# THE ROLE OF CONTEXTUAL FACTORS IN FLOOD IMPACT VULNERABILITY IN THE CONTEXT OF CLIMATE CHANGE: CASE STUDY OF NDIRANDE AND SOUTH LUNZU, BLANTYRE CITY.

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February, 2015

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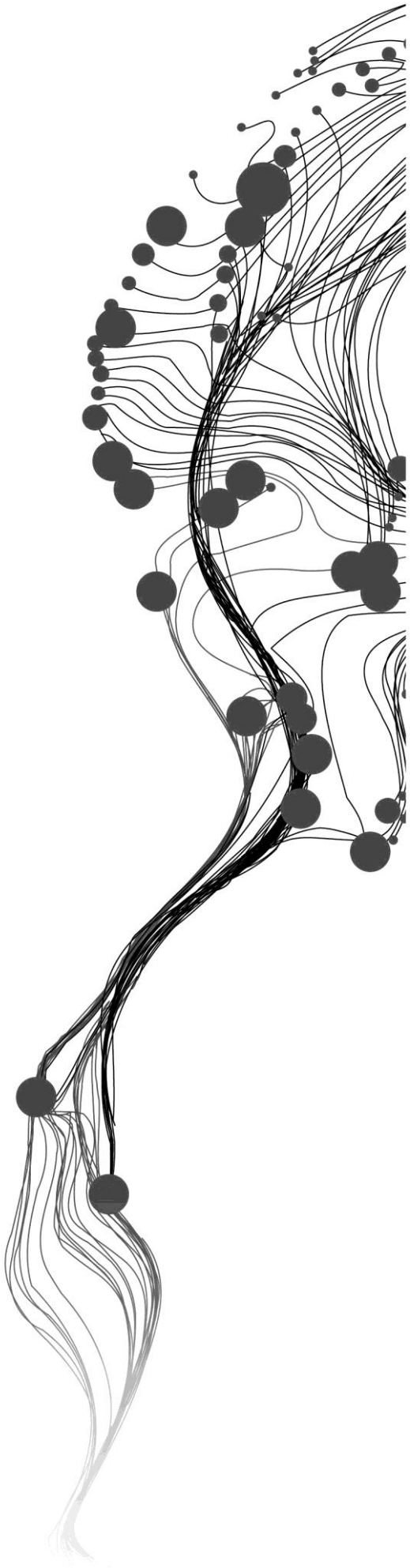

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# ABSTRACT

The aim of the study was to investigate the role of contextual factors on flood impact vulnerability. Household surveys were used to collect data on exposure measures, stressors and coping strategies. Semi-structured interviews were used to collect data from key informants to supplemented household survey data. Statistical test was performed to explore the relationships between exposure measures and flood impacts; stressors and flood impacts; and coping strategies and flood impacts. Data from semi-structured questionnaires was used to provide explanation on the relationship between variables.

Results showed that variations in flood impacts among households were due to variations in contextual factors such as stressors, coping strategies and coping challenges. The role of exposure measures on flood impacts was negligible. In particular households with more stressors were more likely to take social/organisational strategies. Households which took social/organisational strategies were more vulnerable to flood impact in Ndirande while in South Lunzu; social/organisational strategies resulted in low flood impacts. Households with a high number of stressors were more vulnerable to high flood impacts while households which had low income as their coping challenge were more likely to suffer high flood impacts. Housing coping strategies during the flood event had a strong influence on vulnerability variations suggesting that, taking one coping strategy during a flood event instead of the other was a defining factor in terms of how much flood impacts a household suffered. Technological coping strategies were effective in preventing flood impacts among residents who had stayed for a long time in study areas but ineffective for new comers.

The study concluded that type of stressor as perceived by households did not play a role on flood impacts. However, contextual factors such as number of stressors per household, coping strategies and coping challenges played a defining role in the variation of flood impacts among households. The role of exposure factors was minimal on flood impact vulnerability variations compared to the role of contextual factors.

Key words: Vulnerability, Flood, Impact, contextual factors, Ndirande, South Lunzu

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To God be the glory!

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# 1. INTRODUCTION

The 1992 Rio Earth Summit which gave birth to United Nations Framework Convention on Climate Change (UNFCCC) could be described as a watershed in climate change debate. State parties to the UNFCCC also adopted the Kyoto protocol in 1997 on the reduction of greenhouse gasses. The signing of these international protocols by many national governments signify the consensus among state parties to tackle climate change challenges with a united front.

The need to strengthen the coping capacities of communities to climate change has led to efforts aimed at identifying systems, communities and households which are vulnerable to climate change effects. Identification of vulnerable groups is necessary when governments and local authorities are designing programs aimed at reducing systems' and peoples' vulnerability to climate change effects. These efforts have made climate change risks to dominate the global vulnerability discourse in the past two to three decades( O'Brien, Eriksen, Nygaard and Schjolden, 2007;Renaud and Perez, 2010).

In order to contribute to the commitment demonstrated by national governments, this study was conceptualised in order to investigate factors which differentiate households' vulnerability to climate change effects such as floods. It was important to conduct such a study considering that; the greatest impacts of climate change are felt in developing countries whose resources are limited(Dickson, Tiwari, Baker and Hoornweg, 2010). Differentiating vulnerability levels based on household contextual factors may thus be one of the strategies for enabling policy makers in the planning of their limited resources by targeting the most deserving targets in the climate change intervention programs.

## 1.1. Background and Justification.

The case for urban climate change vulnerability and coping research in Malawi is grounded by the shifting patterns of projected population concentration from rural to urban areas. Approximately 85 % of the current population in Malawi lives in rural areas(NSO, 2008). However, this population is expected to decrease due to urbanisation which currently stands at 5.2 per cent per year. This state of affairs inevitably means that, a high percentage of elements at risk of climate change related disasters will be concentrated in urban areas. Realisation of this fact has unfortunately led to undue focus of research on physical exposure to climate change effects as the sole determinants of household vulnerability in urban areas(McSweeney, New and Lizcano, 2008;Wood and Moriniere, 2013) at the expense of other equally important factors. However, vulnerability is a more complex phenomenon which can hardly be explained by physical exposure alone. Hopkins,(2013) for example argues that vulnerability to climate-related impacts such as floods are increasingly for reasons which have nothing to do with greenhouse emissions or actual location in precarious conditions(Liverman, 1991). From this perspective, vulnerability is a contextual concept which is influenced by a wide variety of factors.

It is on this understanding that this study is justified considering that, it was aimed at investigating factors which account for vulnerability differentials among households. The contention is that different households in a neighbourhood are affected by different stressors/contextual factors and even where they are affected by similar stressors, the level of impact is rarely the same. For example, in the event of floods,

the amount of damage incurred will be as a result of the number of stressors per household, type of stressors, households' coping strategies, household coping challenges and households' experience with previous floods. This study assumed that, the level of impact from climate change effects such as floods on households is not only determined by the actual exposure to climate change effects but also by household contextual factors. However, in many studies, more attention is given to predicting climate change effects and projected impacts through the use of models and little attention is given to contextual factors(Burton, Huq, Lim, Pilifosova and Schipper, 2002). This is especially true for Malawi, where the GCM predictive models used give the averages for the southern African region yet households in Malawi experience different contextual conditions. So far little contextual based vulnerability studies have been done in Malawi focusing on informal settlements. This study explored the role of contextual factors on flood impact variations among households. The assumption was that, the mere fact that households are equally exposed to floods does not mean than they will suffer same impact; and households which are less exposed may not necessarily be the ones which will suffer fewer impacts. The study is therefore justified because; it will contribute to a broader understanding of factors which play a role in determining vulnerability.

## 1.2. Research Problem

Most climate change vulnerability studies in Malawi consider vulnerability to climate change as a result of physical exposure to climate change effects and little attention is paid to contextual factors(O'Brien et al., 2007). Climate change studies which have attempted to address vulnerability issues in Malawi have tended to focus only on future projections of climate change based on different scenarios. For example, United Nations Development Program(UNDP) conducted a study aimed at establishing the likely future changes to climate in Malawi(McSweeney et al., 2008). However, there was no attempt to investigate the implication of such projections in the light of the prevailing contextual conditions of likely households to be affected. Further, a climate change vulnerability study conducted by Wood and Moriniere, (2013) only considered the physical exposure aspect of climate change vulnerability at the expense of contextual factors. Such studies are based on Global Climate Change Models(GCM) and consider climate change as a biophysical issue(Burton, Huq, Lim, Pilifosova, and Schipper, 2002). However, in informal settlements, households' conditions vary depending on the context; focusing only on the predicted exposure to climate change effects ignoring contextual factors may lead to interventions which target wrong people.

Vulnerability studies which have so far been conducted in Malawi, with a close leaning towards a contextual approach have tended to focus on indigenous knowledge systems and climate adaptation strategies in rural agriculture(Nkomwa et al., 2014; GOM, 2006). The contextual conditions for rural areas are however, starkly different from informal settlements in urban areas implying that little is known about the impact of contextual factors on the vulnerability of households in such areas. This study has thus been conceptualised to contribute in addressing that knowledge gap. Cochrane and Costolanski (2013) conducted a similar study in Addis Ababa, Ethiopia, where the focus was to understand the perceptions and coping mechanisms of households in the context of climate change using a qualitative approach. However, the present study is different because; firstly, in order to determine the impact of contextual factors on the climate change effect of flood, it will investigate the role of contextual factors on flood impacts, which was not addressed in the above mentioned study; secondly, in addition to using qualitative approaches, this study will also employ quantitative elements and GIS techniques in data analysis. With such an approach, it is anticipated that, the research will produce unique possibilities of generalising

findings based on analysis from one climate change effect, (in this case floods) to other climate change effects occurring under similar contextual conditions.

### 1.3. Research objectives and questions

The main objective of this research was to investigate the role of the contextual factors on household vulnerability to flood impacts by exploring the influence of exposure measures, stressors and coping strategies.

Table 1: Research questions and objectives

| Sub-Objectives | Research Questions |
|---|---|
| Describe flood impacts in the study area | 1. What type of impacts do households suffer in the study area? |
| | 2. Are there differences in flood impacts between the study areas? |
| Describe physical flood exposure factors of households in the study area. | 3. What are the major physical flood exposure factors in the study area? |
| | 4. Can these physical flood exposure factors explain the variations in the flood impacts among households? |
| Identify contextual factors (stressors) influencing household vulnerability to flood impacts | 5. What are the major contextual factors (stressors) influencing flood impacts on households? |
| | 6. Are these contextual factors associated with variations in flood impacts among households? |
| Identify coping strategies which influence household vulnerability to flood impacts | 7. What coping strategies do households take to mitigate flood impacts? |
| | 8. Can these coping strategies be associated with variations in flood impacts vulnerability among households? |
| Explain how the relationship between exposure to floods, contextual factors (stressors), coping strategies and flood impacts determine household vulnerability. | 9. Do physical flood exposure measures adequately explain variations in households' vulnerability to flood impacts? |
| | 10. Is the household vulnerability to flood impacts influenced by household stressors and coping strategies or by physical flood exposure alone? |

### 1.4. Thesis Structure

**Chapter 1:** This chapter presents the background and justification of the study. It also describes the research problem, research objectives and research outline.

**Chapter 2:** This chapter reviews various literature relevant to the study. It explores major debates on the approaches to climate change vulnerability studies; approaches on flood impact assessment, measurement

of exposure and the livelihood vulnerability framework. The conceptual framework shaping this study has also been explained.

**Chapter 3:** This is a methods chapter which focuses on research design, study area, sampling techniques method of data analysis, limitations and quality control.

**Chapter 4: Factors influencing flood impact vulnerability.**
This chapter presents results on the factors which influence flood impact in the study areas. Results on different factors which are assumed to have a role on flood impacts are presented. These factors are then tested against flood impacts to determine those which have a strong influence on flood impact variations among households.

**Chapter 5: The role of contextual factors in flood impact vulnerability**
This chapter discusses the role of contextual factors in flood impact variations among households in the study areas. The role of contextual factors on flood impacts is discussed in comparison to the role of exposure factors on flood impacts.

**Chapter 6: Conclusion and Recommendation**
This chapter presents a summary of the results and provides recommendations.

# 2. LITERATURE REVIEW

This chapter presents a review of literature on the two competing perspectives for studying vulnerability to climate change. The chapter further discusses the different components of flood vulnerability analysis in relation to the two competing perspectives. A framework for the choice of contextual factors has also been presented.

## 2.1. The concept of vulnerability

Different research traditions define vulnerability differently. Thywissen (2006) for example lists 35 definitions of vulnerability from the perspectives of different researchers. This diversity in definitions is accompanied by a similar diversity of methodologies for assessing vulnerability(Hinkel, 2011). Such diversity of definitions denotes the complexity of the concept of vulnerability. Arguably, one of the most authoritative conceptions of vulnerability in the context of climate change is given by IPCC in its Third Assessment Report(TAR) which states that vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes and sees vulnerability to climate change as a function of exposure, sensitivity and adaptive capacity(McCarthy, Canziani, Leary, Dokken and White, 2001, p.6). However, little agreement has been reached among researchers beyond that there are competing conceptualisations of vulnerability and that vulnerability is context specific(Cutter, Boruff and Shirley, 2003). This study explored two competing conceptualisations in the study of climate change related vulnerability to come up with an operational approach which guided the study.

## 2.2. Approaches to the study of climate change vulnerability

The rising effects of climate change in urban areas make it important to identify households that will likely be vulnerable to future climate change in order to effectively target mitigation policies(Skjeflo, 2013). With this motivation, several approaches for studying vulnerability have been developed across disciplines(Adger, 2006). The section below discusses two major approaches to climate change vulnerability discourse.

### 2.1.1 Framing Vulnerability: Outcome and Contextual

Vulnerability as a concept is employed in diverse areas of research which include; hazard management, food security, public health and global environmental change(Fussel, 2007; O'Brien, Eriksen, Nygaard and Schjolden, 2007). The use of this concept by researchers from diverse backgrounds has led to different applications and meanings(O'Brien et al., 2007). Kelly and Adger,( 2000) identify two main approaches to vulnerability in the climate change literature: end point and starting point approaches. The distinction between end-point and starting point exemplify the difference between the two main interpretations of vulnerability. These interpretations are more succinctly summarised as 'outcome vulnerability' and 'contextual vulnerability' respectively(O'Brien et al., 2007).

### 2.1.2 Outcome Vulnerability

Outcome or end-point approach to vulnerability interpretation falls in the biophysical divide of climate change discourse(Hopkins, 2013). This approach considers vulnerability as 'the end- point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, and thence to biophysical impact studies and the identification of adaptive

options'(Kelly and Adger, 2000, p. 326). Under this conception, vulnerability summarises the net impact of the climate problem and can be represented quantitatively as a monetary cost or as a change in yield or flow, human mortality, ecosystem damage, or qualitatively as a description of relative or comparative change(O'Brien et al., 2007). This approach to vulnerability corresponds to what is referred to as 'first generation 'or Type 1 adaptation studies(Burton, Huq, Lim, Pilifosova, and Schipper, 2002).

The outcome approach to the understanding of vulnerability has made immense contribution to climate change studies in general and in the field of vulnerability measurement in particular. For example, it has been successful in producing voluminous "impact literature" summarised and assessed in the successive IPCC Assessment Reports-IPCC, 1990, 1995 and 2001(Burton et al., 2002). However, it has been less developed and less convincing in the case of socio-economic impacts, because less attention is given to socio-economic changes than to climate change (Ibid). For example, in outcome approach, the focus has often been on biophysical vulnerability, whereby the most vulnerable are considered to be those living in the most precarious physical, or environments that will undergo the most dramatic physical changes(Liverman, 1991).

Moreover, the climate model projections upon which this approach is based have two important constraints; firstly, many adaptation measures to climate change vulnerability are location specific, whereas the best climate scenarios provide information only for the globe or large regions. Global climate change models are not sufficiently precise in terms of spatial resolution or scale for vulnerability or adaptation assessment(Burton et al., 2002). Secondly, adaptation is driven more by variability and extremes of climate than by the averages. Climate change scenarios upon which the outcome approach is based have the disadvantage of specifying mostly average conditions. In other words, climate change may lead to small changes in means and large changes in extremes which may lead to under estimation of the intervention programs. Reducing outcome vulnerability involves reducing exposure through climate change mitigation, or developing adaptations to limit negative outcomes(O'Brien et al., 2007).

### 2.1.3 Contextual vulnerability

Contextual vulnerability which is in line with the 'starting-point' approach(Kelly and Adger, 2000) belongs to human security framing in the climate change literature(O'Brien et al., 2007) and provided a conceptual basis for the present study. While the *outcome* framing is a linear approach, *contextual* vulnerability includes the multiplicity of factors with which the system under consideration (individual, institution or region) will interact to create, perpetuate or reduce vulnerability(Hopkins, 2013). For example, vulnerability to climate-related impact such as flood on society is increasingly for reasons that have nothing to do with greenhouse gas emission (Ibid). Thus according to this framing, factors which affects household assets(Moser, 2008) such as low income, food insecurity among others, have a strong influence on the extent to which a particular household is vulnerable. These factors need to be taken into account for the full understanding of vulnerability(Hopkins, 2013). From this perspective, vulnerability is a locally relevant concept, which is influenced by contextual factors (Ibid). It is on this understanding that this study adopted this approach realising that different households are affected by different stressors depending on context. From this perspective, reducing vulnerability involves altering the context in which climate change occurs, so that individuals and groups can better respond to changing conditions(O'Brien et al., 2007).

## 2.2 Methods of Measuring Vulnerability

Birkmann, Fernando and Hettige ( 2006) identified four main techniques of assessing vulnerability. The first technique involves assessment of the built environment with remote sensing estimation of

vulnerability of different urban areas. This technique is aimed at estimating the overall exposure of the settlement area, as well as examining some characteristics of the vulnerability of different city areas by looking at the structure and quality of the environment (Birkmann, Fernando and Hettige, 2006). This vulnerability measuring technique assumes that the type of settlement and housing unit allows a general classification of urban areas with regard to their social-economic status. The assumption is that as far as initial estimation is concerned, a higher or lower vulnerability within a community can be associated with the conditions of the built environment that different people are living in (Ibid). However, the limitation with this method is that the classification and automatic analysis of different housing types are complicated. The advantage is however that, remote sensing methodology allows for comparison of the situation before and after a climate disaster change event. This implies that it is possible to analyse the extent to which the exposure and the structure of the buildings were the major causes of revealed losses(Birkmann, Fernando and Hettige, 2006).

The second vulnerability measuring methodology involves critical infrastructures and sectors vulnerability. The principal focus in this methodology is ground survey of the exposure and susceptibility of basic infrastructure services and their facilities such as hospitals and schools(Birkmann, Fernando and Hettige, 2006). This measurement method is based on quantitative approaches and set along three dimensions-geographical level, sector and components dimension(Leon., 2006). Vulnerability using this approach starts by defining the sector to be addressed, then defining the hazard and the geographical level at which the assessment is being made and finally the component of vulnerability being assessed. To assess vulnerability one has therefore to focus on the dimension of components (Ibid). It is worth mentioning however that, this approach employ vulnerability indicators which make use of arbitrarily set weights to combine different elements. While expert judgement has been employed, the selection of numerical weights can always be questioned(Leon, 2006). Secondly, the indicators used in this approach deliver particular information on vulnerabilities associated with large-magnitude events, but still lacks the capacity to handle different hazard intensities (Ibid).

