Assessing Differences in Household Food Insecurity Vulnerabilities Post-Cyclone Idai in Beira, Mozambique

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

Food insecurity is a complex sustainability challenge that is being worsened by frequent extreme weather disasters, especially within low-to-middle-income-countries (LMICs). Mitigating post-disaster food insecurity requires data for targeted interventions. Yet, there is limited research on household-characteristics connections with post-disaster food insecurity in LMICs. This study therefore focused on the aftermath of the 2019 Cyclone Idai disaster in Beira, Mozambique, and examined the differences in household food insecurity vulnerabilities using household and personal food environment characteristics, and adaptations to the disaster. Social-ecological systems (SES) theoretical and disaster management lenses informed the collection of data across household (microsystem), community (mesosystem) and humanitarian institutions (macrosystem) levels, as well as the assessment of household food insecurity vulnerabilities. A mixed-methods sequential explanatory study design was employed. The quantitative study entailed a household survey that collected data from 975 households. However, descriptive, univariate and bivariate statistical analyses were conducted on n=709, which had a complete set of data for the Household Food Insecurity Access Scale (HFIAS) measurement of food insecurity, and the household, personal food environment and adaptation to disaster variables. The follow-up qualitative study entailed the use of interview guides to conduct audio-recorded focus-group discussions with households and community leaders, and key-informant interviews with selected personnel from humanitarian institutions addressing food insecurity. The qualitative data was transcribed verbatim, and thematic content analysis was applied. Both quantitative and qualitative results were triangulated to present the findings. There were statistically significant increases in household food insecurity one month after the cyclone compared to the month before levels ($p<0.05$), with the median HFIAS score increasing from 14 to 18 post-Cyclone Idai. The presence of multiple vulnerability characteristics such as large household sizes, severe underlying food insecurity and low-income within a household, influenced more severe food insecurity post-Cyclone Idai. Also, the displaced households of the study were isolated from food markets and had pre-existing food accessibility challenges within their personal food environment, which was compounded by the loss of houses post-cyclone. Most adaptations were made during Cyclone Idai response and not preparedness. Adaptations to the disaster that enabled food access included the use of household savings, and food-sourcing facilitated by bridging and linking social capital at the mesosystem and macrosystem levels. Regardless, the facilitation of food-sourcing adaptations was constrained by macrosystem level challenges in targeting vulnerable households for food aid distribution. Additionally, non-reciprocal bonding social capital interactions created food access constraints for households that gave to others. The findings support the mitigation of recurrent, severe post-disaster household food insecurity episodes in Beira, Mozambique. This requires the integration of interventions for household food insecurity, disaster risk reduction and equitable food systems, all underpinned by well-coordinated stakeholder collaborations across all SES levels.

Keywords: Household Food insecurity, Cyclone Idai, Personal food environment, Vulnerability, Disaster management, Beira, Mozambique

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CHAPTER ONE

1.0 INTRODUCTION

In this chapter, the background of the study is presented. This includes details on household food insecurity, underlying vulnerability in Mozambique and the impact of Cyclone Idai. Also, the problem statement, research gap, research question, objectives and significance of the study are outlined in this chapter.

1.1 Background

Food is an essential requirement for nutrition, growth, maintenance of health and proper functioning of the human body (Global Nutrition Report, 2020; Swinburn et al., 2019). As such, various national and international discourses have revolved around improving health outcomes for people through the enhancement of nutrition and ensuring food security (FAO, 2001). Food security refers to the condition in which people have physical, social and economic access to safe and nutritious food required for normal growth, development and an active and healthy life, while food insecurity refers to the lack of access to sufficient food that is safe and nutritious, to support normal growth and development (FAO, 2013). Food insecurity is a global concern because it causes undernutrition, which is linked to multiple adverse health conditions among affected people (HLPE, 2017). Undernutrition, a form of malnutrition, makes people susceptible to anemia, weakens their immunity, increases morbidity and leads to conditions like underweight (low-weight-for-age), wasting (low-weight-for-height) and stunting (low-height-for-age) (HLPE, 2020; FAO et al., 2021).

Varying severities of undernutrition are experienced by affected people, based on their gender and stage of human life (e.g., young children, adolescent girls, pregnant women, seniors) (FAO et al., 2019). Severe impacts are experienced by children, adolescent girls, women of childbearing age and pregnant women, because they require increased nutrients, the lack of which, impedes their development and/or reproductive health linked to the life stage (Global Nutrition Report, 2020). Among pregnant women, undernutrition causes anemia and adverse newborn health impacts (e.g., low-birth weight) (FAO et al., 2019; Broussard, 2019). Low-birth weight negatively impacts child development, resulting in poor physical, cognitive and educational outcomes during childhood and adolescent years (FAO et al., 2020). Manifestations of undernutrition such as stunting, wasting, critical thinness and weakened immunity, can be life threatening, especially among children (FAO et al., 2022). Stunting and wasting contribute to about 45 per cent of all mortality among children under 5 years in low-or-middle-income-countries (LMICs) (HLPE, 2017). Among adults, undernutrition worsens underlying diet-related chronic diseases (e.g., diabetes), and increases death risks due to the disease (Weaver & Fasel, 2018; FAO et al., 2020).

Food insecurity therefore imposes great costs on people and health systems. Health costs create impediments for treating undernutrition despite the far-reaching impacts. For example, only one-

quarter of children under 5 years received treatment for severe undernutrition, out of the 16.6 million children that were affected by undernutrition in 2017 (Global Nutrition Report, 2020). Within coutries in Africa and Asia, undernutrition-related economic losses are equivalent to approximately 11% of annual gross domestic product (Swinburn et al., 2019). Thus, the direct and indirect health costs associated with treating different diet-related diseases and loss of human capital, are projected to exceed 1.3 trillion USD by 2030 (FAO et al., 2020). Apart from health costs, healthy food for preventing undernutrition is expensive and unaffordable for many. About 3 billion people cannot afford healthy diets globally (FAO, et al., 2020; 2021), and this number is on the ascendency as more food insecure people add on to preexisting numbers (FAO et al., 2022). For instance, approximately 928 million people were affected by severe food insecurity in 2020, which was an increase of 148 million more people from estimates in 2019 (FAO, et al., 2021).

The increasing number of food insecure people is a function of multiple factors. However, a key factor is the unprecedented adverse effects of climate change on food systems, which underlie food availability and provide livelihoods to facilitate food access and affordability (Mbow et al., 2019; FAO, 2021). Extreme climate change related events, such as droughts, adversely impact food systems and limit food production and economic output from agriculture, resulting in extreme food shortage and famine (Sen, 1981; De Waal, 1989; FAO, 2017). The slow-onset of such events have encouraged the innovation of agricultural green technologies for improving food production and food availability amidst climate change induced challenges (Schmidhuber & Tubiello, 2007). However, beyond slow-onset events, there are climate-related extreme weather events like cyclones, characterized by thunderstorms, strong winds and flooding rains that cause sudden destructive outcomes for food systems (NOAA, 2011).

Sudden and extreme weather disasters are jeopardizing to food security because of their significant impacts on all components of agricultural and food systems that are relevant for food access (FAO, 2021). Some impacts include the widespread destruction of farm produce, food supply networks and food environments which consist of relevant physical infrastructure (e.g., food markets) and non-physical elements of affordability, accessibility and convenience (OCHA No. 22, 2019; HLPE, 2017). Other impacts are physical and economic losses to food system actors, especially food vendors and consumers, who may lose livelihoods or the lives of income earning family members (Béné, 2020). Food system impacts may trigger erratic and speculative behaviors among actors, leading to price hikes among vendors or consumers due to hoarding of food post-disasters (Forbes, 2017; Nozhati et al., 2019). Cumulatively, extreme weather impacts create barriers to food access and may be compounded by the destruction of houses, geographical displacements and the disruption of social connections among affected households (FAO, 2017; Clay et al., 2021; Clay et al., 2022; Pyle et al., 2021).

