the frequency of flooding and longer duration than Zambians, this motivates people to prepare for future floods.

#### **4.8 Limitation of the Study**

While this flood preparedness study produced interesting results, the limitations of this study should be taken into consideration. First, financial limitation to sample more flooded households and in more than one region or provinces of Namibia and Zambia may have influenced the outcomes of the study. Owing to limited finance, the survey was conducted only in eastern Zambezi region and Mwanzi district in Zambia, therefore, the findings of this research cannot be generalized to the larger population. Second, the scale that was used in measuring the level of disaster preparedness may not be generalised to other areas. This is because the items on the scale were derived from different sources and the items on the scale are not exhaustive. Future research may modify the scale by adding or removing items to fit the type of hazard and the environment. Third, the scales such as sense of community, risk perception and outcome expectancy were reworded to fit in the study sites and the type of disaster the study was based on. The implication of rewording the scale is unknown.

Forth, the study did not attempt to look at what determined the socio-cognitive factors such as self-efficacy. For example, the study did not probe the contribution of social grants in increasing self-efficacy, given that 26% of the Namibian respondents were above 60 and entitled to grant support, which may be an important element of urgency under condition of duress. There was weak reference to national policies, NGO activities, lead time and reaction time analysis and quantifying magnitude of floods. Future research may attempt to fill this gap. Marital status factor has a limitation in that a married person may not have children or responsibilities. Another could be single but taking care of other people. These differences were not explored further in this study.

Fifth, the study depended on responses from households members. It is based on the assumption that the information gathered for the purpose of the study would be true and unbiased. Survey respondents may answer questions based on how they understood the questions. Finally, the use of the Likert Scale used was uni-dimensional and only gives 1-5 options of choice, and the space between each choice cannot possibly be equidistant. Therefore, it fails to measure the true attitudes of respondents. Also, it is

likely that people's responses may have been influenced by previous questions, or concentrated on one response side (agree/disagree). Frequently, people avoid choosing the "extremes" options on the scale, because of the negative implications involved with "extremists", even if an extreme choice would be the most accurate. Despite these limitations, this study provides important information for understanding rural households' flood preparedness and evidence to support the development of effective disaster risk reduction.

#### **4.9 Conclusion and Recommendations**

Floods were an annual recurrent hazards in Mwandia district and eastern Zambezi region since 2000. Flood hazards had both negative and positive impacts. Households acknowledged exploiting the benefits of flood occurrences and also made an effort to adjust to reduce the negative impacts. Furthermore, findings indicates that diverse capital and resources exist in the two study sites and were mobilized in response to impending floods. Flood preparedness was higher in eastern Zambezi region than in Mwandia district. A majority of households were well prepared (52%) for flood hazards in Namibia whilst minority were well prepared (9%) in Zambia. This was statistically significant different between the two study sites and it was influenced by many factors. Mostly households had early warning systems on both sites. Early warning systems are a very crucial component of preparedness as it alert people about the possibility of flood occurrence. Even though households had early warning systems in place, some households failed to plan for emergencies and respond before a flood. Inadequate education and training and unavailability of resources to prepare for floods were also contributing factors.

This study provides evidence that high responsibility for self and others, positive outcome expectancy, feeling of worry about the risk, sense of community are associated with high level of household flood preparedness, and therefore, should be taken into consideration. Acknowledging that floods can be hazardous made households take action in preparing for them. The more worried households were about the damage that the floods would cause to their belongings, the more they were prepared for them.

Similarly having high responsibility for self and others especially increased flood preparedness for the married couples as opposed to the singles.

It should be understood that flood preparedness is dynamic and depends on different factors. Therefore, in order to achieve higher levels of household flood preparedness; first, it is crucial that disaster management officials acknowledge that flood preparedness is influenced by many socio factors as shown in this study. Second, identify and promote factors that influences outcome expectancy and perceived responsibility efficacy. Further research can be carried out in these areas. Third, education and training is required to change the mind-set of the households regarding a need to prepare for floods. For example, understanding that households have a responsibility to prepare for floods and not rely on handouts from the government could be emphasised. This could be carried out through education and training which would be aimed at changing attitudes needed to address beliefs that are more likely to impact preparedness behavior. Another method would be to promote social learning through exchange of experiences. It is reported that when individuals observe others exhibiting preparedness behavior in a disaster prone area, such individuals are able to confirm that these behaviors are appropriate and effective. Another way would be to allow households participate in hazard planning, identification and preparedness exercises, something hands on that would raise the level of flood preparedness.

In a call for disaster risk reduction outlined in the Hyogo Framework for Action (HFA) and Sendai Framework for Disaster Risk Reduction, Zambia and Namibia have to respond to this call. The two states will have to provide measures to reduce the impacts of flood disaster to its citizen both in rural and urban settings through enhanced flood preparedness. To be able to do this, there is a need to establish the state of preparedness in the study sites in order to ascertain the appropriate interventions. This study would help to understand the state of flood preparedness and the implications of various factors influencing households 'flood preparedness. Identifying and understanding these factors are significant findings that might influence emergency planning and management consequently enhancing disaster risk reduction. Furthermore, the study will help to understand which factors the policy makers have to acknowledge as

important in flood preparedness. These factors may be crucial to target in interventions aimed at increasing preparedness for flood hazards.

Finally, this research contributes to the body of literature which is primarily focused on the state of flood preparedness and to a lesser extent on the households on the household's level of flood preparedness, which is one of the key components of disaster risk reduction. In this study, we examined potential factors that are associated with flood preparedness outcomes; further studies are needed to explore the mechanisms of the links between those factors and preparedness outcomes. The researcher expects that this study on flood preparedness will be of use to disaster management practitioners such as policy makers, business organizations and academicians as well as research scholars.

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## 5. STRATEGIES FOR COPING AND ADAPTING TO FLOODING AND THEIR DETERMINANTS IN THE ZAMBEZI REGION OF NAMIBIA AND MWANDI DISTRICT OF ZAMBIA

### 5.1 Abstract

It has been reported that flood events in Namibia and Zambia will increase, due to the variability and changes in the climate, thus increasing the number of people that are exposed to flooding disasters. This exposure will negatively impact the livelihoods of rural households if no interventions are implemented to strengthen the coping and adaptive capacity of the affected local population against flooding. The purpose of this case study was to determine the adaptation strategies that are adopted by rural households to floods in the eastern part of the Zambezi Region in Namibia and the Mwanzi District in Zambia. The study further examined how socioeconomic factors influence the choice of different adaptation strategies. The adaptation strategies were categorised into two groups, namely, short-term coping strategies and long-term adaptation strategies. Six focus group meetings were held and a questionnaire survey of 207 randomly-sampled households was conducted in the flood-prone areas of the study. In Namibia, the results indicated that the majority (96%) of the households coped with floods by gardening and sold poles, 74% sold firewood, 61% collected wild food and 59% received food aid during floods events. In Zambia, the major coping strategies included the sale of reeds and thatching grass (53%), firewood sales (51%), charcoal production and sales (51%) and wild food collection for sale (50%). With regard to the long-term adaptation strategies, the households in Namibia learnt to live with the floods; they engaged in the *mafisa* cattle trade (86%), they harvested the flood water (68%), changed the planting dates (63%), prayed (55%) and practiced conservation agriculture (54%) and fish farming (53%). In Zambia, the main long-term adaptation strategies were conservation agriculture (91%), the acquisition of preparedness skills (66%), the harvesting of flood water (63%), prayer (60%), and the practice of flood-proofing (52%). A multiple linear regression analysis showed that the age, the land size, the length of stay in the flood plain, the duration of the floods, as well as their marital status, significantly influenced their choice of long-term adaptation strategies. Short-

term strategies are heavily dependent on natural resources, which may put pressure on these resources. The study concludes that a variety of factors influence the choice of any specific adaptation strategy. For policy purposes, this suggests that the relevant stakeholder interventions should consider these determinants, in order to enhance the adaptive capacity of rural households to flooding. This study seeks to inform decision-makers and practitioners on how the disaster risks can be reduced and managed in the similar environments of the two countries, and to inform them of the status quo of flood adaptation.

**Keywords:** *Adaptation, coping, floods, Mwandia district, rural households, Namibia, Zambia*

## **5.2 Introduction**

Climate change mitigation and adaptation issues have become the subject of intense global discussion over the past few decades (Dian *et al.*, 2015). In the literature on climate change and human vulnerability, climate change has been seen as the conventional main driver of vulnerability (Räsänen *et al.*, 2016). In Africa, climate change is expected to increase the problems that households face, especially within the agricultural systems, and unless large changes are made, productivity is predicted to decline (Wilk *et al.*, 2013). Moreover, communities in semi-arid areas are particularly vulnerable to the impacts of climate change (Dian *et al.*, 2015). Finding ways of increasing productivity will reduce the vulnerability of households to various types of stressors (Wilk *et al.*, 2013). Targeting interventions that influence the context in which various stressors, including climate, occur, are often a prerequisite for encouraging and enabling adaptive strategies (O'Brien *et al.* 2009). The degree to which farmers can adapt depends on their capacity to take action to lessen the negative impacts. Communities in southern Africa have been coping with and adapting to, floods by implementing measures that are based on traditional knowledge and which have been accumulated through past experience (Armitage and Plummer 2010). However, climate change poses new risks and uncertainties for these communities, and past experience alone can no longer provide a reliable guide for dealing with future conditions

(Armitage and Plummer 2010). This realization has led to the need to implement adaptation approaches that are suited to the present conditions and that will be beneficial in the face of future conditions.

The Intergovernmental Panel on Climate Change (IPCC) (2007:118) defines adaptation as the “adjustment of natural or human systems in response to actual or expected climatic stimuli, or their effects, which moderates harm, or exploits beneficial opportunities”. Two types of adaptation to climate change are differentiated. On the one hand, adaptation strategies are longer-term in nature (Thomas *et al.*, 2007) while coping strategies, on the other hand, consist of household strategies that are short-term in nature, and which are meant to minimise the impacts of floods (Thomas *et al.*, 2007; DFID, 2008). Adaptation strategies can further be grouped into two, namely, those that are proactive (anticipatory) or those that are reactive (de Bruin, 2011). Proactive adaptation strategies are engaged in the anticipation of climate change, while reactive adaptation strategies address the effects of climate change after they have been experienced (Shongwe *et al.*, 2014). For instance, reactive adaptation strategies may involve soil erosion control, irrigation dam construction, the development of new varieties, shifting the planting and harvesting times. On the other hand, anticipatory adaptation strategies may involve the development of tolerant cultivars, research development, policy measures on taxation and incentives, to mention a few. Most adaptation strategies adopted by society are reactive in nature because, in most cases, problems are reacted to as they occur (Bierbaum *et al.*, 2013).

A review of the adaptation measures adopted in the semi-arid areas in southern Africa suggests that there is an adaptation deficit (Dian *et al.*, 2015). Some of the causes of the deficit are related to factors such as access to livelihood capital. Without access to these different types of capital and resources, households are unable to cope with, or adapt to, climate change, which includes flooding. In most cases, the resources on which rural people depend are vulnerable and sensitive to climate change (Reid *et al.*, 2007). In order to cope and adapt to flooding, rural households adopt livelihood strategies. A livelihood is comprised of the capabilities, the capital, including both the material and social resources, as well as the activities, which are mediated by institutional and social

relations (Ellis, 2000). A combination of these factors gives rise to the livelihood strategy of a household. The choice of a livelihood strategy that is pursued by a household is dependent on the socio-economic characteristics and also on the environmental endowments and entitlements at its disposal (Kamwi *et al.*, 2015).

Several empirical studies have been carried out to assess the coping and adaptation strategies relating to climate change, as well as the factors that influence the choice of adaptation strategies. Motsholapheko *et al.* (2011) reported coping strategies, such as labour switching and local mobility, in Botswana, while Sakijege *et al.* (2012) in Tanzania reported the use of sandbags and tree logs, the construction of protective walls and the elevation of house foundations, as well as seasonal displacement. Various adaptation strategies have been reported that are meant to reduce the probability of flooding, for example, the use of dikes and levees (Merz *et al.*, 2010b; Poussin *et al.*, 2012), the wet- and dry-proofing of houses, elevating an area or individual houses, livelihood diversification, migration, soil conservation, different crop varieties, planning flood-resistant crops, planting trees, changing planting dates and irrigating their farms (Bubeck *et al.*, 2012; Deressa *et al.*, 2009; Elum *et al.*, 2017; Kreibich and Thielen, 2009; Motsholapheko *et al.*, 2011; Nangoma, 2007; Osuret *et al.*, 2016), as well as planning, evacuation and early warnings (Aerts *et al.*, 2014; Merz *et al.*, 2010a).

A number of factors influence the choice of adaptation strategies that are related to climate change. In Namibia, these include old age pension and retirement annuities, the value of livestock and food aid (Nyambe and Belete, 2013). Other factors include public, institutional and labour constraints, neighborhood norms and religious belief constraints, the high cost of inputs, technological and information constraints, as well as the farm distances, the land, access to climate information, as well as off-farm job and credit constraints (Otitoju and Enete, 2016; Ozor *et al.*, 2010), while the lack of awareness of insurance products and the inability to afford insurance premiums were found to hinder the adaptation to climate change (Elum *et al.*, 2017). Furthermore, the household size, gender, literacy, poverty, land ownership, the lack of secure property rights, the lack of savings, the farm size, the lack of technical skills and off-farm employment, their farming experience, their wealth and access to credit, access to

water, tenure rights, off-farm activities, and access to extension, were the main factors that enhanced adaptive capacity (Deressa *et al.*, 2009; Gbetibouo, 2009; Nhemachena and Rashid, 2008). In addition, Bird *et al.* (2013) and Maddison (2007) found that direct experience, or past experience, as well as outcome expectancy and education, hinder the adoption of adaptation strategies to climate change.

At present, very little research has been carried out on coping with, and adapting to, flooding, as well as on the factors that influence the choice of adaptation strategies in Namibia and Zambia. Studies on climate change have been conducted in Namibia and Zambia; however, they are limited. Mashebe *et al.* (2016) examined the impact of floods on the livelihoods of the Luhonono community in the Zambezi Region of Namibia. However, the coping and adaptation strategies of floods were not included in their study. Mabuku *et al.* (2018) studied the flood preparedness in a similar study area, but coping and adaptation strategies were not within the scope of the study. In another study, Kamwi *et al.* (2015) looked at the livelihoods and landuse/landcover changes in the Zambezi, but the adaptation to flooding and the factors that influence the choice of adaptation strategies during the floods were not examined. That study focused on an area that was very different from the eastern part of the Zambezi Region. Furthermore, Lwando (2013) carried out a study on climate variability and gender in the Sesheke District of Zambia. In the study, the coping and adaptation strategies, as well as the factors influencing the choice of these strategies, were not investigated. An assessment on the livelihood strategies of rural households in the Zambezi Region and the implications for conservancies and natural resource management was carried out by Ashley and LaFranchi (1997); however, the factors that may drive the households' choice of the adaptation strategies were not studied.

Therefore, there is a need to explore and understand the capacity of the local communities, especially those that are poor, to cope and adapt to flooding and flood disasters, in developing countries like Namibia and Zambia. This study was carried out to determine the different types of capital that rural households had access to, and to determine the short- and long-term flood adaptation strategies adopted by rural households in the eastern part of the Zambezi Region and the Mwandji District of

Zambia. Furthermore, it investigated the socio-economic factors that influence the choice of long-term adaptation strategies.

### **5.3 Materials and Methods**

#### **5.3.1 Study Area**

The study area is divided into two countries (Namibia and Zambia) as described in the following sections.

##### **5.3.1.1 Eastern part of the Zambezi Region in Namibia**

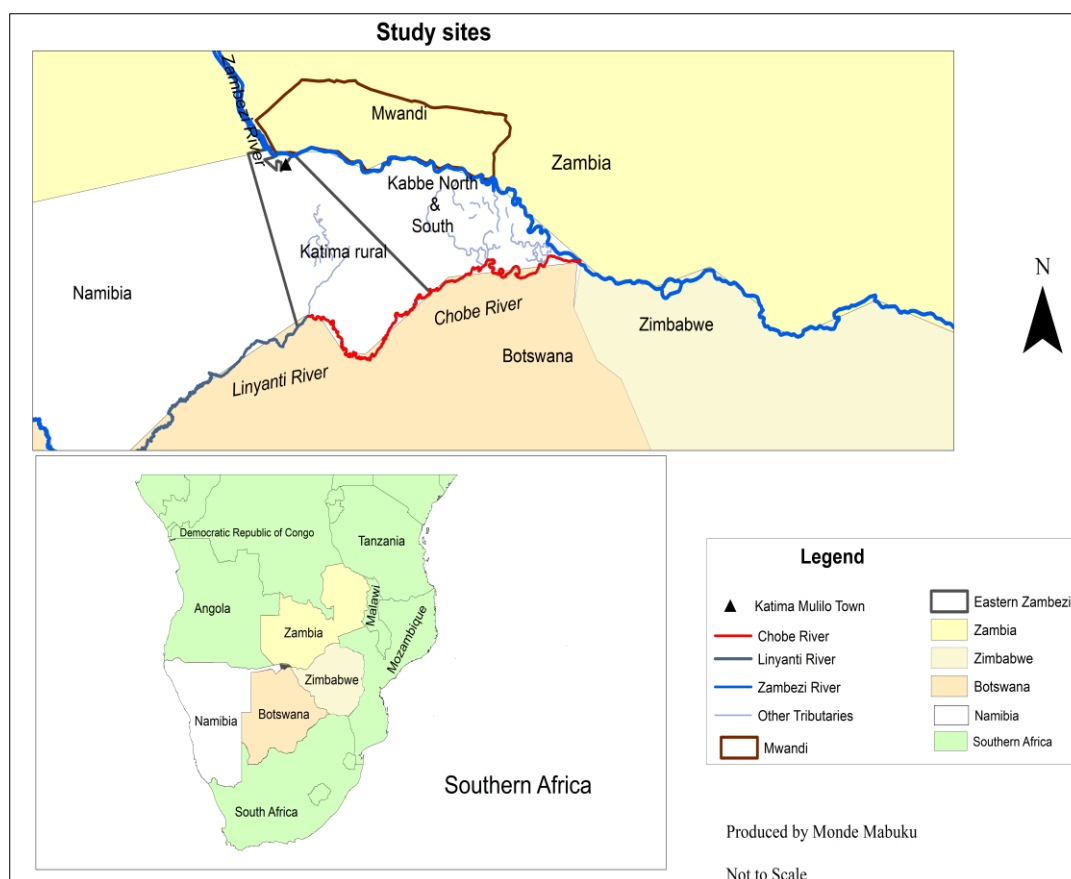
The Zambezi Region is one of the 14 regions of Namibia. It was previously known as the Caprivi, until August 2013 (Steytler, 2014), and it was named after the Zambezi River that runs along its border. The region covers an area of about 14 500 km<sup>2</sup>, accounting for 1.8% of the total land area of Namibia. The region borders with Zambia in the North, Angola in the North-west, Botswana in the East and South, and Zimbabwe in the East. The average rainfall in the Zambezi Region occurs from October to March and ranges between 600 - 700 mm per year, increasing gradually from the South to the North. On average, the frequency of rainfall is more than 60 days per year, with a rainfall variability of less than 20-25%. Evaporation rate is between 2 400 - 2 600 mm per year and the minimum and maximum temperature is between 7<sup>0</sup> C and 35<sup>0</sup> C.