The other approach to measuring vulnerability involves the use of census data. This method is used when assessing the vulnerability of social groups and local communities(Birkmann, Fernando and Hettige, 2006). General indicators available in census and local statistics are used to estimate the vulnerability of different social groups and economic sectors of social communities to hazards.

Other studies use questionnaire-based interviews with households in selected locations to identify and assess the different vulnerabilities of various social groups to hazards. This method requires the most attention to explore the various vulnerabilities of different social groups in selected locations(Birkmann, Fernando and Hettige, 2006). This study also used this approach in the measurement of flood impact to assess the vulnerability of flood prone households. The in-depth questionnaire survey allows for better understanding and estimation of current vulnerability and addresses spatially specific features of vulnerabilities to climate change effects (Ibid). Leon, (2006) argues that the focus on households as an analytic unit is important within the framework of vulnerability assessment, since livelihood strategies and economic conditions can be best assessed at this basic unit. However, to achieve the objectives of this study household flood impact, exposure and coping strategies were also considered which are reviewed in the subsequent sections.

### 2.2.1. Flood Impact Assessment Approach

The concepts damage and impact are often times used interchangeably in the flood impact literature. Flood damage refers to all varieties of harm caused by flooding; it encompasses a wide range of harmful effects on humans, their health and their belongings, on public infrastructure, cultural heritage, ecological systems and industrial production among others(Messner., 2006). Flood damage can be divided into direct and indirect effects. Direct flood damage occur due to the physical contact of objects with the water, indirect damage is induced by flooding but occurs in space and time outside the actual event as **figure 1** shows(Thieken et al., 2009). Flood impact assessment is conducted following different approaches which often times depend on the objectives of the assessment. Most studies however use various aspects of damage caused by the flood in the assessment of flood impact(World Food Program, 2010; Ninno, Dorosh, Smith, and Roy, 2001). Other studies have focused on damage to house structure, household content and flood water depth to assess flood impact(Peters, 2008; Guarin, 2003). Guarin, (2003) for example came up with an inventory of damaged household items, damage to infrastructure and their cost of replacement and repair which were then quantified to determine flood impact.

When conducting flood impact assessment, damage influencing factors are categorised into impact and resistant parameters. Impact parameters reflect the specific characteristics of a flood event for the object under study, e.g. water depth, flow velocity and inundation duration among others. Resistant parameters depend on characteristics of the flood prone objects. They depict the capability or incapability of an object to resist flood impact(Merz , Kreibich and Schwarz., 2010). These include object size, building structure and former flood experience (Ibid). This is in line with the contextual approach which takes into account not only damage caused by physical contact of objects with flood water but also the contextual conditions of such objects.

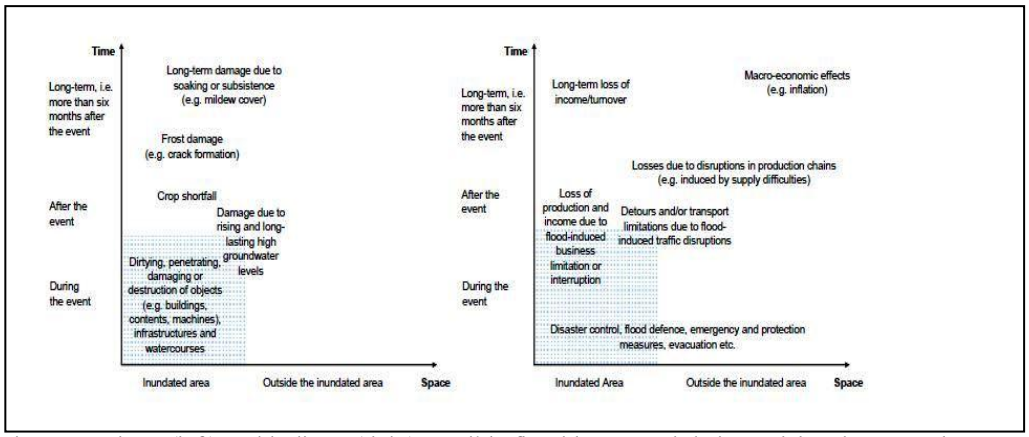


Figure 1: Direct (left) and indirect (right) tangible flood losses and their spatial and temporal occurrence(Thieken et al., 2009)

### 2.2.2. Measurement of Exposure

Exposure is one of the factors which are used in vulnerability assessment. Exposure supply information about the location of the various elements at risk, their elevation, their proximity to the river, their closeness to inundation areas and return periods of different types of floods among others(Messer and Meyer, 2007). Ninno, Dorosh, Smith, and Roy, (2001) however provides an approach for assessing exposure to floods at household level. For example in the assessment of exposure to the 1998 Bangladesh flood, their study used information provided by households on three measures: the depth of water in homestead, the depth of water in the home and the number of days water was in the house. On the other hand Birkmann, Fernando and Hettige, (2006) discusses the use of remote sensing in estimating the

overall exposure of a settlement area as a way of examining other characteristics of the vulnerability of different city areas.

#### 2.2.3. Flood Coping Strategies

The application available skills, resources and indigenous knowledge, in the face of hazards and other threats to reduce the risk of negative impacts is referred to as coping strategy(Twigg, 2004; Wamsler and Brink, 2014). However the choice of skills and resources to be applied varies according to the nature of the hazard threat, the capacities available to deal with it, and to a variety of community and individual priorities that change during the course of disasters.

Coping strategies can be categorised into different forms. For example, Twigg, (2004) came up with four categories of coping strategies. These are economic/material, technological, social/organisation and cultural. However, most strategies involve elements of all these, so the typology should not be used artificially to place particular strategies under particular headings. This categorisation should only be used as a framework for reviewing coping strategies and indigenous knowledge as a whole. On the other hand Dewi (2007) used a similar approach but with a slight modification on the coping categories. Instead of four categories, only three coping categories were used i.e. economic/material, technological, social/organisation.

### 2.3. Framework for selecting contextual factors (Stressors) in the vulnerability assessment

The selection of stressors which were included on the questionnaire was guided by the asset/vulnerability framework. This approach states that vulnerability is linked to the lack of assets-the more assets households have, the less vulnerable they are. The greater the erosion of people's assets the more insecure they are(Moser, 2008). Therefore it is important to define as well as identify those of particular importance in the context of climate change. According to Moser,( 2008) an asset is identified as a "stock of financial, human, natural or social resources that are acquired, developed, improved and transferred across generations. Baud, Sridharan and Pfeffer ( 2006) refer to these assets as capitals which include human, financial, physical and social( see Moser, 2008 p6). Thus, the absence or presence of these capitals at a household level can either reduce or exacerbate household's vulnerability to climate change effects. For example, a study conducted in Sri Lanka using household surveys found that, households in the low income group suffered more impact from disaster than those in the high income group; the study also found that the recovery potential for fishing households were low while those in the white collar jobs recovered much faster(see Leon., 2006). This framework is therefore in line with Kelly and Adger,( 2000) who argues that household vulnerability studies to climate change effects should take into account contextual factors which affect their livelihoods assets or capitals(Moser, 2008; Baud, Sridharan, Pfeffer, 2006). This study has thus been guided by this framework in selecting proxy contextual variables which affect household capitals which are relevant in the area.

### 2.4. Conceptual Framework

The conceptual framework shown in Figure 2 below illustrates two competing conceptualisations of climate change vulnerability studies. The outcome approach is to the left while contextual approach is to the right. The outcome approach is linear which use GCM models to project future emission trends, moving on to the development of climate scenarios, to biophysical impact studies and the identification of adaptive options (represented by the circle to the left in the framework). Any residual consequences that remain after adaptation ('response' box) has taken place define the level of vulnerability (outcome

vulnerability box). The outcome approach has been included here for better understanding of the contextual approach upon which this study was based.

The contextual approach to the right illustrates that vulnerability to climate change effects is as a result of interaction of exposure to climate change effects(such as floods) plus the contextual conditions, which the elements at risk are facing, coping strategies which they undertake and coping challenges which they face. The level of vulnerability can therefore be appreciated by taking all these factors into account, considering that future vulnerability is dependent on current level of vulnerability(O'Brien et al., 2007). Since vulnerability is a theoretical concept(Hinkel, 2011) one way of differentiating more vulnerable groups or households is by looking at the differences in the level of impact suffered from particular climate change effects. In this framework, it is represented by the diamond box. An operational and precise framework of the contextual framework depicting principal components of the analysis has been presented in chapter 4, figure 6.

Figure 2: Conceptual Framework

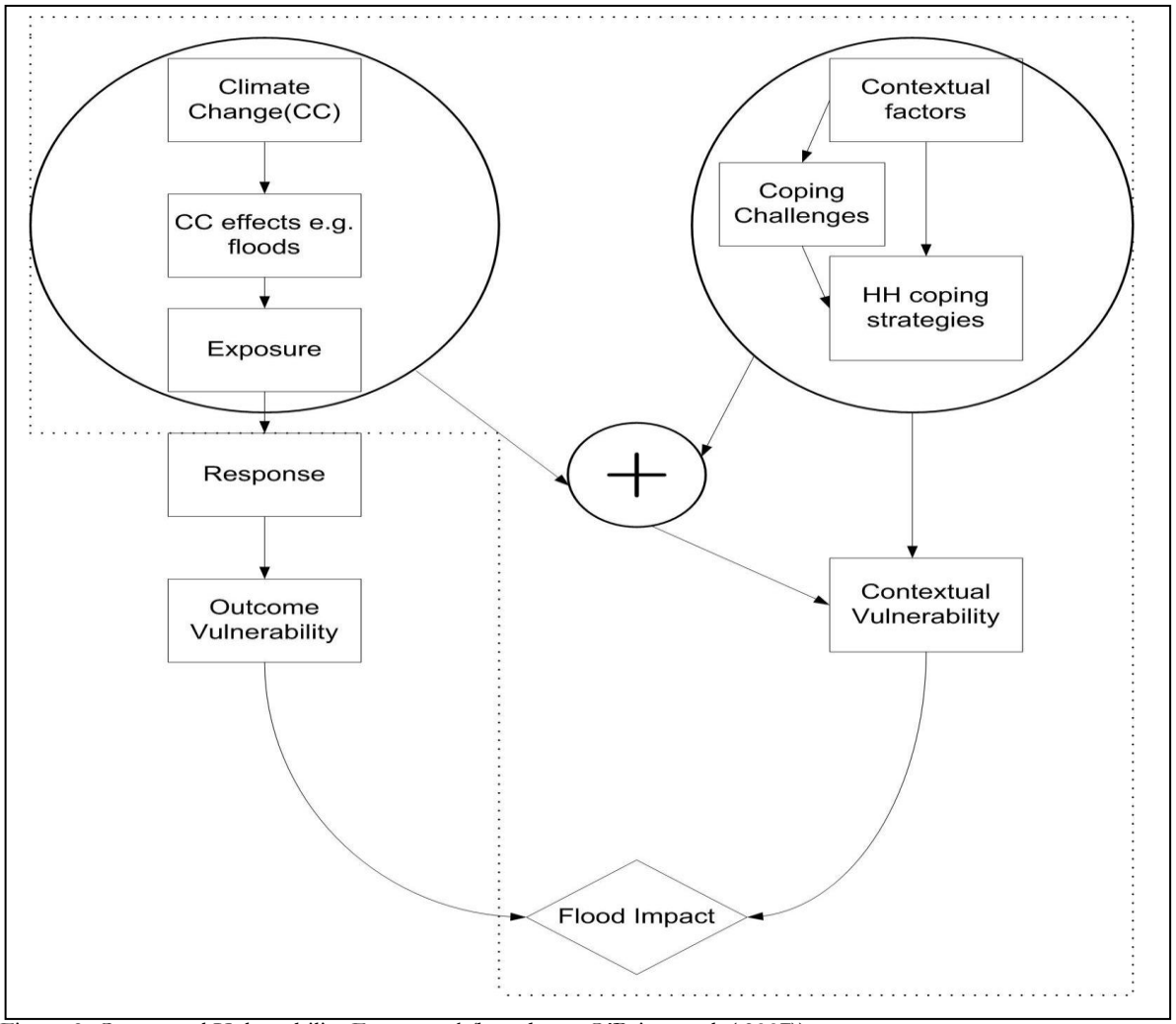


Figure 2: Contextual Vulnerability Framework(based on : O'Brien et al.,( 2007))

This conceptual approach considers vulnerability as a present inability to cope with external pressures or changes, which in this case is changing climatic conditions within the context of other pressures called contextual factors. Here vulnerability is considered a characteristic of social and ecological systems that is

generated by multiple factors and processes. It is an approach which focuses on prior damage, referred to by Kelly and Adger (2000) as the 'wounded soldier' approach and assumes that addressing present-day vulnerability will reduce vulnerability under future climate conditions(Burton et al., 2002). One purpose of studying vulnerability using this interpretation is to identify policies or measures that reduce vulnerability, increase adaptive capacity, support coping strategies or illuminate adaptation options and constraints(O'Brien et al., 2007). For example, vulnerability mapping can be used to identify 'hot spots' of vulnerability to climate change and other stressors, while case studies may provide an understanding of the underlying causes and structures that shape vulnerability(O'Brien et al., 2004). In line with this approach, Brooks, Neil, Adger and Kelly, (2005) argue that the capacity to adapt is associated with a wide variety of supporting mechanisms across society, such as governance, civil and political rights and literacy. Consequently, certain vulnerabilities can be exacerbated due to socio-cultural and economic factors, or coping measures may be enhanced by these same factors(Cochrane and Costolanski, 2013). It is against this conception that the present study adopted an approach which focuses on differentiating household vulnerability to floods as a climate change effect depending on contextual factors.

# 3. RESEARCH METHODS AND STUDY AREA INFORMATION

This section explains the nature of the study areas, data which was collected, data sources, data collection methods, data analysis and limitations of the study.

## 3.1 General Information about Blantyre

Blantyre is the commercial capital of Malawi. Its total population is estimated at 661, 256(NSO, 2008). The growth rate was estimated at 2.8 percent between 1998 and 2008. The population of Blantyre represents 5.1 percent share of the national population. Its average population density is 3, 006 per square kilometre(NSO, 2008).

Blantyre is found in the Southern region of Malawi and it covers an area of 2,012 sq. Km(Blantyre City Council, 2013). It is located on the edge of the Great Rift valley at 15° 47'10'S and 35° 0' 21"E. Its elevation ranges from 780m to 1612m above sea level with undulating terrain dotted by several hills. The climate of Blantyre is greatly influenced by its location within the tropical zone and altitude. The city experiences the Tropical Continental climate with two distinct seasons in a year. The rainy season is from November to April. The mean annual rainfall is 1, 222m of which 80% falls within three and a half months between November and March. Figure 3 below shows Blantyre city and the location of the two study areas.

Land in the city is owned by the central government, Malawi housing corporation (MHC), the private sector and Blantyre City Council. Some 43% of land is planned residential land, 22% is unplanned and 21% is semi-rural. Only the medium and high income classes have access to serviced land for housing(UN-HABITAT, 2008). The city offers a number of economic opportunities but lack resources to implement its strategies and provide the required basic social infrastructure and urban services required for economic development to take place (Ibid). Over 65% of the city's population lives in informal settlements which occupy about 23% of the land. Poverty stands at 24% while unemployment stands at 8%. About 45% of residents in Blantyre are employed in the private sector, 12 % in the public sector, and 36% are self employed, mainly working in the informal sector(UN-HABITAT, 2008).

### 3.1.1. Selection of study areas

This section describes the criteria for selecting the two study areas from which respondents were drawn, their location and population.

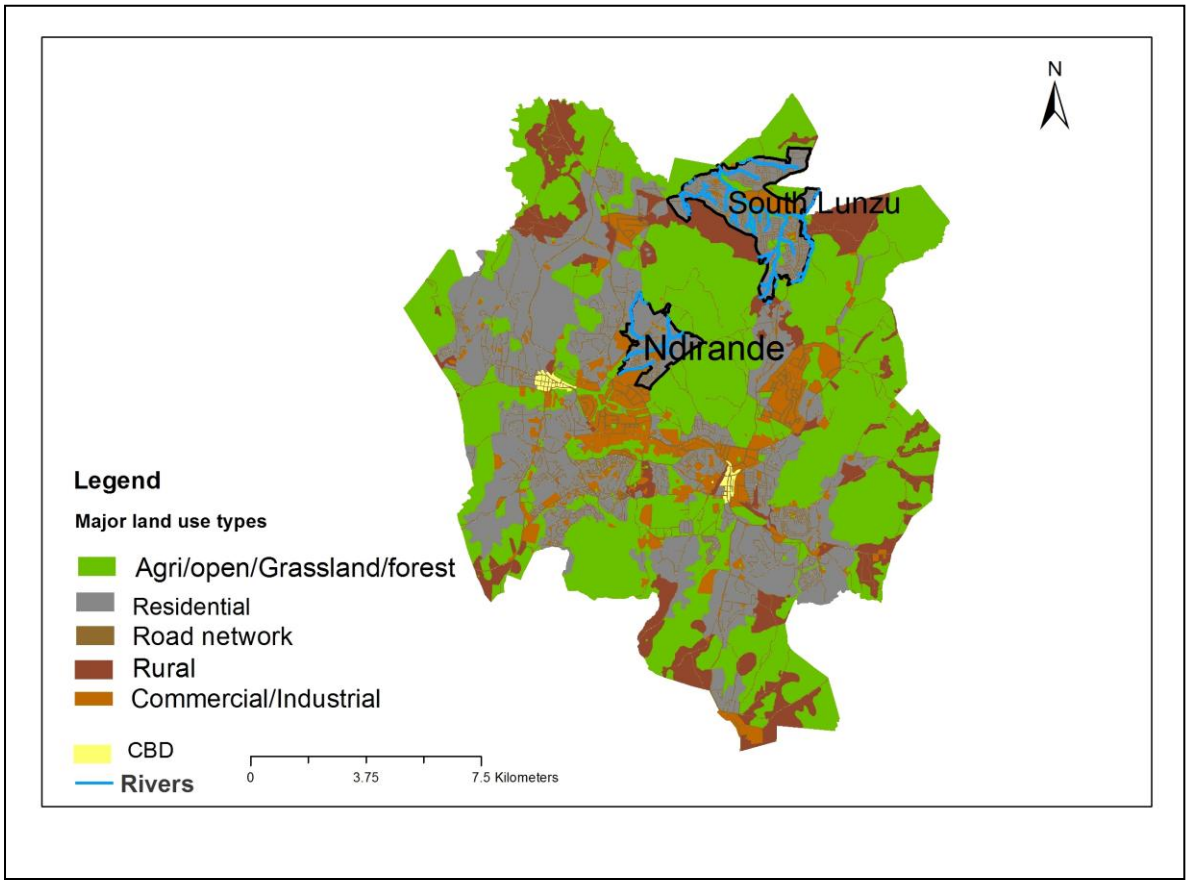


Figure 3: Location of Study Areas in Blantyre (Source: Based BCC Data)

### 3.1.2. Ndirande.

Ndirande is the largest and oldest informal settlement in the city and is located to the northeast of Blantyre Central Business District and north of Makata Industrial Area at the foot of Ndirande Mountain. Chirimba Industrial area is to the northwest. To the south is a ring road, which separates it from the formal high density and Traditional Housing Area. It is three kilometres from Blantyre Central Business District. Two major rivers flow through the study area, namely, Nansolo and Chirimba. However, there are a number of streams, mostly dry during the dry season but usually flood during rainy season. Ndirande is located at 1119 m above sea level. The climate of Ndirande is the same as that of Blantyre described in 3.1 above. It has a population 118, 424 people. This population however also comprises an area which was not surveyed. This is because, administratively, population figures of the areas adjacent to Ndirande are presented under one name despite the areas having their own names. For example, the above population figure represents, Makata Safarao, Zambia and Chirimba. However, in this study, no respondents were surveyed from Chirimba. It is also worth mentioning that, only households along the rivers/streams in the area where floods are experienced were surveyed stretching up to 120 metres both sides of the rives.