Climate-related extreme weather disasters which severely disrupt food security have become the most dominant on a global scale, constituting approximately 80% of all disasters since 2010 (IFRC, 2020). Whilst on average 122 disasters were recorded annually between 1981-1992, this frequency more than doubled to 235 per year between 1993-2004, and further increased by 11% to 260 disasters per year between 2005 – 2016 (FAO, 2017a). Out of 308 disasters that occurred

in 2019, 237 were climate-related, including Cyclones Kenneth and Idai. Cyclone Idai impacted Mozambique and other countries, including Zimbabwe, Malawi and Madagascar (IFRC, 2020; Nhamo & Chikodzi, 2021). The increased frequencies of extreme weather disasters have resulted in increased post-disaster food insecurity, which refers to the decreases in food access experienced by households in the aftermath of disasters. With recurrent extreme weather disasters, disaster management processes and the cost of humanitarian assistance to mitigate disaster impacts, including food insecurity, have increased globally (Sendai Framework, 2015; Bouché, 2019; IFRC, 2020). Notwithstanding, projected increases in the frequency, intensity and spatial extent of climate-related extreme weather events by 2050, has implications for the need to increase humanitarian assistance (e.g., food aid), which is already very limited (Garschagen et al., 2015; IPCC, 2012; Mbow et al., 2019).

Disasters worsen underlying food insecurity which is caused by multifaceted factors. Food insecurity at the individual/household level is due to poverty and the lack of entitlements or resources necessary for food access (Sen, 1981; FAO, 1996; FAO, 2006). Lack of entitlements may occur due to a reduction in subsistence food production or due to employment losses, which reduce the ability to exchange resources for food (Sen, 1981). Poor households dependent on subsistence farming for food, livelihoods and income, bear the brunt of climate-related disasters on their food security, because of the impact on their entitlements (Barrett, 2010; Barrett & Lentz, 2010). Additionally, access to a broader network of resources like clean water, sanitation, health service, elementary education, and engagement in social capital networks (e.g., family and friends' networks, community or humanitarian organizations), determine people's basic capabilities to access nutritious food and mitigate food insecurity (Drèze & Sen, 1989; Burchi & De Muro, 2016; Crowe & Smith, 2012; Vervisch et al., 2013). Hence, the experience of post-disaster food insecurity among households may differ, based on underlying food insecurity and access to a network of different resources.

The multifaceted factors associated with underlying food insecurity and post-disaster food insecurity lie within distinct areas of development challenges (e.g., disaster risk, poverty, social exclusion in accessing basic amenities). However, the need to address these challenges interconnectedly has been recognized and discussed on global and national scales. In 2015, the United Nations General Assembly adopted Agenda 2030 for sustainable development, with 17 interlinked sustainable development goals (SDGs) (UN SDGs, 2016). The SDGs aim to achieve a better and sustainable future for all people through achievement of all the goals by 2030. The SDGs highlight food security, climate change and natural disaster risk reduction and the need to ensure that no one is left behind (UN SDGs, 2016). Specifically, SDG 1.5 states that "By 2030 build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters" (UN SDGs, 2016). Additionally, SDG 2 for Zero Hunger aims to end hunger, eradicate all forms of malnutrition, achieve food security and promote sustainable agriculture; whilst SDG 13 on climate action advocates taking deliberate actions to increase climate change adaptation and minimize impacts on marginalized communities (UN SDGs, 2016).

No country, however, is on track to achieving SDG 2 (Zero Hunger), whilst the number of food insecure people continues to increase amidst climate change impacts, especially in low-and-middle-income countries (LMICs) in Africa and Asia (FAO et al., 2019; FAO, 2021). The SDGs were ratified by 193 countries, including LMICs such as Mozambique which have played significant roles in aligning the global SDGs with their own national policies and development agenda (Horn & Grugel, 2018). The processes involved in achieving the SDGs differ for different countries, as extreme weather events do not affect all countries equally, neither are the prevalence of food insecurity and development contexts for all countries the same. Extreme climate-related disasters are concentrated in geographical areas where more than 80 percent of the world's food insecure people live (Garschagen et al., 2015). Notably, LMICs in Asia and Africa have more than 70 percent of the world's food insecure people because their livelihoods are heavily dependent on natural elements like land, water and agriculture, which are vulnerable to climate change impacts (FAO et al., 2019; 2020).

Nearly 90 per cent of ongoing urban development is occurring in LMIC regions, and is characterized by informality, poverty, hunger, food insecurity and social inequalities in access to urban amenities like clean water and healthcare (State of the World's Cities, 2010; UN DESA, 2019). In particular, coastal LMICs and their cities are vulnerable to extreme weather events because in addition to the underlying development challenges, their location makes them hotspots for exposing large numbers of people to disasters and post-disaster food insecurity (Oppenheimer et al., 2014; UN-HABITAT, 2016). The greatest impact of extreme climate-related events is therefore occurring in geographical regions already characterized by challenged urbanization, high disaster risk and pre-existing food insecurity (UN DESA, 2019; UN-HABITAT, 2016). LMICs grappling with these combined challenges are highly susceptible to post-disaster food insecurity episodes, which exacerbates underlying food insecurity in the long-term, and complicates the achievement of SDG 2.

Mozambique typifies an LMIC grappling with food insecurity challenges which is worsened by the impacts of extreme weather events. More than 50% of Mozambican households experience food insecurity and about 40% of children are stunted due to undernutrition (World Bank, 2018a). Mozambique's food system is heavily dependent on a subsistence agricultural sector which employs more than 70% the country's population. Characterized by low productivity, this sector provides livelihood opportunities for 90% of the economically-active female population of the country (Matyas & Silva, 2013; CIAT&World Bank, 2017). Local evidence shows that the effects of climate-related shocks have a strong persistent influence on agriculture and the food security of households (World Bank, 2019; Raimundo & Caesar, 2023). For instance, in 2015, the country's agricultural sector was affected by climate-related stressors including droughts, erratic rainfall, floods and tropical cyclones which led to approximately 78% of farmers losing part of their crops, animals and farm implements (World Bank, 2018a). Accordingly, about 1.78 million people were already severely food insecure in Mozambique in December 2018, before Cyclone Idai made landfall in March 2019 (OCHA et al., 2019).

Furthermore, Mozambique has the fourth longest coastline on the African continent and a long history of being affected by climate-related extreme weather events like tropical cyclones (CIA, 2023; Palalane et al., 2016). About 137 cyclones were recorded in Mozambique between 2000 to 2012 (World Bank, 2018b). According to climate models, the frequency and intensity of cyclones reaching Mozambique's coast has been on the ascendency and is expected to increase further with climate change (INGC, 2009). In 2019, two of the worst categories of Cyclones, Idai and Kenneth, struck the country, with Cyclone Idai being referred to as the 'deadliest storm ever' in the Southern Hemisphere (Hope, 2019). Cyclone Idai pummeled the southeastern African coast and damaged almost 90% of the coastal city of Beira, in the Sofala province (NASA, 2019). An estimated 715,378 hectares of cultivated farmlands were flooded, uncountable losses of livestock were recorded and more than 600 people were killed (OCHA et al., 2019; Government of Mozambique, 2019). The name 'Cyclone Idai' has become an unforgettable name in Mozambique and humanitarian circles because of the widespread devastating loss of lives, assets, infrastructure and food system disruption following the cyclone. The devastating impact of Cyclone Idai was linked to its landing in a more populated urban area, Beira city, compared to other areas in the Sofala Province (MacClune & Norton, 2021).