This study area covers a total of 4 106.9 km<sup>2</sup>. It was selected for two reasons. Firstly, it is the region in Namibia that is most affected by floods. Secondly, there is a dearth of information on the flood adaptation strategies in this area. This study was carried out to fill this gap. It has a population of 30 917 people and 5 265 households, while the population density is 3.1 persons/km<sup>2</sup>. The people in the Eastern Zambezi Region derive their source of income from business activities (excluding farming), wages and salaries, farming, old age pensions, cash remittances, retirement funds and orphan grants (Steytler, 2014). The abundance of water is a distinctive feature that differentiates the Eastern Zambezi Region from the other parts of the Zambezi Basin. Of the four permanently-flowing rivers in the Zambezi Region, three are in the eastern

part, namely, the Chobe, Linyanti and Zambezi Rivers. The Zambezi River in the north-east (the Zambezi Region) occasionally overflows into the flood plain, to the Chobe River west of the Kasane border with Botswana, causing a reverse flow in the Chobe, in a south-westerly direction towards Lake Liambezi. The source of the water in the northern river systems are the rains in southern Angola that reach up to 1 000 mm per year.

### **5.3.1.2 Mwandu District of Zambia**

The Mwandu District, in the western province of Zambia, was selected as the second study area because it is adjacent to the eastern part of the Zambezi Region in Namibia, and they are only separated by the Zambezi River. The Mwandu District was part of the Sesheke District until November 2013, when it was declared to be a separate district (Provincial and District Order, 2013). It is situated at the southern end of the Western Province. It lies between 23° and 26° longitude East and 15° and 18° latitude South, and it shares a border with the Sesheke, Kazungula and Kalomo Districts of the Southern Province (Lwando, 2013). It also borders on the Kaoma, Shangombo and Senanga Districts. The district consists of 6 248 households and 27 922 inhabitants (Central Statistics Office, 2012). It falls under the Kazungula-Mwandu plain (Zone 7A) food economy zone. According to the Zambia Vulnerability Assessment Committee (2004), this livelihood zone generally has a semi-arid climate, with periodic droughts and flooding. The main economic activities include crop and livestock production, formal employment, trading, curios (related to tourism), fishing and the sale of wild fruits. The vast area of wetland along the Zambezi River flood plains and the river banks is important for cattle grazing (Saasa *et al.*, 2015). Figure 5.1 shows the location of the study area.



**Figure 5.1** The location of the study area

### 5.3.1.2 Nature and duration of flooding in the Eastern Zambezi Region and the Mwandu District

In the Zambezi Region, in particular, climate risk factors, especially floods, are problematic (Nyambe and Belete, 2013). Although floods and droughts are the usual climate risk factors that often affect this region, floods are more frequent than droughts (Nyambe and Belete, 2013). Their frequency, and the degree to which they affect the rural households in the Zambezi Region of Namibia, show how critical they have become to their livelihood. Floods are an annual occurrence in the study area. These annual floods are regarded as normal, and they have no, or little, negative impact on the people’s livelihoods (Mabuku *et al.*, 2018). However, the study area has recently witnessed the recurrence of severe flooding (Long *et al.*, 2014). Annual floods are not a threat to people’s livelihoods because they could carry out their normal activities, despite the floods. In 2008 and 2009, very high rainfalls in the Cuvelai, Kavango,



Kwando and Zambezi River catchments resulted in extreme flooding (the worst in more than 40 years). The floods affected approximately 23,000 people, 25% of the population in the region, and it was regarded as a disaster. The spatial extent of these flooding events has also increased, inundating areas that were previously regarded as higher ground (Mudabeti, 2011). According to Mabuku (2013), the total area that was affected, between 2000 and 2012, showed an increasing trend, with 2009 indicating more than 58% of the eastern part of Zambezi Region being inundated. In the years 2004, 2008, 2009, 2011, 2012 and 2013, above normal (4 m) water levels were recorded in the Zambezi River. Lake Liambezi, through the Bukalo channel, received the floodwaters from the Zambezi River after a long, dry period had caused it to dry up in the 1990s (Inambao, 2009). According to the International Federation of the Red Cross (IFRC) (2011), the Zambezi River flooded the Eastern Zambezi Region and the Mwandia District, negatively impacting over 100 000 people and destroying the infrastructure, field crops and livestock. The floods affected 90% of the population in the eastern part of Zambezi Region. During the floods, people who were relocated in camps were faced with reduced harvests on the floodplains and the inaccessibility to social service institutions, such as clinics and schools (Nhubu, 2015), and during their relocation, people depended on government aid. The floods also resulted in an outbreak of water-borne diseases. The duration of the floods was reported to be between one and seven months (Mabuku *et al.*, 2018). Table 5.1 shows the area of the crop fields that were flooded in the eastern part of the Zambezi Region. Data in Table 5.1 was derived from Mabuku (2013).

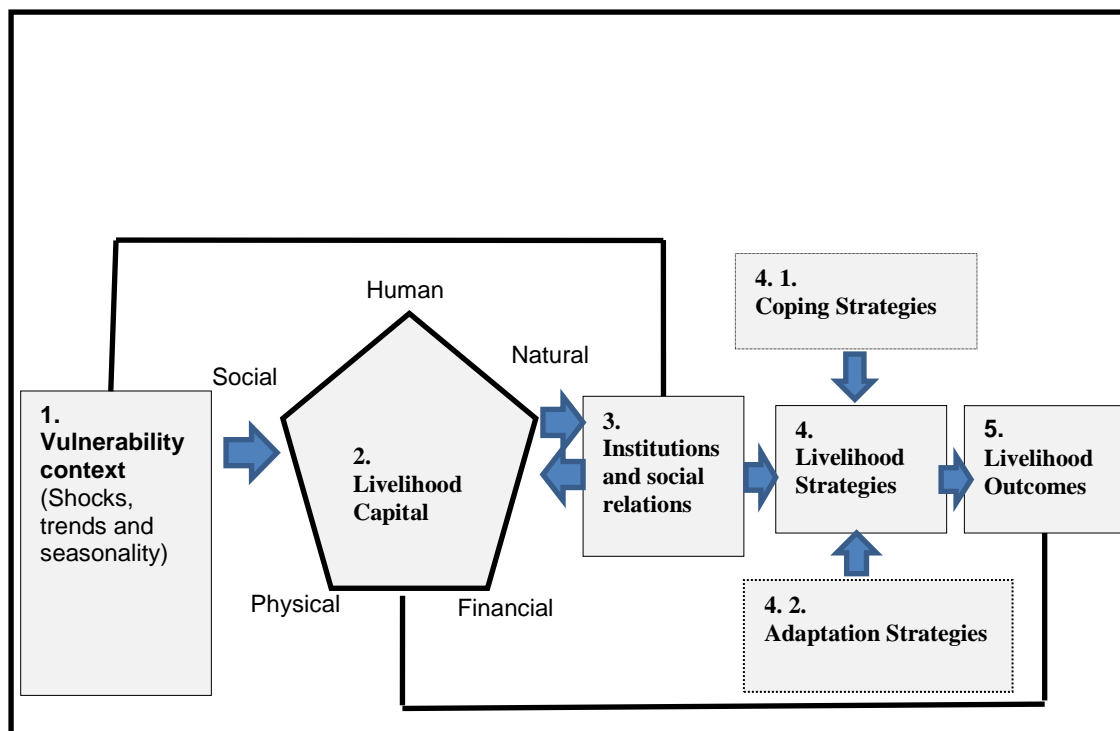
**Table 5.1 Flooded crop fields in eastern Zambezi Region of Namibia (adapted from Mabuku, 2013)**

<b>Flood Year</b>	<b>Crop fields flooded (km<sup>2</sup>)</b>
2009	18.7
2010	16.3
2011	15.8
2004	15.2
2007	13.2
2006	12.2
2012	11.0
2008	10.0
2000	8.0
2003	7.5
2001	7.0
2005	5.2
2002	5.0

### **5.3.2 Conceptual Framework**

This study used the Sustainable Livelihood approach (SLA), which includes the notion of five different types of capital, in order to frame the inquiry and capture the perceptions of the coping/adaptive capacity in the data collection process. The SLA holds that the analysis of livelihoods consists of five different types of capital, which necessitate positive livelihood outcomes (Figure 5.2) (DFID, 1999). These different types of capital include human (skills, knowledge, ability to labour and good health), natural (soil, water, air, genetic resources), financial (cash, credit/debt, savings), social (networks, social claims, social relations, affiliations, associations) and physical capital (DFID, 1999). According to Filmer and Pritchett (2001), different types of capital provide information on a household's structural income status and its underlying welfare. In the presence of shocks, such as floods and droughts, people deploy these different types of capital in various combinations, and they are influenced by institutions and processes in order to cope with, or adapt to, these shocks (DFID, 1999). As floods impact the different types of capital that are accessible to rural households, people need to cope and adapt, considering that the availability of the endowments and entitlements for their livelihoods, and the way they are conditioned, may be affected.

The framework is a useful tool for understanding the impact of sustainable livelihood measures for increasing a communities' adaptive capacity, from the local people's point of view. One of the ways of understanding a livelihood system is to analyse the coping and adaptive strategies pursued by individuals and communities, as a response to external shocks and stresses, such as floods (Osman Elasha *et al.*, 2005). The ability of a livelihood to cope with, and recover from, stresses and shocks is key to its adaptation. Those who are unable to cope or adapt are inevitably vulnerable and unlikely to achieve a sustainable livelihood. Assessing the ability to adapt positively, or to cope successfully, requires an analysis of a range of factors (Scoones, 1998). The SLA provides a guide to these different factors for understanding a sustainable livelihood. The SLA can also be used as a framework for developing indicators, to help policy-makers and others chart progress towards the attainment of sustainable livelihoods (Morse and McNamara, 2013). Moreover, The SLA is a flexible approach that can be implemented in many different ways, depending upon the local context and the expertise available for the analysis. The livelihood capital, as well as the coping and long-term adaptive strategies (Boxes 1, 2, 4.1 and 4.2 in Figure 5.2), were the areas of interest in the framework of this study. Figure 5.2 was adapted from Kamwi *et al.* (2015).



**Figure 5.2 Sustainable Livelihood Approach Framework (adapted from Kamwi *et al.*, 2015)**

### 5.3.3 Questionnaire and Data Collection

Data collection was comprised of household surveys, focus group discussions, observations and informal discussions. A household questionnaire was divided into the following sections:

- i. Demographic information, which included age, gender, marital status, etc.
- ii. Livelihood capital: Households were asked about what different types of capital they had access to e.g. social, financial, human and natural. The different types of capital had specific questions to answer. For example, the household skills were specified and households would then choose which of the skills they possessed. The details are in the attached questionnaire.
- iii. Vulnerability context (the presence of shocks, such as floods and droughts): Households were asked what type of shocks they experienced in 2014 and 2015. They were also asked to name the years, between 2000 and 2015, in which they experienced annual floods. The focus group households were asked to indicate which of the flood years they regarded as disasters. The questions had the years

listed in chronological order and the respondents had to indicate which years they recalled the flooding to have occurred.

- iv. Coping and adaptation strategies adopted by rural households: Households were asked how they managed to cope and how they adapted to both the flooding and flood disaster. They were presented with a list of strategies. The questions were of the “Yes/No” type; “No,” for if they had not adopted the strategy and “Yes” for if they had adapted the strategy. The choice of the independent and dependent variables was based on previous literature, such as those used by Deressa *et al.* (2009), Gbetibouo (2009), Maddison (2007), Nhemachena and Hassan (2008) and Yesuf *et al.* (2009). The dependent variables were verified during a pilot study, to determine their applicability in the study area. Households added the strategies that were missing from the list.

Before the main household survey was conducted in July 2015, the pre-testing of the questionnaire was conducted, as part of the pilot study. Eight enumerators, of whom four were from Zambia and four from Namibia, were trained for two days on how to carry out data collection. The enumerators were all conversant in English, as well as one of the local spoken languages in each country. The household survey was supplemented by six focus group discussions, consisting of between six and eight participants each. Focus groups included both women and men. The questionnaire was written in English, but it was translated into the Silozi and Subia languages during the interview. These are the languages that respondents are conversant with in Zambia and Namibia, respectively.

#### **5.3.4 Sampling**

The population of this study comprised of all households located in the Mwandu District of Zambia and the Eastern Zambezi Region of Namibia. The selection of samples for the study was done using the multi-stage sampling technique. Multistage sampling entails two or more stages of random sampling based on the hierarchical structure of natural clusters within the population (Sedgwick, 2015). Clusters are natural groupings

of people—for example, electoral wards, general practices, schools, or households (Sedgwick, 2015).

Firstly, one region was selected from the 13 regions in Namibia, because this region experiences more floods annually than the other regions of the country. Secondly, from each of the selected regions, the two most flood-affected constituencies in the region were chosen. These constituencies are referred as the Eastern Zambezi Region of Namibia. In Zambia, the Mwanzi District was selected as the study area, since it lies adjacent to Eastern Zambezi region of Namibia and shares the same river. The third stage comprised of the random selection of villages from the Mwanzi District of Zambia and the Eastern Zambezi region of Namibia. For each country, villages that are known to be flood-prone were drawn from a list that was provided by the local community members who had knowledge about the area. Villages were listed according to their experience of flooding. From the list, households were randomly sampled, with the head of the household being the respondent.

The fourth stage involved the random sampling of 207 respondents. The sampling frame consisted of a list of all households in these selected villages. Beaman and Dillon (2009) define a household as a group of people living together, making common arrangements for food and other essentials for survival and acknowledging the authority of a man or woman who is the head of household. Where the head of the household was not available, any adult member of the household, who was knowledgeable about the general livelihood of the household, was interviewed. Ultimately, a questionnaire survey of 207 randomly-sampled households was conducted in the study area, where 114 households were interviewed in the eastern part of the Zambezi Region of Namibia and 93 in the Mwanzi District of Zambia. All households within the study area had an equal chance of being sampled. This survey was part of a broader study of 445 households that were sampled from flood-prone and non-flood-prone areas. However, for the purposes of this study, only households sampled from the flooded areas were used.

### 5.3.5 Ethical Considerations

Ethical clearance was granted by the University of KwaZulu-Natal, South Africa (Ethical Clearance Number: HSS/0596/015D). Informed consent was obtained from all the participants in the study. The respondents were required to sign a Participation Declaration, indicating that they understood the nature of the research and their willingness to participate in it. Respondents were free to withdraw from the study at any time if they so wished. The reporting of results would ensure that no individuals were identified by name.

### 5.3.6 Data Analysis

Data were entered in Microsoft Excel and analyzed in the Statistical Package for the Social Sciences (IBM SPSS) Version 22. Firstly, descriptive statistics were applied to the analysis of the household's livelihood capital, as well as their coping and adaptation strategies. The Pearson's Chi-square analysis was used to determine the significant difference between the coping and adaptation strategies of the two study sites and a T-test was used to test if there was a relationship between independent and dependent variables (McHugh, 2013). It was assumed that the data follow a normal distribution since the sample size was large enough. It was appropriate to use cross-tabulation and Chi-square since the data were categorical and the aim was to see if there was any association between the independent and dependent variables and to test whether the observed differences were significant. In this case, the Chi-square value was calculated by using the following formula:

$$\chi^2 = \sum_{i=1}^n \frac{(O-E)^2}{E} \quad (5.1)$$

Where “ $\chi^2$ ” is the Chi-square value, “ $\Sigma$ ” is the summation, “O” is the observed frequency, and “E” is the expected frequency.

Secondly, a Principal Component Analysis (PCA) was carried out to group the adaptation strategies into components. Previous studies applied the PCA to either assess the adaptation strategy or to examine the factors influencing the choice of adaptation strategies (Otitoju and Enete, 2016; Ozor *et al.*, 2010). A PCA is useful when there are many variables that are correlated to some degree, and the purpose is to reduce the dimensionality, in order to use fewer variables (Statacorp, 2009). Reducing the dimensionality helps to identify patterns among the variables and to identify the commonalities among the rows (or objects). This is achieved by transforming to a new set of variables, the Principal Components (PCs), which are uncorrelated and which are ordered so that the first few retain most of the variations present in all of the original variables. When running the PCA in SPSS, the Bartlett Test of Sphericity and the Kaiser, Meyer, Olkin (KMO) are the output. The Bartlett Test of Sphericity tests the hypothesis that the correlations in a correlation matrix are zero (inter-dependent) (Anastasiadou, 2011; Obst, 2004), while the KMO tests the adequacy of the data to carry out a PCA (sample sufficient) (Anastasiadou, 2011; Kien *et al.*, 2011). If the KMO index is high ( $>0.5$ ), the PCA can act efficiently, and if the KMO is low ( $<0.5$ ), the PCA is not relevant (Christofaro *et al.*, 2017). Some references give a table for the interpretation of the value of the KMO index obtained. The results of the KMO are interpreted in Table 5. 2 below. The data in the table is adapted from (Kaizer, 1974). The Bartlett test compares the observed correlation matrix to the identity matrix (Kiirithio, 2014). In other words, it checks if there is a certain redundancy between the variables that can be summarized in a few number of factors. If the variables are perfectly correlated, only one factor is sufficient. If the values outside the main diagonal are high in absolute value, some variables are correlated; if most of these values are near to zero, the PCA is not really useful. For the Factor Analysis to be recommended as being suitable, Bartlett's Test of Sphericity must have less than a 0.05 significant level. In this study, the Bartlett Test of Sphericity yielded approximately  $X^2$  of 3 275.860, with a 105 degree of freedom at a 0.001 significance, which is a strong indication that the data were appropriate for the factor analysis. The results of the KMO in this study were equal to 0.854 for both study sites, indicating the adequacy in the sample to carry out PCA.



**Table 5.2 Interpretation of the KMO as in the Kaiser, Meyer, Olkin measure of sampling adequacy (Adapted from Kaizer, 1974)**

<b>KMO value</b>	<b>Degree of common variance</b>
0.9 to 1	Marvelous
0.8 to 0.89	Meritorious
0.7 to 0.79	Middling
0.6 to 0.69	Mediocre
0.5 to 0.59	Miserable
0.0 to 0.49	Unacceptable

Thirdly, a correlation analysis and a multiple linear regression were used to determine the factors influencing the households' choice of adaptation strategies. Linear regression was applied because the dependent variables were continuous. Other studies have used multivariate regression (Nyambe and Belete, 2013), the Heckman Probit Model and multinomial logistic regression (Gbetibouo, 2009), as well as the Analysis of Variance and Garrett Ranking (Elum *et al.*, 2017), for determining the factors influencing the choice of adaptation strategies. A multiple linear regression analysis was run, using the scores of each case in the sample, and it modelled a number of explanatory variables. Explanatory variables in the model included the age and duration of the floods, as a continuous variable, whilst other variables were categorical, as shown in Table 5.3. In the multiple linear regression analysis, dummy variables were constructed for these categories and they were nominal. Adaptation strategies were the dependent variables in the model and included the following: tree planting, acquiring better skills on flood preparation, relocation to higher ground, constructing flood-proof houses or elevating the houses during construction, the adoption of flood resistance crops, improving post-harvest storage, the marketing of produce, the adoption of conservation agriculture, the strengthening of early warning systems and preparedness, fish farming, early and late planting, as well as flood-water harvesting and praying. These adaptation strategies were grouped into various components.

**Table 5.3 Explanatory variables used in multiple linear regression**

<b>Independent Variables</b>	<b>Sub-Categories</b>	<b>Type of Variable</b>	<b>Measures/codes</b>
Age	Age of respondent	Continuous	years
Family size	Number of members in a household	Continuous	number
Duration of floods	Duration of floods	Continuous	months
Gender	Male	Dummy	1=male or else 0=female
Marital status	Single	Dummy	1=single or else 0=married
Occupation	Unemployed	Dummy	1=unemployed or else 0=employed
Education level	Secondary education	Dummy	1=yes or else 0=no
	Tertiary education	Dummy	1=yes or else 0=no
	No formal education	Dummy	1=yes or else 0=no
Duration of stay in the community	≤10 years	Dummy	1=yes or else 0=no
	11 - 19 years	Dummy	1=yes or else 0=no
	≥20 years	Dummy	1=yes or else 0=no
Land size	≤ 0.5 ha	Dummy	1=yes or else 0=no
	0.5 ha - 1 ha	Dummy	1=yes or else 0=no
	1 ha - 2ha	Dummy	1=yes or else 0=no
	≥ 2 ha	Dummy	1=yes or else 0=no

Note: When entering a dummy valuable in the regression model, one category is left out of the model, namely, the reference variable.