#### 3.1.3. South Lunzu

South Lunzu is a peri-urban Township located to the east of Ndirande mountain and it is a relatively new area compared to other townships around Blantyre(Tchereni, Grobler and Dunga, 2013). It emerged due to its closeness to two main industrial areas of Chirimba and Limbe. The township is more organised compared to Ndirande. Its elevation is between 1100 and 1200 metres above sea-level(Sakuma et al., 2009). Seasonal rivers and streams flow through the area from Ndirande mountain with south Lunzu river on the eastern side providing perennial water (Ibid).

South Lunzu was selected because; it is relatively new and planned compared to Ndirande. These characteristics made it possible to collect data with sufficient variations for statistical analysis

These two areas were chosen because, the nature of their settlements make its residents prone to flooding. In addition, the latest flood in these two areas occurred in the recent past (2012/2013) and could be verified from officials responsible for the administration of the area. The fact that, floods in these locations occurred in the recent implied that respondents would be able to remember their flood experiences. Moreover, Ndirande was selected because it represents the largest and oldest informal settlements in Blantyre with several rivers and streams running through it.

### 3.2. Data Collection and Sources

Both primary and secondary data sources were used for this study. This was done to ensure that, primary sourced information is verified by secondary data and vice-versa for accuracy thereby ensuring the reliability of the collected data.

#### 3.2.1 Secondary Data

Secondary data for the study comprised, internet sources such and Shape files collected from Blantyre City Council for spatial analysis. Shape files which were used in spatial analysis are listed in **Table 2** below.

Table 2: Data layers used

| Data Layer | Description |
|---|---|
| landusegeneral.shp | This layer contains general land uses for Blantyre city |
| contours15m.shp | This layer contains elevation in metres at a 15 m interval |
| rivers2.shp | This layer contains all rivers passing through Blantyre city |
| cityboundary.shp | This layer contains city boundary. |

#### 3.3. Primary data.

Primary data was collected through household surveys and key informant interviews. The section below describes how household surveys and key informant interviews were conducted.

#### 3.3.1. Household Surveys

Household surveys were the principal source of data in this study. The questionnaire was in English however, during the survey, the interview had to be translated in a local language. As a result of this,

research assistants were trained on the correct translation of each item on the questionnaire to avoid multiple meanings due to variations in translation. In addition, a pilot survey was conducted on 20 households. This was done to ensure that questions were capable of enlisting the desired data. To, this end some questions which were seen to be ambiguous were removed from the questionnaire and some questions were modified

On average, the questionnaires were lasting between 15-25 minutes per household. After the administering a questionnaire, GPS coordinates were recorded. In general, the questionnaire was designed in such a way that it was capturing household information relating to flood exposure measures, damage caused by floods; contextual factors/stressors influencing flood impacts and household flood coping strategies and challenges which households face in implementing their coping strategies.

#### 3.3.2. Key informant Interviews

Semi-structured interviews were conducted with key informants to verify data collected through household surveys. Officials were interviewed to enlist their perspective on the flooding situation of the study areas, socio-economic characteristics and support which households receive from institutional establishments during floods. Three key informants were drawn from each study area giving a total of six. Two officials were interviewed from the district commissioner's office responsible for disaster preparedness and the estate development officer from Blantyre city council (BCC). The interviews from key informants were recorded and later transcribed for analysis. Key informant interviews from the study areas targeted village heads and where it was impractical to interview the village head, a study area resident with over 6 years of continuous stay in the area was interviewed. This period was chosen because some of the interviewed respondents during household surveys were new residents in the area and they were unable to provide the flooding situation of the areas. The results were then qualitatively analysed and were used to provide explanation for the relationships between variables.

#### 3.3.3. Observation and Mapping

The accuracy of some of the data collected from both households and key informants was verified through observation by the researcher. For example, data on distance from a household waste disposal site to the nearest drainage, mode of waste disposal, distance to nearest water and flood coping mechanism was verified through observation. To this effect, pictures were captured where necessary. In order to map the location of households from whom data was collected, GPS coordinates were recorded. These coordinates were digitised for visualisation in a GIS environment.

### 3.4. Sampling

Non-probabilistic method of sampling was used. This method is used where it is difficult to establish a sampling frame due to unavailability of population data(Katz, 2006). This was the case because; there is no statistical database for the study areas indicating the definite number of households affected by floods. For household surveys, transect approach was adopted in the determination of spatial extent from where respondents were drawn. The transects were based on households which are located in areas with the likelihood of being flooded according to their location relative to river position and elevation thresholds. This area was determined with the assistance of the local people familiar with the area. To this effect, 105 households from Ndirande and 108 from Lunzu were selected following rivers courses flowing through the study areas-transect segments centred on sections identified as flood prone by local people and stretched up to 120 metres either side of the river. However, for the purposes of flood impact analysis, only 60 households from Ndirande and 83 from Lunzu were used, because these are the ones who

indicated to have experienced the same flood. The last flood in these two study areas occurred in the 2012/2013 rainfall season (rainfall in Malawi falls from November to March). The total sample of 213 was however used to analyse the relationship between coping strategies on one hand and flood impact on the other. The reason for adopting this approach was that since the 70 interviewed households out of 213 were not affected by the 2012/2013 flood, it presented a possibility that, their coping strategies were different from households who were affected. To verify that all respondents were referring to the same flood, the district commissioner's officer was interviewed and indicated that officers from his office went to the area to assess the situation, and the flood impact assessment in that year was only done once(he referred to it as flood impact situation appraisal). The estate development officer from Blantyre city council also verified the occurrence of this flood after having been asked of the possibility that there could have been more than one flood in the area during this 2012/2013 rainfall season. The area which experiences flood in Ndirande is concentrated around the market where indiscriminate waste dumping of is common whereas in South Lunzu it is spread. As such fewer households were sampled from Ndirande because it's a compacted settlement and more were sampled from South Lunzu because the area which experienced floods is relatively spread. **Figure 4** below shows example of location of households which were sampled.

Figure 4: Example of location of sampled households in Ndirande (Source: Author, 2014)

Table 3 below shows a summary of the research output from the field, it shows number of interviewed respondents per study area,

Table 3: Fieldwork output

| **Household Surveys** | |
|---|---|
| **Study Area** | **Number of surveyed households** |
| Ndirande | 105 |
| South Lunzu | 108 |
| **Key Informant Interviews** | |
| Study Area | |
| Ndirande | 3 |
| South Lunzu | 3 |

| | |
|---|---|
| Blantyre City Council Official | 1 |
| Government-Desk officer for disaster, Blantyre district | 1 |

### 3.5. Limitation of the Study and Quality Control

One of the limitations for this study was time. There was inadequate time to fully train the three research assistants who assisted in data collection. As a result, it was impossible to collect data for some variables, especially those which required probing to get the desired responses. Had there been enough time, the researcher could have individually administered all the questionnaires to ensure that the necessary depth level of information was extracted from the respondents. In addition, most of the measurements such as distance and flood depth were subjective in nature. For example in estimating flood depth, respondents were stating flood depth in relation to a wall, tree or their height. The interviewer had to translate this into rough depth estimates in centimetres using a ruler. One other issue, which limited the study, was that, respondents were reluctant to give information on their income. This was noted through inconsistencies between monthly income and their reported expenditure on various utilities. This led to the variable income to be of limited use in the analysis. Data on lost income due to flood was not possible to get as the majority could not quantify their lost income due to the irregular nature of their income sources. In view of these limitations, the questionnaire was redesigned in a way that it had adequate variables on both flood impact measures, contextual factors and exposure to compensate for the ones whose data was not possible to collect and was further supplemented by information key informants. The unavailability of a sampling frame also made it difficult to choose a sample whose representativeness could be determined by objective means. To deal with this, effort was made to ensure heterogeneity in the respondents selected in terms of age, gender and distance from rivers. This ensured that various households' social economic status were represented in the sample.

### 3.6. Data Analysis

Figure 5 below shows the main steps which were followed in the data analysis process. Field data was collected in line with the research problem and literature review. Two main sources of data were used, primary and secondary. Principal analysis was based on primary data and supplemented by secondary data.

Primary data was collected in four types; questionnaire surveys, semi-structured interviews, field observation and household location points. Secondary data was in the form of Shapefiles for visualisation in GIS. Data from questionnaires was entered into Software Package for Social Scientists (SPSS) for statistical analysis, household location points were digitised in Shapefiles. Semi-structured interviews were transcribed for qualitative analysis. Results from spatial data, statistical analysis, semi-structured interviews, and field observation were synthesised upon which discussion, conclusion and recommendations were based.

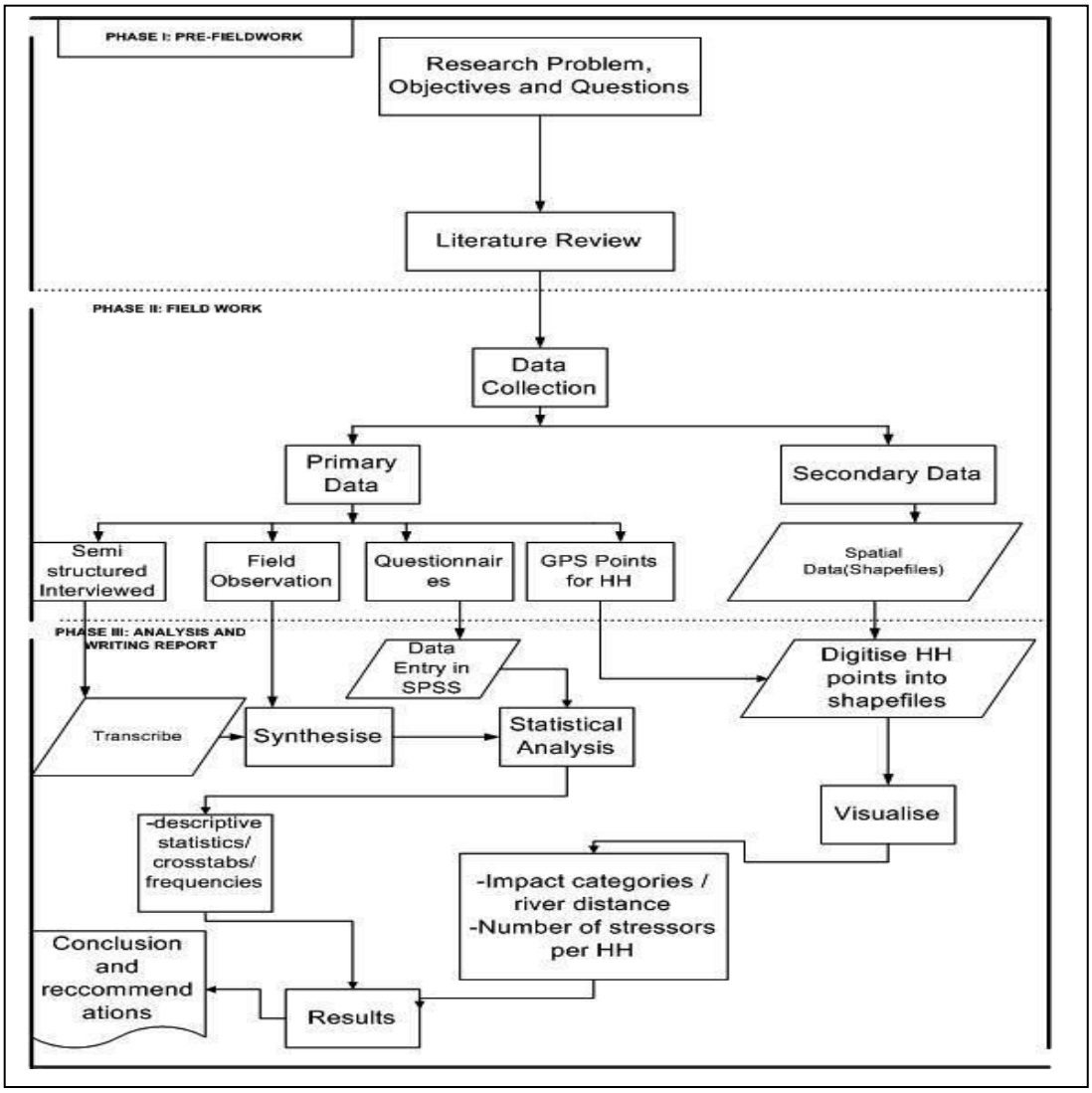


Figure 5: Data analysis flow procedure

# 4. FACTORS INFLUENCING FLOOD IMPACT VULNERABILITY

This chapter presents results of the flood impact analysis in the study areas based on households' perception of damage to their tangible assets. The chapter further presents results on factors which play a role in variations of household vulnerability to flood impacts. Three components have been presented, namely exposure measures, contextual factors and coping strategies. Exposure measures were tested against flood impacts to find out if impact variations depended on exposure. On the other hand, contextual factors and coping strategies were tested against flood impacts to find out if flood impacts varied depending on them. The findings on the role played by exposure measures on flood impacts have been analysed in comparison to findings on the role of contextual factors and coping strategies on flood impacts. The comparison was done by looking at the level of significance in the statistical tests performed on each factor against flood impacts. Results have been used to ascertain the role of a contextual approach in flood impact vulnerability.

## 4.1. Operationalisation of components used in the analysis

This section presents main procedures which were followed to operationalise the main components of the flood impact vulnerability analysis. A conceptual overview of the analysis which is based on the main conceptual framework in figure 2 has been given. The section explains how flood impact assessment was conducted based on three components. It describes how exposure measures, stressors, coping strategies and coping challenges were tested against flood impacts to find out the role which they play in the flood impact variations among households.

### 4.1.1. Conceptual overview of the analysis and operational definitions of principal concepts

The study was centred on four major components in the study of vulnerability as figure 6 below shows. It focused on exposure factors, stressors (contextual factors), coping strategies and flood impacts. The conceptual overview of flood impact vulnerability analysis is a detailed version of the contextual vulnerability aspect of the conceptual framework in figure 2. It illustrates the conceptual linkages between the various components which were explored to ascertain the role of contextual factors on flood impacts based on the sample drawn from two informal settlements. The underlying rationale in the analysis was that, there are three components; namely exposure, contextual factors/stressors and coping strategies which combine to influence household vulnerability to flood impacts. The analysis was aimed at finding the relative significance of the role played by each component. The framework therefore illustrates that for a full picture of household vulnerability to flood impacts, factors such as stressors, coping strategies and coping challenges need to be explored in line with the contextual approach.

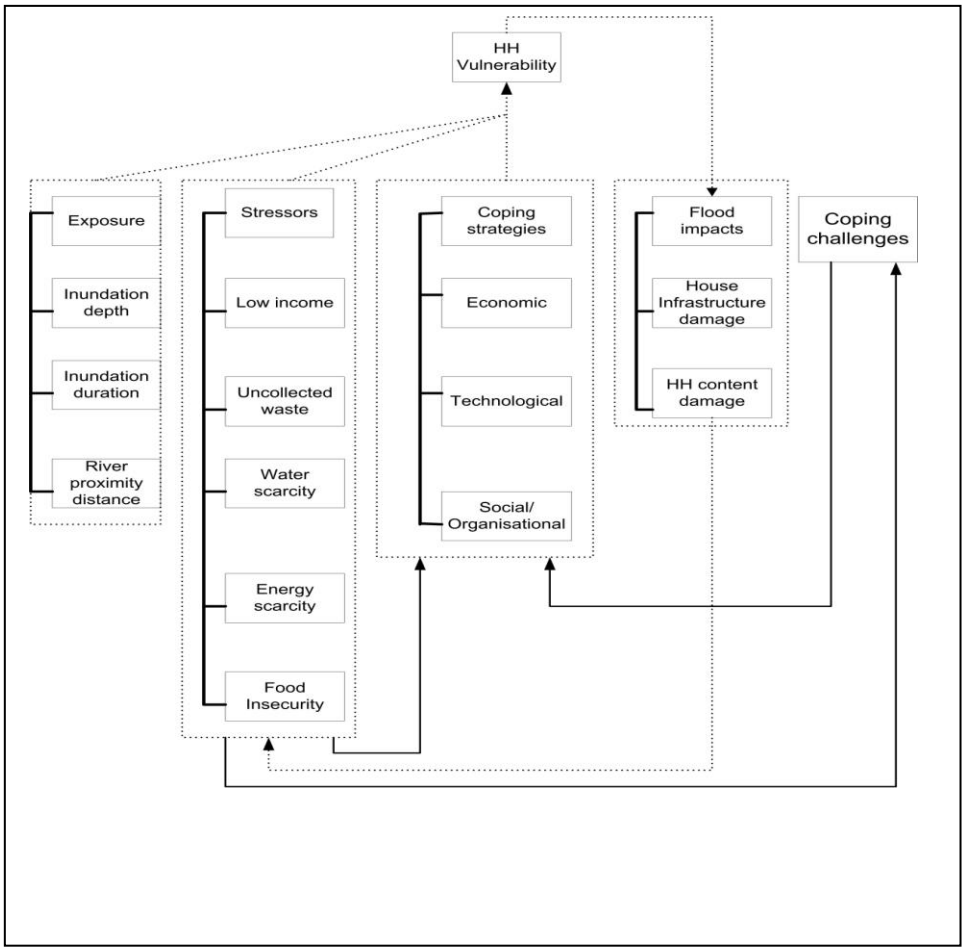


Figure 6: Conceptual overview of household flood impact vulnerability analysis

#### 4.1.2. Rationale for the choice of contextual factors

The selection of contextual factors which were used in this study was based on various studies conducted in the study areas and was guided by the general asset/vulnerability framework(Moser, 2008; Baud, Sridharan and Pfeffer, 2006). Several studies identified major stressors in the study areas. The issue of low income forms one of the major challenge for Blantyre city(UN-HABITAT, 2008; Mussa and Pauw, 2011). Chipeta (2009) found that water scarcity was a major issue in Blantyre(Palamuleni, 2002). On the other hand, Kayuni, and Tambulasi, (2005) reported that energy scarcity is a major challenge in the city while Cammack (2012) found that the problem of uncollected waste is a major challenge for Ndirande. Food insecurity was also found to be a major challenge in Blantyre city(Brown, 2011). It is based on these studies that these contextual stressors were selected for analysis in order to find out how they relate to flood impact vulnerability.