Urbanization in Mozambique, although occurring at a more gradual rate compared to other African countries, is intricately linked to household food insecurity (Raimundo et al., 2014). Less than 40% of Mozambique's population live in urban areas where food is 18% more expensive than in rural areas, with households spending approximately 56% of their income on food (World Bank, 2017). Amidst urbanization in Mozambique, little progress has been recorded on indicators for development such as access to healthcare, electricity, clean water and income. This has resulted in high inequality levels in urban areas, thus inhibiting the capability of residents to be food secure (World Bank, 2018a). High levels of poverty and food insecurity have therefore been identified in connection with inconsistent access to urban amenities like clean water, electricity and medical treatment in Mozambique (Frayne & McCordic, 2015; Stevano, 2019; McCordic et al., 2021). Additionally, the country's food system is being impacted by rapidly urbanizing agricultural areas (Matyas & Silva, 2013; Lequechane et al., 2020).

Mozambique ranks 185 out of 191 countries on the UN Human Development Index (HDI), as approximately 60% of the population live below the poverty line of US$ 1.9 per day, while extreme weather disasters have created barriers to poverty reduction (World Bank, 2021). These characteristics have made Mozambique eligible for support from donors and humanitarian institutions for decades, and yet vulnerability has been increasing amidst worsening social inequality and child malnutrition (Hanlon, 2009; World Bank, 2018a). Increased household post-disaster vulnerability, threatens the long-term ability of survivors to withstand future disasters (Atara et al., 2020). In order for households and disaster management organizations to minimize disaster risks and address post-disaster impacts including food insecurity, there should be an understanding of differential vulnerability to ensure that the most affected and most needy people are assisted (Ingram et al., 2012; IFRC, 2020; FAO, 2021).

In support of SDG implementation, there is an increased need to apply theoretical framings to highlight the interconnections that exist between factors influencing post-disaster food insecurity,

rather than treating them distinctly. A beneficial theoretical framework is the social-ecological systems (SES) framework, which emphasizes a 'systems view' and highlights the interconnected physical and social interactions occurring within multiple levels of a system to produce vulnerability (Turner et al., 2003). The SES framework is particularly relevant for food insecurity research because it supports the incorporation of varied, complex and cross level interactions of factors paramount to food security (Story et al., 2008; Ingram et al., 2012; Herforth & Ahmed, 2015). With the arrival of Cyclone Idai in 2019 and its widespread impacts, the application of an SES framework is relevant for identifying how different indicators interacted to influence exacerbated post-disaster food insecurity and to inform future vulnerability reductions.

This study therefore examined differential household food insecurity vulnerabilities post-Cyclone Idai, to understand why some households may have experienced exacerbated post-disaster food insecurity. The study adopts an overarching SES framework and multiple indicators for assessing differences in household food insecurity post-Cyclone Idai. The indicators focused on household level food insecurity measurements, household characteristics (e.g., household income), and household personal food environment characteristics (e.g., accessibility, affordability and convenience) before and after Cyclone Idai in Beira city. Additionally, differences in household adaptations to manage the disaster, especially food-sourcing adaptations are examined, based on household connections with different social capital networks after Cyclone Idai. The study is relevant for informing future post-disaster food insecurity reductions because of the frequent occurrences of climate-related cyclones in Mozambique.

1.2 Problem Statement

The Government of Mozambique committed itself to mitigating the impact of extreme weather disasters, hence, reducing vulnerability to disasters was one of the top priorities defined in the 5-year Government Plan (2015-2020) (IMF, 2016). The government has adopted several plans, policies and laws for disaster management. One fundamental policy adopted was the National Policy on Disaster Management (NPDM) in 1999, which has since been replaced by the National Disaster Risk Reduction Master Plan (2017-2030) in 2017 (IFRC, 2021). Despite these efforts, there have been barriers to implementing the plans due to challenges with facilitating multi-stakeholder collaborations between the different actors involved in disaster management and the provision of international humanitarian aid (IFRC, 2021). Additionally, despite growing evidence that disasters are drivers for increasing inequality and poverty in Mozambique, there is limited data on post-disaster experience and loss which is relevant to guide recovery efforts (World Bank, 2019).

The impact of disasters may not evolve into severe forms by understanding the dynamics of vulnerability, including the multidimensional factors influencing food insecurity and adopting adaptations to manage them (Ingram et al., 2012; FAO, 2021). Household food insecurity influences more disastrous outcomes for households, such as increased adverse health impacts in the aftermath of extreme weather disasters (Garschagen et al., 2015; Ainehvand et al., 2019). Notably, data on post-disaster food access disparities provides evidence which can be used to

prevent exacerbated food insecurity as part of improved disaster management (Clay et al., 2021; Clay, 2022). Assessing what contributed to increased food insecurity after Cyclone Idai is therefore a pertinent input for addressing food security as part of disaster management in Beira, Mozambique. While it may be impossible to prevent tropical cyclones from occurring in Mozambique, focusing on what makes some groups disproportionately affected by disasters or experience more limited food access will help inform vulnerability reductions during future disasters.

Mozambique is ranked among the top three most vulnerable African countries to extreme weather events and on average, two cyclones enter the Mozambique Channel each year. However, the Sofala province where Beira is located, is one of the most cyclone-prone provinces (Lequechane et al., 2020; Kolstad, 2021). The residents of Beira city, in the capital of the Sofala province, Mozambique, were already experiencing severe food insecurity and high levels of poverty, according to assessments carried out before Cyclone Idai struck the city in March 2019 (OCHA et al., 2019). The city of Beira after Cyclone Idai, therefore, provides a unique opportunity for assessing the experience of household food insecurity and factors associated with differences in post-disaster food access, to inform vulnerability reductions. In this study, it is argued that the experience of household food insecurity following Cyclone Idai in Beira, was not consistent, but rather varied, based on preexisting household food insecurity, household and personal food environment characteristics and household food-sourcing adaptations using social capital networks post-Cyclone Idai.

1.3 Research Gap

Urban food security research has rapidly evolved in sub-Saharan African LMICs like Mozambique (Frayne et al., 2010; Frayne et al., 2014; McCordic, 2017; Crush et al., 2020). However, not much research has been done in post-extreme weather disaster settings, even though this is pivotal in preparedness for future disasters. Most of the studies conducted have focused on quantitative measures of food access in rapidly urbanizing low-income cities (Frayne & McCordic, 2015; Szabo, 2016; Tacoli, 2017; Tuholske et al., 2018, 2020), or nutritional shifts amidst urbanization, economic and demographic changes (Popkin et al., 2020; Reardon et al., 2021). Within post-disaster settings, emphasis has been laid on adaptations to climate-related extreme weather events, particularly, household food-sourcing adaptations using linking social capital networks (e.g., food aid through non-governmental humanitarian institutions). Yet, not much is known about how other social capital networks support adaptations to address food insecurity during climate-related extreme weather disasters (IPCC, 2012; IFRC, 2020).

Additionally, the complex interconnections between factors linked to food insecurity has influenced calls for applying SES frameworks towards understanding household vulnerability to climate change related impacts, including issues like post-disaster food access and household food environments interactions (Depietri, 2020; Clay et al., 2021; Turner et al., 2017; Global Panel on

Agriculture and Food Systems for Nutrition, 2017). In general, studies that applied the SES framework to assess household food insecurity in the aftermath of extreme weather disasters were not identified. This study therefore seeks to address these gaps by examining the differences in household food insecurity vulnerabilities after the Cyclone Idai disaster in Beira, Mozambique, informed by the SES framework. Using the SES framework will help highlight the interconnected factors shaping increased post-disaster food insecurity vulnerability. This is pertinent because increased post-disaster food insecurity can worsen undernutrition, increase susceptibility to diseases, and exacerbate the impact of disasters on vulnerable groups in Mozambique.

1.4 Principal Research Question

How are the characteristics of households, their personal food environment, and adaptations to disasters associated with differences in household food insecurity post-Cyclone Idai in Beira Mozambique?