## **5.4 Results and Discussion**

### **5.4.1 Overall Sample Characteristics**

The survey sample results indicated that an average rural household in the study area consisted of five people in Zambia and four people in Namibia. In both Zambia and Namibia, the household heads were dominated by males. Within the households interviewed in Zambia, the majority of respondents had a secondary level of education (Grade 8 to 12) and only 3% had no formal education. With respect to marital status, the majority were married, 14% were single and 16.7% were widowed or separated. On the other hand, within the households interviewed in Namibia, the majority had attained

primary school education and, again, the majority were married. Meanwhile, the majority of the household heads in Zambia and Namibia had no formal employment. The majority of the households had lived in the flood plain for less than 20 years in Zambia, as opposed to the majority in Namibia, who had lived in the flood plain for more than 20 years. Table 5.4 shows the characteristics of the sampled respondents.

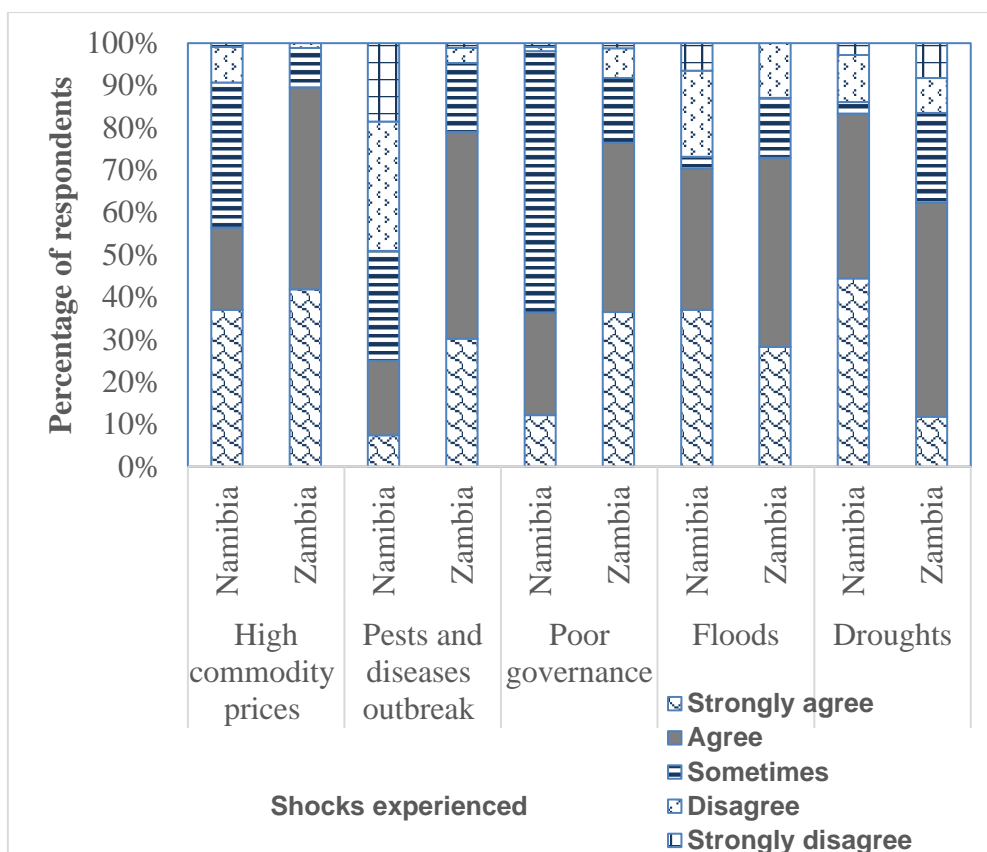
**Table 5.4 Demographic characteristics of respondents in the study area**

Variables	Measure	Zambia n (%)	Namibia n (%)	Significant level	t statistics
Gender of the respondents	Male	58 (62)	63 (55)	0.306	1.06
	Female	35 (38)	51 (45)		
	Significant	0.017**	0.209		
Education	$\chi^2$	5.68	1..579	0.130	9.875
	Primary	38 (41)	33 (29)		
	Secondary	50(54)	65(57)		
	Tertiary	2 (2)	4 (3)		
	No formal education	3 (3)	12 (11)		
Marital status	Significant	0.001***	0.001***	0.008***	15.663
	$\chi^2$	90.7			
	Single	31 (33)	44 (39)		
	Married	62 (67)	70 (61)		
Occupation	Significant	0.001***	0.001***	0.145	6.875
	$\chi^2$	125.8	126.8		
	Employed	7 (7)	10 (9)		
	Unemployed	86 (93)	104 (91)		
Length of stay in the community	Significant	0.001***	0.001***	0.001***	37.94
	$\chi^2$	208.9	138.5		
	<10 years	31 (34)	7 (6)		
	10-20 years	19 (21)	10 (9)		
Land size	>20 years	42 (46)	97 (85)	0.007***	14.19
	Significant	0.001***	0.001***		
	$\chi^2$	39.7	128.9		
	<0.5 ha	9 (11)	1(1)		
	0.5 ha – 1 ha	8 (10)	5(5)		
	1 ha – 2 ha	5 (6)	10 (9)		
Land size	> 2 ha	61 (73)	90 (85)	0.001***	0.001***
	Significant	0.001***	0.001***		
	$\chi^2$	144	204.4		

Note: Statistically significantly at 0.1\*, 0.05\*\*, 0.01\*\*\* levels,  $\chi^2$  Pearson chi-square and t is t-test.  
Population size: Total population size=207, Zambia = 93, Namibia = 114

#### 5.4.2 Types of Shocks Experienced

In this study, shocks were reported between 2004 and 2014. High commodity prices, pests and disease outbreaks, poor governance, floods and drought were reported in Namibia and Zambia (Figure 5.3). The majority of respondents in Zambia experienced high prices in commodities, as well as the outbreak of pests and diseases. Diseases, such as foot-and-mouth, mostly affected their livestock, especially the cattle. Crop damage, caused by birds, elephants, hippos and other wildlife, discouraged farmers from increasing their crop production in parts of the Zambezi Region. A hike in the commodity prices was reported in the two countries. The majority of Namibians reported that they experienced flooding every year, between 2000 and 2015. Some households that cultivated land on both the higher ground and the flood plains, indicated that they experienced floods and droughts. Responses on the frequency of flooding indicated that floods impacted both study areas every year, from 2004 to 2014. Results from 2010 to 2013 indicated that 100% of the respondents in Namibia were flooded, while less than 50% were flooded in Zambia (Mabuku *et al.*, 2018). The duration of flooding was, on average, four months in Namibia and two months in Zambia (Mabuku *et al.*, 2018). However, in Namibia and Zambia, the maximum duration of floods was eight and six months, respectively, was reported. During these floods periods, some households were accommodated in relocation camps.



**Figure 5.3 Shocks experienced in the study area**

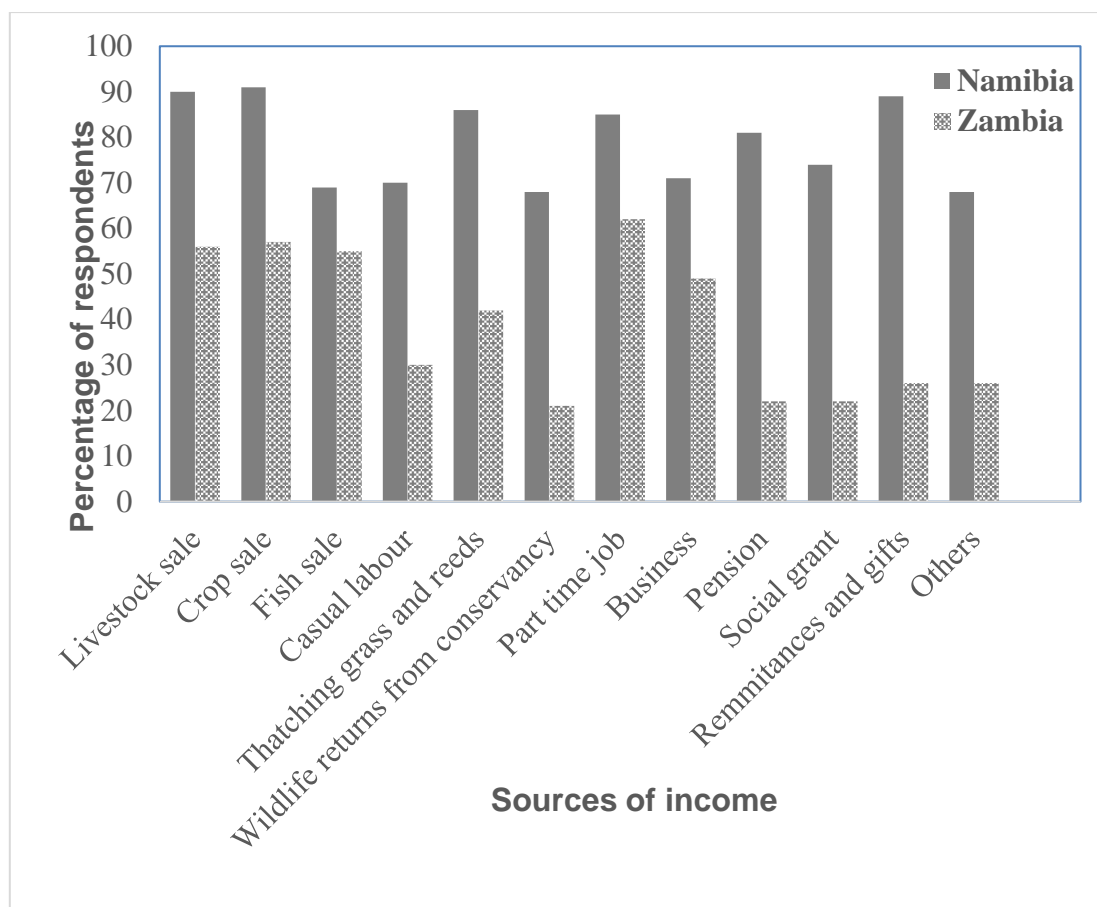
### 5.4.3 Household Livelihood Capital in the Eastern Zambezi Region and the Mwandi District

#### 5.4.3.1 Household livelihood activities and sources of income

Households in the two countries engaged in different livelihood activities and sources of income (figure 5.4). Some households participated in part-time jobs. During the focus group discussions in Zambia, some household members indicated that they travelled to Namibia to seek part-time jobs, such as cattle herding, fishing, weeding and housekeeping. Another source of income was the sale of livestock, either as meat or as live animals. This was done to sustain their livelihoods, namely, to buy food and to pay for their children’s school uniforms and fees. Most households practiced *matapa farming* (flood plain farming) and dry land arable farming, and good harvest crops, such as maize, groundnuts and beans, are sold. Fishing is an important livelihood activity

and income source, especially during a flood event. These livelihood sources were dependent on the floods; the more floods that occurred, the more such activities were practiced. For example, fishing and the sale of reeds and thatching grass were more common during the flood periods. Flood-plain farming was also highly dependent on the occurrence of floods. This is the main reason why people moved into the flood plains. Flood-plain farming is advantageous since there is no need for fertilisers and irrigation, which therefore reduces the costs of these agricultural inputs. All these sources of income are influenced by the occurrence of floods.

Some Namibian citizens and permanent residents received monthly pension grants from the government. A pension grant is given to every Namibian citizen and permanent resident who has attained 60 years of age, and older. Unlike Zambia, Namibians also receive monthly social grants, besides their pension grants. These social grants are given to those whose households have disabled persons, orphans, war veterans, and so on. Other sources of income include the sale of thatching grass and reeds. The Chi-square test results and the t test indicated that there was a significant difference in all the sources of income derived by households, between the two countries ( $p < 0.05$ ). In Namibia, since most elders and disadvantaged groups obtained monthly grants, they responded to flood disasters better than their counterparts in Zambia, who did not receive such grants. This could be the reason why the level of flood preparedness of Namibians is higher than that of the Zambians (Mabuku *et al.*, 2018). Other sources of income, such as remittances and gifts, were received in the form of money and goods from friends and families.



**Figure 5.4 Household Livelihood Activities and Sources of Income**

### 5.4.3.2 Households’ skills and education

The key indicators for human capital are education, the capacity to work, the possession of skills, vocational training and access to extension services (Israr and Khan, 2010). This study focuses on the human capital of skills and education that are possessed by the households. In terms of education, the results showed that the majority of the household heads in Zambia are literate, as defined by their ability to read and write (Kamwi *et al.*, 2015). The higher rate in literacy in both countries may be influenced by the old age policy on education. In both Zambia and Namibia, there were programmes that were designed to encourage the school drop-outs to return to school, regardless of their age.

Many households have acquired different skills from attending school, as well as from their friends and family members. These skills improve the overall wellbeing of a

household, with the skillful individuals having more and diverse opportunities for earning a livelihood, especially during a flood disaster (Israr and Khan, 2010). A household may have more than one skill. In Namibia, the most prominent skills were beer-brewing, hunting, weaving, sewing, carpentry, craft-making, wood-carving, traditional medicine, construction and fishing. The most prominent skills in Zambia were cropping and livestock rearing, construction, weaving, sewing, fishing, gardening and skills in traditional medicine. There was a significant difference in all the skills possessed between the two countries ( $p < 0.05$ ).

#### **5.4.3.3 Households' membership to associations**

Social capital has implications for societal development and overall livelihood development (Israr and Khan, 2010). In this study, the membership of households to groups or associations was assessed. A number of organizations operated in different sectors of the study area. These organizations formed groups or committees to involve the rural community in the development of their areas, including the management of floods and droughts. In Zambia, 28% of the respondents had members of their households who belonged to various groups or associations, such as health care, the Mwandu General Contractor, the Catholic Relief Services, the *zuha mwabuloko* women's group ('Wake up from your sleep'), as well as Mwandu multipurpose groups. About 28% of the household members belonged to Mwandu cooperative committees. Some 22% of household members belonged to water associations and 21% were members of community forests or conservancies.

In Namibia, 41% had at least one family member who belonged to a conservancy, such as the Salambala Conservancy. About 21% of the households had a member belonging to groups, such as the relief programmes, the Red Cross, First Aid, education, HIV and AIDS groups, and 17% of the households had a member who belonged to a water association, such as the *malukaka* Water Point Committee. Furthermore, 13% of the household members belonged to cooperatives, such as the Likwama Co-operative, and 9% of the members belonged to a community forest and conservancy committee. The overall results showed that there are active social networks and committees that are



responsible for flood disaster management, including evacuation and relief aid. These different organisations or groups assist during a flood disaster, thereby reducing the negative impacts of floods.

#### **5.4.3.4 Access to land**

Land is considered to be one of the most important sources of natural capital and its productivity increases the portfolio of livelihood strategies, even in times of disaster (Israr and Khan, 2010). Rural households with access to productive land have the opportunity to increase the agricultural production and hence improve their wellbeing (Woolcock and Narayan, 2000), which has implications for the choice of the adaptation and the coping strategies of the households. In Namibia, 93% of all households had access to land, as opposed to 69% in Zambia. Of those who had access to land in Namibia, 91% owned the land, whilst the corresponding figure in Zambia was 59%. Among those who owned land, 79% of Namibians owned two or more hectares of land, while this figure was 65% for Zambia. Statistically, Namibians had more access to, and ownership of, land than the Zambians ( $p < 0.05$ ).

During the focus group discussions, households indicated that their only option for coping with flood was to sometimes relocate temporarily, or permanently, to higher ground. However, some members, who did not have access to land, were forced to stay in the flood plain, even when a flood disaster struck. Furthermore, owning a piece of land on higher ground allowed them to cultivate it and spread the risk during a flood disaster. However, those who owned land on higher ground, the cost of relocating temporarily, or permanently, from the flood plain was unaffordable.

#### **5.4.4 Coping Strategies Adopted by Rural Households in the Eastern Zambezi Region and the Mwanzi District**

During a flood hazard, households in both study sites adopted certain coping strategies, as indicated in Table 5.5. Households adopted more than one strategy to cope with flood disasters. In Namibia and Zambia, 74% and 51% of the households, respectively, were

reported to have sold firewood. There is a significantly higher percentage of Namibians who selected this strategy than Zambians ( $p < 0.05$ ). Besides the sale of firewood, 61.5% of households in Namibia and 50% of those in Zambia collected wild food, such as fish, vegetables and fruits, as a way of supplementing their diets during these flood events. The natural foods are known to have a high nutritional value and are regarded as delicacies. For example, wild vegetables and fish may be eaten with porridge (*buhobe*). Wild fruits, water lilies and water potatoes (*Makwangala and njilikilwa*) were abundant when the water receded. Despite households supplementing their diets with natural resources during a flood hazard, the food was not enough to sustain the whole household, hence there was a reliance on food aid from the government. About 59% of Namibians and 43% of Zambians received food aid from their governments, regional councils, NGOs, church organizations and United Nations agencies. The food was received in the form of emergency food relief, which included maize flour, tinned fish and cooking oil. Other emergency support consisted of evacuation rescue operations that provided transport to higher ground, medical treatment, mosquito nets, candles, improved sanitation, water disinfectants and tents. Furthermore, the sale of reeds and grasses was adopted by 49% of Namibians and 53% of Zambians. After crop failures caused by flooding, some households in Zambia crossed over into Namibia to look for part-time jobs e.g. they looked after cattle and got housekeeping jobs. About 36% of Namibians and 32% of Zambians got part-time jobs to cope with flood disasters. A further 30% of Namibians and 44% Zambians borrowed money or food from relatives and friends. Other coping strategies in both countries, such as charcoal production and fish sales, were adopted when a flood disaster struck. However, charcoal production was only practiced in Zambia. Most coping strategies were dependent on their natural resources. This has implications for landuse/landcover changes. For example, charcoal production involves the cutting of trees, which, in the long term, may cause deforestation and land degradation. A similar study by Kamwi *et al.* (2015) found that the prominent coping strategies in Namibia were part-time jobs, wild food collection, food aid and borrowing from relatives during hardship.

**Table 5.5 Percentage of participants who adopted the coping strategies during a flood hazard in the study area**

<b>Coping strategies</b>	<b>Namibia (% respondents)</b>	<b>Zambia (% respondents)</b>	<b>Significant</b>
Participated in part time job	36	32	ns
Collected wild food	61	50	ns
Sold reeds and grass	49	53	ns
Received food aid	59	43	ns
Sold firewood	74	51	***
Borrowed from relatives	30	44	**
Other(charcoal production, sale of poles, gardening)	96	51	***

**Note:** Statistically significant at 0.1\*, 0.05\*\*, 0.01\*\*\*, and ns-not statistically significant. A household may adopt a combination of different coping strategies and, in that case, the total exceeds 100%. Results are from a cross-tabulation and a T-test

#### **5.4.5 Adaptation Strategies Adopted by Households in Zambia and Namibia**

The results of household surveys and focus group discussions indicated that there were adaptation strategies undertaken by local people, at a household and individual level (Table 5.6). *Mafisa* cattle trading was an important adaptation strategy that involved trading cows to other members of the community, who could take care of them, but the person who gave away the cow retained the ownership of the calves that were produced. It was a way of distributing wealth, but also of spreading the risk during a flood disaster. As such, 86% of Namibians, compared to 41% of Zambians, adopted this strategy. Flood water harvesting was also mentioned as an important strategy. Focus groups indicated that this strategy involved the digging of water wells before the flood season so that when floods occurred, these wells would be filled up with water, which, in turn, would be used for livestock drinking and watering gardens after the flood water had receded. This is one of the adaptation strategies that was exploited and that was a benefit resulting from the floods. Nearly 76% of households in Namibia and 58% of those in Zambia adopted this strategy. Furthermore, changing the planting dates was adopted by both countries. Since the severity of floods was unpredictable, households had to plant their crops early or late, depending on the onset and recession of the floods. About 72% of Namibians and 55% of Zambians practiced the strategy. Different planting dates

were also considered to be an important adaptation to droughts and floods in Egypt, Kenya and Senegal (Maddison, 2007).