#### 4.1.3. Flood Impact Assessment

The procedure which was followed in the flood impact assessment process is shown in figure 7 below. In order to come up with household flood impacts related to house structure damage, two measures were used and combined using a matrix in table 4: (i) specific house structure damaged e.g. wall, external toilet, protective trees etc. and (ii) Window damage. The rationale for using windows as a separate aspect was that it acted as a yardstick for qualifying the extent of damage in the other house structural aspects. Knowing whether windows were damaged or not assisted in gauging the extent of damage to the other house structure aspects mentioned. This is because windows are usually above one meter from the ground such that any destruction occasioned to windows may act as an indicator of the severity of the flood and

damage caused to the other house structure aspects. This was opted for because of the absence of more objective means of assessing the magnitude of structural damage due to limitations in time and resources.

Household content flood impact classes were derived using a matrix in table 5 based on (i) specific household contents which were damaged e.g electrical appliances, furniture etc. and (ii) the extent of flood water coverage-i.e. whether house floor was partially or completely covered. Flood water coverage was opted for to supplement in gauging the extent of flood damage to specific household items. Complete floor coverage of flood water was thus an indicator of significant damage to household content and vice versa. The household structure impact values were then combined with HH content impact values to give an overall flood impact class on a household using the matrix in table 6.

In this study the word 'damage' denotes the actual physical destruction caused by the contact of flood water with household property(Messner., 2006). The word 'impact' on the other hand was used as a proxy for qualitatively combining the effect of various destruction 'damage' occasioned to household property on the livelihoods of a household.

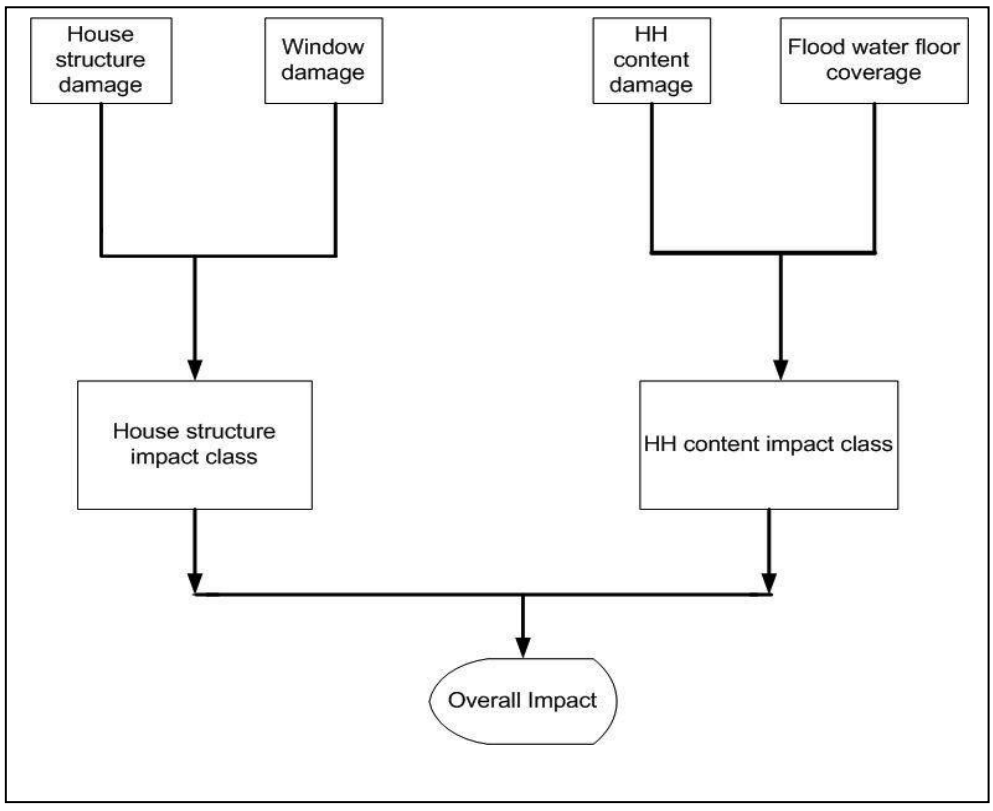


Figure 7: Flood impact assessment procedure

#### 4.1.4. House structure flood impact classes

The rationale behind the matrix was to gauge the magnitude of impact on a household occasioned by flood water to the house structure. To achieve this, damage to windows of a house was used as a proxy for the level of damage. The position of a window on a house makes it difficult for flood water to reach, if flood water is not forceful enough because windows are usually above one meter from the ground. Small floods are thus not expected to cause any damage to windows. However, where damage occurs to

windows, it becomes an indicator of the extent to which the other aspects were damaged. Several studies have explored the role of windows when assessing damage to the other aspects of the house. When window loss occurs, interior damage of a house can be substantial(Ayscue, 1996). Issa, Isaa, Shanker, and Gencorelli, (1996) estimated that a damage of 5% to the window exerts horizontal force against the interior wall. This implies that, a combination of window damage and other structural damage to the house can provide a qualitative estimate of the magnitude of structural damage to various aspects of the house in absence of more objective means of assessing level of damage to structural aspects of the house. However, where the whole house was damaged, window damage was not taken into account as it did not make any difference.

**Table 4** shows a matrix used for deriving household structure impact classes. It shows that where there was no damage to the house structural aspect and there was no window damage, it was assigned the impact class of 0(No damage-i.e. None); where there was damage to any aspect of the house e.g, walls or external toilet but there was no damage to the window, it was assigned the impact class of 1(little impact); where there was damage to any structural aspect of the house and there was also damage to windows, it was assigned an impact class of 2(high), and where the whole house was completely destroyed, it was given the impact class of the 3(severe)-windows here were not considered as it made no difference.

| **Damage to window** | **NO** | **YES** |
|---|---|---|
| **Damage to house structure aspect** | | |
| None | 0 | 1 |
| Toilet/Kitchen | 1 | 2 |
| Protective trees | 1 | 2 |
| Wall | 1 | 2 |
| Whole house | 3 | 3 |

Table 4: Matrix for deriving house structure damage classes

#### 4.1.5. Household content flood impact classes

Table 5 shows the matrix which was used to derive household content impact classes. Where there was no flood damage to any household content, it was assigned 0 (No impact i.e. none) whether there was partial or complete floor water coverage. Where household items were damaged but there was partial floor water coverage, it was assigned 1 (Little), where household items were damaged and there was complete floor coverage by flood water, it was assigned 2(High) and where all content was damaged, it was assigned 3(Severe) whether there was complete or partial coverage of flood water.

| **Flood water coverage** | Partial | Complete |
|---|---|---|
| **Damage house structure** | | |
| None | 0 | 0 |
| Food items | 1 | 2 |
| Kitchen utensils | 1 | 2 |
| Furniture and clothes | 1 | 2 |

| | | |
|---|---|---|
| Electrical appliances | 1 | 2 |
| All content | 3 | 3 |

Table 5: Matrix for deriving household content damage impact classes

#### 4.1.6. Overall Impact Classification

A combination of household content damage impact classes and house structure damage impact was used in a matrix shown in table 6 below to come up with overall household flood impact. Where the impact class value to both household content and house structure was no impact (0) the overall impact was also no impact (0). Where the impact class to house structure was little (1) and impact to household content was no impact (0), the overall impact was little (1). In cases where the impact to house structure was little(1) and impact to household content was high(2), the values were added and rounded to the nearest whole number which then became its impact class high(2). However, in the case of severe damage where, damage class for house structure or HH content was severe (3) (complete destruction of the house or damage to all HH content), it was assigned the overall impact of severe (3) regardless of the combination involved because loss of all household content or damage to the whole building signify the highest level of impact to a household one can think of.

| **Damage to household**<br>**Damage house structure** | None (0) | Little (1) | High (2) | Severe (all content(3) |
|---|---|---|---|---|
| None (0) | 0 | 1 | 1 | 3 |
| Little (1) | 1 | 1 | 2 | 3 |
| High (2) | 1 | 2 | 2 | 3 |
| Severe/whole house (3) | 3 | 3 | 3 | 3 |

Key:
0= No flood impact
1= Little flood impact
2=High flood impact
3=Severe flood impact

Table 6: Overall flood impact matrix

#### 4.1.7. Operationalisation of flood exposure measures

Three indicators were used to measure households' exposure to floods in the study area. These were house inundation depth, river proximity distance and inundation duration in the house(Ninno et al., 2001; Merz, Kreibich and Schwarz., 2010). Table 7 below shows the underlying assumptions behind the use of each indicator. These exposure measures were tested independently against flood impacts for their influence on vulnerability variations. Several measures which are independent of each other were used for verification and comparability purposes.

| **Flood exposure indicator** | **Assumption** |
|---|---|
| Inundation depth(centimetres) | The greater the inundation depth, the greater the building and contents parts which are damaged and the greater the impact |
| Duration of inundation(hours) | The longer the duration of inundation, the greater the saturation of building structure and contents and the higher the probability of impact |
| River proximity distance(metres) | Households located closer to rivers suffer more flood impact than those located far away from it. |

Table 7: Flood exposure measures and their underlying assumptions behind their selection(Merz, Kreibich, and Schwarz, 2010; Ninno, 2001)

#### 4.1.8. Operationalisation of contextual factors/stressors

To assess major stressors in the study area, several proxy measures were used depending on data availability. **Figure 8** below shows an overview of stressors (contextual factors) and proxy measures which were used in the assessment. The figure is just one component of the contextual vulnerability framework. The dotted lines from the stressors to the vulnerability box signify that, stressors have the potential to make households vulnerable in combination with other factors not shown in the figure but shown in the conceptual framework in figure 2.

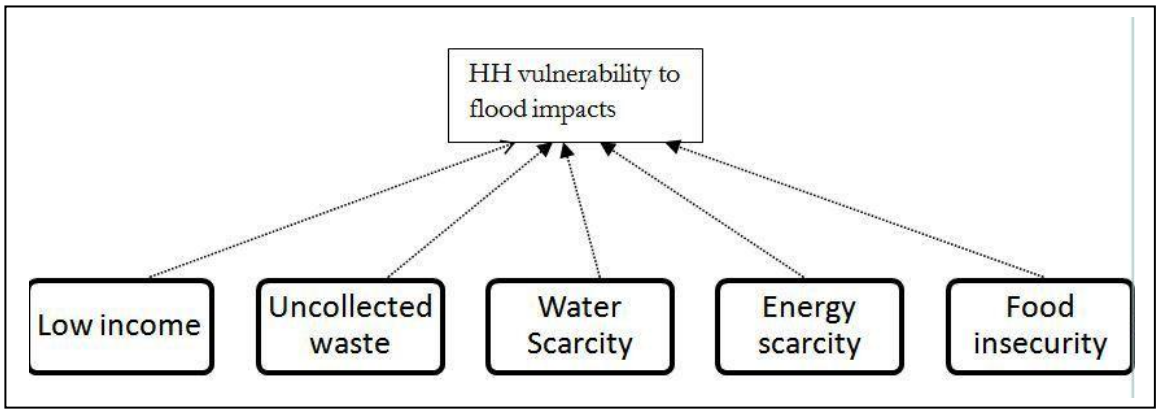


Figure 8: Overview of proxy measures for assessing contextual factors

**Figure 9** below shows stressors which were assessed and the proxy measures which were used to measure them including the underlying assumptions for using such proxy measures.

| Stressor | Proxy measures | Assumption |
|---|---|---|
| Income | Household size | HH with a high household size spend more money taking care of the family members such that they are left with less income and ill-prepared to reduce flood impacts. The higher the household size the more stressed is a household |
| Uncollected waste | Distance between a household's nearest dumpsite and nearest water drainage channel | HH with a short average distance between their nearest dumpsite and nearest drainage channel have uncollected waste problem which may have implication on flood impacts. (distance between households' nearest dumpsite and nearest drainage channel was measured) |
| Water scarcity | Distance between household and water source | Long distance between a household and its nearest water source may be an indirect indicator of water stress. This may reduce its preparedness during floods. The longer the distance, the more likely that the household is stressed and the higher the likelihood of being vulnerable to flood impacts. |
| Food insecurity | Number of days per month a HH doesn't eat adequate and quality food | Number of days per month which a household is unable to eat the desired quality and quantity of food per month may be an indicator of food insecurity. Lack of this basic need may imply that less time and resources are dedicated for flood preparation. The |

| | | |
|---|---|---|
| | | higher the number of days per month the more stressed is a household and the higher the likelihood of suffering flood impacts. |
| Energy scarcity | Amount of money spent on energy per month | Amount of money spent on energy may be an indicator of the household energy challenges. The higher the amount of money spent on energy, the more difficult it is to access energy sources. This may have a negative effect on a household as they may be unable to prepare for floods. The higher the expenditure on energy, the more stressed is a household and the higher the likelihood of suffering high flood impacts due to ill-preparedness. |

Figure 9: Description of proxy measures for assessing HH stressors

#### 4.1.9. Operationalisation of household coping strategies.

Assessment of household coping strategies was based on (Twigg, 2004). Coping strategies which were identified during the study were categorised based on Twigg (2004) and major coping forms have been summarised in the figure 10 below. The figure illustrates coping strategies which have the potential to influence households' vulnerability depending on their effectiveness.

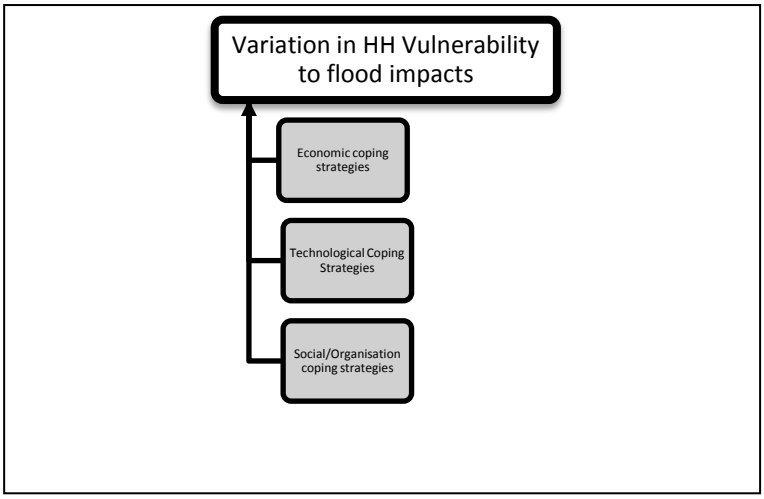


Figure 10: Framework for coping activities

## 4.2. Results and Interpretation.

This section presents results on the various components of the analysis. Components have first been individually reported. Subsequently, results of the statistical tests of individual components against flood impacts have been reported.

### 4.2.1. Household flood impacts

Figure 11 below shows the frequency distribution pattern of flood damage impact for both household content and structure. There were more households in South Lunzu which suffered high damage to their household's contents than in Ndirande in terms of percentage of surveyed households. In all the categories, the percentage of those who suffered damage is higher in South Lunzu than in Ndirande. This variation may be due to difference in flood exposure levels, contextual factors or coping strategies or coping challenges.

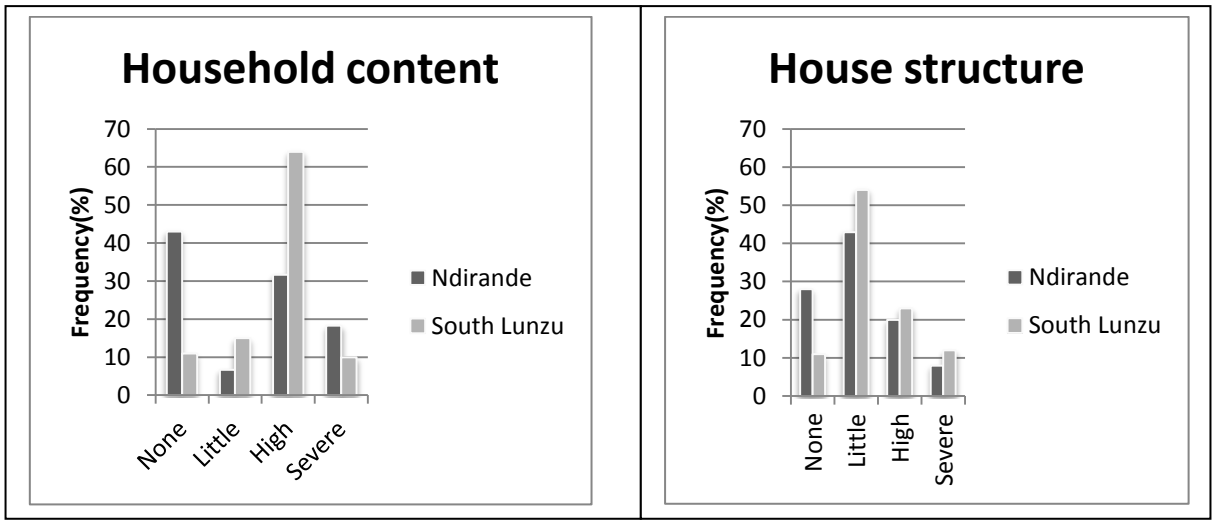


Figure 11: Flood impact frequency pattern

### 4.2.2. Overall Flood Impact

To come up with final categories for the flood impact vulnerability analysis the initial four impact categories were reclassified into two categories (i.e. low impact and high impact) as figure 12-right below shows. In order to reclassify the four initial impact categories the 'none' and 'little' impact categories were reclassified as low impact category; while 'high' and 'severe' were reclassified as high impact category. These were the categories which were used in all the analysis in the study.

The rationale for reclassification was to reduce the number of cells with no values when performing a Chi-Square test. Using all four categories was resulting into more than 5% of the cells having no values which is against the Chi-Square test requirements(Field, 2013). Moreover, many impact categories were obscuring the patterns in the data. Reducing the categories was thus a remedy to these problems as patterns began to emerge and the Chi-Square test requirements were met. The final picture which emerges is that more households suffered high impact in South Lunzu than in Ndirande. This finding suggests that households in these areas faced varying levels of exposure to floods, experienced different contextual conditions- or undertook different coping strategies

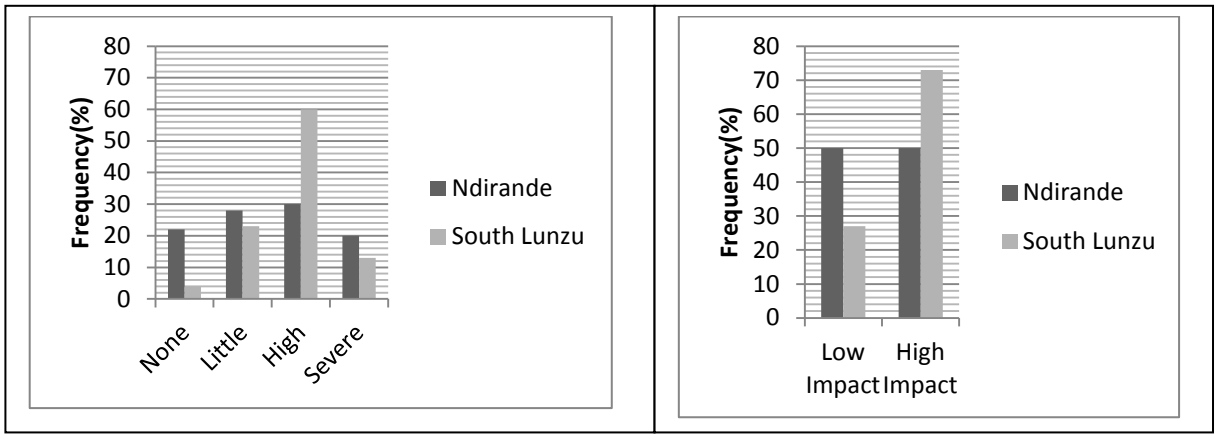


Figure 12: Overall flood impact classes (frequency-% of the surveyed households)

#### 4.2.3. Exposure Measures

One of the components which were assumed to have an effect on households' vulnerability to flood impacts as indicated in the analytical framework (figure 6) is exposure. Exposure measures were tested against flood impacts in section 4.3. The reason for performing this procedure was to find out if flood impacts vary depending on household exposure level.