1.5 Main Objective

To assess how the characteristics of households, their personal food environment and adaptations to disasters are associated with differences in household food insecurity post-Cyclone Idai in Beira, Mozambique.

1.5.1 Specific Objectives

The specific objectives are:

1. Assess the differences in household food insecurity pre- and post-Cyclone Idai.
2. Identify the differences in household food insecurity by the household characteristics post-Cyclone Idai.
3. Examine the differences in household food insecurity based on the accessibility, affordability and convenience characteristics of the personal food environment post-Cyclone Idai.
4. Assess the adaptations to disasters related to household food insecurity during Cyclone Idai, and how they enabled or constrained food access.

1.6 Significance of the Study

The challenges associated with food insecurity in Mozambique suggest that the complexity of vulnerability within the country may be difficult to quantify. This underscores the importance of the goals for sustainable development, which the government and donor agencies seek to implement at all levels to ensure that vulnerability is reduced. However, the frequency of extreme weather events and the increases in the number of food insecure people can undermine efforts

towards the sustainable development goals on food security (SDG 2) and climate action (SDG 13) (FAO, IFAD, UNICEF, WFP, 2020). Consequently, sustainable development may never be achieved if the vulnerability of marginalized groups keeps being exacerbated by the adverse impacts of climate-related events (Denton, 2002).

Science-backed evidence is required to support sustainable development (Kates et al., 2005), especially for countries like Mozambique. An assessment of the differences in household food insecurity based on a wide range of indicators for vulnerability such as the characteristics of households, personal food environment and adaptations to disaster, will help to highlight differential vulnerabilities and disparities in post-disaster adaptations for food access. Situating the study within the SES framework further helps to clarify the socio-ecological relationships and multilevel interactions that were involved in shaping post-Cyclone Idai food insecurity vulnerability.

Climate change has dire ramifications for household food insecurity in Mozambique in the present and the future, as highlighted by Cyclone Idai's arrival in 2019 and its impact on the country's food system. Since Cyclone Idai was one of the most catastrophic extreme weather events in the history of Mozambique, a post-disaster study of this event is relevant for informing preparedness for tropical cyclones, that are either more or less disastrous. Findings can inform mutually reinforcing actions for addressing household food insecurity and disaster risk reduction in Mozambique, an urbanizing country vulnerable to extreme weather events. Particularly, the findings could guide humanitarian and development interventions that have the potential to mitigate or eliminate post-disaster food insecurity, given effective implementation and adequate funding. This study provides a basis for increased knowledge of the experience of food insecurity post-Cyclone Idai in Beira, Mozambique.

1.7 Scope of the Study

This dissertation is sectioned into 6 chapters. Chapter One introduces the study and discusses the impacts of food insecurity and the factors linked to the increases in household food insecurity, such as the effect of climate-related extreme weather disasters on food systems and food security, especially in LMICs that are undergoing urbanization challenges like Mozambique. Additionally, the problem statement, research gap, objectives and significance of the study are outlined in this chapter. Chapter Two presents the literature reviewed and expands on the theoretical and conceptual framework guiding the research, whilst Chapter Three details the methodology that was applied to arrive at the stated objectives. Chapter Four focuses on the analysis of the data collected and the results from the analysis. Chapter Five delves into the discussion of the results within the context of related studies and the literature reviewed in Chapter 2. Finally, Chapter 6 summarizes the findings and provides recommendations based on the study's findings.

CHAPTER 2

2.0 LITERATURE RIEVIEW

2.1 Introduction

This chapter presents a review of the literature for contextualizing the study using existing knowledge. Understanding food insecurity vulnerabilities in the aftermath of a natural of households in Beira requires the use of multiple constructs. The review therefore provides an overview of key themes on the concept of food insecurity and its evolution, household and personal food environment characteristics, social vulnerability, as well as disaster management and post-disaster food insecurity factors. The section concludes with a description of the theories that were adopted to connect the relevant themes and the conceptual framework of the study.

2.2 Background of the Food Insecurity Concept

Food security or insecurity is a multidimensional and complex concept. The concept has evolved and developed over the years from perspectives on supply-side food production, famines and food entitlements and later to climate-change-related impacts and sustainability perspectives (FAO, 2006; Ericksen, 2007; Ingram et al., 2012; Mbow et al., 2019). The diffuse evolution of the construct is partly attributable to the multiple disciplines (e.g., agriculture, nutrition, economics, public health) and sectors (e.g., national, international, humanitarian), for which food security is pertinent (Jones et al., 2013). This has also influenced the use of different names by different disciplines to refer to the concept. Various studies have used the terms hunger, starvation, undernutrition and malnutrition to represent food insecurity, however, the term 'food insecurity' encompasses and remains the most widely used term by the Food and Agriculture Organization of the United Nations (FAO et al., 2019; 2020; 2021).

Amidst different conceptualizations, several definitions have been adopted for the food security concept. Hence, by 1996 there were already approximately 200 definitions for food security (Smith et al., 1996) and still counting. Notwithstanding, food security is commonly defined as "a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2006 p1), whilst food insecurity "exists when people do not have adequate physical, social and economic access to food" (Clay, 2002; FAO, 2013 pg 50). The variety of definitions has translated into difficulties in the measurement of food security, as there are multiple scales, numerous human and environmental variables to be considered, and different tools that have varying complexities (Jones et al., 2013;Vaitla et al., 2017; Pérez-Escamilla et al., 2017). As such, the collection of data for a complete analysis of the concept is daunting and almost impossible.

To support the measurement of food insecurity, some theories have been proposed to explain the phenomenon and advance actions to address it. This is particularly important amidst the

interconnected challenges of population growth, urbanization, climate change, extreme weather disasters, poverty and geographical disparities that influence food (in)security (FAO, 2021; Human Development Report, 2022). Theories on food security highlighted below reflect the shift from the initial food availability approach towards entitlements, dimensions and more current food system frameworks, for understanding and explaining the research variables related to the phenomenon. Three of the commonly applied theories adopted for understanding food insecurity are explained below.

2.2.1 Food Entitlements Concept

Historically, food insecurity was conceptualized as a shortage of food production on global or national scales, however, the scale of focus shifted to consider food access at the household or individual level because of the seminal work of Amartya Sen in 1981. Sen's 1981 analysis of the causes of famine established that the lack of entitlements necessary for food access at the individual or household level was the cause of food insecurity. Entitlements consisted of an endowment set and an entitlement set. The endowment set refers to the combination of all tangible resources (e.g., land, animals), and intangible resources (e.g., skills, labor power) that a person owns legally. The entitlement set refers to all the possible combinations of goods and services that a person can use his endowment resources to legally obtain (Sen, 1981).

When a person has just enough endowments to obtain food, situations that lead to a decline in those endowments and entitlements can lead to starvation and this concept is referred to as entitlement failure (Sen, 1981). People may experience entitlement failures when their entitlement set does not contain the minimum amount of food to avoid starvation and they do not have access to non-entitlement transfers such as food aid or charity (Osmani, 1993). Entitlement failures may take the form of 'direct entitlement failure' where there is a reduction in own food production or a 'trade entitlement failure' due to reductions in the rate of food exchange because of factors such as employment losses (Sen, 1981). Households reliant on subsistence farming for both their endowment and entitlement sets are therefore the most likely to experience the highest forms of entitlement failures post-disasters, if there are no interventions.

Historical famines in Ethiopia and the Darfur region of Sudan have provided insights for explaining entitlement failures and starvation. During the Ethiopian famine in 1973 which was triggered by a drought, there was an agricultural and pastoral crisis, however, food availability declined only about 7%. Despite the minimal decline in food availability, there was widespread starvation linked to disruptions in transport networks for food supply and structural changes resulting in economic, income and purchasing power declines. The highest starvation-related mortality, was recorded in the Wollo province because most of their endowments and entitlements were tied to agriculture (Sen, 1981). Apart from starvation (food insecurity) being linked to entitlement failure, De Waal, (1989), argues that death during famines is more linked to disease rather than starvation. In his study of the 1984-1985 famines in the Darfur region, Sudan, he

identified that starvation itself resulted in a few deaths, however, localized disease outbreaks such as diarrhea, due to the lack of access to social amenities like clean water and sanitation, killed more people (De Waal, 1989).