Conservation agriculture was reported to be an adaptation strategy that is practiced in the study area, with 61% of the households in Namibia, and 44% of those in Zambia, adopting this strategy. During the focus group discussions in Namibia, respondents indicated that some fields were left fallow for at least 2-3 years. During this period, plants, such as *Sesbania sesban*, grew naturally in these fields. These plants are known to fix nitrogen, but also to prevent soil erosion during high flows. Tree planting was adopted by 46% of the households in Namibia and 61% of those in Zambia. Most of the households reported that the strategy involved the planting of trees, such as fruit trees, to supplement their food source. It was reported that the strengthening of early warning systems involved monitoring the water level, especially during the months of high flows. About 31% of the households in Namibia and 76% of those in Zambia indicated the importance of the strategy. Flood-proofing involved elevating the houses and using common materials, other than clay that can withstand water. Although flood-proofing was an adaptation that households would have liked to adopt, only a few households adopted this strategy because of the costs involved.

**Table 5.6 Adaptation strategies adopted by rural households in the study sites**

<b>Adaptation strategies</b>	<b>Namibia (% respondents adopting the strategy)</b>	<b>Zambia (% respondents adopting the strategy)</b>	<b>Significant</b>
Tree planting	46	61	ns
Acquiring better skills on how to prepare for floods	23	37	***
Relocation to higher ground	38	58	ns
Constructing flood proof houses or elevating the houses very high	57	55	ns
Adoption of flood resistance crops	57	22	ns
Improve post-harvest storage and marketing of produce	60	59	ns
Adoption of conservation agriculture,	61	44	ns
Strengthening of early warning systems	31	76	***
Fish farming	58	30	ns
Changing planting dates	72	55	ns
Flood water harvesting	76	57.7	***
Praying	63	55.8	ns
Other ( <i>mafisa cattle trade, live with floods, water diversion</i> )	86	41	***

Results of a cross-tabulation and t tests. Statistically significantly at 0.1\*, 0.05\*\*, 0.01\*\*\* levels, and ns-not significant

#### **5.4.5.1 Principal components of adaptation strategies in the Eastern Zambezi Region**

The results of the PCA returned four principal components of the Namibian study site, as shown in Table 5.7 below. The four components in the analysis were interpreted in terms of the relationship between the strategies included in each component. Seven adaptation strategies correlated strongly with the first principal component, including the adoption of flood resistance crops, the improvement of the post-harvest marketing of produce, soil conservation, fish farming, constructing flood-proof houses or elevating the houses above the ground, tree planting and conservation agriculture. Six out of the seven strategies addressed food production and only one was structural. These food production strategies accounted for a variance of 46% in the data. Adaptation

strategies that correlated strongly with Component Two were the relocation to higher ground and the strengthening of early warning systems and preparedness. These strategies were related to relocation and flood preparedness. This group was named Flood Preparedness Strategies and accounted for about 13% of the variance in the data. The strategies that correlated strongly with Component Three were prayer, adopting better skills on how to prepare for floods and changing the planting dates. The strategies of Components Three were the religion- and education-related adaptation strategies, which accounted for a variance of about 12%. Finally, strategies that correlated strongly with Component Four were flood water harvesting, as well as other strategies, including water diversion by digging trenches from the fields, living with floods and the *mafisa* cattle trade. The strategies of Component Four were related to water harvesting, accounting for a variance in the data of about 8%.

**Table 5.7 Principal Component Analysis and their loadings in the Eastern Zambezi Region of Namibia**

Adaptation strategies	Component			
	1	2	3	4
Adoption of flood resistance crops	<b>0.93</b>	0.05	0.08	0.00
Improve post-harvest storage and marketing of produce	<b>0.92</b>	0.21	0.00	-0.01
Soil Conservation	<b>0.91</b>	0.10	0.07	0.12
Fish farming	<b>0.91</b>	0.14	0.11	0.02
Constructing flood proof houses/elevating the houses very high	<b>0.88</b>	0.10	-0.02	-0.02
Tree planting	<b>0.85</b>	-0.19	-0.11	-0.11
Adoption of conservation agriculture, Relocation to higher ground	<b>0.84</b>	0.11	0.15	0.20
Strengthening of early warning systems	-0.04	<b>0.84</b>	-0.06	0.26
Pray	0.24	<b>0.82</b>	0.19	-0.07
Changing planting dates	0.06	0.35	<b>0.78</b>	-0.11
Better skills on how to prepare for floods	0.55	-0.10	<b>0.70</b>	0.06
Other ( <i>mafisa</i> cattle trade, water diversion, living with flood)	-0.49	-0.31	<b>0.52</b>	-0.07
Flood water harvesting	-0.13	0.04	0.08	<b>0.89</b>
% of variance	0.33	0.16	-0.30	<b>0.70</b>
	46%	13%	12%	8%

#### **5.4.5.2 Principal components of adaptation strategies in the Mwanzi District of Zambia**

Contrary to the four principal components that were extracted from Namibia, only three principal components were extracted in Zambia, and they can be interpreted in terms of the relationship between the strategies included in each component. Despite there being only three principal components in Zambia, the majority of the adaptation strategies were highest in Component One, which is similar to the first principal component in Namibia. The results of the component analysis in Zambia are shown in Table 5.8. About eight adaptation strategies correlated strongly with the first component, which addressed food production. Only one was a structural strategy and it included the following: constructing flood-proof houses or elevating the houses improving the post-harvest marketing of produce and the adoption of flood resistance crops, flood water harvesting and other strategies (the *mafisa* cattle trade, water diversion by digging trenches from the fields and living with floods), flood water harvesting, tree planting, fish farming and conservation agriculture. Similar to those in Namibia, these adaptation strategies were named as the food production strategies. They accounted for about 49% of the variance in the data. About four strategies were loaded highly on Component Two and these included the acquisition of better skills on how to prepare for floods, soil conservation, praying and the strengthening of early warning systems and preparedness. These strategies were related to education and religion, and they were therefore named educational strategies. They accounted for a variance of 12% in the data. Finally, only the relocation to higher ground strategy loaded higher on Component Three and accounted for a variance of 9%. Component Three indicates the relocation of household members from the flooded areas to higher ground during the flood period and their return when the water recedes.

**Table 5.8 Adaptation strategies and their loadings in the Mwanzi District of Zambia**

Adaptation strategies	Components		
	1	2	3
Constructing flood proof houses or elevating the houses very high	0.87	0.33	0.01
Improve post-harvest storage and marketing of produce	0.84	-0.07	0.36
Flood water harvesting	0.82	0.05	0.14
Other ( <i>mafisa</i> cattle trade, water diversion, living with flood)	0.80	0.24	0.14
Tree planting	0.74	0.40	-0.13
Fish farming	0.73	0.44	-0.07
Adoption of flood resistance crops	0.69	0.49	0.01
Adoption of conservation agriculture,	0.57	0.54	-0.20
Develop better skills on how to prepare for floods	0.14	0.78	0.11
Pray	0.11	0.77	-0.14
Soil Conservation	0.23	0.77	0.05
Strengthening of early warning systems	0.44	0.52	0.39
Changing planting dates	0.28	0.52	0.39
Relocation to higher ground	0.02	-0.01	0.88
% of variance	49%	12%	9%

#### **5.4.6 Factors influencing the Choice of the Households' Adaptation Strategies in the Study Area**

The results of the correlation and regression analyses indicated that several factors influenced the households' choice of adaptation strategies in the Zambian and Namibian study sites. Factors, such as marital status (widows), occupation (unemployed), education level (secondary education, never attended school), family size and age of head of the household, correlated with Component One, and food production strategies, such as flood resistant crops, conservation agriculture and fish farming, were reported in Namibia. Component Two (prayer, soil conservation, the strengthening of early warning systems and developing skills on how to prepare for floods) correlated with age of the head of the household and the duration of the flood. Component Three (relocation to higher ground) correlated with the gender, marital status, family size and the age of the head of the household. Finally, Component Four correlated with the marital status and length of stay in the community ( $\leq 10$  year).



However, in the Mwanzi District, the correlation analysis results showed that marital status (married), land size and the age of the head of the household correlated with Component One, while the flood duration, the age of the head of the household and marital status correlated with Component Two. There were no factors that correlated with Component Three in the Mwanzi District.

The results of multiple linear regression (Table 5.9 and 5.10) showed the factors that influenced the choice of adaptation strategies in Zambia and Namibia. The significant results, at a 90%, 95% and 99% confidence level, are discussed below. The section below explains how different factors influenced the choice of adaptation strategies.

#### **5.4.6.1 Age**

The results in the Eastern Zambezi Region showed that age positively and significantly influenced the likelihood of taking up adaptation strategies in Component One ( $P < 0.01$ ) (Table 5.10). This is a component that addresses food production, such as tree planting (orchards), fish farming and the adoption of flood-tolerant crops, etc. This means that, for each year of increase in age, the respondents were 0.03 more likely to adopt food production strategies ( $P < 0.05$ ). The older the respondents, the more likely they were to adopt the strategies mentioned. Gbetibouo (2009) found that age had a positive relationship with the adoption of climate change adaptation strategies. Similarly, Deressa *et al.* (2010) argued that the age of the household head represented the level of experience in farming. The older the respondents, the more experienced they were in farming and the more they were exposed to past and present climatic conditions; they were, therefore, more likely to adopt the above strategies. Enete and Onyekuru (2011) found that the age of the farmer was positively and significantly related to the level of investment in climate change adaptation practices by the farmer. They further noted that older farmers had more experience and were able to make healthier production decisions than younger farmers (Enete and Onyekuru, 2011).

Age correlated negatively with the food production strategies in the Mwanzi District of Zambia. Furthermore, the regression analysis showed that age negatively and

significantly influenced the likelihood of taking up adaptation strategies in Component One ( $P < 0.01$ ) in the study site. This is a component that addresses food production, such as tree planting (orchards), fish farming and the adoption of flood-tolerant crops, etc., which means that for each year's increase in age, the respondents were 0.02 less likely to adopt food production strategies in Component One ( $P < 0.01$ ) (Table 5.10). The older the respondents, the less likely they were to adopt the strategies mentioned. The reason for this may be attributed to the fact that young people are energetic, considering the amount of physical labour that is required to adopt these strategies. For instance, Adesina and Zinnah (1993) noted that, as farmers grow older, they are less likely to change from their old practices, in this case from farming-related strategies to other types of adaptation strategies. In a similar study, Seo *et al.* (2005) found that age negatively influenced the probability of a farmer adapting to climate change, while Hassan and Nhemachena (2008) found that age has an insignificant influence on a farmers' adaptation to climate change. This result is contrary to the findings of Deressa *et al.* (2010), who argued that the age of the household head represented the level of experience in farming. The older the respondents, the more experienced they were in farming and the more they were exposed to the past and present climatic conditions; therefore, they were more likely to adopt the above strategies.

#### **5.4.6.2 Duration of floods**

The duration of floods refers to the number of months that a household experienced flooding in a particular year. The duration of floods experienced in the Eastern Zambezi Region significantly influenced the choice of adoption of Component Three (food production) and Component Two (flood preparedness) strategies ( $P < 0.01$ ). However, an increase in the number of months that the households were flooded negatively influenced the choice of adopting food production strategies by 0.136 ( $P < 0.01$ ). When households were flooded for a few months, they were 0.18 more likely to adopt food production strategies and 0.27 more likely to adopt flood preparedness strategies. This could be because floods of shorter duration, in most cases, are more disastrous, which prompts the need to adopt food production strategies and flood preparedness activities.

The duration of floods in Zambia positively correlated with the Component Two strategies. The regression analysis showed that the flood duration positively and significantly influenced the choice of adopting Component Two (religious and educational strategies) ( $P < 0.1$ ). An increase in the number of months that a household was flooded, increased the likelihood of adopting Component Two by 0.183 (Table 5.9). When the flood duration was anticipated to be long, the members of the households preferred to pray and to develop their skills on how to prepare for the floods.

#### **5.4.6.3 Length of stay in the flood plain**

The length of stay of the community positively and significantly influenced the choice of Component One (food production strategies) in the Eastern Zambezi Region. Those who had lived in the flood plain for less than 10 years were 0.553 more likely to adopt food production strategies than those who had lived in the flood plain for more than 10 years. This is because these members have less flood experience, compared to those who have lived in the flood plain for more than 20 years; there is, therefore, a need for them to adopt food production strategies. On the other hand, those who had lived in the flood plain for less than 10 years were 1.17 times less likely to adopt floodwater harvesting and other strategies, such as the *mafisa* cattle trade, as well as living with floods and digging trenches (Table 5.10). This may be attributed to the fact that these members have less flood experience than those who have lived in the area for more than 20 years. They may also have fewer skills for harvesting water or they may not yet have developed the social networks (trust) to adopt the *mafisa* cattle trade.

#### **5.4.6.4 Land size**

When the other variables are held constant, the land size was a significant determinant in adopting adaptation strategies for flood disasters in the Eastern Zambezi Region of Namibia. Land-size positively determined the choice of adaptation strategies in Component Four (flood-water harvesting). Those respondents who had more hectares of land were 0.394 more likely to adopt flood-water harvesting strategies. This is because land plays a very vital role in the livelihoods of the household members in this study area. When the other variables are held constant, the land size was a significant

determinant in adopting adaptation strategies for flood hazards in the Mwandu District. Land-size negatively determined the choice of food production, as well as the educational and religious adaptation strategies. Those respondents who had less than 0.5 ha of land were more likely to adopt floodwater harvesting, food production and educational and religious strategies, than those who had more than 2 ha of land.

#### **5.4.6.5 Occupation, family size and marital status**

Occupation positively and significantly influenced the choice of taking up strategies in Component One (food production) in Namibia. Those who were unemployed were 0.558 more likely to adopt these strategies than those who were employed ( $P < 0.1$ ). Furthermore, single-headed households were more likely to adopt food production strategies than those who were married, while widows were less likely to adopt food production strategies than those who were married. The correlation analysis results indicated that family size correlated positively with food production strategies and religious strategies; however, a further regression analysis did not show any statistical significance. This is because the more members there are in the family, the more need there is for food in the household. Ndamani and Watanabe (2016) indicated that the likelihood of adaptation to climate change was higher in large households than in small households. Similarly, the fact that larger households are more likely to adapt to climate change is probably due to the fact that they have a higher endowment of labor (Oyekale and Oladele, 2012)

Marital status also showed a correlation with food production, education and the relocation strategy uptake in the Mwandu District of Zambia. Those who were separated, or living together without a formal agreement, were less likely to adopt food production strategies than a married couple. On the contrary, those who were separated were positively and significantly adopting education strategies. In a similar study, Okayo *et al.* (2015) showed that showed there was a significant relationship between marital status and the uptake of precautionary measures to mitigate floods in Kenya.

**Table 5.9 Results of multiple linear regression on determinants of adaptation strategies to flooding in the Mwanzi District**

	Component 1- Food production			Component 2- educational			Component 3- relocation		
	Coef.	Odds ratio	Sig.	Coef.	Odds ratio	Sig.	Coef.	Odds ratio	Sig.
(Constant)	3.91		0.01	2.67		0.13	0.33		0.87
Female	-0.07	-0.04	0.77	-0.17	-0.09	0.55	0.21	0.10	0.53
Single	-0.41	-0.13	0.20	0.02	0.01	0.96	0.55	0.18	0.18
Widowed	-0.08	-0.03	0.82	0.45	0.15	0.27	-0.08	-0.03	0.86
Separated	-1.28	-0.24	0.04**	1.29	0.24	0.06*	0.42	0.08	0.58
Living together	-1.77	-0.49	0.001***	-0.09	-0.02	0.86	0.76	0.21	0.16
Divorced	-0.08	-0.02	0.87	-0.51	-0.11	0.39	-0.78	-0.17	0.25
Primary education	0.04	0.01	0.96	-0.65	-0.15	0.57	-0.89	-0.21	0.48
Secondary education	-0.44	-0.16	0.64	-1.19	-0.45	0.26	-0.62	-0.23	0.60
Tertiary	-0.29	-0.03	0.83	0.12	0.01	0.94	0.31	0.03	0.85
Length of stay (≤10year)	-1.28	-0.61	0.16	-1.00	-0.48	0.34	0.66	0.32	0.57
Length of stay (11-20 year)	-0.99	-0.41	0.29	-0.68	-0.28	0.53	0.66	0.28	0.58
Family size	0.02	0.07	0.53	0.05	0.14	0.27	-0.03	-0.10	0.48
Size of land	-0.32	-0.37	0.001***	-0.33	-0.38	0.001***	-0.09	-0.10	0.48
Age of HH	-0.02	-0.34	0.001***	-0.01	-0.13	0.30	0.01	0.10	0.47
Employed	0.75	0.18	0.22	0.41	0.10	0.56	-1.31	-0.31	0.11
Duration of flood	0.03	0.04	0.75	0.17	0.25	0.06*	-0.10	-0.15	0.32

Statistically significantly at 0.1\*, 0.05\*\*, 0.01\*\*\* Sig. = Significant, Coef. =Coefficient

**Table 5.10 Multiple linear regression on determinants of adaptation strategies to flooding in the Eastern Zambezi Region**

	Component 1- food production strategies			Component 2 - flood preparedness			Component 3 -religious			Component 4 -flood water harvesting		
	Coef.	Odds ratio	Sig.	Coef	Odds ratio	Sig.	Coef	Odds ratio	Sig.	Coef	Odds ratio	Sig.
(Constant)	-0.92		0.37	-0.34		0.78	-1.82		0.15	-0.32		0.80
Male	-0.09	-0.04	0.67	-0.06	-0.03	0.81	0.11	0.06	0.66	0.25	0.12	0.35
Single	0.60	0.28	0.01**	0.11	0.05	0.70	-0.10	-0.05	0.73	0.53	0.25	0.08
Widowed	0.25	0.07	0.52	-0.49	-0.13	0.30	-1.05	-0.28	0.03**	-0.17	-0.04	0.74
Separated	-0.45	-0.06	0.50	-1.27	-0.17	0.11	-0.57	-0.08	0.48	-1.76	-0.24	0.04
Living together	0.34	0.05	0.58	-0.01	0.00	0.99	-0.64	-0.09	0.40	-0.65	-0.09	0.41
Unemployed	0.55	0.19	0.09**	0.22	0.08	0.57	0.06	0.02	0.88	-0.15	-0.05	0.72
Primary education	-0.48	-0.08	0.55	1.27	0.21	0.19	0.85	0.14	0.38	-0.14	-0.02	0.89
Secondary education	-0.63	-0.29	0.33	0.82	0.38	0.29	0.19	0.09	0.81	-0.84	-0.39	0.30
Tertiary education	-0.47	-0.09	0.55	0.75	0.14	0.42	0.23	0.04	0.81	-1.19	-0.23	0.22
Length of stay (≤10year)	0.80	0.19	0.03**	0.18	0.04	0.68	-0.03	-0.01	0.94	-1.17	-0.27	0.01***
Length of stay (11 to 20 years)	-0.03	-0.01	0.91	0.54	0.16	0.13	0.16	0.05	0.65	0.16	0.05	0.66
Family size	0.01	0.04	0.64	0.00	0.03	0.79	0.03	0.18	0.12	0.02	0.10	0.41
Size of land	0.071	0.041	0.68	-0.13	-0.07	0.46	0.03	.017	0.86	0.39	0.22	.021**
Age of head of household	0.03	0.47	0.001**	0.01	0.19	0.20	0.01	0.24	0.12	0.01	0.10	0.52
Flood duration	-0.18	-0.19	0.05**	-0.27	-0.29	0.01**	0.15	0.16	0.17	0.16	0.17	0.15

Statistically significantly at 0.1\*, 0.05\*\*, 0.01\*\*\* Sig. = Significant, Coef. =Coefficient

## **5.5 Challenges or Limitations of the Study**

One of the limitations of this study was its multicollinearity in multiple linear regression. When two or more predictor variables in a multiple regression model are highly correlated, the coefficient estimates of the multiple regression may change erratically, in response to small changes in the model or the data. The multicollinearity problem is a scenario in which two or more variables are highly correlated; in simple terms, one variable can be predicted from the others. In order to avoid multicollinearity in a multiple regression model, we excluded predictors that were correlated by looking at the VIF and Tolerance values (between 1 and 5, above 10 indicating a problem). We also created dummy variables from our classes. The reference dummy variable was not included in our statistics in the model.