#### 4.2.4. Distribution of exposure measures

**Figure 13** below shows that most households who reported flood inundation depth greater than 21 centimetres were located in South Lunzu relative to Ndirande. This indicates that in terms of percentage of interviewed households, there were more households exposed to high inundation depth in South Lunzu than in Ndirande.

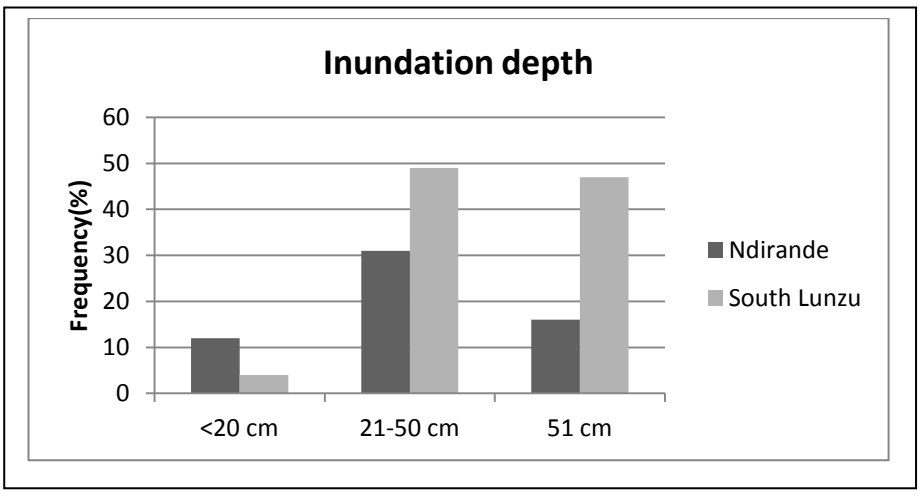


Figure 13: Inundation depth frequency distribution

Figure 14 below shows results on the reported inundation duration. Results show that, most households who reported flood inundation duration of more than 15 hours were located in South Lunzu. This signifies correspondence with results on inundation depth. Higher inundation duration corresponds to higher inundation depths. For purpose analysis in relation to flood impacts in section 4.3, the inundation

duration was reclassified into two categories (=> 11 hours and < 11 hours) as having more categories was obscuring patterns in the data.

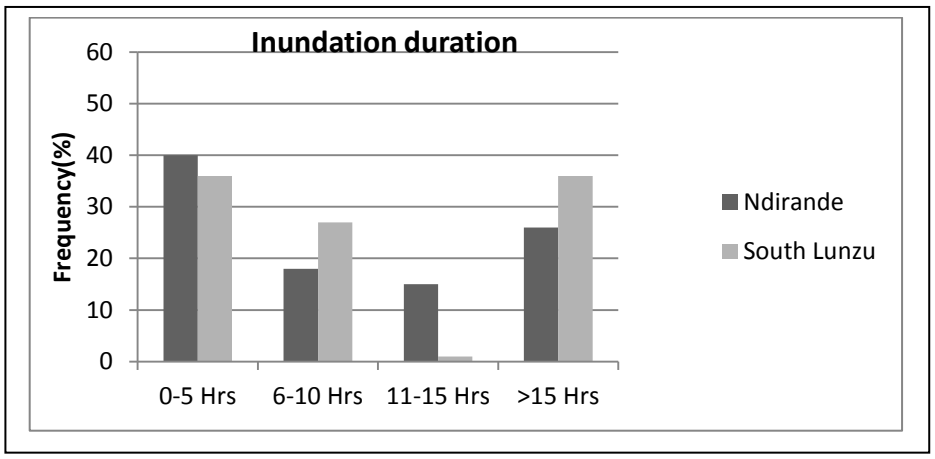


Figure 14: House inundation duration frequency distribution (% of surveyed households)

#### 4.2.5. Contextual factors/ Stressors in the study area

The study investigated factors which affect households' ways of earning their living in the study areas. Respondents were asked to mention the number of stressors which they face according to the perceived importance of each stressor. The aim was to assess relative influence of stressors on households' vulnerability to flood impacts and to find out if the number of stressors per household has a bearing on households' vulnerability.

**Table 8** below shows types of stressors in the study area based on households' perception of the most important stressor (ranked as number one where a household experienced multiple stressors).

Table 8: Stressors perceived as number one (most important)

| | Frequency distribution | |
|---|---|---|
| Type of stressor | Ndirande(n=59) | South Lunzu(n=83) |
| Low income | 20 (33%) | 31 (37%) |
| Uncollected waste | 17 (28%) | 5 (6%) |
| Water scarcity | 13 (22%) | 20 (24%) |
| Energy scarcity | 4 (7%) | 15 (18%) |
| Food insecurity | 5 (8%) | 12 (15%) |

Results on factors which are perceived as most important by households in table 8 above show that in both Ndirande and South Lunzu low income is perceived as the most important stressor which affect households' livelihoods. However in terms of percentage of the interviewed households, there was a high proportion in South Lunzu who perceive low income as the number one stressor compared to Ndirande indicating that income poverty is high in South Lunzu relative to Ndirande.

Results on uncollected waste and water scarcity were also verified though field observation as figure 15 below shows. The picture for Ndirande (A) shows that households dump their waste in drainage channels

implying that distance between a household dumpsite and water drainage channel is zero (i.e. highest stress from uncollected waste). This observation is also in line with the short average distance between household waste dumpsite and water drainage channel in Ndirande compared to South Lunzu (table 9). Many households also perceived uncollected waste as a most important challenge in Ndirande than in South Lunzu. The picture below shows that water is an important challenge in South Lunzu (figure 15 **B).** In fact many households in South Lunzu also mentioned water scarcity as their number one stressor compared to Ndirande (Table 8).


Figure 15: Contextual stressors: (A) Uncollected waste (B) Water scarcity (Source: Author, 2014)

Several proxy measures were used to assess major stressors in the study areas. These proxy measures were used in order to compare with perception based responses given by respondents on the stressor which they consider as most important. The results are presented in **table 9** below.

| **Stressor** | **Proxy measures** | **Ndirande(Average)** | **Range** | **South Lunzu(Average)** | **Range** |
|---|---|---|---|---|---|
| Income | Household size | 4.8 | 7 | 5 | 8 |
| Uncollected waste | Distance between a household's nearest dumpsite and nearest water drainage channel | 6 metres | 16 | 27 metres | 74 |
| Water scarcity | Distance between household and nearest water source | 17 metres | 70 | 81 metres | 400 |
| Food insecurity | Number of days per month a HH doesn't eat adequate and good quality food | 21 | 31 | 14 | 26 |
| Energy scarcity | Amount of money spent on energy per month | MK 6192(EUR 11.91) | 35000 | MK4692(EUR 9.03) | 12000 |

Table 9: Proxy variables for measuring stressors.

The indicators used show wide variations among households judging by the range values. This suggests the existence of households with extreme social economic status (extremely stressed households and better off households). Such a pattern signify that households' responses when faced with flooding may also differ. The wide range values in proxy measures may imply that their ability or inability to prepare and respond to flood events also vary widely. One surprising finding is that households' perception on food

insecurity show that few households consider it as a major problem yet the average number of days per month when households don't eat adequate and good quality food is high. A possible explanation could be that, what matters to households is the mere availability of food and not quality and quantity.

With respect to energy, high expenditure on energy in Ndirande meant that households are more stressed and money which could have been used to enhance their flood preparedness is spent on energy. Surprisingly, it is in South Lunzu where, more households perceive energy scarcity as their number one stressor yet they pay less relative to Ndirande. The large household size for South Lunzu may be the reason why many more households perceive energy as their major stressor as it negatively affects their income.

#### 4.2.6. Number of stressors per household

To ascertain if the number of stressors per households influence household vulnerability to flood impacts, the study investigated the number of stressors which each household was facing. Respondents were thus asked to indicate the number of stressors which affected their livelihoods. The results show that majority of respondents in both study areas experience between 3 to 4 stressors (figure 16) which means that households' livelihoods are affected by multiple stressors and stressors vary from one household to another. However for purposes of analysis in relation to flood impacts in section 4.4., these stressors were divided into two categories depending on the frequency distribution of stressors in a study area(=> 4 stressors and <=3 stressors categories for Ndirande; =< 2 stressors and => 3 stressors categories for South Lunzu ) to reduce obscurities in patterns and to reduce percentage of Chi-Square contingency table cells having no values.

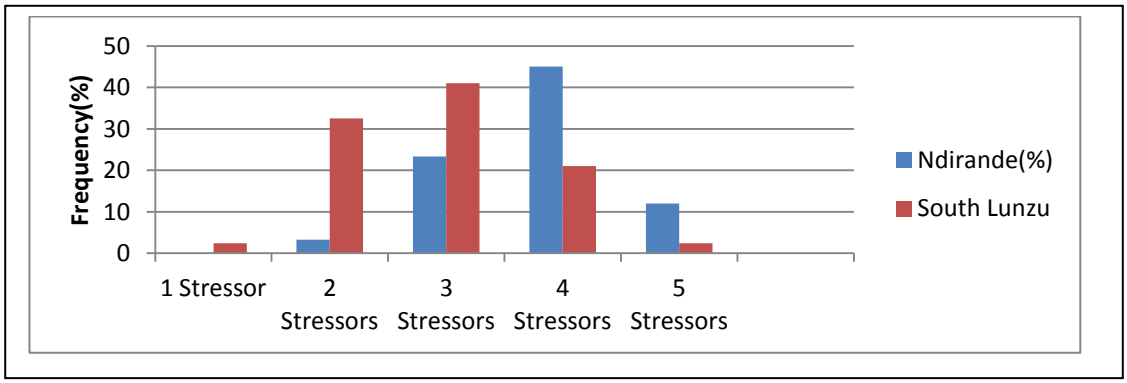


Figure 16: Number of stressors per HH

Results in Table 10 and 11 are based on river distance categories of 15 metres. The cut off points for these zones was based on the Blantyre city council recommended distance of 15 metres from the river where people are allowed to settle. Based on this distance all households settling beyond 15 metres from the rivers are assumed to be safe from floods while those within 15 metres are assumed to be unsafe from floods. Few households were interviewed within the first 15 metres from the river because there are relatively few households settled in that zone compared to the 16-30 and >31 zones.

Figure 17 and tables 10 and 11 below show the spatial distribution of number of stressors per household in the study areas. The picture which emerges is that of a random pattern suggesting the co-existence of extremely stressed households, those who were moderately stressed and those who were better off are located in the same neighbourhoods and 'plots'. Such a distribution suggests that, households are bound to respond differently to the same level of flood exposure depending on their stress. This may ultimately

differentiate their vulnerability to flood impacts. This is also supported by the existence of wide range values when specific stressors were measured; for example, using expenditure on energy per month (table 9 above).

Table 10: Spatial distribution of stressors per household in Ndirande

| | Distance from river | | |
|---|---|---|---|
| No. of stressors | 0-15 metres | 16-30 Metres | >31 Metres |
| 5 Stressors | 3(27%) | 2(10%) | 7(29%) |
| 4 Stressors | 5(45%) | 13(65%) | 9(38%) |
| 3 Stressors | 2(18% | 5(25%) | 7(29%) |
| <2 Stressors | 1(9%) | - | 1(4%) |
| Total interviewed in each zone: | 12 | 21 | 27 |

n=60

Table 11: Spatial distribution stressors per household in South Lunzu

| No. Of Stressors/HH | Distance from river | | |
|---|---|---|---|
| No. of stressors | 0-15 metres | 16-30 Metres | >31 Metres |
| 5 Stressors | - | 2 (7%) | - |
| 4 Stressors | 1(10%) | 8(29%) | 9(20%) |
| 3 Stressors | 2(20%) | 13(46%) | 19(56%) |
| <2 Stressors | 7(70%) | 5(18%) | 17(37%) |
| Total interviewed in each zone: | 10 | 28 | 45 |

n=83

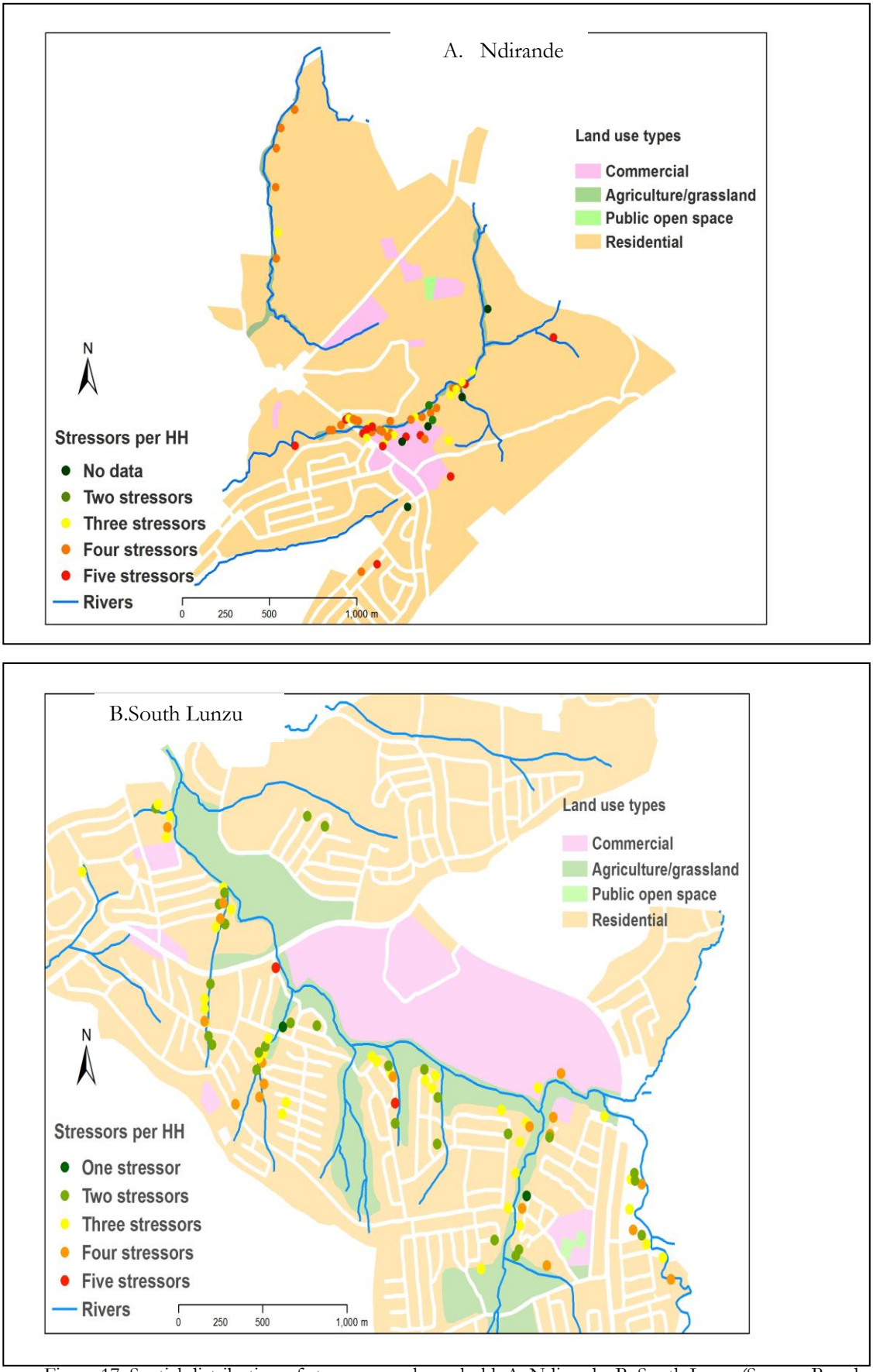


Figure 17: Spatial distribution of stressors per household: A. Ndirande; B. South Lunzu(Source: Based BCC data)

#### 4.2.7. Coping strategies

The study investigated types of coping strategies which households in the study area were taking. The aim was to discover variations in the strategies which were being taken by different households.

#### 4.2.8. Economic/Material coping strategies

The principal element of this strategy was economic diversification. An analysis of the coping strategies falling under this theme shows that having more than one source of income was the central feature during times of stress caused by floods when some economic activities were becoming impossible to undertake. For example one respondent reported that *"…after floods I try to make sure that I work more than I normally do to get more income for my family and to repair the damaged items…"* This example suggests that households undertake economic coping strategies mainly to diversify their income sources by whatever way at their disposal.

#### 4.2.9. Technological Coping Strategies

This category involves land management, building materials and construction methods. Land management coping strategies for example included managing the surrounding land in a way that slows down rainwater runoff, creating outlets to manage water overflow when it is in excess, planting trees, grass or sugarcane along streams, rivers or drainage channels to stabilise the river banks.

Figure 18: Some observed flood coping strategies (old tires-left; stone embankments-middle; sand bags right)(Source: Author, 2014)

Building and construction coping strategies included adaptation of the house to repeated floods, reinforcing houses by tying with wire, nailing down walls and windows and putting heavy items (sand bags, tyres)-(figure 18-right) to protect roofing or wall, anchoring old tyres along the river banks to shield house from flood water(figure 18-left), elevate part of the house, building house using reinforced materials, constructing a stone/cement ridge/embankment along the river to shield house from river flood water(figure 18-middle).

#### 4.2.10. Social/Organisational strategies

The study revealed that, the family, extended social relations, mutual assistance and social contact were among the most mentioned coping strategies[1] in times of floods. For example, respondents reported that they vacate their house to seek refuge at neighbours' or relatives' house during flood to avoid loss of life, and property ; some indicated that they source relief items from government, whereas others reported that they repair their damaged house with members of their family to mitigate labour costs. On the other hand, others stated that they ask for work or for assistance from other community members and in some

[1] Household who mentioned social coping options revealed a pattern which shows extreme reliance on relatives and friends' goodwill to support them. Organisational support was however uncommon.

cases they borrow money from relatives or money lenders on *katapila* arrangement where the borrower is required to pay double (100% interest) the borrowed amount and in the event of default, the interest is compounded.[2] Table 12 below shows a summary of coping strategies which were identified during the study according to category.