These seminal studies informed the expansion of entitlements to include household access to a broader set of social resources like clean water, sanitation and health services that have significant impacts on the health and nutrition of households (Drèze & Sen, 1990). Studies show that access to complementary commodities such as healthcare, elementary education, drinking water, sanitation facilities and participation in community decision-making processes form part of the basic capabilities that enable people to avoid being food insecure (Drèze & Sen, 1990; Burchi & De Muro, 2016). Recent studies show that inconsistent access to complementary resources (e.g., clean water, medical access, income) is indicative of poverty and has had adverse effects on household food access in urban LMICs (Frayne & McCordic, 2015; McCordic et al., 2021).

Sen's research initiated the need to assess food insecurity by reflecting on the differences in household deprivations due to failed entitlements and capabilities at the individual and household levels rather than relying on nationally aggregated statistics on food availability. Poor households are usually food insecure and experience the worst famines, due to failed entitlements and the lack of basic capabilities. Sen, (1981) referred to poor people as "destitute", and this group included nomadic pastoralists, migrants without land, dependents of farmers and laborers. The entitlement approach is useful for explaining famine as a direct entitlement failure for communities heavily reliant on subsistence agriculture. Within urban areas non-reliant on agriculture, famines or food insecurity may be a 'trade' or 'income' entitlement failure. Applied to this study, post-disaster food insecurity is linked to the decline of food availability as well as entitlements and capability failures.

2.2.2 Four Pillars Concept

The four pillars approach to food security or insecurity theorizes that people are food secure when their access to food is based on the simultaneous fulfilment of food availability, food access, utilization and stability requirements (FAO, 2006; Jones et al., 2013). Several measures for food security are focused on the different dimensions and as such there is currently no one tool for assessing all the dimensions (Barrett & Lentz, 2010; Pérez-Escamilla et al., 2017). However, the term 'food access' has been used synonymously in place of 'food security', because all the other dimensions (availability, utilization and stability) are considered as requirements for ensuring adequate food access (Coates et al., 2003; Pinstrup-Andersen, 2009; Jones et al., 2013). The multiple dimensions and their different applications are highlighted below.

2.2.2.1 *Food Availability*

The earliest use of the term food security was focused on food availability at the World Food Conference held in 1974 (Smith et al., 1996). Food security was defined as the "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (FAO, 2006 Issue 2, pp 1). Food availability was later redefined as having sufficient quantities of food of appropriate quality, that is supplied through domestic production, stock levels, imports including food aid and net trade (FAO, 2008; FAO, 2006). The definition appeared appropriate in the 1980s, because of the focus on assuring the availability and price stability of basic foodstuff at international and national levels, to meet the needs of increasing human populations, as suggested by neo-Malthusian theories (Clay, 2002; Scanlan, 2001).

The recognition that the adequacy of global or national food production did not translate into food adequacy at the community, household or individual levels was initiated by the food entitlements research of Amartya Sen in 1981. He illustrated using case studies of historical famines in Ethiopia, the Sahel and Bangladesh, that households starved because of the lack of 'entitlements' to obtain food, rather than inadequate food production or supply at the national level (Sen, 1981). The findings from Sen, (1981) notwithstanding, the old food availability approach appears to still exert its influence in recent times. This is illustrated through the international food security agenda that supports increased food production by small farmers in rural Africa, with less attention to the economic, social and environmental pressures (e.g., urbanization), related to food supply and food consumption changes (Crush & Frayne, 2010; Lang & Barling, 2012; Battersby, 2017).

National-level estimates of food security are usually focused on the food availability pillar. One measurement approach uses food balance sheets on nationally aggregated food supply data, including the total amount of food produced and imported as yardsticks for cross-national comparisons (Jones et al., 2013). With the emergence of industrial agriculture, more than enough food is being produced and yet more than 1 billion people in the world are food insecure (FAO, 2009; FAO et al., 2020). The rate of global food production increased faster than the world population in the 2000s, and there was more than enough food to feed the 10 billion people, projected as the world's population by 2050 (Holt-Giménez et al., 2012). However, the 2007-2008 food crisis and the economic crisis in 2009 – 2012, drew attention to the multiple factors including demographics, poverty, economic and social empowerment, governance, climate and environmental factors that are strongly linked to food insecurity (CFS, 2015). These happenings necessitated a rethinking of the food production approach towards a food access approach.

2.2.2.2 *Food Access*

At the global level, it was established that the concept of food security could no longer be discussed from a food production perspective without incorporating other food entitlement factors that

guarantee food access at the household level (FAO, 2006). The food security definition includes 'physical, social and economic' access which encompasses entitlements or the set of all commodity bundles over which a person can establish command, given the economic, legal, political and social arrangements of the community in which they live, including traditional rights such as access to common resources (FAO, 2006; CFS, 2015). Mostly, inequalities within food systems that limit people's physical, social and economic access to healthy food occur not only during food production, but run through other elements until consumption (e.g., limited transport access for food supply) (Global Nutrition Report, 2020).

The 'physical' aspect of food access refers to the physical availability or the ability to reach available food sources, based on factors such as proximity to markets, transportation access and infrastructure (HLPE, 2017). Indicators for assessing physical access to food are largely found within food environment research, that adopt tools like the Nutrition Environment Survey, which incorporates type of neighborhood (e.g., low-income, high-income) and spatial access (e.g., distance of home from food outlet) indicators (Alber et al., 2018; Glanz et al., 2005). Studies have associated spatial access to food outlets and supermarkets with improved dietary diversity in Nanjing China (Zhong et al., 2018) and supermarket patronage in Matola (McCordic et al., 2022). Other approaches for assessing physical access include mapping food vendors using geographic information systems (GIS) e.g., counts, densities and proximity networks (Turner et al., 2018). Research on physical access to food within LMICs is still in its infancy, although rather advanced in developed countries (Turner et al., 2017; HLPE, 2017).

Urbanization has significantly changed food systems and the physical access to food through transformations in food production, processing, transportation, distribution and consumption (Seto & Ramankutty, 2016; Baker & Friel, 2016). Low-income communities in urban areas with limited physical access to supermarkets or fresh and affordable food outlets, show prevalence of food insecurity and are referred to as 'food deserts' (Guthman, 2008; Short et al., 2007; HLPE, 2017). Some low-income communities may also have food environments that are swamped with the presence of processed and ultra-processed (refined carbohydrates and sugar sweetened beverages) food outlets, which contribute to the spread of non-communicable diseases and the concurrent manifestations of malnutrition and obesity in communities (Popkin, 1999; Popkin, 2004; Popkin et al., 2020). Regardless, physical access is linked to economic access, as poor people are likely to live in food deserts.

Economic access to food refers to income or the purchasing power to acquire food (FAO, 2001; FAO, 2009). Food insecurity is strongly linked to the inability to afford food and is symptomatic of poverty (Mattes, 2020; FAO et al., 2021). Indicators for assessing food insecurity are usually based on economic access, such as access to income and assets, which are also used as indicators of household poverty (Upton et al., 2016). Typically, people living in urban areas are net buyers of food, which makes them depend on food markets and become more affected by the prices of food and food affordability (Szabo, 2016). The cost of food, unaffordability of healthy diets and lack of income or remittances are strongly linked to increased food insecurity in LMICs (FAO et al., 2020).

Ensuring economic access to food involves looking within food systems to concurrently address factors that drive up the cost of nutritious food supply and supporting consumers with insufficient income, to enable food access.