Another limitation was that the PCA always considered the low variance components in the data as noise and recommended the need to discard the components. However, sometimes those components may be important and may influence the results, and therefore the interpretation. The study relied on the views of the respondents, who would answer based on how they understood the question or based on their mood, and this may not reflect the true answer. Age factor reaches a peak beyond which efficiency decreases. This is ignored in the analysis and is therefore a limitation.

In some cases, households indicated that they are adopting certain adaptation strategies, but in reality, these adaptation strategies are planned and have not yet been implemented. Some questions, such as how many years they have experienced floods, may be difficult for some respondents since it is required that they remember the flood events that occurred each year. The results may be affected by such a selective memory.

Despite these limitations, the study method and analysis can be replicated in other areas. It must be stated that assessing the effectiveness of adaptation strategies was out of the scope of this study. Little is known about whether these coping and adaptation strategies are effective in reducing the vulnerability of households to flooding. Furthermore, in

this study, only descriptive statistics were used in the analysis of the livelihood capital to provide an overview of what different types of capital exist and how they affect adaptation.

## 5.6 Conclusions

Rural households depended on both short-term coping strategies and long-term adaptation strategies, in order to minimize the negative impacts of floods and flood disasters. In Zambia, the majority of households coped with floods by means of charcoal production, the sale of firewood, as well as the sale of grass and reeds. On the other hand, the majority of Namibians coped by selling poles and firewood, by collecting wild food and receiving food aid. With regard to the long-term adaptation strategies, the majority of households in Zambia had early warning systems in place, they planted trees, they had improved post-harvest storage, marketing and flood water harvesting, while they also relocated to higher ground temporarily and changed their planting dates. Most of the long-term adaptation strategies that were reported in Namibia included *mafisa* cattle trading, praying, flood-water harvesting, changing planting dates and fish farming.

The study has shown that rural households in the Mwanzi District of Zambia and the eastern part of the Zambezi Region of Namibia accessed different livelihood capital, such as land, natural resources, skills, income, and social capital. These different types of capital are very important in the face of floods, as they enhance the adaptive capacity of rural households. For example, the elderly in Namibia receive pension grants and some social grants, which is not the case in Zambia. This means that during a flood disaster in Namibia, the elderly, or those who receive social grants, may have some capacity to cope or even adapt to, the disaster, compared to their Zambian counterparts, who do not have access to such grants. The study further showed that, apart from floods, other shocks are experienced in the study area, such as droughts, pests and diseases, price increases in commodities and poor governance.



The study further reviewed the important role that certain factors, such as age, the duration of the floods, the land size, the length of stay in the floodplain and the educational level, play in determining the adoption of long-term adaptation strategies to reduce the negative impacts of flooding in both countries. For example, there was a substantial difference in the adaptation strategies, depending on whether the household heads were old or young, had a bigger land size or not, and whether they were educated or not. The results of the factors influencing flood adaptation are mixed and they depend on the context.

For policy implication, this suggests that when promoting adaptation strategies to flooding there is a need to take into account the different factors influencing the choice of adopting the strategies. For example, designing age-inclusive flood disaster action plans at a household level should be considered. Furthermore, high priority should be given to improving the knowledge and skills of rural households on climate change and adaptation strategies. The government should support the education of household members through various policies. For example, adult literacy can be intensified and offered to school drop-outs at an affordable cost, and specialised education in climate change adaptation should be implemented. This will increase their skills and knowledge, with regard to climate change adaptation, and it will lead to the better use of available information on flood disaster and climate change. Policies that enable households to access free extension services have the potential to significantly increase their awareness of the changing climatic conditions and increase their knowledge on the appropriate adaptation strategies.

Providing households with the necessary resources to adapt to flood disasters will increase their adaptive capacity. For instance, policies that enable households to access affordable credit will increase their financial capital, allowing them to meet the costs associated with the various adaptation options, such as relocation. Providing flood victims with resettlement subsidies is another intervention that could enhance the relocation of households to higher ground during a flood disaster. Policies that will ensure that land is fairly allocated to flood victims will ensure that households adapt to some of the strategies.

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## **6. A FRAMEWORK FOR MEASURING RURAL HOUSEHOLDS' FLOODS DISASTER RESILIENCE IN MWANDI DISTRICT OF ZAMBIA AND ZAMBEZI REGION OF NAMIBIA**

### **6.1 Abstract**

Like many other countries, Namibia and Zambia face the potential of increasing natural hazard events such as floods, which will cause losses. Promoting community resilience is one of the priorities in Namibia and Zambia. Assessment of household flood disaster resilience using a composite index is an important element of disaster risk management and planning. Many assessments have been undertaken worldwide to measure resilience to disasters. However, most of the assessments have been done at the national level. This study designs a Household Flood Disaster Resilience Framework (HFDRF) and uses this framework to assess households' level of flood resilience in the rural communities of Mwandu district of Zambia and Eastern Zambezi region of Namibia. The HFDRF takes a bottom-up approach using indicators derived from primary data through household surveys, literature review, focus group discussions and observations from eastern Zambezi Region and Mwandu District of Namibia and Zambia, respectively. Variables used to develop a framework and assess a household flood disaster resilience include livelihood capital, flood preparedness and adaptive capacity indicators. The assessment results indicated that overall, households in Namibia had higher flood resilience than those in Zambia. Household Flood Disaster Resilience (HFDR) in Namibia was moderate (0.5) compared to Zambia's study site, which scored below moderate (0.46). Furthermore, flood severity (0.47), natural capital (0.94), financial capital (0.73), human capital (0.58), flood preparedness (0.56) had above moderate scores in Namibia than in Zambia and these differences were statistically significant ( $p < 0.05$ ). However, adaptive capacity (0.14), physical capital (0.15) and social capital (0.48) were below average and higher in Zambia than in Namibia, but these differences were not statistically significant between the two study sites. The study concludes that household flood disaster resilience differs per community and households. The study has provided an analytical framework on how to quantify a household flood disaster resilience using livelihood capital, adaptive capacity and flood



preparedness indicators. The proposed analytical framework will provide the baseline for developing a quantitative tool to measure resilience continuously against floods and other disasters using the indicators provided. The framework can be used in developing a resilience decision support system which will help policy-makers and households to enhance resilience in the study area and beyond.

Keywords: Adaptation, floods, livelihood capital, Preparedness, resilience, Namibia, Zambia.

## **6.2 Introduction**

The world's climate has been changing for several thousand years (Kotir, 2011). There is consensus that climate change has increased the frequency and intensity of disaster events and this trend is expected to continue (Field *et al.*, 2014). The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report confirms and reinforces the evidence that climate change is real and poses serious environmental, social and economic threats (IPCC, 2014). In Namibia, climate change is likely to exert its greatest impact on natural resources and hence threaten the livelihoods of the majority of local people who live in rural areas and depend on these natural resources for their livelihood activities (Mfuno and Ndombo, 2005; Kandjinga *et al.*, 2010). Southern African regional and national level climate change projections suggest that for Namibia significant climate change-related impacts are likely in the future (Kandjinga *et al.*, 2010). Rain-fed agricultural system on which people's livelihoods depend on will be particularly vulnerable. Due to the anticipated effects of increasing climate change and variability on long-term agricultural productivity, the Namibian Government identified the need to prioritize the strengthening and development of the adaptive capacities of smallholder farmers, pastoralists, and natural resource managers (Mfuno and Ndombo, 2005). While Namibians have long coped with extreme climatic conditions, climate change presents a significant additional challenge, as it will make living in an already harsh environment more difficult (Crawford and Terton, 2011). The government recognised that addressing adaptation at the local level, i.e., through

community-based adaptation (CBA) is key to future sustainable development (Kandjinga *et al.*, 2010).

Resilience is becoming an increasing part of disaster studies and related disciplines (Manyena, 2014). Over the past four decades, the concept of community resilience has gained prominence in science and policy circles (Renschler *et al.*, 2010). Diffusion of the concept of community resilience also signifies the recognition of the fact that not all threats can be avoided and there should be mechanisms in place to ensure that disturbances are kept to a minimum (Renschler *et al.*, 2010). In response to concerns about the consequences of an increase in frequency and severity of disaster events such as floods, Hyogo Framework for Action in 2005 and later Sendai Framework for Disaster Risk Reduction were adopted to enhance resilience to disasters (Saja *et al.*, 2018). Both Zambia and Namibia are signatories to these frameworks and have used them in drafting their country policies. A rapidly growing body of knowledge and community of practice in applying resilience thinking to disaster risk management gained prominence after the adoption of these frameworks. As a result, there have been several competing notions and definitions of resilience (Manyena, 2014).

“Resilience is the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat” (Cutter *et al.*, 2008:599). UNISDR (2008:21) defines resilience as “the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure”. Furthermore, Cutter *et al.* (2014) define community resilience as a concept that “enhances the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to actual or potential adverse events in a timely and efficient manner”. While, Holling (1973:14) defines resilience as “a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables”. The term has been widely adopted as a way of framing the complex dynamics between linked social-ecological

systems and their ability to respond to disturbance (Carpenter *et al.*, 2001; Folke *et al.*, 2002). Ecologists were the first to embrace the general concept of resilience. Since then, it has been adapted or reinvented for the case of short-term disasters and long-term phenomena, such as climate change. It was applied in ecology to understand and explain the trajectories of ecological systems as they seek equilibrium (Alexander, 2013). The concept in ecological sciences largely focus on the capacity of a system to absorb changes but still maintain its core function (Nguyen and James, 2013). More recent conceptualisations of resilience, mostly with regard to human systems, give greater recognition to the potential need of a system to adapt and change its core structures and functions (Aldunce *et al.*, 2015).

There is little integration across domains and disciplines on community resilience assessment, its driving forces, and geographic variability (Cutter *et al.*, 2014). There is a consensus among hazard scholars that the first step toward community disaster resilience should be focused on understanding (Cutter, 2016). Irajifar *et al.* (2013) revealed that most of the frameworks for measuring disaster resiliency are generic and broader in the context of environmental hazards. Variables and attributes of some of the frameworks are not workable at a community level for measurement purposes. Their application is clumsy at a local level, particularly where the availability of data for certain indicators is a challenge. They further suggested that defining a proper context and scale for resiliency models is necessary to provide a consistent basis for data development required for assessment. Many of the analytical frameworks for assessing adaptive capacity based on a large scale such as the national level, and less attention was given to represent capacity at local and community levels (Thatsarani and Gunaratne, 2018). It is against this background that this study seeks to develop a resilience analytical framework for quantifying floods resilience at household level by applying the concepts of livelihood capital, adaptation and flood preparedness. The main purpose of an analytical framework is to indicate the information to be collected in order to analyse the subject, and indicate how the information is put together in the analysis (Levine, 2014).

Therefore this study's objectives were to develop a Household Flood Disaster Resilience Framework (HFDRF), and assess the overall households flood disaster resilience through the development of composite indexes of livelihood capital, flood preparedness and adaptive capacity. The Sustainable Livelihood Approach (SLA) was the basis for identifying the indicators in this study. The development of a HFDRF will help in understanding the rural household's level of flood resilience in the study area. The framework can be used as a monitoring tool in tracking flood resilience at the household level in Zambia and Namibia. Furthermore, assessment of flood disaster resilience will help in developing hazard specific policies and programmes, therefore, reducing the negative impacts of floods. Measuring resilience will indicate how vulnerable the households are and, by so doing, recommendations to enhance flood disaster resilience and reduce the impacts of floods on rural households can be made to policy makers and planners.

### **6.3 Materials and Methods**

#### **6.3.1 Data Collection**

The study used a multiple items approach using both Likert scales and dichotomous responses to design questionnaires for measuring household resilience. As noted by de Vaus (2002), it is beneficial to use multiple indicators to measure the complexity of a concept. Multiple items also help to increase the reliability and precision of the measure. Data for variables were collected at household level through a questionnaire survey collected in 2015 in Zambia and Namibia. Due to funding, data was collected only in one year (2015). More information on how data was collected including the sample size is explained in Chapter 4 and 5.

#### **6.3.2 Data Analysis**

In developing a household flood disaster resilience framework and analysing data for the construction of the household flood disaster resilience composite index the following steps were followed.

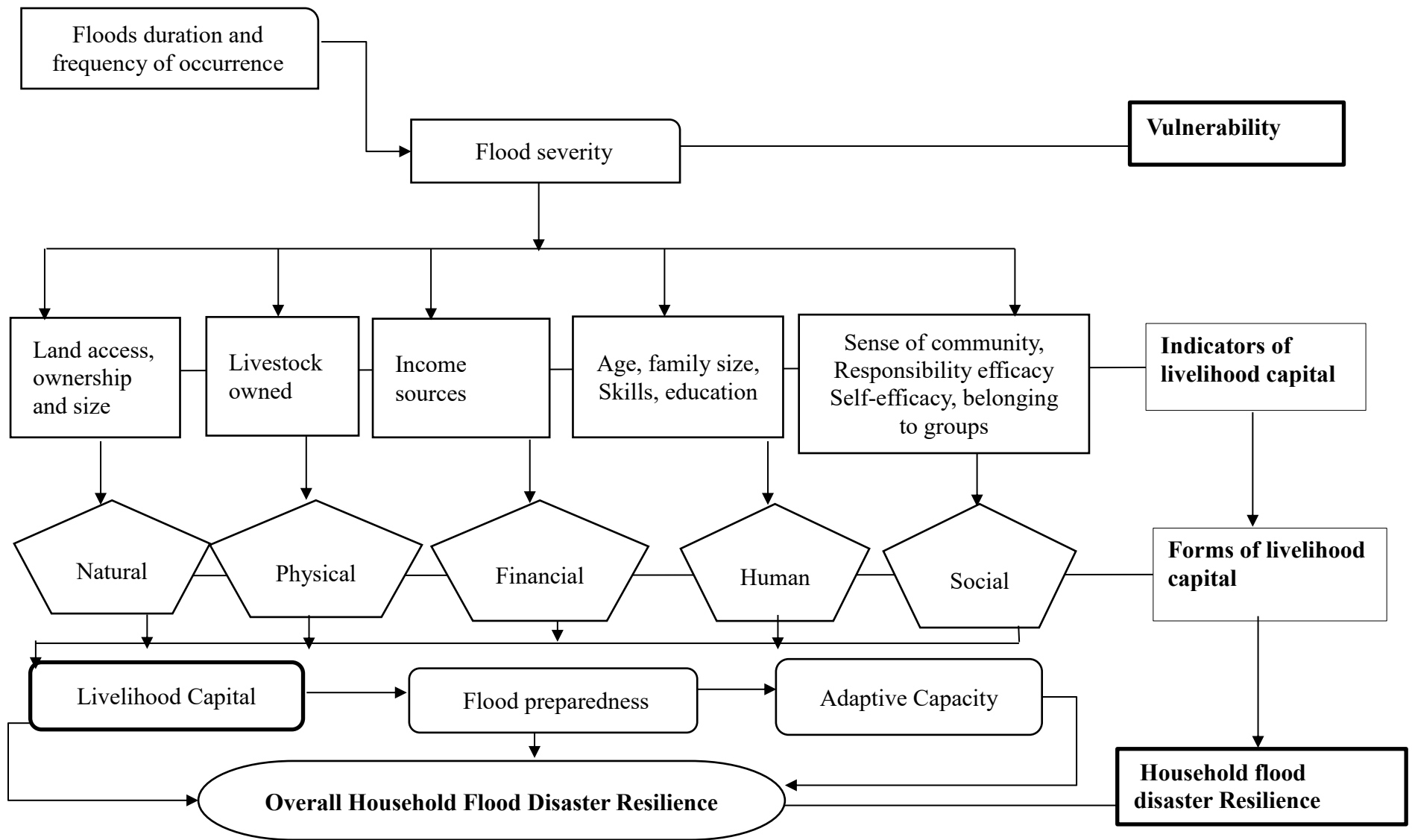
### 6.3.2.1 Conceptual Framework

This framework has been named a Household Flood Disaster Resilience Framework and is shown in Figure 6.1. In developing a Household Flood Disaster Resilience framework and assessing flood resilience, the following steps were followed: A conceptual framework can be created, or extended from an existing framework. Regardless of its origin the conceptual framework is an important step in constructing a resilience assessment because it positions the assessment in the context of the field of disaster resilience, and guides the scope and treatment of assessment elements (Parsons *et al.*, 2016). Against this background, we developed the framework and named it, “Household Flood Disaster Resilience Framework (HFDRF)”. In this study, different frameworks were reviewed and used in the development of a HFDRF. Firstly, a Sustainable Livelihood Approach (SLA) by Scoones (2016) was used to select the variables or indicators for measuring livelihood capital. The SLA is a holistic and people centered approach to understanding and addressing the various and diverse factors that influence poverty or wellbeing and the typical relationships between these factors. At the centre of this approach is an analysis of the resources or capital that poor people and communities have access to and use. These capital are five and are; natural, physical, financial, social and human. HFDRF adopted SLA’s five livelihood capital as one of the variables to measure resilience. A number of researchers adopted the SLA’s five livelihood capital as indicators of resilience (Elasha and Elhassan, 2005; Manyena, 2006; Keating *et al.*, 2017).

The second framework reviewed and adopted was the Household Livelihood Resilience Approach (HLRA) by Quandt (2018). This approach draws from the Sustainable Livelihoods Approach and the five capital to measure resilience. However this framework goes further to measure livelihood resilience in Kenya and the effectiveness of agro-forestry in building livelihood resilience for agricultural households. The framework measured resilience at a household level and further provided methods to analyze, visualize, and interpret results of livelihood resilience (Quandt, 2018). Disaster resilience was assessed using indicators related to community connectedness, available resources, planning and procedures and risk and vulnerability (Arbon *et al.*, 2016).

Responses to questions were scored using a Likert scale and added to form an overall assessment of disaster resilience in the community in which the survey was undertaken. HFDRF follows the methods of analysis from HLRA. The third framework was by Kusumastuti *et al.* (2014) who developed a resilience framework using 49 indicators of preparedness dimension and 18 indicators of vulnerability. Preparedness was one of the dimensions of resilience included in this study.