In terms of relative importance, judging by numbers of households taking a particular form of coping strategy, it appears that technological strategies are pursued by many households. In fact, majority of households who did not suffer flood impact during the 2012/2013 rainfall season flood event, were taking technological coping measures relating to the housing aspect. However, with respect to livelihood coping strategies, the most important ones were economic, especially before the flood event. With respect to effectiveness, the results show that, the adopted coping measures were effective or ineffective depending on the area in which they were applied, number of stressors per household and duration of residence in the area.

| Type of coping strategy | Coping activity |
|---|---|
| Economic | -Look for additional sources of income<br>-Stock up shops so there are enough supplies to sell<br>-Increase working hours<br>-Save money<br>-Use savings<br>-Work overtime<br>-Look for alternative employment<br>-Borrow money from relatives, moneylenders<br>-Pawn appliances and valuables |
| Technological | -Reinforce houses by tying with wire<br>-Nail down walls and windows and put heavy items(sand bags, tyres) to protect roofing<br>-Put anchor old tyres along the river to shield house from flood water<br>-Elevate part of the house<br>-Build house using reinforced materials<br>-Construct a stone/cement ridge along the river to shield house from river flood water<br>-Plant sugar cane/trees along the river to create flood water buffer<br>-Digging and cleaning drains<br>-Secure access to the house to avoid intrusion of debris and waste<br>-Create a small hole in the house to let out flooded water<br>-Remove water using a plate to reduce its volume<br>-Earth filling to elevate room level |
| Social /Organisation | -Vacate house to avoid loss of life<br>-Source relief items<br>-Repair house with members of the family to avoid cost of labour<br>-Ask for work or for assistance from other community members<br>-Borrow money from relatives<br>-Keep household items at neighbours house<br>-Keep items on top of others e.g. on bed shelves to prevent them from getting wet with flood water |

Table 12: Identified coping activities (Categories based on Twigg, (2004)

[2] This coping option emerged both as an economic and social coping strategy

#### 4.2.11. Challenges to coping strategies

The study further investigated challenges which households face in the implementation of their coping strategies. Table 13 below shows a summary on the frequency distribution of the most common challenges which households encounter in the study areas. Results show that, the major stumbling block in the implementation of coping strategies was low income. These challenges are not distributed equally among households such that, their effect on household flood impacts are also bound to differ even where the level of physical exposure to floods is the same. Results on the role of coping challenges on flood impacts have been presented in section 4.3 below**.**

Table 13 Frequency distribution of coping challenges

| | Study Area | |
|---|---|---|
| HH Challenge to coping strategies | Ndirande | South Lunzu |
| Low income | 31(52%) | 45(54%) |
| Lack of corporation from landlord | 7(12%) | 3(4%) |
| Destruction of trees by livestock and children | 4(7%) | 1(1%) |
| Bricks/cement expensive | 1(2%) | 15(18%) |
| Laziness/busy with other activities | 4(7%) | 15(18%) |
| Other challenges | 12(20% | 4(5%) |

### 4.3. The role of physical exposure on household flood impacts

To ascertain the role which flood exposure played on household flood impacts, the relationship between exposure and household flood impact was explored. The aim was to assess the applicability of the contextual approach in flood impact vulnerability in the context of climate change. The operating assumption was that, vulnerability to flood impacts vary depending on the contextual conditions which households face and not mere exposure to flooding. To prove this assumption, the relationship between exposure measures and flood impacts was tested. In performing this test it was assumed that if exposure measures are the sole determinants of household vulnerability, the number of households highly impacted by floods would be associated with those who are highly exposed either due to experiencing high inundation depth, long inundation duration or by being located close to rivers. The four flood impact categories were then reduced into low impact and high impact for purposes of analysis based on the rationale explained in section 4.2.2.

#### 4.3.1. Inundation depth and flood impacts

Results for Ndirande show no association between flood depths and flood impacts **(**Chi-square= 4.01; df= 2, p>.05) (table 14). This implies that, the observed flood variations cannot be attributed to variations in inundation depth. Other factors may thus be responsible for the variations in flood depths and not exposure.

Table 14: Relationship of inundation depth and flood impacts in Ndirande

| Flood Depth | Flood Impact class | |
|---|---|---|
| | Low Impact | High Impact |
| >51cm | 7 (24%) | 9 (30%) |
| 21-50 cm | 13 (45%) | 18 (60%) |
| <20cm | 9 (31%) | 3 (10%) |

n=59

In South Lunzu, households which were exposed to high inundation depth also experienced high flood impact compared to those which were exposed to low inundation depth(Chi-square=14.2; df=2; p=<.05)(table 15). Although, high inundation depth was associated with high flood impacts, the degree of association was not strong (Cramer's V= .415). Such a result implies that, not all the variations in household flood impacts can be explained by the flood depth exposure measure alone. This finding raises the possibility that contextual factors plays a role in the impact variations as will be shown in subsequent sections.

Table 15: Relationship between inundation depth and flood impacts in South Lunzu

| Inundation depth | Flood Impact class | |
|---|---|---|
| | Low Impact | High Impact |
| >51 | 3 (13%) | 36 (59%) |
| 21-50cm | 7 (77%) | 14 (39%) |
| <20cm | 2 (9%) | 1 (2%) |

n=83

#### 4.3.2. Inundation duration

The inundation duration was reduced into two categories from the initial four, to reduce the number of cells having no values in the Chi-Square contingency table to meet the requirements of the Chi-Square test. The resulting patterns from both study areas show that households which were exposed to long inundation duration were not necessarily the ones which suffered high flood impact. Moreover, the influence of this exposure measure on household flood impact is not statistically significant (Chi-square= .069; df= 1, p>.05 for Ndirande and Chi-Square= .391; df = 1; p > .05 for South Lunzu) (tables 16 and 17). This finding appear to support the contention in the contextual approach as there could be other factors not related to physical exposure which were responsible for such a pattern.

Table 16: Relationship between inundation depth and flood impacts in Ndirande

| | Flood Impact class | |
|---|---|---|
| Inundation duration | Low Impact | High Impact |
| > 11 Hours | 12 (40%) | 13 (43%) |
| <=11Hours | 18 (60%) | 17 (58%) |

n=60

Table 17: Relationship between inundation depth and flood impacts in South Lunzu

| | Flood Impact class | |
|---|---|---|
| Inundation duration | Low Impact | High Impact |
| > 11 Hours | 7(32%) | 24 (39%) |
| <=11Hours | 15(29%) | 38 (61%) |

n=83

#### 4.3.3. River proximity distance

Results for both Ndirande(Chi-Square=.418, df=2, p >.05) and South Lunzu(Chi-Square=2.14, df=2, p >.05) show that households which were more exposed (close to rivers) did not necessarily suffer high flood impacts (tables 18 and 19). This suggests that, it is not the mere household location close to rivers which explains flood impacts but rather other factors.

Table 18: Relationship between river proximity distance and flood impacts in Ndirande

| River distance | Flood Impact class | |
|---|---|---|
| | Low Impact | High Impact |
| > 31 Metres | 14(47%) | 13(43%) |
| 16-30 Metres | 11(37%) | 10(33%) |
| 0-15 Metres | 5(16%) | 7(23%) |

n=60

Table 19: Relationship between river proximity distance and flood impacts in South Lunzu

| River distance | Flood Impact class | |
|---|---|---|
| | Low Impact | High Impact |
| > 31 Metres | 13(59%) | 32(53%) |
| 16-30 Metres | 5(23%) | 23(38%) |
| 0-15 Metres | 4(18%) | 6(10%) |

n=83

#### 4.3.4. Summary on exposure measures

Results show that two exposure measures (inundation duration and river proximity distance) do not influence variations in household vulnerability to flood impacts. Only inundation depth was weakly associated with variations in flood impacts in South Lunzu. However the same inundation depth did not influence flood impacts in Ndirande. These findings suggest that household vulnerability to flood impacts is not entirely dependent on physical exposure to floods. This conclusion is justified by the fact that it is only one exposure variable which had a minor influence on flood impacts in one study area. The results signify that, there are other factors which explain the vulnerability of households to flood impacts and not physical exposure. These other factors will be explored in the subsequent sections.

### 4.4. The role of contextual factors on flood impacts

Having found that, exposure measures do not provide adequate explanation for the variations in household flood impacts, the relationship between contextual factors and household flood impact was explored in order to ascertain their role on the variations in household flood impacts with specific reference to type of stressor and number of stressors per household.

Low income was associated with high flood impacts (tables 20 and 21). However, this association is statistically non-significant (Chi-Square=6.6; df=4; p>.05 for Ndirande and Chi-Square=5.6; df=4; p>.05 for South Lunzu). This implies that type of stressor was not the cause of the variations in flood impacts.

Table 20: relationship between stressors and flood impacts

| | Flood impact class | |
|---|---|---|
| Stressor type | Low Impact | High Impact |
| Water scarcity | 10 (35%) | 3 (10%) |
| Energy scarcity | 1 (3%) | 3 (10%) |
| Food insecurity | 3 (10%) | 2 (7%) |
| Uncollected waste | 6 (21%) | 11 (37%) |
| Low income | 9 (31%) | 11 (37%) |

Ndirande (N=59)

Table 21: Relationship between stressors and flood impacts

| | Flood impact class | |
|---|---|---|
| Type of stressor | Low Impact | High Impact |
| Water scarcity | 4 (18%) | 16(26%) |
| Energy Scarcity | 3 (14% | 12(20%) |
| Food insecurity | 1 (5%) | 11(18%) |
| Uncollected waste | 2 (9%) | 3 (5%) |
| Low income | 12 (55%) | 19(31%) |

South Lunzu (N=83)

While individual stressors did not show any influence on household flood impacts, results for South Lunzu show that households with a large number of stressors were more likely to suffer high flood impacts. Households with more than three stressors had a higher likelihood of being vulnerable to flood impacts than those with two or less stressors (Chi-Square=7.6; df=1; P<.05) (table 22). This signifies some level of consistency with the underlying contention in the contextual approach i.e. that contextual factors play a role in differentiating the more vulnerable households from the less vulnerable depending on the number of stressors per household. However results for Ndirande did not show any relationship between number of stressors per household and flood impacts (Chi-Square=.86; df=1; p>.05). The differences in findings between Ndirande and South Lunzu also suggest the differences in contextual conditions which households in these areas face.

Table 22: Relationship between number of stressors/HH and flood impacts in South Lunzu

| | Flood Impact class | |
|---|---|---|
| Number of Stressor/HH | Low impact | High Impact |
| =>3 Stressor | 9(41%) | 45(74%) |
| <= 2 Stressors | 13(59%) | 16(26%) |

n=83

### 4.5. Coping strategies and flood impacts

Results on the relationship between housing coping strategies and flood impacts show that housing coping strategies which households were taking during the flood event were associated with flood impacts(Chi-Square= 7.37; df= 2; p <.05 for Ndirande and Chi-Square=6.290; df= 1; p <.05 for South Lunzu)(table 23 and 24. This signifies the influence of coping strategies in the observed household flood impact variations. In Ndirande, social/coping strategies were associated with high impact, whereas taking technological strategies did not result in any difference between suffering low impact and high impact. In South Lunzu, households which were taking social/organisational strategies suffered low flood impact. This finding suggests that while social/organisational strategies were effective in South Lunzu, in Ndirande the same strategies were ineffective.

The relatively rural character for South Lunzu as opposed to Ndirande might have accounted for the difference in the effectiveness of the social/organisational strategies. The traditional social ties which compel households to assist each other during crisis times might have been watered down by individualised living of urban life. The semi-rural nature for South Lunzu means that people are still compelled to assist each other on humanitarian grounds-which are best described by the *ubuntu* philosophy embedded in the local tradition; where, by virtue of being humans those who are better off are expected to assist those who are in crisis

Table 23: Housing coping strategies during floods for Ndirande

| | Flood Impact class | |
|---|---|---|
| Coping category | Low Impact | High Impact |
| None | 7 (24%) | 1(13%) |
| Social and Organisational | 5 (17%) | 12(40%) |
| Technological | 17 (59%) | 17(57%) |

n=60

Table 24: Housing coping strategies during floods for South Lunzu

| | Flood Impact class | |
|---|---|---|
| Coping category | Low Impact | High Impact |
| Social and Organisational | 20(90%) | 38(62%) |
| Technological | 2(9%) | 23(38%) |

n=83

Moreover the number of stressors per household was related to coping strategies. In Ndirande households with more than four stressors were more likely to take social/organisational coping strategies while those

with less than three stressors were more likely to take technological strategies (Chi-square=6.64; df=2; p<.05**)(table 25).** This is consistent with results on the relationship between coping challenges and flood impacts presented in the subsequent paragraphs where low income was associated with high flood impacts in Ndirande. Households with more stressors were thus opting for social/organisational strategies because these strategies do not require money to undertake**.** This suggests that number of stressors per household and flood coping challenges had an influence on the type of household flood coping strategies. It is therefore these contextual conditions which in turn influenced vulnerability variations as argued in the contextual approach.

Table 25: Relationship between number of stressors per household and type of coping strategies in Ndirande

| | Coping Strategies | | |
|---|---|---|---|
| Number of Stressors/HH | Technological | Social/Organisational | None |
| >=4 Stressors | 5(17%) | 9(53%) | 2(25%) |
| <=3 Stressors | 24(83%) | 8(47%) | 6(75%) |

n=54

Results on housing coping strategies which were taken before and after floods, including livelihood coping strategies at all phases did not show any discernible pattern in relation to flood impact variations. This could be attributed to the fact that, data on flood impacts was limited to immediate damage caused to household property and not to post flood impacts.

The study further investigated the role of challenges which households face when implementing coping strategies. Results show that high flood impact was associated with households with low income as their coping challenge (Chi-Square=14.07, df=5, p<.05; Cramer's V =.488)(tables 26). No relationship was found between coping challenges and flood impacts in South Lunzu (Chi-square=8.42; df=5; p>.05(table 27)**.** The variations in flood impacts can thus be attributed to coping challenges in Ndirande and to multiple stressors in South Lunzu. These findings are consistent with the contextual approach.

Table 26: HH coping challenge and flood impact: Ndirande

| Coping challenge | Flood Impact class | |
|---|---|---|
| | Low impact | High impact |
| Laziness | 4 (14%) | - |
| Expensive cement and bricks | - | 1 (3%) |
| Children/animals destroy grass | 1 (3%) | 4 (10%) |
| Lack of cooperation from landlord | 3 (10%) | 4(13%) |
| Low income | 11 (38%) | 20(67%) |
| Others | 10 (35%) | 2(7%) |

n=59

Table 27: HH coping challenge and flood impact: South Lunzu

| Coping challenge | Flood Impact class | |
|---|---|---|
| | Low impact | High impact |
| Laziness | 1 (5%) | 3 (5%) |
| Expensive cement and bricks | 6 (27%) | 9(15%) |
| Children/animals destroy grass | - | 1 (2%) |
| Lack of cooperation from landlord | 2 (9%) | 1 (2%) |
| Low income | 7 (32%) | 38(62%) |
| Others | 6 (27%) | 9(15%) |

n=83

#### 4.5.1. Spatial distribution of housing coping strategies during the flood event

The maps in figures 19 and 20 show that in both study areas adoption of a particular form of coping strategy is not dependent on location. Household taking different forms of coping strategies are located in a mixed pattern. Going by this pattern, effectiveness of a particular coping strategy may be crucial in the determination of households which are vulnerable and those which are not. Mere exposure to floods by location may thus not predict household's vulnerability.

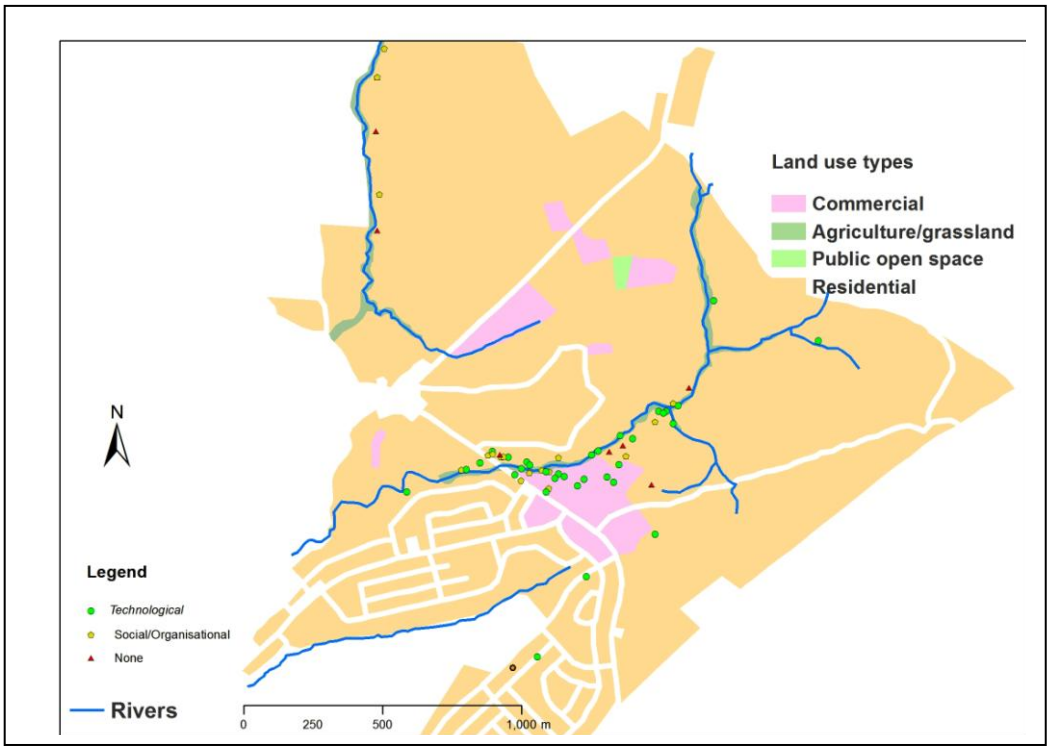


Figure 19: Spatial distribution of housing coping strategies taken during the flood in Ndirande(Source: Based on BCC data)

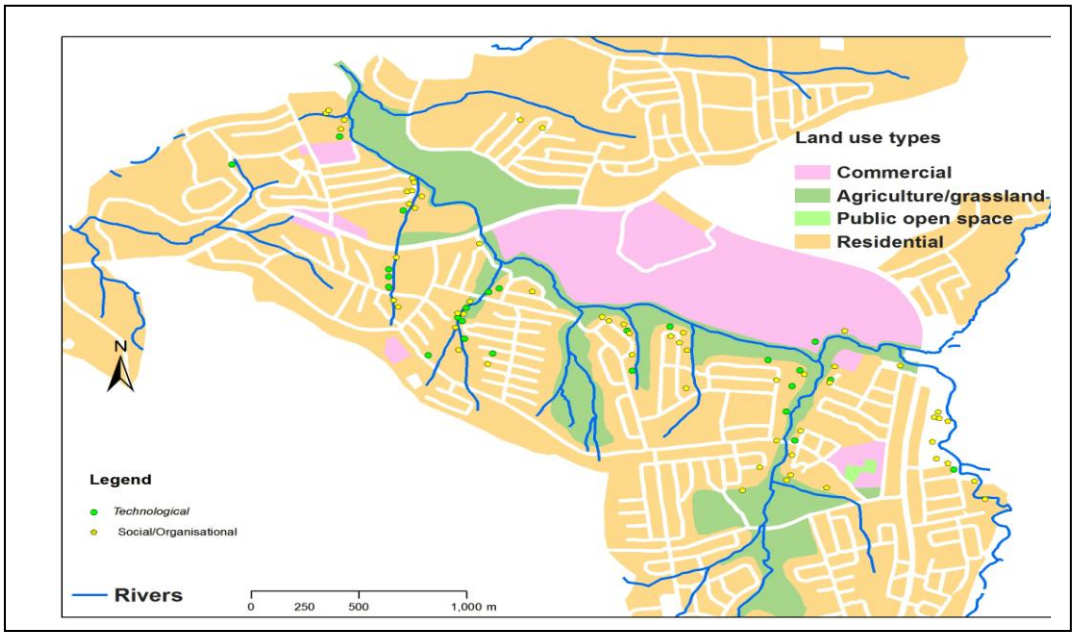


Figure 20: Spatial distribution of housing coping strategies taken during the flood event in South Lunzu.(Source: Based on BCC data)

## 4.6. Conclusion

The study found that it is only one exposure measure (inundation depth) in South Lunzu which had a minor influence on vulnerability variations in flood impacts. All other exposure measures did not play any role in influencing flood impacts. Overall, high numbers of stressors per household and low income as a coping challenge were the major cause of high flood impacts. The effectiveness of coping strategies depended on area and household. Technological strategies were effective for long time residents but ineffective for new comers in the area. Contextual factors therefore had a strong influence on flood impact vulnerability relative to exposure measures.