There are also marked differences in people's food access based on social inequalities. Inequalities linked to food access focus on underlying social systems or processes that create unequal access e.g., marginalization of certain groups in policymaking (Global Nutrition Report, 2020). Social access to food is also embedded within configurations of social relations e.g., family and community relations that distinctively shape food access (Delormier et al., 2009). However, there are limited scales for capturing social factors linked to food access, such as access to social capital networks. Regardless, access to social capital networks has been invaluable for food access during disaster recovery and is associated with post-disaster food insecurity (Aldrich & Meyer, 2015). Additionally, access to social amenities such as primary health facilities and medical centers also influences the incidence of disease which mutually reinforces food insecurity (MSSRF & WFP, 2002). Other studies also identified strong relationships between household food insecurity and access to medical care (McCordic, 2017).

Measuring food access is complex because of the multiple dimensions. Some studies have incorporated the use of experiential indicators for assessing food security both objectively such as the number meals missed and subjectively such as social access to food and food preferences (Coates, 2013). Unlike food availability assessments that focus on food supply at national scales, food access is usually assessed from the demand side at household or individual scales. Commonly used scales include the Household Food Insecurity Access Scale (HFIAS), for assessing household food insecurity prevalence and to detect changes in a household's food insecurity status (Coates et al., 2007). Additionally, the Food Insecurity Experience Scale (FIES) is useful for assessing the experiences of increasing difficulties in accessing food due to resource constraints at the individual level (FAO et al., 2019).

2.2.2.3 *Utilization*

Utilization focuses on the differences in food allocation, the nutritional quality of the food and the extent to which nutrients are absorbed and metabolized by individual household members (Jones et al., 2013). Getting access to food is not enough if a person is unable to make use of the food for living a healthy life, based on factors like age, gender, education, food safety, health and nutrition of households, access to sanitation or hygiene, food storage and processing, which determine people's nutrient uptake or food utilization (Doak et al., 2005; FAO et al., 2019; Islam & Kieu, 2021). Utilization also depends on adequate food preparation, feeding practices, good healthcare and dietary diversity (FAO, 2008). For improved utilization among households, there must be a focus on the amounts and relevant kinds of food allocated and consumed by individual household members and the nutritional quality and bioavailability of nutrients (Jones et al., 2013).

The measurement of utilization has been useful for highlighting the 'double burden of malnutrition' which is the combined existence of undernutrition (e.g., micronutrient deficiencies, childhood stunting and underweight) and obesity, overweight and diet-related non-communicable diseases (Popkin et al., 2020). Utilization is assessed using anthropometric measurements to provide details on the nutritional status of vulnerable groups. Anthropometric indicators for children (e.g., underweight, stunting), adults (e.g., Body Mass Index) and the elderly (e.g., thinness), are compared with the averages for well-nourished people in the same age and gender groupings, to determine the difference between normal or abnormal development (FAO, 2001; van Wesenbeeck, 2018). However, anthropometric measurement may represent more than food intake, as other factors such as an individual's health may confound the results.

Other types of tools have therefore been introduced for assessing utilization. These include the accurate estimation of food allocation and intake using Food Variety Score (FVS), the Household Dietary Diversity Index (HDDI) which counts the number of different food items consumed over a week and the Dietary Diversity Score (DDS), for counting the food groups consumed. The food groups can also be summed up to calculate the frequency of consumption for each food group, known as the Food Frequency Score (FFS) and the Food Consumption Score (FCS), which adds to the FFS by weighing food groups according to their nutritional quality (Jones et al., 2013; Upton et al., 2016). Additionally, others have assessed the percentage of the population that does not meet the minimum number of calories required for an average person, as stipulated by the FAO and the WHO, known as the prevalence of undernutrition (Reddy et al., 2019). The more indicators for utilization that one attempts to measure, the more complex it becomes.

2.2.2.4 *Stability*

For a population, household or individual to be food secure, they must have access to adequate food at all 'times', regardless of sudden shocks (e.g., economic crisis, physical disruptions from climate-related events) or cyclical events (e.g., seasonal food insecurity). Food security therefore has temporal attributes and may be subject to short-term sharp disruptions (transitory or seasonal) or long-term chronic disruptions (Clay, 2002). Short-term disruptions may be seasonal or transitory. Seasonal food insecurity is usually predictable and experienced by farming households during the annual hunger season, which is the time of the year when the stock from previous harvest has dwindled, whilst food prices increase and jobs decrease (Vaitla et al., 2009). In contrast, sudden, short-term disruptions in food access that are relatively unpredictable refer to transitory food insecurity (FAO, 2008). Seasonal food insecurity lies between chronic and transitory food insecurity which are closely linked, whilst the successive experience of transitory food insecurity increases the vulnerability to chronic food insecurity (Maxwell & Frankernberger, 1992; FAO, 2008). Long-term disruptions indicate chronic food insecurity, which reflects the lack of access to adequate food, because of structural problems with availability, access and utilization, over a long period (Barrett & Lentz, 2010).

The globalization of food systems, trade and the introduction of green initiatives and fast-growing crop alternatives are lauded for increasing the supply of food globally to increase stability (Lang & Barling, 2012; Baker & Friel, 2016). However, climate-related fluctuations have become more frequent, thus influencing unpredictable, short-term fluctuations and transitory food insecurity episodes, which adversely affect chronic food security. Chronic food insecurity is usually not assigned adequate attention and resources in global agenda, unlike the attention given to short-term (transitory) disruptions to household food security from emergencies and disasters (Vaitla et al., 2009). Notably, underlying chronic food insecurity conditions are linked to, and exacerbate post-disaster food insecurity outcomes (Fitzpatrick et al., 2020; Béné, 2020).

The stability dimension refers to the stability of food availability, food access and food utilization conditions over time, without disruptions (Habiba et al., 2015). As such, assessing the continuous supply of the other 3 pillars is a useful way of assessing stability (García-Díez et al., 2021). Measures of the stability dimension include, assessing the volatility and fluctuations in the price of food and seasonality (HLPE, 2017). Additionally, coping strategies such as the short-term dietary changes used by households for addressing the insufficiency of food at the household level, may be assessed (Maxwell, 1996). Another useful measurement approach is the coping strategy index (CSI) tool, which consists of a series of coping strategies that households adopt to cope with short-term falls in food consumption expressed as numeric values (Coates, 2013). Countries that are unable to establish food storage facilities and food stockpiling practices due to the lack of technical expertise and financial resources are more likely to experience food instability with climate change (Islam & Kieu, 2021).

2.2.3 Food Systems Concept

A food system incorporates "all the elements (environment, people, processes, inputs, infrastructure, institutions etc.,) and activities related to food production, processing, distribution, preparation and consumption and the outputs of these activities including socioeconomic and environmental outcomes (HLPE, 2017 p11). The food system approach conceptualizes food security as an outcome of the cyclical interactions between the elements within a food system (Ingram et al., 2012; Ingram & Zurek, 2018). While the definition indicates several interconnected elements that constitute a food system, this can be simplified into 3 distinct elements of *food supply chains, food environments* and *consumer behavior* which encompass, the relationships from food production to food consumption (HLPE, 2017; Global Panel on Agriculture and Food Systems for Nutrition, 2017).

Proper functioning of the food system is needed for ensuring that the four pillar requirements for food security are fulfilled. Consequently, efforts by countries to end food insecurity hinge on ensuring that food systems can deliver food availability, access, utilization and stability within the earth's planetary boundaries (Stordalen & Fan, 2018). The food systems framework complements

the four pillars approach by highlighting the interconnections between the pillars. Whereas food supply chains are associated with food availability, food environments are associated with the physical, economic and social dimensions of food access, while consumer behavior is associated with the food utilization pillars. Although the stability pillar is not directly mentioned, inconsistent access to any of the three elements due to disruptions (e.g. climate-related extreme weather events), has an impact on the stability pillar. A change in one food system element is likely to affect other elements and the whole food system (Devereux et al., 2020).