Finally, we reviewed the Australian Natural Disaster Resilience Index (ANDRI) (Parsons *et al.*, 2016). This framework audits the state of disaster resilience in Australia at one point in time. The ANDRI assessment of disaster resilience distinguishes two sets of capacities: coping capacities and adaptive capacities. HFDRF included the dimension of coping and adaptive capacity in measuring flood disaster resilience as in ANDRI. Other resilience frameworks reviewed include the Prevalent Vulnerability Index (PVI) which assesses predominant disaster vulnerability conditions by measuring exposure in prone areas, socioeconomic fragility and lack of social resilience across countries in Central and South America (Cardona *et al.*, 2010).



**Figure 6. 1 Household Flood Disaster resilience Framework**

### 6.3.2.2 Selecting variables

The second step toward developing a HFDRF and Household Flood Disaster Resilience (HFDR) composite index was the identification of relevant, measurable, and robust indicators as recommended by (Asadzadeh *et al.*,2015, 2017a). Indicators were selected based on their analytical soundness, measurability, relevance to the phenomenon being measured and relationship to each other. In this case, five livelihood capital, flood preparedness, adaptive capacity (coping and adaptation) were the selected indicators. Adaptive capacity indicators were all the coping and adaptation strategies adopted by the households. Below are the different variables or indicators included in HFDRF and composite index.

#### i. Livelihood capital variables

This step involved selecting livelihood capital indicators or variables that measure the five capital as defined by the SLA (Scoones, 2016). Table 6.1 shows the variables and indicators selected to measure different livelihood capital. The sum of all the yes response under each livelihood capital category made up the index of each livelihood capital.

**Table 6. 1 Selected indicators of livelihood capital**

<b>Livelihood Capital</b>	<b>Quantitative Indicators</b>	<b>Scale</b>
Financial Capital	Remittances and gifts	1=Yes, 0=No
	Thatched grass and reeds income	1=Yes, 0=No
	Crop sale	1=Yes, 0=No
	Livestock sale	1=Yes, 0=No
	Pension grants	1=Yes, 0=No
	Social grants	1=Yes, 0=No
	Part time job	1=Yes, 0=No
	Wildlife returns from conservancies	1=Yes, 0=No
	Business	1=Yes, 0=No
	Other income sources	1=Yes, 0=No
Human Capital	Percentage of households within productive age (18-65)	1=18-65 years, 0=otherwise



<b>Livelihood Capital</b>	<b>Quantitative Indicators</b>	<b>Scale</b>
	Household head with primary education	1=Yes, 0=No
	Household head with secondary education	1=Yes, 0=No
	Household head with tertiary education	1=Yes, 0=No
	Household member has wood carving skill	1=Yes, 0=No
	Household member has gardening skill	1=Yes, 0=No
	Household member has traditional medicine skill	1=Yes, 0=No
	Household member has cropping and livestock rearing skills	1=Yes, 0=No
	Household member has weaving skill	1=Yes, 0=No
	Household member has construction skill	1=Yes, 0=No
	Household member has craft making skill	1=Yes, 0=No
Social Capital	Household member has sewing skill	1=Yes, 0=No
	Household member has fishing skill	1=Yes, 0=No
	Household member has hunting skill	1=Yes, 0=No
	Sense of community	1=High, 0=low
	Responsibility efficacy	1=High, 0=low
	Self-efficacy	1=High, 0=low
Natural Capital	Critical awareness	1=High, 0=low
	Risk perception	1=High, 0=low
	Participation in groups	No of groups
	Access to land	1=Yes, 0=No
	Size of land	No of ha
Physical Capital	Ownership of land	1=Yes, 0=No
	Crop harvested	ha
	Total number of livestock owned (pigs, cattle, goats, horses, sheep, donkeys)	No. or Number

ii. Flood preparedness variables

Similar to Kusumastuti *et al.* (2014) who developed a resilience framework using 49 indicators of preparedness dimensions and 18 indicators of vulnerability, preparedness was one of the dimension of resilience in this study. A flood preparedness scale was designed with 47 items or questions. More details on the items or questions on preparedness scale are found in (Mabuku *et al.*, 2018). The items on the scale were grouped into six components as indicated in Table 6.2. The 47 items on flood preparedness scale measured the extent to which a person or household was prepared for floods. Respondents indicated the extent of their preparedness with regard to each

item on a 3-point scale: 1 = yes, 2=no and 3=I don't know. The questions were recorded to a dichotomous scale: 1= yes, 0 = otherwise (no and don't know). The score was calculated by summing up all the yes responses. The score range was 0 to 47. The inference is that households with higher scores had higher preparedness levels and therefore more resilient to floods. More details on indicators in each category is available in (Mabuku *et al.*, 2018). The results were normalised using the normalisation equation.

**Table 6. 2 Flood preparedness indicators**

<b>Flood preparedness indicators</b>	<b>Scale</b>
Resource availability	1=Yes, 0=No
Preparedness Knowledge	1=Yes, 0=No
Emergency plan	1=Yes, 0=No
Warning system	1=Yes, 0=No
Response Mechanism	1=Yes, 0=No
Education and training	1=Yes, 0=No

iii. Adaptive capacity indicators

Following Quandt (2018) who measured resilience using coping and adaptive capacity indicators, HFDRF consisted of all the short term coping and long term adaptation strategies a household adopted. The assumption was made that the more the adaptation strategies a households had, the more diversified were their livelihoods and therefore higher flood resilience. Table 6.3 indicates the coping and adaptation variables used to measure flood resilience. The summation of all the yes response is the index representing Adaptive Capacity

**Table 6. 3 Coping and adaptation indicators used in measuring flood resilience**

<b>Coping strategies</b>	<b>Scale</b>
Participated in part-time job	1=Yes, 0=No
Collected wild food	1=Yes, 0=No
Sold reeds and grass	1=Yes, 0=No
Received food aid	1=Yes, 0=No
Sold firewood	1=Yes, 0=No
Borrowed from items (food, money etc) from relatives	1=Yes, 0=No
Other (charcoal production, sale of poles, gardening)	1=Yes, 0=No
<b>Adaptation strategies</b>	<b>Scale</b>

Tree planting	1=Yes, 0=No
Acquiring better skills on how to prepare for floods	1=Yes, 0=No
Relocation to higher ground	1=Yes, 0=No
Constructing flood proof houses or elevating the houses very high	1=Yes, 0=No
Adoption of flood resistance crops	1=Yes, 0=No
Improve post-harvest storage and marketing of produce	1=Yes, 0=No
Adoption of conservation agriculture,	1=yes, 0=No
Strengthening of early warning systems	1=yes, 0=No
Fish farming	1=yes, 0=No
Changing planting dates	1=yes, 0=No
Flood water harvesting	1=yes, 0=No
Pray	1=yes, 0=No
Other (mafisa cattle trade, live with floods, water diversion)	1=yes, 0=No

### 6.3.2.3 Imputation of Missing Data and Data Normalisation

The third step involved imputing missing values. Extreme values were examined as they could become unintended benchmarks. In this case, missing values were not included in the analysis. Other methods of handling missing values exist such as regression, multiple imputations, nearest neighbour and so on. Since indicators are expressed in different statistical units, ranges or scales, this step involved transforming them into a common scale or measurement unit through data normalization or data standardization techniques (Asadzadeh *et al.*, 2015). This step is crucial prior to any data aggregation as the indicators in a data set had different measurement units. Indicators were normalised to render them comparable by using linear scaling (ranging) transformation method. Ranging is the transformation of the original range of data that is usually performed through employing Min-Max (Minimum-Maximum) scaling technique (Asadzadeh *et al.*, 2017b). Min-Max decomposes each indicators' value into the same range between 0 and 1 and provides easily understood comparisons among places at a particular point in time (Asadzadeh *et al.*, 2017b). Most resilience indices have used simple correlation technique or mostly applied min-max (linear scaling) ranging method to transform values. The Min-Max equation is;

$$x_{sc} = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (6.1)$$

Where  $x_{sc}$  = Standardized value

$X$  = Value of the indicator measured in any unit

$X_{\min}$  = pre-determined minimum values

$X_{\max}$  = Pre-determined maximum values.

An assumption was made that higher scores of livelihood capital base, adaptive capacity and flood preparedness indicated higher levels of households' resilience.

#### **6.3.2.4 Weighting**

In this study each indicator was given equal weights to aid interpretation and reduce ambiguity. Weighting always takes place when elements are combined together (Mayunga, 2007). Thus, if the domains are summed together to create an overall index, this means that they are given equal weight, it would be incorrect to assume that items can be combined without weighting (Mayunga, 2007). There are other possible approaches used to assign weights to different domains (Mayunga, 2007). First, weight could be assigned based on the availability of research evidence on the theoretical model of a concept to be measured. Secondly, survey or statistical analysis techniques such as factor analysis could be used to generate weights. Thirdly, the score of individual domains can be weighted and combined in accordance with the focus of particular policy initiatives. Fourthly, weights can be generated through interviews with policymakers and other stakeholders or experts. Finally, weights could be assigned entirely arbitrarily, for example selecting equal weights in the absence of empirical evidence.

#### **6.3.2.5 Aggregation**

The next step was to create a composite index consisting of livelihood capital, flood preparedness and adaptive capacity for each household. An index is often composed of several different indicators combined using some mathematical formulae to give a single value called an index or rank (Simpson, 2008). Indices are powerful tools because of their ability to summarize more complicated technical data into a simpler way that non-experts can easily understand (Birkmann, 2006). Indicators were aggregated according to the underlying theoretical framework. This was done following

the guidelines in Quandt (2018). To create the composite index for each of the five livelihood capital the individual indicator scores were averaged for each household (Campbell *et al.*, 2001; Erenstein *et al.*, 2007). This means that for each household, all the results for each livelihood capital, flood preparedness and adaptive capacity were averaged and aggregated to come up with a household flood resilience index. The equation below shows how the composite index was calculated following recommendation from Mayunga (2007).

$$HFDRI = \frac{\Sigma(SCIw_i+FCIw_i+HCIw_i+PCw_i+NCIw_i+FPIw_i+ACIw_i)}{n} \quad (6.2)$$

Where HFDRI = Overall Household Flood Disaster Resilience Index

SCI = Social Capital Index

FCI =Financial Capital Index

HCI =Human Capital Index

PC = Physical Capital Index

NCI =Natural Capital Index

FPI= Flood Preparedness Index

ACI=Adaptive Capacity Index

w<sub>i</sub> = Weight for Index *i*

n =Number of resilience indicators

The results of the composite index ranged from 0 to 1. The interpretation was that any index above 0.5 had above average resilience and any household that scored below 0.5 had below average resilience score.

#### **6.4 Results and Discussions**

The results of HFDRI shows that Eastern Zambezi Region of Namibia had an average resilience index scores of 0.5 while Mwanzi district of Zambia results indicated below average resilience index score of 0.4. There was a statistically significant difference in resilience mean scores between Mwanzi district of Zambia and Eastern Zambezi region of Zambia (p<0.001). The following sections describe the different parts of the HFDRF

and the calculated scores of different indicators that made up a Household Flood Disaster Resilience Composite Index (HFDRI)

#### **6.4.1 Vulnerability: Flood severity**

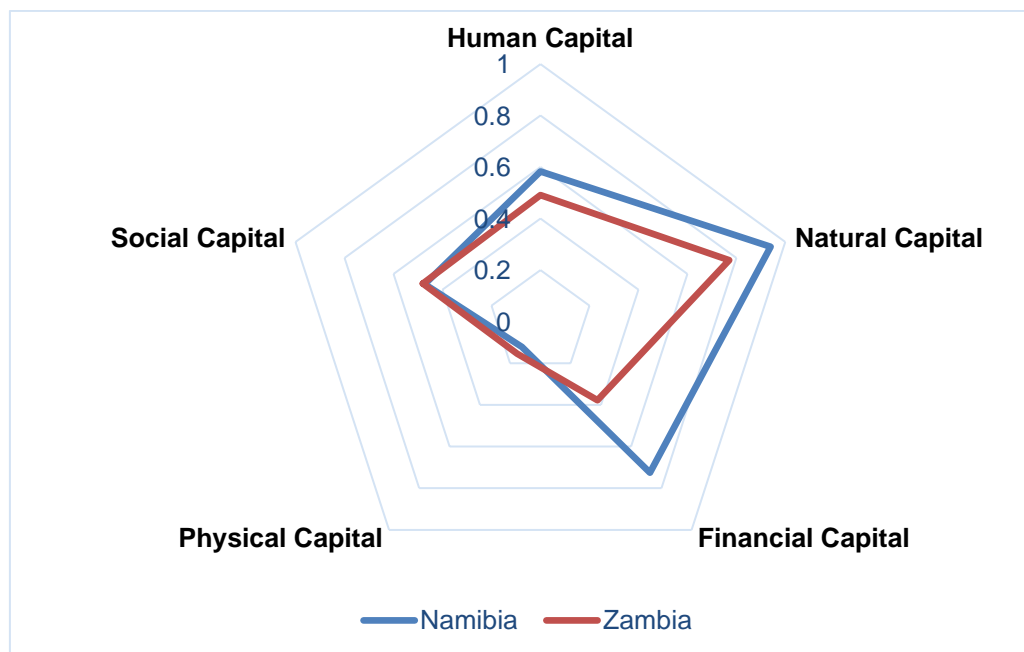
In the framework, the vulnerability is defined by the presence of floods and the frequency of occurrence. In this case, flood severity is a function of the duration and frequency of flood occurrence. Flood duration in this is defined as the number of months from the time water affected the households to the time the water receded, allowing people to continue their normal daily activities. While, frequency of occurrence was defined as the number of years the floods have struck in the study area. The flood severity has an impact on the different indicators of livelihood capital such as land, crops, livestock, schools, clinics, etc. These impacts could be negative or positive depending on how severe the floods are. In this study, the results of flood severity was 0.47 in Namibia and 0.44 in Zambia as in Table 6.4. These results were statistically significant different ( $P < 0.001$ ). Eastern Zambezi region of Namibia experience flood hazards more frequently and of longer duration as compared to Mwandia district of Zambia. The assumption is that the higher the score of flood severity the more severe the floods and the less resilience the households were. More floods occurrence and number of months households were flooded affected their resilience.

#### **6.4.2 Forms of Livelihood Capital**

Capital are considered to be stocks of different types of assets that can be used directly or indirectly to generate livelihoods. They can give rise to a flow of output, possibly becoming depleted as a consequence, or may be accumulated as a surplus to be invested in future productive activities. Based on the five types of capital identified by the sustainable livelihood framework, five types of capital are identified. These are social, physical, financial, natural and human. Livelihood capital was generally higher in Namibia than in Zambia, with access to natural, financial and human capital higher than social and physical capital as indicated in Figure 6.2. These differences could be attributed to a country's level of economic development status, e.g., GDP.

Economically Namibia is better than Zambia, this would manifest in the differences observed in most of the results.

Financial and natural capital were accessed better in both countries as the scores were all above the average. The access to social and physical capital was almost similar in both countries but was below average for both study sites. Both physical and social capital reflected poor accessibility in both the study sites. They were found to be relatively lower in both study areas. The physical capital which is closer to the centre of the pentagon shows that its access was the least in both Zambia and Namibia. For all the livelihood strategies adopted financial and natural capital were relatively the most owned by all the households considering their positioning away from the centre of the pentagonal radar. Figure 6.2 and Table 6.4 shows the mean scores or indices of different capital in the study area.



**Figure 6.2 Livelihood Capital scores for Mwandu district of Zambia and Eastern Zambezi region of Namibia**

**Table 6. 4 Household Flood Disaster Resilience Framework components mean scores and their t test results**

<b>Indices</b>	<b>Namibia's mean scores</b>	<b>Zambia's mean scores</b>	<b>Significance</b>
Flood Severity	0.47	0.44	0.001***
Human Capital Index	0.58	0.49	0.026**
Natural Capital Index	0.94	0.77	0.000***
Financial Capital Index	0.73	0.38	0.000***
Physical Capital Index	0.12	0.15	0.000***
Social Capital Index	0.47	0.48	0.476
Flood Preparedness Index	0.56	0.48	0.000***
Adaptive Capacity Index	0.10	0.14	0.272
HFDRI	0.50	0.41	0.000***

Note: \*\*\* statistically significant at 0.001, \*\*0.05 and \*0.1

a) Human Capital

According to Mayunga (2007), human capital is one of the most important determinants of resilience among other forms of capital. For instance, knowledge and skill of individuals on hazards, hazard history, and hazard risk in their community can be an important resource in building community resilience (Mayunga, 2007). Economists define the concept of human capital as the capabilities both innate and derived or accumulated, embodied in the working-age population that allows it to work productively with other forms of capital to sustain the economic production (Smith *et al.*, 2001). The more the human capital available in the community, the more the capacity for building resilience to any form of disasters. Human capital is referred to education and includes knowledge and skills that are accumulated through forms of education attainment, training, and experience (Mayunga, 2007). It also applies to any other advantages people have, including disaster experiences, which give them the ability to cope with, adapt to, and recover from disasters. The results of human capital index in this study indicated a mean score of 0.58 in eastern Zambezi region of Namibia and a mean score of 0.49 in Mwandia District of Zambia. Households in Namibia had more access to human capital than those in Zambia and these results were statistically significantly different between the two study sites ( $p < 0.05$ ). On average more



Namibians reported a higher number of skills, labour availability and level of education than the households in Mwandia district of Zambia. However, Zambians had higher number of productive age (18-65years) than the Namibians. Children and the elderly tend to have less capacity to adapt due to the less physical strength to survive disasters, elderly often have less education and have fewer financial resources.

#### b) Natural Capital

Land is among one of the productive natural capital and sign of wealth of people which enable them to live in peace and honour in the rural space (Israr and Khan, 2010). It is considered as one of the important natural capital and its productivity increases the portfolio of livelihood strategy. The livelihood of many rural people depends on natural capital (Israr and Khan, 2010). It has greater significance in livelihoods on poor agriculture-based communities. Those households who have access to land have better livelihood opportunity and wellbeing, therefore fore able to respond to disasters when they strike. Furthermore, access to productive land enables the household to have better opportunities in increasing the agriculture production and hence wellbeing which eventually translates to higher resilience to disasters especially floods. The natural capital index indicated a higher access in Namibia (0.94) than Zambia (0.77). These results were statistically significantly different between the two study sites ( $p < 0.001$ ). This means that more households had more access to land, had more ownership of land and bigger size of land in Namibia than in Zambia. However, all these indicators had above average scores in both study areas. Both study sites had above average access to natural capital.

#### c) Financial Capital

Financial capital was measured by the different income sources each household had access to and those receiving any form of social grants. Namibia scored highly on financial capital than Zambia. The scores in Namibia were above average (0.73) and were below average in Zambia (0.31). These differences were statistically significant different ( $p < 0.001$ ). More Namibians had access to more income sources and form of

social grants such as pension, child support and other as opposed to Zambians. This meant that Namibians were able to diversify their livelihoods more as they had many choices in terms of their income sources. More livelihood diversifying could translate to higher flood resilience.

#### d) Physical Capital

Physical capital is one of the most important resources in building capacity of the community to cope with disasters because it allows people to develop livelihood strategies that improve their resilience (Mayunga, 2007). Evidence has existed for some time that people who have access to physical capital are generally better prepared for disasters including flooding than those who have not. Physical capital was reported 0.12 scores in Namibia and 0.15 scores in Zambia. Zambia reported higher scores in physical capital than Namibians. However, physical capital was below average in both countries. There was a statistically significant difference between the scores in two countries ( $p < 0.001$ ). Physical capital included all the livestock owned by the households. In this regard more Namibians had more livestock than Zambians, however, the scores for both countries were way below the average.