# 5 THE ROLE OF CONTEXTUAL FACTORS IN FLOOD IMPACT VARIATIONS

**Introduction**

This chapter discusses major findings presented in chapter four in reference to other studies. It focuses on factors which are essential in explaining variations in the vulnerability of households to flood impacts. By focusing on exposure factors, stressors, coping strategies and coping challenges, the chapter highlights the role of contextual factors on household vulnerability to flood impacts. The chapter endeavours to prove based on the results and with reference to other studies that, a contextual approach should be preferred in climate change vulnerability studies for a full understanding of factors which explain vulnerability. The role of contextual factors on flood impacts is discussed in comparison to the role of exposures measures on flood impacts. The aim is to highlight the degree to which each of these two sets of factors plays a role in flood impact variations among households. Issues to be addressed include:

- The role of exposure measures on flood impacts
- The role of contextual conditions on flood impacts and
- The role of coping strategies on flood impacts

**5.1. Flood impacts in the study areas**

One way of assessing flood impacts at a household level looks at the damage caused by floods on households' tangible assets(World Food Program, 2010; Birkmann, Fernando and Hettige, 2006). Messer and Meyer (2007) define flood damage as all varieties of harm caused by flooding. From the research findings, it is apparent that there are intra and inter area variations in the level of flood impacts among households. Overall, there were more households which suffered high flood impacts in South Lunzu than in Ndirande. Such a pattern suggests the existence of factors which differentiate household in these study areas in terms of damage which they sustain during a flood event.

With respect to infrastructure, majority of households suffered less damage in both study areas compared to household content damage although with a higher proportion in South Lunzu. However, the general picture which emerges when the level of infrastructure damage is compared to content damage is that the level of damage to household content does not tally with the level of damage to infrastructure content. A lot more households, suffered damage to their household contents compared to damage which they suffered to house infrastructure. One point worthy noting is that, where the only explanation for damage is household exposure to flood, it is expected that household content damage pattern should follow infrastructure damage pattern. This is because, if infrastructure is damaged, household' content should ideally also be damaged since household content is kept inside the house infrastructure. However, these variations in damage between household content and house infrastructure is a reasonable ground to suggest that the concerned flood victims took different actions during floods depending on their circumstances hence the variations in the sustained damage among households.

Spatially, the distribution of household flood impacts did not show any dominance of one impact category in relation to distance from the river. Households which incurred high flood impacts and those which incurred low flood impacts were almost evenly distributed. This is consistent with the finding that, location close to rivers did not increase the vulnerability of households to flood impacts; neither did being located away from the river lead to low vulnerability. During interview with the official from Blantyre city

council, it was indicated that, the minimum allowable distance from the river where people can settle is 15 metres. Since being located away from the river did not reduce vulnerability, this distance threshold becomes of limited use, going by the results in the present study.

### 5.2. Exposure factors influencing flood impacts

Literature on flood impacts assessment identifies several exposure measures that can be used in the flood impacts analysis. Some of such parameters include inundation duration, inundation depth, river proximity distance, frequency of inundation and flood duration among others (Messer and Meyer, 2007). This study however focused on inundation depth, inundation duration and river proximity distance as the major exposure measures in the study areas. Each of these exposure measures was separately tested against household flood impacts.

One of the most important exposure measure is inundation depth(Messer and Meyer, 2007). The role of this measure in Ndirande was insignificant whereas in South Lunzu the measure played a role in influencing flood impacts although a limited one. This finding casts doubts on the viability of using flood depth measure alone when assessing household vulnerability to flood impacts without considering contextual conditions. Moreover the study has shown that households with low income as a flood coping challenge were more vulnerable to high flood impacts in Ndirande. This signifies that, high flood impacts in Ndirande were not associated with flood depth because it was caused by failure of households to take appropriate flood coping measures due to the low income coping challenge(Poshan, Sharma, Marshak, and Stites, 2013; Twigg, 2004). Such a finding is evidence of the influence of contextual conditions in the distributional pattern of household vulnerability to flood impacts.

The absence of any association and presence of a weak association in one case between flood depth as an exposure measure and flood impact suggests that numerous other factors do play a role in explaining vulnerability to flood impacts. In support O'Brien et al., (2007) argues that vulnerability is a characteristic of multiple factors and that present day vulnerability may affect vulnerability under future conditions(Burton et al., 2002). Thus household with varying existing vulnerability conditions cannot be expected to experience similar flood impacts even where their exposure conditions are the same(Kelly and Adger, 2000).

The use of inundation duration as an exposure measure in flood impact assessment studies is well documented in literature(Ninno, 2001; Merz, Kreibich and Schwarz., 2010). On this basis, the present study also used it and the overall picture which emerged when it was tested against household flood impacts was that, it does not influence vulnerability variations. Moreover, it has been shown that, housing coping strategies which were taken during the flood event influenced flood impacts. The variations in flood impacts could thus be attributed to differences in housing coping strategies which were taken by households during the flood. This finding appears to suggest that contextual conditions had more influence on flood impact variations relative to exposure measures.

Analysis of the role of river proximity distance in explaining flood impact vulnerability variations among households has revealed that location in relation to the river did not influence the level of impact suffered by households. This finding is in line with Birkmann, Fernando and Hettige, (2006) who found that houses outside the designated safe zone on the basis of distance from the sea were also significantly destroyed from a tsunami just like those in the unsafe zone. On this basis, they concluded that it was

important to employ different intervention tools to promote reduction in vulnerability underlying the importance of the contextual approach.

### 5.4. Major stressors in the study areas

Study findings indicate that most households consider low income, uncollected waste, food insecurity, water scarcity and energy as major challenges to their livelihoods although with varying perceptions as to the degree of importance. The study further found that, in general most households experience between three to four stressors. These findings are in line with several other studies done in the area. Mussa and Pauw, (2011) for example found that most households experience multiple shocks in the study areas. Water scarcity, energy scarcity, low income, food insecurity and uncollected waste in Blantyre have been reported in several other studies(Chipeta, 2009; UN-HABITAT, 2008; Kayuni and Tambulasi, 2005). Peters (2008) demonstrated that low income represent an extra factor for vulnerability in Naga city as not being able to fulfil basic needs during 'normal' times implies lack of adequate nutritional status during flood crisis.

One of the key findings is that, majority of households perceive low income as their most important stressor. The study found that, the average household size in the study areas is above the Blantyre city average of 4.4(Blantyre City Council, 2013). In terms of inter area comparison; Ndirande has a relatively low household size (4.8) than South Lunzu which has 5. The lower household average for Blantyre is influenced by low density neighbourhoods whereas the study was done in high density neighbourhoods which is characterised by large family sizes. Household size has a high influence on households incomes as most of the households' income is spent on taking care of the members thereby leaving the household with little income which in turn affect their ability to adequately prepare for flood events(Peters, 2008).

Uncollected waste also featured highly as one of the most important stressor especially in Ndirande. The author observed that, most households in Ndirande use their nearest water drainage channels as dumping sites. On average, the distance between a household nearest dumpsite and water drainage channel was found to be 6 metres for Ndirande and 27 metres for South Lunzu. Figure 21 below illustrates some of the observed scenarios in Ndirande. Cammack, (2012) reported that in 2009-2010, Blantyre city council had planned to clean the water drainage channel in Ndirande, however the plan never came to fruition as the earmarked funds were diverted to other projects. This signifies that, the problem of uncollected waste and waste dumping in drainage channels is still a major issue as the present study found. It was reported during the interviews with Ndirande village heads, Blantyre city officer and the district commissioner's representative that waste dumping in drainage channels is the major cause of flooding.

Figure 21: Distance between household dumping sites and water drainage channels in Ndirande
(Source: Author, 2014

The other stressor which the study investigated was water scarcity. Results show that, water is a major stressor for households in South Lunzu relative to Ndirande. A Water for People study conducted in Blantyre reported that Ndirande has the highest number of water kiosks among low income areas in the city which appear to confirm this study's finding(Maoulidi, 2012). Moreover, the water consumption average dairy per capita for high density areas ranges from 87-130 litres against an average of 152 litres for Blantyre city(Palamuleni, 2002). This confirms that water scarcity is indeed a stressor as found in the present study.

The study found that food insecurity was not a prominent stressor among the households. Findings based on households' perception on food insecurity however contradict the findings on the proxy measure which was used to gauge the level of food insecurity. The average number of days per month which households reported not to eat food of the desired quality and quantity was 21 for Ndirande and 14 for South Lunzu. However, only 8% of the surveyed households perceived it as their most important stressor in Ndirande and 15 % in South Lunzu. This suggests that it is the mere availability of food which matters but quality and quantity don't matter. This notwithstanding, food insecurity remains a stressor in the study area(Bie, Mkwambisi, and Gomani, 2008).

One other finding on the stressors is that, energy sources are scarce and expensive in the study areas. However, in terms of importance, different households perceive it differently. While households in Ndirande pay more for energy, not many households perceive it as their major stressor compared to South Lunzu where they pay less but relatively many households consider it as their major stressor. This pattern suggest the inter linkage between the various stressors which households face. As discussed in the preceding paragraphs, income poverty is more acute in South Lunzu than in Ndirande judging by household size(Mussa and Pauw, 2011). This may be a determining factor on their perception of energy as an important stressor, since access to it depends on the availability of money and rapid urbanisation has exacerbated its demand and price(UN-HABITAT, 2008; Kayuni and Tambulasi, 2005).

The finding that there are more households in South Lunzu, who suffered high flood impacts, have large household size and perceive energy as expensive yet they pay less compared to Ndirande signifies the importance of contextual conditions in flood vulnerability studies. This is because exposure measures have failed to adequately explain the flood impact vulnerability variations.

#### 5.4.1. The role of contextual factors/stressors on flood impacts

Having found that all the exposure measures do not influence flood impacts except for inundation depth in South Lunzu which was weakly associated with flood impacts, the role of stressors was explored to find out if they can explain the impact variations

Although individual stressors which were perceived as most important by households did not influence flood impact vulnerability variations, the study found that in South Lunzu, the number of stressors per household influenced vulnerability to flood impacts. Households with three and four stressors were more likely to suffer high flood impacts than those who had one or two stressors. This partly explains why in South Lunzu, all the exposure measures applied have shown no association with flood impacts and in one case where the association was found, it proved to be weak.

While the results for Ndirande showed no association between number of stressors per household and household flood impacts, the study results showed that variations in flood impacts among households were attributable to the coping challenges which households reported. In particular, 67% of households who reported low income as the reason why they did not undertake some flood coping strategies suffered high flood impacts. This means that, exposure measures had no influence on flood impacts in Ndirande because the variations in impacts were partly due to variations in challenges which households were facing when undertaking flood coping measures(Twigg, 2004; Wamsler and Brink, 2014). Thus, although low income did not show any influence on flood impacts when considered as a stressor, it was found to have a strong influence when considered as a coping challenge. On this basis, the study concluded that, low income stressor increases households vulnerability to flood impacts compared to other stressors.

It was therefore concluded that, multiple stressors and challenges which households face in undertaking coping strategies were responsible for variations in the vulnerability among households. These factors are dependent on household context as per the contextual approach(Hopkins, 2013).

### 5.5. Household flood coping strategies

The study shows that households take different activities in order to minimise flood impacts on their livelihoods. These strategies fall into three major coping categories; economic, technological and social/organisational(Twigg, 2004). Although these strategies were categorised in such a way, they are however not mutually exclusive as household often take a combination of these at the same time.

From the results, it has been shown that the dominant forms of coping related to housing in Ndirande were technological at all the three phases of the flood event. Technological coping strategies involve land management practices, building material and construction methods(Twigg, 2004). Considering that housing aspect coping strategies relate to activities aimed at physically protecting a house structure from the destructive force of a flood, it is not surprising that, technological coping strategies dominated. Specific coping activities such as reinforcing houses by tying with wire, nailing down walls and windows meant that majority of households could afford them, most of which are locally sourced.

However, in South Lunzu, dominant forms of coping before floods were technological whereas during and after floods, the dominant coping was social/organisational. Considering that income poverty is higher for households in South Lunzu, this could be the reason why during and after floods the dominant coping strategies were social/organisational in nature. Undertaking these kinds of activities do not necessarily require a household to be of a better financial standing since they are dependent on the good will and benevolence of others(Poshan, Sharma, Marshak and Stites, 2013).

In terms of coping strategies related to the livelihood aspect, most households in Ndirande were taking economic coping strategies before floods. However, during and after the flood event, the dominant coping strategy was social and organisational. Most of the coping activities which fall under the economic category require households to have some money beforehand. For example, coping activities such as borrowing from relatives and money lenders and pawning appliances implies that extremely poor households cannot undertake them. Money lenders for example are very unlikely to lend their money to households who they know may not be able to pay back(Poshan, Sharma, Marshak and Stites, 2013). One respondent for example said that," *all belongings were destroyed after the flood, I had nothing to sell."* This explains the decline in the number of households who were taking economic strategies during and after the flood

event and a corresponding increase in the number of those who were taking social and organisational strategies in Ndirande.

#### 5.5.1. The role of household coping strategies on flood impacts.

In order to explain why exposure measures were found not to influence flood impact variations in all cases and a weak association in one case, the influence of flood coping strategies was tested against household flood impacts.

Housing coping strategies which were taken during floods were a defining factor on whether a household suffered high or low impacts. In Ndirande, more households taking social/organisational coping strategies suffered high flood impacts. However, taking technological measures did not lead to any difference between suffering high impact or low impact. On the other hand, in South Lunzu, households who took social/organisational strategies during the flood event suffered low impacts relative to those who took technological coping strategies. This suggests that, exposure measures did not influence the flood impacts due to the defining role of coping strategies on flood impacts which is context dependent. The fact that, the effectiveness of these coping strategies varied according to area, further renders credence to the relevance of the contextual factors in the study of vulnerability.

The relevance of the contextual approach is further grounded by the fact that, in Ndirande the number of stressors per household had an influence on housing coping strategies which were taken during the flood event. Households with four or more stressors were more likely to take social/organisational strategies while those with three or less were more likely to take technological strategies. Moreover, results show that households who had low income as a coping challenge in Ndirande suffered high flood impacts. This demonstrates that number of stressors is related to household income status which in turn affects the choice of a coping strategy during a flood event(Twigg, 2004). The low income coping challenge in Ndirande was thus the influencing factor for households' choice of social/organisational strategies which do not require money and ultimately resulted in high flood impacts. Households' vulnerability can thus be attributed to this interconnectedness of contextual factors. The study thus concluded that, exposure factors only aggravated the likelihood of vulnerability whereas contextual factors influenced the variations among household with varying stressors and living under different contextual conditions.

Housing coping strategies taken before and after the flood event just like livelihood coping strategies at all the coping phases of the flood did not show any meaningful discernible pattern in relation to household vulnerability to flood impacts. This suggests that, when data for household flood impact vulnerability is restricted to damage caused by immediate contact of flood water with household tangible property, housing coping strategies taken before and after the flood event and livelihood coping strategies at all the phases may be of limited use in the analysis. However, with a larger sample, the results may be different raising the need for further research.

One noteworthy finding is that 70(33%) of the 213 surveyed households reported floods in the years preceding the one which was reported by two thirds of the sample implying that they did not suffer any impact during the flood reported by the majority. Interestingly, the dominant coping strategies which this group applied were technological which were also applied by those who suffered flood impacts. However, technological coping strategies did not lead to low impacts when applied by the two thirds who reported the 2012/2013 flood. Analysis of the years which this group reported indicate that, they range from 1988 to 2009. This raises the possibility that experience with previous flood had a bearing on the effective application of the technological coping strategies(Poshan et al., 2013; Wamsler and Brink, 2014). This is

because most of the households who reported the 2012/2013 flood event appear to have been new residents in the study areas.

### 5.6. Summary

The study found that number of stressors per household, coping strategies during floods and coping challenges influences the variations in household vulnerability to flood impacts. It has been shown that effectiveness of a coping strategy depended on the context of the area. Number of stressors influenced coping strategies which in turn influenced flood impacts. Only inundation depth as an exposure measure showed influence on flood impacts in one study area. Inundation duration and river proximity distance did not show any influence on flood impact variations. This shows that a contextual factors are important in the study of vulnerability to flood impacts in the context of climate change.

### 5.7. Conclusion

The study found that differences in flood impacts suffered by households could not be attributed to exposure measures except in one case where a minor influence was found. The study concluded that the fact that exposure measure did not influence flood impacts is consistent with the contextual approach which implies that contextual factors played a defining role in flood impact vulnerability. Such a conclusion is supported by the following specific findings:

(i) Housing coping strategies taken during the flood event differentiated those who suffered high impacts and those who suffered low impact. For example, households taking social/organisational coping strategies suffered high impacts in Ndirande but low impact in South Lunzu implying that vulnerability to flood impacts depended on the type of coping strategy and the contextual conditions of an area and not exposure.

(ii) Households with low income as a coping challenge suffered high flood impacts in Ndirande suggesting that, adoption of social/organisation coping strategies in Ndirande as stated above was influenced by the coping challenge.

(iii) Households with high number of stressors suffered high flood impacts in Lunzu than those with few stressors implying that exposure measures did not influence flood impacts due to the defining influence of multiple stressors which households were facing.

(iv) Number of stressors per household influenced the type of coping strategy during the flood event. In Ndirande households with more than four stressors were more likely to take social/organisational copings strategies while those with less than three stressors were more likely to take technological measures. It has been shown that social coping measures increased the vulnerability of households in Ndirande.

(v) The effectiveness of coping strategies was area and household dependent as the same coping strategy was effective in one study area and ineffective in another, e.g. social coping strategies were effective in South Lunzu but ineffective in Ndirande; technological strategies were effective for the group which did not suffer impacts from the 2012/2013 flood but ineffective for those who suffered impacts from this flood.

These findings support the notion that, when studying vulnerability a contextual approach should be preferred as flood impacts depended on the contextual factors which households experience.

### 5.8. Limitations of the study

The use of two study areas led to some inconsistencies in the findings as different sample sizes were used whose representativeness could not be determined through objective means. The fact that most of the components were based on qualitative measures, which in most cases were dependent on the personal judgement of data collectors imply the existence of some degree of subjectivity in the results which explains some of the uncertainties in the results. In addition, the measures which were used in the study were self reported by households and not objectively measured. This implies the existence of some level of bias in the results. Such biasness may be the reason why there are some uncertainties in the findings. These limitations notwithstanding, the findings in this study provides a basis for further research aimed at verifying the uncertainties using different data collection and analytical methods not used in the present study.