2.2.3.1 *Food Supply Chains*

Food supply chains comprise of all the various avenues and processes by which food availability is ensured. The supply of food through domestic food production is the main avenue by which food is made available in most countries (Barrett & Lentz, 2010). Food production biased agenda that governed the development of the food security construct focused on short supply chains from farm to plate, usually found in rural food environments. Regardless, food supply chains have evolved to encompass the production of raw materials for food, processing, packaging, marketing and storage, which create economic and social development opportunities (Caron et al., 2018).

Food processing and packaging contribute to longer food supply chains by adding value to raw food, making it easier to be transported over long distances via different modes, which supports the expansion of food distribution and retail markets (HLPE, 2017). Changes in food supply chains have evolved with industrialization, commodification, globalization of markets and urbanization, usually accompanied by shifts in socio-demographics, incomes, culture and consumer demand for food (Global Panel on Agriculture and Food Systems for Nutrition, 2017; Ingram & Zurek, 2018). These influential factors, combined with trade liberalization laws have catalyzed the spread of supermarkets, transnational food franchises and industrial retail, which have transformed traditional food supply chains (Capone et al., 2014).

Transformations within food systems, are therefore theorized as a transition from the traditional stage when food supply chains are short and characterized by low food processing and small enterprises, to the transitional stage where food supply chains are longer and stretch from rural to urban areas, and finally to the modern stage where food supply chains are very long and dominated by supermarkets and large processing companies (Reardon, 2011; Reardon et al., 2019). Nevertheless, changes in food supply chains also include the spread of informal markets in urban LMICs, to cater for the needs of the urban poor (Raimundo et al., 2020), which is usually not considered in food supply chain transformation studies. Where applicable, food supply chains may include structural food aid, received through donations or imports from donor countries to meet the emergency needs of people in crisis situations, such as disasters and conflicts (FAO, 1996; World Bank, 2014).

2.2.3.2 *Food Environment*

The types of food supply chains that exist in a city shape the second component of the food systems framework known as the 'food environment'. According to Herforth and Ahmed (2015), there are more than 500 measurements focusing on different aspects of the food environment using different approaches. For example, different types of food environments have been identified with different indicators for assessing them; consumer food environment, community food environment, organization food environment (e.g., workplace, schools), and perceived food environment (Fernandes et al., 2017; Glanz et al., 2005; Story et al., 2008; Alber et al., 2018). The multiple dimensions and factors associated with the description of the food environment created challenges with consistencies in food environment assessments, thereby limiting the advancement of food environment research (Moore et al., 2008).

To promote research on the food environment component of the food system, 'food environment' has been characterized as comprising of two distinct components that have interactions between them. The food environment is defined as "the interface that mediates people's food acquisition and consumption within the wider food system, and encompasses external dimensions (*availability, prices, vendor and product properties, promotional information*) and personal dimensions (*accessibility, affordability, convenience and desirability of food sources and products*)" (Table 2.1) (Turner et al., 2018 p95). The external and personal food environment are inextricably linked, with the external food environment acting as a precursor to the personal food environment. For instance, availability precedes access, price precedes affordability, vendor and product properties precede convenience whilst marketing and regulation precede desirability (Turner et al., 2017).

Table 2.1 Description of the Food Environment according to Turner et al., 2018

External domain ⇌ **Personal Domain**	
***Availability*:** This always precedes accessibility and refers to the presence or absence of food products or vendors within a given context.	***Accessibility:*** This includes time, transport and physical distance contexts that shape access to food that is available.
Prices: This refers to how much food costs and interacts with affordability.	***Affordability:*** This depends on the purchasing power of individuals.
Vendor and product properties: This refers to attributes such as vendor opening hours and product properties, which are related to convenience for consumers.	***Convenience:*** This involves factors such as effort, time and access to facilities for food purchase and preparation.
Marketing and regulation: This includes promotional information and policy regulations pertaining to food products.	***Desirability*:** This refers to people's preferences, desires, acceptability, knowledge and culture that shape food acquisition.

Both the external and personal dimensions of the food environment provide a comprehensive way for assessing the physical, social and economic dimensions of food access rather than focusing on only certain aspects of food access. However, the socioecological interactions between the external food environment and personal food environment dimensions have been under-researched in LMICs (Turner et al., 2018, 2020). A systematic literature review of food environment research in LMICs showed that studies usually assessed the external food environment with the most studied subdomain being availability whilst marketing and regulations were the least studied (Constantinides, et al., 2021). Under the personal food environment dimension, desirability was the most studied while convenience was the least studied (Constantinides, et al., 2021).

Food environment research has been extensively applied to the description of the external food environment (Turner et al., 2018, 2020). In Global North countries, external food environments are usually formal and well-built structures e.g., grocery stores and supermarkets (Story et al., 2008; Downs et al., 2020). In contrast, households in LMICs obtain available food through a range of options such as urban agriculture (Zezza & Tasciotti, 2010, Conforti et al., 2020), food remittances (Crush & Caesar, 2018), informal food markets (McCordic & Raimundo, 2019; Raimundo et al., 2020), and supermarkets (das Nair, 2020). The external food environment in LMICs in Southern Africa show a hybridized form of Global North and South characteristics, illustrated by the coexistence of sophisticated, good infrastructure markets and non-market food sources, which overlap with informal food vendors (Battersby & Crush, 2014; Even-Zahav, 2016).

Determining which food environment measure to use must be guided by the purpose of the assessment, the validity and reliability of the measure adopted, and the resources and expertise available (Ohri-Vachaspati & Leviton, 2010; Constantinides et al., 2021). Since the external food environment characteristics, such as spatial density of food sources and vendor properties have received much attention, it is important that personal food environment characteristics such as food accessibility, affordability and convenience are considered. Focusing on the personal food environment is relevant for post-Cyclone Idai food insecurity assessment, as an estimated 90 per cent of infrastructure within the city of Beira was impacted (Mbah, 2019), with covariate shocks on external food environment dimensions (e.g., market vendors).

2.2.3.2.1 Operationalizing the Personal Food Environment

Food environments may be assessed at several scales such as global, regional, national, household or individual scales (HLPE, 2017; Raja et al., 2019). The characterization of the personal food environment subdomains of accessibility, affordability and convenience at the household level, by other studies are outlined below.

Accessibility: According to Penchansky & Thomas, (1981), accessibility refers to the relationship between the location of a good's supply and the location of clients by taking into consideration their transportation resources, distance, travel time and cost. Food access is determined by the

physical, economic and social accessibility to food (Szabo, 2016; Clay, 2022). Assessing all these dimensions is quite complex and will require several indicators. However, for food security, accessibility is usually measured as spatial proximity to food sources using geographic information systems methods (GIS) (Charreire et al., 2010). Studies have considered the location of a household's home as relevant for facilitating access to food markets (Glanz et al., 2005; Story et al., 2008). Living in informal settlements in urban areas has also been associated with reduced accessibility for the urban poor and exposure to environmental hazards (Tacoli, 2017). The use of such variables aligns with the 'physical distance contexts' that shape the accessing of available food, as defined under the personal food environment dimension of the Turner et al. (2018) framework (Table 2.1).

Affordability: Affordability is a measure of whether people have the financial resources for purchasing sufficient food items needed by their households (Nozhati et al., 2019). The price of food and affordability are variables sensitive to changes in food availability and accessibilty (Turner et al., 2018). Food access at the household level is largely determined by affordability which is synonymous with household incomes (Tacoli, 2017). The lack of decent employment can make people income- and time-poor, restricting their ability to meet their food needs (Stevano, 2019). Concurrent occurrences of time poverty and income poverty are indicative of extreme poverty, which limits food affordability (Bardasi & Wodon, 2010). A focus on affordability reflects the concept of endowments or entitlements required by people to enable their ability to obtain food (Sen, 1981). Affordability related to household income is the most important issue in determining household food insecurity pre-and post-extreme weather events (Nozhati et al., 2019).