#### e) Social Capital

According to Norris *et al.* (2008:137), “individuals invest, access, and use resources embedded in social networks to gain returns”. In this study, social capital incorporates several subcategories which includes a sense of community, responsibility efficacy, participation in organization etc. Social capital in Zambia had scores of 0.48 while Namibia had scores of 0.47. However, these scores were not statistically significantly different between the two study sites. These scores were below the average for both countries. Social capital is very important in resilience. Social capital is related to human well-being and security, mostly on a societal rather than individual level. Out of all the capital, the most influential factor is the social capital.

### **6.4.3 Flood Preparedness**

Flood preparedness is measured by a number of indicators which are grouped into the following: flood preparedness knowledge and skills, emergency plan in place, availability of a household evacuation plan when a flood disaster strike, the existence of an early warning system and the effectiveness of the warning system in place, response mechanism, and availability of assistance during flood, education and training. Higher preparedness in Namibia than in Zambia with scores of 0.56 and 0.48 respectively were reported. The results were statistically significant different ( $p < 0.001$ ). Namibia had above average flood preparedness scores while Zambia had below average flood preparedness scores. Zambians were less prepared for floods compared to Namibians.

### **6.4.4 Adaptive Capacity**

Adaptive capacity has been identified as a key component of disaster resilience but is rarely included in disaster resilience assessments (Tierney, 2014; Parsons *et al.*, 2016). Although it has been a core theme of the theoretical literature on disaster resilience, adaptive capacity and the agency of societies to transform and learn in the face of natural hazards, it is a newer concept in resilience assessment (Engle, 2011). A community's coping and adaptive capacities in the face of floods is used as proxy for its level of adaptation for future climate change. The ANDRI assessment included adaptive capacity in assessing resilience (Parsons *et al.*, 2016). In this framework, adaptive capacity is a function of all strategies adopted for coping and adapting to flooding. Within this framework, the more the coping and adaptation strategies the more adaptive capacity and therefore the more resilient the households would be. Adaptive capacity was below average in both Zambia and Namibia. Adaptive capacity index scores were 0.14 for Zambia and 0.10 for Namibia. The scores were not statistical significant different between the two study areas. In both the study sites, adaptive capacity recorded the lowest of all the elements of resilience used in the framework. This could be because the indicators used were not exhaustive.

## **6.5 Limitation of the Framework**

Although the HFDRF is beneficial to flood planning and management because it assesses the households level of resilience and helps in identifying households which may require mitigation efforts, it has some limitations.

Natural capital scores exhibit higher scores because only livestock were included in the indicators, however, the framework is flexible in that more indicators can be added to measure natural capital. The framework did not exhaust all the elements or indicators that measure resilience as per literature, it is extremely difficult to identify all the relevant indicators that influence household resilience. In addition, there are limitations to the flood preparedness and adaptive capacity in that they are not static in nature they are dynamic. Another limitation is based on the adaptive capacity, an assumption was made that the more the adaptation strategy adopted the higher the flood resilience the households were, the study did not consider the effectiveness of these strategies in reducing the impacts of floods, a stepwise progression to implementing different strategies among households and whether the households value one mechanism above all others. Further research could be carried out to fill this gap.

Lastly, in this study we assigned equal weights to all the indicators due to lack of information on these indicators, there is a possibility that these indicators may not carry same weights in reality and thus may affect the outcome. For example, long-term adaptations could be more heavy weighted than short-term coping but these were not probed during data collections and there is no literature on these indicators and their weights. Also, the effectiveness of thee adaptation strategy was not probed, as this may have been used in assigning these strategies

The HFDRF is crude but it provides an important start to an understudied aspect of risk reduction because it provides a method for assessing household resilience that may better assist communities to allocate limited resources to vulnerable households. Implementation of this framework for households' vulnerability assessments could serve as a critical tool to help enhance local resilience. While developed in the Mwandu

district of Zambia and eastern part of the Zambezi region of Namibia, the framework and the assessment steps are flexible for their application in other geographic areas.

## **6.6 Conclusions and Recommendations**

Developing an HFDRF and assessing rural households flood resilience proved helpful in summarising and presenting a number of variables linked to resilience. This chapter has proposed a composite index which shows a systematic presentation of the constituent elements that underlie resilience and include the order in which they pan out. This composite index is designed to help key stakeholders, decision makers, and the general public to easily comprehend and understand multidimensional complex systems since the results are presented as scores. HFDRF can be adjusted and refined over time. That means new data sets can be added to substitute the current sets of data or can be included as additional to the current data. Furthermore, the assessment steps can be repeated, replicated and modified.

The HFDRF recognizes that resilience is a function of three elements crucial for the survival of rural households in times of flood disasters. These elements included (i) livelihood capital measured by the five forms of capital which are: financial, social, human, physical and natural (ii) adaptive capacity which was measured by the number of coping and adaptation strategies adopted by households and (iii) floods preparedness which was measured by resources availability, preparedness knowledge, emergency plan, warning system response mechanism and education and training. The HFDRF highlights the importance of five livelihood capital, adaptive capacity and flood preparedness in measuring households flood resilience. Adaptive capacity included both short-term adaptation strategies and long-term adaptation strategies. It emphasizes that coping strategies are equally important as long term adaptation strategies as the rural community will most likely continue settling in flood-prone areas. Households will still need the means to cope as the floods strike.

The framework was operationalized to the data from eastern Zambezi region of Namibia and Mwandu district of Zambia. The results indicated slightly above average

households flood disaster household resilience in Namibia and below average resilience in Zambia. This framework has provided measurements for assessing rural households' resilience in the face of flood disasters. This means households' resilience could be compared over a period of time and in different locations using similar indicators. Finally, the HFDRF builds upon the SLA, HLRA and ANDRI in seeking to address the underlying five livelihood capital, adaptive capacity and flood preparedness. The HFDRF provides a framework targeting households at local level as opposed to other frameworks which measure resilience at national level, this means that this framework will provide the guidance for implementing more sustainable practices that empower local communities to enhance flood resilience.

Finally, this framework provides a step-by-step procedure in analyzing data, which will guide the future research, data collection, and data improvement efforts. The results from this study showed that action can be taken to build resilience to hazards and strengthen adaptive capacity to further climatic shocks. Nevertheless, managing floods effectively in vulnerable areas requires diversifying livelihood strategies and income generating options, therefore the need to enhance these indicators.

It is recommended that further indicators of physical capital, natural capital and institutional be added in further resilience assessments and wider application of the framework is required to improve the methodology. Furthermore, we recommend the use of spatial analysis through the application of GIS to give an insight into the geographic distribution of flood resilience across the study area. Finally, in this framework, changes in the constituent elements of the index can be simulated to assess the impact of different policy interventions.

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## **7 CONCLUSIONS AND RECOMMENDATIONS FOR POLICY AND FURTHER RESEARCH**

### **7.1 Conclusions**

The first objective of this thesis, as outlined in Section 1.3 was the assessment of rural households' floods impacts on income, crop production and livestock ownership. This objective was presented in more detail in Chapter 3. This Chapter tested the hypothesis that there was no statistical significant difference in the income, crop produced and livestock ownership between the flooded and the non-flooded households. In order to meet this objective, a method which can be applied without the baseline study was sought and used. In Chapter 3, the use of PSM as an approach to analyze the impacts of floods by comparing the flooded and non-flooded households was explored. This approach allows planners and government to conduct an assessment which can help identify vulnerable households. This method can be implemented in impact assessment studies where baseline data is missing.

While flooded households had higher mean income from the sale of livestock, sale of crops, sale of fish, remittances and gifts than the non-flooded households in Mwandia district of Zambia, in Eastern Zambezi region of Namibia, no statistically significant differences were observed in the mean number of livestock owned between the flooded and non-flooded households. As opposed to Namibia, in Zambia flood disasters had a negative impact on flooded households' livestock ownership. Non-flooded households had higher number of livestock than flooded households. This demonstrates the need to advocate for coping and adaptation strategies against adverse flood impacts in relation to income, livestock ownerships and crop production. We conclude that indeed flood had positive and negative impacts on rural households in the study area. Flood impact assessment results from this study show that normal floods had positive impact on flooded household's crop production in Namibia. More flooded households reported higher production than the non-flooded households in Eastern Zambezi region of Namibia.

The second and third objectives outlined in Section 1.3 were to evaluate the rural households' level of flood preparedness and determine the factors that influences flood disaster preparedness. This objective is presented in more detail in Chapter 4. The chapter demonstrates that the level of rural households flood disaster preparedness varied between the two study sites. Flood preparedness was higher in eastern Zambezi region of Namibia than in Mwandu district of Zambia. Statistics showed that a majority of households in Namibia were well prepared (52%) for flood hazards whilst minority were well prepared (9%) in Zambia. These results were statistically significantly different between the two study sites. This study also investigated the different factors that influence the level of flood disaster preparedness. The results showed that factors such as high responsibility for self and others, positive outcome expectancy, feeling of worry about the risk, sense of community were associated with higher levels of rural households flood preparedness. We conclude that flood preparedness is not static in nature but dynamic and that it depended on different factors such as age, sense of community, risk perception and responsibility efficacy.

The fourth and fifth objectives were to determine the coping and adaptation strategies to flooding adopted by rural households and determine socio-economic factors influencing the choice of adaptation strategies in the study area, which is addressed in Chapter 5. This chapter highlights that rural households depended on both short-term coping and long-term adaptation strategies in order to minimize the negative impacts of floods and flood disasters. In Zambia the majority of households coped with floods through charcoal production, sale of firewood, sale of grass and reeds. On the other hand, the majority of Namibians coped by selling poles, firewood, collected wild foods and received food aid. Concerning long-term adaptation strategies, the majority of households in Zambia used both traditional and modern early warning systems, planted trees, improved post-harvest storage and marketing and flood water harvesting, relocated to higher ground temporarily, and changing planting dates, among others. In Namibia most of the long-term adaptation strategies reported were; *mafisa* cattle trading, praying, flood water harvesting, changing planting dates and fish farming. Policies that will enable households' access to free extension services have the potential to significantly increase households' awareness of changing climatic conditions and

increase their knowledge on the appropriate adaptation strategies. Identifying already existing coping and adaptation strategies can help planners develop or modify strategies which are already accepted within the rural community. It also allows planners and scientists to see what strategies work best under certain climatically and biophysical conditions and better develop a set of best practices for floods to prevent unintended negative impacts.

The sixth and last objective, of this study were to develop a Household Flood Disaster Resilience Framework (HFDRF) detailed in Chapter 6. Chapter 6 presented a step by step analysis on how to develop a composite index using livelihood capital, flood preparedness and adaptive capacity and applying these steps to Mwandia district of Zambia and Eastern Zambezi region of Namibia. The Sustainable Livelihood Approach was the basis for identifying livelihood capitals indicators in this study. The results indicated that Overall Household Flood Disaster Resilience in Namibia was average (0.5) compared to Zambia's study site which was below average (0.47). On one hand, flood severity (0.47), natural capital (0.94), financial capital (0.73), human capital (0.58), flood preparedness (0.56) had higher scores in Namibia than in Zambia and these differences were statistically significant ( $P < 0.05$ ). Moreover, adaptive capacity, physical capital and social capital were higher in Zambia than Namibia and these differences were not statistically significant between the two sites. The study concludes that household flood resilience differs across communities and that Namibians had higher resilience than Zambians. The chapter provided a guide on how to calculate a household flood resilience composite index using livelihood capital, adaptive capacity and flood preparedness. The proposed framework will provide the baseline for developing a quantitative tool to measure resilience continuously against floods and other disasters using the indicators aforementioned. The framework can be used in developing a resilience decision support system which will help policy makers and households to monitor and track resilience levels in the study area and beyond. Assessment of flood resilience will help in developing hazard specific policies and programmes therefore reducing the negative impacts of floods. Furthermore, a deep understanding of measuring resilience will indicate how vulnerable the households are and by so doing recommendations to improve resilience and reduce the impacts of

floods on rural households can be made to policy makers and planners. This objective was met as it has shown that great potential exists for measuring resilience as a tool for monitoring flood impacts and vulnerability of the rural households.

Finally, the main aim of the entire study was to assess the impacts of floods on income, crop and livestock production at household level and flood disaster preparedness in order to formulate appropriate household resilient framework for sustainable livelihood. In addition, the different socio-economic and socio-cognitive factors that influence adaptation and flood preparedness were assessed. This detailed study showed how livelihood capital, adaptation strategies adopted and preparedness levels could be used to measure the resilience of rural households, the results can contribute towards a comprehensive plan for the tracking of flood disaster resilience in Sub-Saharan Africa.

## **7.2 Recommendations for Policy and Further Research**

### **7.2.1 Recommendation for Policy**

This study has a number of implications for policy makers. In summary some of the recommendations coming out from this study are as follows. Firstly, this study has found positive and negative impacts of floods for both study areas and have applied an econometric model PSM to assess these impacts. For policy implication PSM method is an impact assessment method that can help policy makers in evaluating impacts in areas with missing baseline data. Evaluating the impacts would help decision makers in targeting the most impacted areas and sectors with negative impact.

Secondly, promoting adaptation strategies to flooding needs to consider different factors for households' in order to minimize the adverse effects of flooding on rural livelihoods. Improving the knowledge and skills of rural households on climate change and adaptation strategies should be given a high priority. The government would support household members' education through various policies. For example, adult literacy can be intensified and offered to school dropouts at affordable costs and specialised in climate change adaptation education. This will increase the skills and

knowledge towards resilience measures and better use of available information on flood disaster and climate change. Providing households with the necessary resources required to adapt to flood disaster will increase their adaptive capacity. For instance, policies that will enable households' access to affordable credit increase households' financial capital, allowing them to meet the costs associated with the various adaptation options such as relocation. Providing flood victims with resettlement subsidies would be another intervention to enhance households' relocation to higher ground during a flood disaster. Policies which will ensure that land is fairly allocated to flood victims would allow households' adopt some of the adaptation strategies. It is crucial for policy makers and government to design policies and plans informed by research through monitoring and tracking flood resilience of households, by using the framework developed in this study.

This study has recommended some interventions to enhance flood preparedness in two countries. These include among other; the need for policy makers and disaster management practitioners to acknowledge and understand that there are factors influencing flood preparedness which are crucial for emergency planning and management. These factors may be crucial to target interventions aimed at increasing preparedness for flood hazards. The results on household preparedness would help to understand the state of flood preparedness and the implications of various factors influencing households 'flood preparedness. Education and training is required to change the mind-set of the households regarding a need to prepare for floods. For example, understanding that households have a responsibility to prepare for floods and not rely on handouts from the government could be emphasised. This could be carried out through education and training which would be aimed at changing attitudes needed to address beliefs that are more likely to impact preparedness behavior. Another method would be to promote social learning through exchange of experiences. It is reported that when individuals observe others exhibiting preparedness behaviour in a disaster prone area, such individuals are able to confirm that these behaviours are appropriate and effective. Another way would be to allow households participate in hazard planning, identification and preparedness exercises, something hands on that would raise the level of flood preparedness. The study recommend the involvements of psychologists in

counselling flood victims and also to sensitise them on the need to prepare for floods and enhance resilience.

Developing a HFDRF and assessing rural households flood resilience proved helpful in summarising and presenting a number of variables linked to resilience. This chapter has proposed a composite index which shows a systematic presentation of the constituent elements that underlie resilience and include the order in which they pan out. This composite index is designed to help key stakeholders, decision makers, and the general public to easily comprehend and understand multi-dimensional complicated systems since the results are presented as scores.

Finally, this research contributes to the body of literature which is primarily focused on the state of flood preparedness, adaptation and consequently resilience which are some of the key components of disaster risk reduction. The researcher expects that this study will be of use to disaster management practitioners such as policy makers, business organizations and academicians as well as research scholars.

### **7.2.2 Recommendations for Further Research**

In order to compliment government efforts at the policy level, academic research on climate change impacts, flood preparedness, adaptation and resilience must advance knowledge on these. The following measures could be adopted in future research in order to monitor and enhance disaster resilience and design the appropriate disaster risk reduction strategies.

- Further research on the impacts of flood is recommended since this study only focused of agriculture based impacts.
- In analysing impacts of flood using PSM, larger sample size is recommended as more non-flooded households were discarded during matching step. Furthermore, data can be collected at different flood events to account for the differences in the outcomes as well as including as many as possible confounders in estimating propensity scores.



- There is a need for academic research in Zambia and Namibia and beyond to further capture the socio-demographic, political, cultural, economic, and other dimensions of flood preparedness and adaptation. In this study the factors were only limited to demographic and socio-cognitive as the starting point.
- This study identified the coping and adaptation strategies for flood but did not evaluate their effectiveness in reducing the negative impacts of floods, it is recommended that further research be carried out to evaluate the effectiveness of these adaptation strategies. Further analysis on the livelihood capitals and how they frame adaptation to flooding could be further investigated.
- It's recommended that further study explore the institutional set up of flood disaster management in the two countries, this could explain the differences observed in two countries.
- There is also a need to look at the causal linkages in the factors influencing the choice of adaptation strategies and level of preparedness as this will help to understand linkages among different factors of preparedness and adaptation. In this study factors were looked as linear. For instance, outcome expectancy and responsibility efficacy are found to be more significant in promoting level of flood preparedness, further research in identifying and promoting factors that influences outcome expectancy and perceived responsibility efficacy could be carried out.
- It is recommended that further indicators of physical capital, natural capital and institutional be added in further resilience assessments and wider application of the framework is required to improve the methodology. The use of spatial analysis through the application of GIS to give an insight into the geographic distribution of flood resilience across the study area is highly recommended.

## APPENDIX 1: ETHICAL CLEARANCE LETTER



10 June 2015

Ms Monde Patrina Mabuku 214584737  
School of Bioresources Engineering  
Pietermaritzburg Campus

Dear Ms Mabuku

Protocol reference number: HSS/0596/015D  
Project title: Flood preparedness and economic impacts of floods on rural households

### Full Approval – Expedited Application

In response to your application received on 28 May 2015, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

**PLEASE NOTE:** Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Dr Shamila Naidoo  
On behalf of Dr Shenuka Singh (Chair)  
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr Aidan Senzanje, Dr Maxwell Mudhara & Prof Jewitt  
Cc Academic Leader Research: Prof Onesimo Mutanga  
Cc School Administrator: Ms Marsha Manjoo

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Humanities & Social Sciences Research Ethics Committee  
Dr Shenuka Singh (Chair)  
Westville Campus, Govan Mbeki Building  
Postal Address: Private Bag X94001, Durban 4000  
Telephone: +27 (0) 31 260 3587/8350/4557 Facsimile: +27 (0) 31 260 4609 Email: [ximbap@ukzn.ac.za](mailto:ximbap@ukzn.ac.za) / [snvmanm@ukzn.ac.za](mailto:snvmanm@ukzn.ac.za) / [mohunp@ukzn.ac.za](mailto:mohunp@ukzn.ac.za)  
Website: [www.ukzn.ac.za](http://www.ukzn.ac.za)

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## APPENDIX 2: LETTER OF AUTHORISATION FROM NAMIBIA



### REPUBLIC OF NAMIBIA ZAMBEZI REGIONAL COUNCIL



Tel: +264 66- 26 1700  
Fax: +264 66-25 2650

Ngoma Road  
Govt. Building

Private Bag 5002  
Katima Mulilo  
Namibia

Enquires: Ms. C.L Chunga

Our Ref:  
Your Ref:

Date  
20 March 2015

Dear Ms. Monde Mabuku

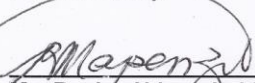
**SUBJECT: REQUEST FOR CONSENT TO CARRY OUT A STUDY IN EASTERN ZAMBEZI**

I refer to your letter dated 02 March 2015, bearing the above subject matter is hereby acknowledged and refers.

Kindly be informed that permission to carry out a study in Eastern Zambezi is hereby approved.

I hope you will find the above to be in order.