# 6. CONCLUSION AND RECOMMENDATIONS

The study investigated the role of contextual factors in the study of household vulnerability to flood impacts. It focused on the influence of flood exposure measures on flood impacts in comparison to the influence of contextual factors and coping strategies on flood impacts variations.

## 6.1. Conclusion

One of the objectives of the study was to investigate flood impacts in the study areas. To this effect, the study found and concluded that the major types of flood impacts which households suffered in the study area were damage of the household content and house structure which ultimately affected their livelihoods.

The study further found that major physical exposure factors in the study areas were inundation depth, inundation duration and river proximity distance. All of these measures did not influence variations in the vulnerability to flood impacts among households. High exposure did not necessarily lead to high flood impacts. One exposure measure however had a minor influence on flood impacts in one study area.

The major stressors which households face are low income, uncollected waste, water scarcity, food insecurity and energy scarcity. However, households in the study areas perceived them differently in terms of importance except low income which majority of households perceived as the most important stressor to their livelihoods. In short the majority of households experience multiple stressors.

Although individual stressors did not have any influence on flood impacts, the number of stressors per households had a strong influence on flood impact variation. In South Lunzu households with more than three stressors suffered high impacts compared to those with less than three stressors. In Ndirande number of stressors per households influenced the choice of flood coping strategies during the flood event. Households with four or more stressors were more likely to take social/organisational strategies while those with three or less stressors were more likely to take technological strategies.

Moreover, low income as a coping challenge had strong influence on flood impacts in Ndirande signifying that more stressors had a negative effect on household income. This in turn influenced households to take social/organisational strategies which do not require money to undertake ultimately resulting into high vulnerability to flood impacts. The same social/organisational strategy in South Lunzu however resulted into low flood impacts. This is attributable to the semi-rural nature of South Lunzu which means that households still feel more compelled to assist each other.

Overall, the study found that exposure measures are not adequate in explaining flood impact vulnerability variations among households. This is because all the exposure measures which were tested in the study have shown no relationship with flood impacts except in one study area where high exposure had an influence on high flood impacts although to a minor degree. On the other hand, most of the contextual factors; such as number of stressors per household, housing coping strategies and coping challenges have been found to have a strong influence on household flood impact variations. More stressed households also suffered high flood impacts. This conclusion is consistent with the conceptual approach which advocates the inclusion of contextual factors in climate change vulnerability studies in general and flood impact vulnerability in particular.

### 6.2. Recommendations

Based on the conclusion made, this study recommends that, when conducting climate change vulnerability studies the contextual approach should be preferred. This is because, vulnerability to flood impacts is not only dependent on physical exposure but also on the contextual factors which affect households' daily living. Less emphasis on contextual conditions in climate change vulnerability studies may lead to undesirable climate change effects mitigation intervention strategies and policy directions especially in low income countries.

The authorities in the study area should have mechanisms of informing new residents in the area about the flood situation of the area and on possible appropriate actions which they should take in readiness for the flood. This is because, the study found that older residents of the study area who took technological measures suffered no impact and yet the same coping strategies were ineffective when applied by new residents.

It is also recommended that another study be conducted using a much larger sample and where the measures should be objectively measured and not self reported by households. This would make it possible for some of the uncertainties in the present study to be verified.

# LIST OF REFERENCES


Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*(3), 268–281.

Ayscue, J. K. (1996). *Hurricane Damage to Residential Structures: Risk and Mitigation* (No. 94). Baltimore.

Baud, I.S.S., Sridharan., N and Pfeffer, K. (2006). Mapping urban poverty for local governance in an Indian Mega-city: The case of Delhi. *Urban Studies*, *45*(7), 1385–1412.

Bie, S., Mkwambisi, D and Gomani, M. (2008). *Climate change and Rural Livelihoods. Review Study Report of Norweigan Support to FAO and SCC in Malawi with a note on some Regional Implications*. Aas. Retrieved from www.nai.uu.se/events/archives/conferences/african_agriculture/bie.pdf

Birkmann, J., Fernando, N and Hettige, S. (2006). Measuring vulnerability in Sri Lanka at the local level. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies* (pp. 329–356). Tokyo: United Nations University.

Blantyre City Council. (2013). *Blantyre City Council: Lunzu Urban Structure Plan*.

Brooks, N., Neil Adger, W and Mick Kelly, P. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, *15*(2), 151–163.

Brown, D. (2011). Making the linkages between climate change adaptation and spatial planning in Malawi. *Environmental Science & Policy*, *14*(8), 940–949.

Burton, I., Huq, S., Lim, B., Pilifosova, O and Schipper, E. L. (2002). From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy*, *2*(2-3), 145–159.

Cammack, D. (2012). *Peri-urban governance and the delivery of public goods in Malawi, 2009-11. Africa Power and Politics*. London.

Chipeta, L. (2009). The Water Crisis in Blantyre City and its Impact on Women: The Cases of Mabyani and Ntopwa , Malawi. *Journal of International Women' S Studies*, *10*(4), 17–33.

Cochrane, L and Costolanski, P. (2013). Climate change vulnerability and adaptability in an urban context: A case study of Addis Ababa , Ethiopia. *International Journal Of Sociology and Anthropology*, *5*(6), 192–204.

Cutter, S. L., Boruff, B. J and Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly*, *84*(2), 242–261.

Dewi, A. (2007). *Community-Based Analysis of Coping with Urban Flooding : a Case Study in Semarang, Indonesia.* University.

Dickson, E., Tiwari, A., Baker, J and Hoornweg, D. (2010). *Understanding Urban Risk: An approach for assessing disaster and climate risk in cities*. Washington: The World Bank.

Field, A. (2013). *Discovering statistics using IBM statistics* (4th ed., pp. 720–759). London: Sage.

Fussel, H. M. (2007). Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change*, *17*(2), 155–167.

GOM. (2006). Malawi national adaptation programmes of action (napa). Lilongwe: Ministry of Mines, Natural Resources and Environment.

Guarin, G. P. (2003). *Flood risk assessment for the town of San Sebastian in Guatemela*. University of Twente-ITC.

Hinkel, J. (2011). "Indicators of vulnerability and adaptive capacity": Towards a clarification of the science–policy interface. *Global Environmental Change*, *21*(1), 198–208.

Hopkins, D. M. (2013). *The Social Phenomenon of Climate Change*. Otago. Retrieved from http://otago.ourarchive.ac.nz/bitstream/handle/10523/4215/HopkinsDeborahM2013PhD.pdf?sequence=1&isAllowed=y

Issa, R. R. A., Isaa, C. A., Shanker, A and Gencorelli, P. (1996). Effectiveness of Storm Shutters in Hurricane Damage Prevention. In R. A. Cook. & M. Soltani (Eds.), *Hurricanes of 1992,*. New York: American Society of Civil Engineers.

Katz, H. (2006). Global surveys or multi-national surveys? On sampling for global surveys. In *Thoughts for the Globalization and Social Science Data Workshop*.

Kayuni, H.M and Tambulasi, R. I. C. (2005). Urbanization, Environment and Development in Africa' seminar, 25 (pp. 1–10).

Kelly, P. M and Adger, W. N. (2000). Theory and Practice in Assessing Vulnerability to Climate Change andFacilitating Adaptation. *Climatic Change*, *47*(4), 325–352.

Leon., J. C. (2006). Vulnerability assessment: The sectoral approach. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies* (pp. 300–315). Tokyo: United Nations University.

Liverman, D. (1991). *Vulnerability to global environmental change*. Retrieved from http://www.academia.edu/1186212/Vulnerability_to_global_environmental_change

Maoulidi, M. (2012). *Water and sanitation needs assessment for Blantyre, Malawi* (No. 27/2012). New York.

McCathy, J.J, Canziani, O.F, Leary, N.A, Dokken, D.J and White, K. . (Ed.). (2001). *Climate Change 2001: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to The Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.

McSweeney, C., New, M and Lizcano, G. (2008). *UNDP climate change country profiles: Malawi* (pp. 1–27). Retrieved from http://country-profiles.geog.ox.ac.uk

Merz, B. H, Kreibich, R. and Schwarz, A. T. (2010). Assessment of economic flood damage. *Natural Hazards and Earth Sciences*, 1697–1724.

Messer, F and Meyer, V. (2007). Flood damage, vulnerability and risk perception-challenges for flood damage research. In J. Schanze (Ed.), *Hazard, Vulnerability and Mitigation Measures* (pp. 149–167). Dresden: Springer.

Moser, C. (2008). Pro-poor asset adaptation to urban climate change, 1–22. Retrieved from http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1256566800920/6505269-1268260567624/Moser.pdf

Mussa, R and Pauw, K. (2011). Poverty in Malawi: Current status and knowledge gaps. *International Food Policy Research Institute*, *9*(December), 1–4.

Ninno, C., Dorosh, P. A., Smith, L. C and Roy, D. K. (2001). *The 1998 Floods in Bangladesh*. Washington D.C.: International Food Policy Research Institute.

Ninno, C. Del (Ed.). (2001). *The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies, and Response* (p. 114). Intl Food Policy Res Inst. Retrieved from https://books.google.com/books?id=X0f6kOd4IzsC&pgis=1

Nkomwa, E. C., Joshua, M. K., Ngongondo, C., Monjerezi, M and Chipungu, F. (2014). Assessing indigenous knowledge systems and climate change adaptation strategies in agriculture: A case study of Chagaka Village, Chikhwawa, Southern Malawi. *Physics and Chemistry of the Earth, Parts A/B/C*, *67-69*, 164–172.

NSO. (2008). *Malawi Population and Housing Census Report*. Zomba.

O'Brien, K., Eriksen, S., Nygaard, L. P and Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, *7*(1), 73–88.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H and West, J. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change*, *14*(4), 303–313.

Palamuleni, L. G. (2002). Effect of sanitation facilities, domestic solid waste disposal and hygiene practices on water quality in Malawi's urban poor areas: a case study of South Lunzu Township in the city of Blantyre. *Physics and Chemistry of the Earth, Parts A/B/C*, *27*(11-22), 845–850.

Peters, G. G. (2008). *Integrating Local Knowledge Into GIS-Based Flood Risk Assessment:The Case of Triangulo and Maboro communities in Naga City-The Philippines*. ITC-University of Twente and Wageningen University.

Poshan, D., Sharma, J., Marshak, A and Stites, E. (2013). *Living in the Margins: Coping with Flood Risks and Managing Livelihoods in Nepal ' s Far-western Terai* (pp. 1–42). Somerville. Retrieved from http://fic.tufts.edu/assets/TUFTS_1385_Nepal_2_online-UPDATED.pdf

Renaud, F and Perez, R. (2010). Climate change vulnerability and adaptation assessments. *Sustainability Science*, *5*(2), 155–157.

Skjeflo, S. (2013). Measuring household vulnerability to climate change—Why markets matter. *Global Environmental Change*, *23*(6), 1694–1701.

Tchereni, B., Grobler, W and Dunga, S. (2013). Economic Analysis of Energy Poverty in South Lunzu, Malawi. *Journal of Economics and …*, *4*(4), 154–164.

Thieken, A. H., Ackermann, V., Elmer, F., Kreibich, H., Kuhlmann, B., Kunert, U and Seifert, J. (2009). Methods for the evaluation of direct and indirect flood losses. In *RIMAX Contributions at the 4th International Symposium on Flood Defence (ISFD4)* (pp. 1–10).

Thywissen, K. (2006). *Components of risk: a comparative grossary*. Bonn: United Nations University: Institute of Environment and Human Security.

Twigg, J. (2004). *Good Practice; Review Disaster Risk Reduction* (Vol. 44). London: Overseas Development Institute.

UN-HABITAT. (2008). *Malawi : Blantyre urban profile*. Nairobi.

Wamsler and Brink, E. (2014). Moving beyond short-term coping and adaptation. *Environment and Urbanization*, *26*(1), 86–111.

Wood, L and Moriniere, L. (2013). *Malawi climate change vulnerability assessment*. Retrieved from http://community.eldis.org/.5b9bfce3/Malawi VAFinal Report_12Sep13_FINAL.pdf

World Food Program. (2010). *Pakistan flood impact assessment* (pp. 1–28). Retrieved from http://documents.wfp.org/stellent/groups/public/documents/ena/wfp225987.pdf

# APPENDIX

## Appendix 1

The role of contextual factors in flood impact vulnerability: Case study of Ndirande and South Lunzu

**QUESTIONNAIRE**

Questionnaire No.: Interviewer: Date:

My name Felemont Banda, an MSc student at the University of Twente-Faculty of Geo-Information Science and Earth Observation studying Urban Planning and Management. I would like to ask you some questions relating to the flooding situation in Ndirande. This information will be used for academic purposes only in the writing of my thesis.

A. INTRODUCTION
House No:
Gender: Female ☐ Male ☐
Transect in which household is located_____
Household GPS coordinates_____

B. FLOODING SITUATION IN THE STUDY AREA

1. How many flood events have you experienced since you settled in this area? ☐
2. When did you experience the last flood? ☐
3. In which years did other flood events occur?

| Year | Year |
|---|---|
| | |
| | |
| | |
| | |

4.. What was the depth of the flood you last experienced?
1. <20cm ☐ 2. 21-50cm ☐ 3. > 51cm ☐

5. How much time did the last flood you experienced take (hour/mins)? ☐

C. FLOOD IMPACT ASSESSMENT

**1. DIRECT TANGIBLE LOSSES**

**Physical damage to property**

6. Which aspects of your house were damaged by the last flood?

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7. Which household contents were destroyed by the last flood which you experienced?

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8. Did the wall of your house get scratched because of flood water?

9. Was the wall of your house completely destroyed or partly destroyed by the water in the last flood?

10. . Were the windows damaged from this flood? 1. Yes ☐ 2. No. ☐

11 . If yes, was the damage; 1. Complete ☐ 2. Partial ☐

12. What other household contents were damaged by this flood?

**DIRECT INTANGIBLE LOSSES**

**People Lost, Injured and Ill**

13. What was the impact of the last flood you experienced on the following? (indicate number)

D. CONTEXTUAL FACTORS INFLUENCING FLOOD IMPACT

14. What are the major problems which affect your livelihoods? (rate these problems on a scale of 1-3, where 1 means only a little bit important; 2. Moderately important 3. Very important)

| Problem(stressor) | Rate |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| | |

15. Which of the following stressors do you experience?
Rank them on a scale of 5(5 not important, 4. Least important 2. Slightly important 3. Moderate 2. Very important 1. most important

| **Stressor** | **Relative importance** |
|---|---|
| Poverty | |
| Poor sanitation | |
| Water scarcity | |
| Food insecurity | |
| Energy scarcity | |

**Income**

16.What is the total monthly income of the head of the household

| Income category | Tick one |
|---|---|
| 1. <MK30000 | |
| 2. MK31, 000-40,000 | |
| 3.MK 41, 000-50, 000 | |
| 4. >MK50, 000 | |

17. What is the size of your household? ☐

**Uncollected waste**

18. What is the distance (m) from your refuse dumping site to the nearest drainage? ☐

**Water scarcity**

19. What is the distance to your nearest source of drinking water in metres

20. . How much money do you spend on water per month? ☐

Food Insecurity

21. How many days per month do you fail to eat food of the quantity and quality you are satisfied with? ☐

**Energy Scarcity**

22. What type of energy source do you use?

23. If you don't use electricity, how much time do you spend to secure your energy source?

| **Energy Source** | **Number of hours spent fetching for it** |
|---|---|
| 1. Charcoal | |
| 2. Fuel wood | |

| | |
|---|---|
| 3. Alternative source during power cuts | |

24. How much money do you spend on energy per month?

**E. COPING MECHANISM**

25. What actions do you take before flood to mitigate its impact on your household?_____
_____
_____
_____

26. What actions do you take during floods to mitigate its impact on your household?_____
_____
_____
_____
_____

27. What actions do you take after floods to mitigate its impact on your household?_____
_____
_____
_____
_____

28. What challenges do you face when undertaking the actions mentioned in 25 – 28?_____
_____
_____
_____
_____

29. Which of the following actions do you undertake …..?(tick applicable actions)

| Coping Aspect | Before flooding | During flooding | After flooding |
|---|---|---|---|
| **Housing** | 1. Reinforce wooden/ thatched houses by tying with wire .<br>2. Nail down walls and windows and put heavy items (sandbags, tyres) on top to protect roofing.<br>3. Prepare second-hand or scrap materials for future repairs .<br>4. Elevate part of the house/ build mezzanine .<br>5. Build house using reinforced materials or over two storeys. | 1.Secure access to the house to avoid intrusion of debris and waste .<br>2. Vacate the house to avoid loss of life . | 1. Source relief materials .<br>2. Dry walls with an electric fan to avoid deterioration .<br>3. Repair house with family members to avoid the cost of labour .<br>4. Repair the damage 'little by little'.<br>5. Earth-filling to elevate room levels .<br>6. 'Leave as it is'. |

| Coping Aspect | Before flood | During flood | After flood |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Livelihood** | 1. Look for additional sources of income .<br>2. Stock up shops so there are enough supplies to sell .<br>3. Increase working hours.<br>4. Save money.<br>5. Replace stock in shops and purchase agriculture products.<br>7. Elevate shop buildings.<br><br>. | 1. Stop working outdoors.<br>2. Use savings.<br>3. Temporary change in business location (second floor, roof or other safer place).<br>4. Look for jobs in flood-free areas to meet family needs .<br>5. Work overtime. | 1.Ask for work or for assistance from other community members.<br>2. Look for alternative employment.<br>3. Sell stored items on credit .<br>•4.Sell scrap material from damaged houses.<br>4. Work for food (on farms.<br>6. Borrow money from relatives, moneylenders ('loan sharks', charging high interest) or from the government .<br>7.Pawn appliances and other valuables .<br>8. Work overtime . |

30. Why doesn't your household take some of actions which your neighbours take(give e.g.) to mitigate flood impact? ----------

## Appendix 2

**INTERVIEW GUIDE**

My name Felemont Banda, an MSc student at the University of Twente-Faculty of Geo-Information Science and Earth Observation studying Urban Planning and Management. I would like to ask you some questions relating to the flooding situation in Ndirande. This information will be used for academic purposes only in the writing of my thesis.

FLOODING HISTORY IN NDIRANDE AND SOUTH LUNZU

1. Have you recorded any flood events in Ndirande?
2. When did the last flood occur in Ndirande?
3. In comparison to other recorded flood events in Ndirande, what rank would you give it in terms of impact?

MAJOR STRESSORS IN NDIRANDE AND SOUTH LUNZU

4. What are the major problems which the residents of Ndirande face?
5. In what way do these problems influence the nature of flood impacts experienced by households?

CHARACTERISTICS OF MOST AFFECTED HOUSEHOLDS

6. During the recoded flood events, which categories of households in terms of characteristics were most affected?
7. What type of damages do the affected people mostly report to your office?

OBSERVED COPING MECHANISM BY AUTHORITIES

8. Do you know of any activities which households in flood prone areas undertake to mitigate flood impacts on their households?
9. If yes, what type of activities do people in these flood prone areas undertake before, during and after a flood event?

CHALLENGES TO COPING STRATEGIES

10. Do you know of any challenges which people in the Ndirande flood prone areas face when undertaking their activities aimed at mitigating flood impacts?
11. Do you have any suggestions on how, the household's flood impact mitigating activities can be supported?