Yours sincerely,

  
Ms. Regina Ndopu-Lubinda  
Chief Regional Officer



All official correspondence must be addressed to the Chief Regional Officer

## APPENDIX 3: HOUSEHOLD QUESTIONNAIRE



### Flood disaster preparedness and economic impacts on rural household's Survey

This questionnaire is part of a research project to examine the flood impacts and preparedness of rural households. Your responses are important in enabling me in obtaining an understanding as possible of this topical issue. The study is being conducted through the **University of KwaZulu-Natal** and sponsored by **WaterNet**. Your decision to take part is entirely voluntarily. If you decide to take part in this questionnaire, the information will be treated in the strictest confidence.

Name of interviewer: .....

Name of interviewee.....

Date of interview:  
.....

Village Name:  
.....

Constituency.....

Ward:  
.....

Country:.....

**Your answers are confidential**

#### Section A: Human assets

**PLEASE ENTER CODES PROVIDED ONE PER QUESTION.**

What is the age of the head of the household? Enter the age

What is the sex of head of household? **Enter the code (1=Male, 2=Female)**

What is the head of the household marital status? **Enter the code (codes 1=Single, 2=Married, 3=Living together, 4=Separated, 5=Divorced, 6=Widowed)**

What is the head of house designation? **Enter the code (codes 1=employed 2=Unemployed, 3= Student)**

A5. What is the level of formal education you have attained? **Enter the code (codes 1= grade 1-4, 2 = grade 5-7, 3= grade 8-10, 4= grade 11-12, 5=Tertiary, 6=Adult literacy, 7=Never attended)**

A6. How many members of the households are females?

A6.1. how many females are in the following age groups **(Enter number)**

**Less or equal to 20 years old,**

**21 to 30 years old,**

**31 to 40years old,**

**Equal or greater than 41).**

A7. How many of the members of the households are males

A7.1. How many males are in the following age groups **(Enter number)**

**Less or equal to 20 years old,**

**21 to 30 years old,**

**31 to 40years old,**

**Equal or greater than 41 years).**

A7. How long have you lived in this community? **Enter the code (codes 1 = <10 years, 2 = 11-20 years, 3 = All my life)**

A7.1. If you have lived in this community for less than 10 years, where did you live before? **Enter code (1=Flood areas, 2=high ground)**

A7.2. why did you move from where you lived 10 years ago to this community now? **Enter code (1=flood, 2=marriage, 3= drought, 4=employment, 5=other)**

A8. Please indicate the skills that your household members possesses, **tick all that apply?**

<b>Skill</b>	<b>Tick</b>
Wood carving	
Gardening	
Traditional medicine	
Carpentry	
Cropping and livestock rearing	
Weaving	

Home construction	
Craft making	
Sewing	
Fishing	
Hunting	
None	
other	

## B. Disaster or hazard and vulnerability

### **Now I would like to ask you questions about vulnerability and disasters of your household.**

To what extent do you agree with the following statements? Please do not skip any of the statements. Please enter code (codes, 1=strongly agree, 2=agree, 3=Sometimes, 4=disagree, 5=strongly disagree)

Did you experience high commodity prices in 2015	
Did you experience any pests and diseases outbreak in 2015	
Did you experience poor governance in 2015	
Did you experience floods in 2015	
Did you experience drought in 2015	

B2. To what extent has the following disaster affected your households in 2015

Disasters type	Hectares of farming land affected/destroyed	Number of livestock affected(died,sick)	Estimated monthly income lost due

			to the disaster
Flood			
Drought			
Pest and disease outbreak			
Others (Specify)			

How did you cope with these disasters above? **(tick all that applies)**

Did nothing	
Participated in piece work	
Collected wild food	
Sold reeds and grass	
Received food aid	
Sold firewood	
Borrowed from relatives	
Other (Specify)	

What time of the year are you likely to experience these disasters and for how long? **(CHECK ALL THAT APPLIES)**. For the time of the year: indicate names of the months

Disasters	Time of year	Duration
Flood		
Drought		

**Answer this section if household is affected by a flood disaster**

How has the flood occurrence in your village changed during the past 10 years? **(CHECK 1 RESPONSE) (1=Major decline, 2=Minor decline, 3=No change, 4=Minor increase, 5=Major increase, 6=Don't know)**



Over the last 12 years indicate which years you have experienced flood disaster. (**Tick the appropriate box for which year you have experienced flood**)

2004	
2005	
2006	
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	

Since 2004 until now, Do you think flooding area extent is increasing, decreasing, and constant or don't know? **Enter code (1=increasing, 2=decreasing, 3=constant, 4=don't know)**

Give reasons if there is an increase in flood area extent and rank them (1= most important, 2 = second most important, 3 = third most important, 4= forth most important)? (DO NOT READ THE RESPONSES)

<b>Reason</b>	<b>Degree of importance</b>
Too many people encroaching flood plains	
Agricultural expansion	
Increase in demand for reeds and papyrus	
Government rules	
Deforestation	
Don't know	
Other (specify)	

What adaptation strategies have you adopted in order to reduce the impacts of flooding on income, agricultural production and rank them according to the importance. **Check all that applies**

<b>Adaptation strategies</b>	<b>Tick the strategy</b>
Tree planting	
Better skills on how to prepare for floods	
Relocation to higher grounds permanently	
Constructing flood proof houses or elevating the houses high	
Adoption of flood resistance crops such as rice	
Improve post-harvest storage and marketing of produce	
Sustainable and appropriate programmes for both crops and livestock such as conservation agriculture	
Strengthening of early warning systems and preparedness	
Practicing in aquaculture	
Soil conservation	
Early and late planting	
Flood water harvesting	
Pray	
None	
Don't know	
Other (specify)	

**Please check more than one field per question in this section (Tick all that applies)**

B12. Please indicate the 2015 sources of income for your household and indicate the estimated monthly income obtained from such sources within the household.

<b>Source of income</b>	<b>Tick Income source</b>	<b>Estimated monthly income(N\$) Enter code (1= less than 50, 2=51-100,</b>

		<b>3=101-500, 4=500 and above)</b>
Employment		
Livestock sale		
Crop sale		
Fish sale		
Casual labour		
Sale of thatching grass or reeds		
Wildlife returns from Conservancy		
Piecework (part-time jobs)		
Cuca shops		
Pension grant		
Social grants		
Remittances and gifts		
Other (e.g. Selling of forest products e.g. poles, firewood)		

### Section C: Physical and natural assets

**Please check more than one field per question in this section.**

Does your household have access to any land? **Enter code (1= Yes, 2= No)**

C2. Who owns the land you have access to? **Enter codes (1=owner, 2=rented)**

What is the size of the land you have access to? **Enter codes ( 1 = 0.5 ha, 2 = 0.5 to 1 ha, 3 = 1 to 2 ha, 4 = 2 or more ha)**

What is the major use of your land and what is the proportion of the land use (enter answers in the table below)

Major use	Tick all that applies	% of land under each use	Comment
Crops			
Grazing/livestock			
Settlement			
Vegetable gardens			
Other			
None			

What is the total land you cultivated in 2014/15 agricultural season: enter code (1 = 0.5 ha, 2 = 0.5 to 1 ha, 3 = 1 to 2 ha, 4 = 2 or more ha)

(INDICATE THE ANSWERS OF THE FOLLOWING QUESTIONS IN THE TABLE BELOW)

C7-By order of importance, What are the main crops cultivated by your household this 2014/2015 planting	C8-What was your production of [crop] in kg last year?	C9-What did you do With the production? <b>1 = Mostly sell</b> <b>2 = Mostly keep for home use</b>	C10-Of the proportion you keep, how many months did it last for household Consumption?	C11- How did you acquire seeds/planting material last year? <b>1 = Purchase</b> <b>2 = Exchange with farmers</b> <b>3=Gift from relatives/family</b>
---	--	---	--	--

season? Please enter code for up to 5 main crops from list below.		<b>3 = Some sales &amp; some kept</b>		<b>4= Reserved from previous harvest</b>
		<b>4 = used to pay for sharecropped land</b>		<b>5=received from NGOs, govt</b>
				<b>6= did not get seeds this year</b>
				<b>7= Other</b>

C12. Did you use pesticides during this current planting season 2014/2015? (1= yes, 2=no)

Answer question C13 to C17 in the table below.

C13. Which of the following animal have you owned over the past 3 years. <b>Enter codes (1=Cattle, 2=Sheep, 3=Goats, 4=Poultry,</b>	C14. Over the last 3 years, how many number of animals did your household own	C15 . How many were sold	C16. What was the estimated income from the sale of these animals	C17. What was the Reason for selling or battering ( <b>Codes for C17 reasons for selling, 1 = No longer needed, 2 = To pay daily expenses, 3 = To buy food for HH, 4 = To pay medical expenses, 5 = To pay for other emergency, 6 = To pay off debt, 7 =To pay for social event, 8 = To pay for a funeral, 9 = To pay school</b>
--	---	--------------------------	---	--

<b>5=pigs, 6=none</b>				<b>costs, 98 = No second reason, 88 = other).</b>

C18-C19 questions should be answered in the table below

Livestock type	C18. How many of your livestock have died in 2015?	C19. What are the reasons for dying? <b>Enter codes , Reason for dying codes, 1= Drowned, 2=Illness, 3= Starvation/drought, 88= other)</b>
Cattle		
Sheep/goats		
Donkey/Horses		
Poultry		
Pigs		

**Section D: Social assets**

**Please check all that apply in this section.**

Has any member of your household received any assistance on flood disaster management from government? (CHECK ALL THAT APPLIES)

No assistance	
Flood relief	
Grants	
other	

Does any member of your household belong to any associations or groups?

Organization	Yes (1)	No (2)	Name
Community forest			
Water Association			
Conservancy			
Co-operative			
None			
Other (specify)			

Do you know how the floods are being managed? (1=yes, 2=No)

3.1 If yes, what type of management is applied? (CHECK ALL THAT APPLIES)

Government	
Community participation	
Joint management (community and governemnet)	
Traditional	
Don't know	

Do you know the regulations that govern flood disaster management? (Yes = 1, No = 2, 3 = Don't know)

Yes	
No	
Don't know	

4.1 If yes, mention them (CHECK ALL THAT APPLIES)

Disaster management plan	
--------------------------	--

Contingency plan	
National disaster policy	
Other (specify)	

4.2 Where did you hear of these regulations, check all that applies? (**Tick all that applies**)

Councilor	
Community leaders	
Extension agents	
None	
other	

What are your roles and responsibilities in managing these flood disasters? (**CHECK ALL THAT APPLIES**).

Report flood occurrence	
Prevent deforestation	
Relocating to higher grounds	
Other (specify)	

Do you participate in any disaster management activities in the region? **1=Yes, 2= No**

D6.1. If yes, what are these activities?

Activities	

### Section E. Flood Preparedness level



**This section is to be answered by flood victims. Please enter the codes provided**

Use these codes for this section (codes 1=yes, 2=No, 3= unsure)

**Resource mobilization capacity**

Are there any resources in the community to assist you in times of flood?	
---	--

**Tick all that applies**

	Boats	Food	Blankets	Mosquito net	water	finance	other
If yes, what are these resources?							

Sometimes people adopt particular behaviors in order to prepare for a flood disaster. Thinking about a flood disaster in your household, did you or someone else in the household do the following (1=Yes, 2=no 3= unsure.)

Make radio set fully serviceable	
Keep torch lights and candles	
Keep readily available list of emergency phone numbers in case of a flood emergency	
Store emergency food and water	
Keep first aid kit ready	

**Flood preparedness Knowledge**

Now I would like to ask you the question based on your knowledge related to flood disaster preparedness. Please indicate by use of the code for D2-D6 (1=yes, 2=no, 3=unsure)

Do you know the location of your emergency evacuation center	
Do you read material on flood preparedness	
Do you attentively listen to or watch radio or television messages about flood preparedness	
Do you attend meetings for the purpose of establishing flood preparedness	
Have you attended any first aid course in the last three years	

### Household emergence planning

During a possible flood, does your household have a plan for a safe place	
Does your household have a meeting place to come together after a possible flood	
Are you or any member of your household involved in planning /coordinating with government on flood disaster preparedness	

### Warning systems

Do you receive early warning before the flood	
Is the message of the early warning clear to you	
Do you respond to such issued warning	
Do you keep valuable things safely when a warning is issued	
Do you think Early warnings are the key to reducing the impacts of floods	
Do you think Traditional early warning systems are the best way of warning people	
Does the community organize itself to monitor water levels in any way?	
Do households have ways they can predict the risk of flood disaster?	
When the floods come I will get a warning	
The government has the biggest responsibility for warning us	
There is a lot we can do ourselves about early warning	

### Response mechanisms

	Yes	No	Unsure
Are there any groups in the community which come together to help during flood disaster?			
If yes, do they help everyone?			
Do you help anyone else when disasters strike			

	Government	Red cross	NGOs	Other (mention)
Who is responsible for helping you?				

	Radio	Telephone	Headman	Newspaper	Other (mention)
How do they contact you?					

### Education and training on flood disaster

	Yes	No	Unsure
Do you attend any meeting held by schools/NGO/Government for the purpose of establishing flood preparedness			
Do you teach any member of the household what to do in case of a flood emergency			
Did you or member of the household attend a first aid training			
Do you participate in mock drills rehearsal for the purpose of flood preparedness			

### Section F: Socio-cognitive Factors

## Risk Perception

Suppose a flood does happen, then how likely do you think each of the following would be and how much do you feel worried? Scale (**0=not at all, 1=little, 2=quite, 3=very much**)

<b>Risk perception statements (Likelihood)</b>	
Supplies such as electricity, water will be interrupted	
Some of your assets such as livestock will be seriously damaged or destroyed	
Your own home will be seriously damaged or destroyed	
You or your loved ones will be hurt (wounded or killed)	
Your field will get flooded before the harvesting time	
You are likely to suffer from malaria or diarrhea	
<b>Risk perception (Feeling of worry). How much do you feel worried about each of the following</b>	
Supplies such as electricity, water will be interrupted	
Some of your assets such as livestock will be seriously damaged	
You or your loved ones will be hurt (wounded or killed)	
Your field will get flooded before the harvesting time	
You are likely to suffer from water borne diseases (e.g. malaria or diarrhea)	

## Critical Awareness

In regard to what happens in your household, please describe the extent to which you agree or disagree with each of the following statements. (**0=completely disagree, 1=disagree, 2=agree, 3= completely agree, 4=don't know**)

<b>Critical awareness statements</b>	
--------------------------------------	--

I think about flood disaster and impacts issues in my household and community	
I talk about flood disaster problems and issues with others in my community	

### **Perceived Responsibility efficacy**

In regard to what happens in your household, please indicate the extent to which you agree or disagree with each of the following statements. (0=completely disagree, 1=disagree, 2=agree, 3= completely agree, 4=don't know)

<b>Responsibility efficacy statements</b>	
I have responsibility to help my family and others during a flood disaster	
I have the right to know what to do in the event of a flood disaster	
I have the right to contribute to reducing the risk of flood disaster	
I am aware of the emergency procedures I need to follow if a flood disaster warning is issued	
I have a responsibility to comply with the evacuation procedures under any circumstances	
When the floods come I have responsibility to warn others if I receive the warning	
The government has the biggest responsibility for warning us in a flood emergence	
We can learn to live with floods if we organize ourselves	

### **Positive and negative outcome expectancy**

The following statements measures outcome expectancy belief, please describe the extent to which you agree or disagree with each of the following statements. (0=completely disagree, 1=disagree, 2=agree, 3= completely agree, 4=don't know)

Outcome expectancy statements	
Preparing for flood disasters will significantly reduce damage to my home should a flood disaster occur	
Preparing for flood disasters will improve my everyday living conditions	
Preparing for flood disasters will improve the value of my house/property	
Preparing for flood disasters will improve my ability to deal with disruptions to family/community life following a flood disaster	
Flood disasters are too destructive to bother preparing for	
A serious disaster is unlikely to occur during my lifetime	
Preparing for a flood disasters is inconvenient for my household	
It is difficult to prepare for a flood disasters	

### F5. Self-efficacy

The following statements measures your self-efficacy belief, please describe the extent to which you agree or disagree with each of the following statements (0=completely disagree, 1=disagree, 2= agree, 3=completely agree, 4=don't know)

Self-efficacy statements	
--------------------------	--

I can always manage to solve flood related problems if I try hard	
If someone oppose me in flood preparation I can find means and ways to prepare myself	
It is easy for me to stick to my aims and accomplish my goals of preparing for floods.	
Thanks to my resourcefulness, I know how to handle unforeseen situations such as a flood disaster.	
I can prepare for flood disaster if I invest the necessary effort.	
I can remain calm when facing a flood disaster because I can rely on my coping abilities.	
When I am confronted with a flood disaster I can usually find several solutions.	
If I am affected by flood, I can usually think of a solution.	
I can usually handle whatever comes my way.	

### **F6. Sense of Community**

Now I would like to ask you question related to Sense of community. How well does each of the following statements represent how important you feel about this community where you live in? (Codes **0=Not at All important, 1=Somewhat Important, 3= Important, 2= Mostly important, 3=completely important**)

<b>Sense of community statements</b>	
I get important needs of mine met because I am part of this community	
Community members and I value the same things.	
This community has been successful in getting the needs of its members met.	
Being a member of this community makes me feel good	
When I have a problem, I can talk about it with members of this community	

People in this community have similar needs, priorities, and goals	
I can trust people in this community	
I can recognize the members of the community	
Most community members know me.	
This community has symbols and expressions of membership such as clothes, signs, art, architecture, logos, landmarks, and flags that people can recognize.	
I put a lot of time and effort into being part of this community.	
Being a member of this community is a part of my identity.	
Fitting into this community is important to me.	
This community can influence other communities.	
I care about what other community members think of me	
I have influence over what this community is like	
If there is a problem in this community, members can get it solved.	
This community has good leaders.	
It is very important to me to be a part of this community	
I expect to be a part of this community for a long time.	
Members of this community have shared important events together, such as holidays, celebrations, or disasters.	
I feel hopeful about the future of this community.	
Members of this community care about each other.	

**End of survey and thank you very much for your time**

**Focus group discussion questions for rural community (4-5 participants)**

Demographical information of the participants

<b>Name of participants</b>	<b>Age</b>	<b>Occupation</b>	<b>Gender</b>	<b>Members of household No</b>




What are your type of livelihood sources?

.....  
 .....

From 2001, which of the years have you experienced flooding (years experienced flooding)?

2000		2003		2006		2009		2012		2015	
2001		2004		2007		2010		2013		2016	
2002		2005		2008		2011		2014			

What kind of resources should someone regarded as rich have in possession?

.....  
 .....  
 .....

Wealth ranking

	Rich	borderline	Poor
Resources	number	number	number

How are the floods impacting the following?

Income

.....  
.....

Crop production

.....  
.....

Livestock production

.....  
.....

Other impacts

.....  
.....

What adaptation strategies have you adopted to deal with floods, especially reducing the negative impacts of floods on income, crops, livestock production?

Income

.....  
.....  
.....  
.....

Crop production

.....  
.....

Livestock production

.....  
.....

What challenges are you facing in adopting these strategies?

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What are the adaptation strategies other than the ones mentioned above do you think should be adopted to minimize the economic impacts of floods?

Crop production

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.....  
.....

Livestock production

.....  
.....

Income

.....  
.....

What kind of resources do/will you require to adopt such strategies mentioned above?

.....  
.....

How do you think you can acquire those resources?

.....  
.....

What kind of skills do you possess?

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.....

What type of skills will you require to be prepared for future flood disasters

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.....

Do you belong to any formal or informal groups

.....  
.....

What are these groups

.....

.....

Do you regard yourself prepared to face future floods? If yes how are you prepared? If not why?

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**End of the focus group**