Convenience: Convenience is related to decision making, time, efforts and resources involved in choosing, cooking and consuming food (Turner et al., 2018; Fernandes et al., 2017). Several studies have highlighted that the relationship between access to a network of resources including access to energy (e.g., electricity, cooking fuel) and water, are associated with food insecurity and wellbeing in LMICs (Frayne & McCordic, 2015; Nozhati et al., 2019; McCordic & Frayne, 2020; McCordic et al., 2021). Although food unavailability after disasters is widespread, access to fuel, water for cooking and washing dishes as well as soap for cleaning have been associated with restricted food consumption post-disasters (Clay, 2020; Clay et al., 2021). Additionally, the loss of homes, whole kitchens and cooking equipment (e.g., fridges, stoves) have also been linked to increased vulnerability to food insecurity, as households were unable to prepare fresh or healthy meals or lost stored food after a tornado (Pyle et al., 2021). Access to resources for 'convenience' is also indicative of the capability to be food secure and important for food safety and utilization especially within post-disaster contexts.

2.2.3.3 *Consumer Behavior*

Consumer behavior is the third distinct element of the food system and is largely shaped by both food supply chains and food environment factors. Food availability (food supply chains) and food

price (food environment) appear to be the strong driving forces behind the food choice of consumers, who may opt for lower-priced food by default. However, apart from price, factors like the nutritional value, food safety, media, advertisements, social acceptance, lived and personal experiences of consumers also influence the making of food choices (Glanz et al., 2005; Ericksen, 2007; Fanzo and Davis, 2021). The processes through which food is selected, acquired, prepared and presented for consumption are evidence of consumer behavior and this differs across individuals, households, communities, cultures, countries and regions (HLPE, 2017; Dangerfield et al., 2021). Consumer behavior is rapidly changing from the consumption of high fiber diets to ultra-processed food (nutrition transition) particularly in urban areas in LMICs, which mirrors dietary patterns of consumption already seen in high-income countries (Popkin, 2001; Kearney, 2010).

The behavior of consuming home-cooked food in rural areas, characterized by households with low-income agricultural livelihoods and short food supply chains, is shifting towards the frequent consumption of cooked food purchased from outside the home, to mimic behaviors in large cities with higher income households and long food supply chains (Reardon et al., 2021). A study on diet quality and urbanization in Mozambique, found that unprocessed perishable foods were the most acquired food items by 70% of study participants. However, the consumption of processed foods increased with increasing city sizes, compared to farm-owner households who purchased fewer unhealthy processed foods, but showed decreased dietary diversity (Smart et al., 2020). The differences in consumer behavior from the study appeared correlated with urbanization, transformations in food supply chains and food environments within the geographical area.

Food insecurity, and its association with urbanization and consumer behavior has gained increased attention because of nutrition and epidemiological transitions (Global Nutrition Report, 2017). Notably, nutrition transition in African LMICs does not always follow the linear model of social change, but is bound up in the identities, culture, economic necessity and personal preferences of the people (Riley & Dodson, 2016). For instance, a study from Eastern and Southern Africa shows that regardless of rural or urban settings, processed foods constituted more than 40% of a household's food purchasing budget (Tschirley et al., 2015). Additionally, traditional and local food retailers have also incorporated the sale of ultra-processed food, previously found in only urban supermarkets (Global Panel on Agriculture and Food Systems for Nutrition, 2017). These transitions in LMICs raise concerns regarding the consumption of ultra-processed food resulting in diet-related diseases (e.g., micronutrient deficiencies, obesity) and non-communicable diseases (NCDs) (e.g., diabetes and hypertension) (Doak et al., 2005; Popkin et al., 2020).

Consumer behavior towards food purchase and consumption may undergo temporary changes in association with different types of disasters. Depending on the impacts of extreme weather disasters on households, consumers may change their food preparation methods (e.g., due to loss of stored food and kitchenware, loss of jobs or homes) (Kennett-Hensel et al., 2012). Consumer behavior has been noted to shift towards the consumption of ultra-processed food in the aftermath of disasters due to impacts on food preparation abilities (Forbes, 2017). Disasters may also trigger

consumer behavior such as panic buying of food, which impacts food supply chains, as high-income households with higher purchasing power buy and hoard limited food that is available, resulting in reduced food access for low-income households (Dulam et al., 2021).

2.3 Assessing Household Food Insecurity

The measures of food insecurity based on the conceptualizations above, are broadly categorized into anthropometric assessments, direct household assessment tools and proxy assessments which can be applied at different scales such as national, household, rural or urban (Haysom & Tawodzera, 2018). Anthropometric measures of food security may be used at the national, community or individual household level to provide information on nutritional status and also as a proxy measure for the utilization pillar (FAO, 2001; Jones et al., 2013). Anthropometry refers to the direct measurements of height, weight and waist circumference of the human body, which is usually collected through Demographic and Health Surveys (DHS) for assessing the nutritional status of men, women (between 15-49 years) and children (under 5years) (The DHS Program, 2019). Cross-country analyses of food security in West Africa based on anthropometric DHS data, have indicated high levels of food insecurity that differ across countries, although within-country analyses show similarities between rural and urban households results (van Wesenbeek, 2018).

The second group of household assessment tools also referred to as food insecurity experience measurement scales (FIEMS), offer the most direct measurement of food insecurity. FIEMS measure food insecurity based on individual/household perceptions of the physical and psychosocial dimensions of the experience of food insecurity and are applicable across different socio-cultural settings (Haysom & Tawodzera, 2018). The four main types of food insecurity experiences that are measured by most scales include the experience of uncertainties in food availability and food access, compromises in dietary quality or food preferences, eating less food and going hungry (Frongillo, 2022). The US Agency for International Development (USAID)'s funded project called food and nutritional assistance (FANTA) developed a generic FIEMS for the access pillar of food security, called the Household Food Insecurity Access Scale (HFIAS), that is easy to use, validate, and allows for comparability across LMICs and regions to support the work of development organizations (Webb et al., 2006; Coates et al., 2007). A systematic review of 22 peer-reviewed papers assessing food insecurity between 2000 to 2021, showed that the HFIAS was the most utilized measure, spanning across studies conducted in 36 developing countries in Sub-Saharan Africa (Saha et al., 2021).

Other FIEMS have been developed since the HFIAS to support the assessment of food insecurity. Notable ones include the Household Food Insecurity Access Prevalence (HFIAP), Household Hunger Scale (HHS) and the Food Insecurity Experience Scale (FIES) (Coates et al., 2007; Haysom & Tawodzera, 2018; Leroy et al., 2015). The HFIAP and the HHS were developed from FANTA's HFIAS tool. However, the FIES tool was developed by the FAO to assess progress on SDG 2 for 'Zero Hunger'. The tool has been validated in 147 countries to ensure its applicability

in both HICs and LMICs settings (FAO et al., 2019; Nord et al., 2016). The FIES is gradually becoming a widely adopted tool for assessing food insecurity in LMICs after the HFIAS and is applicable at both the household and individual levels (Carrillo-álvarez et al., 2021; Saha et al., 2021).

The third category of measurement tools described as 'proxy tools' includes Coping Strategies or the Coping Strategy Index (CSI) (Haysom & Tawodzera, 2018). This last group of assessment indicators are particularly useful for complementing food insecurity assessments in contexts where data on factors like income are inaccurate or unavailable. Food insecurity coping strategies may take the form of adopting different economic activities (e.g., migration to seek new job opportunities), consumption smoothing (e.g., sale of assets, borrowing food), and changes in consumption pattern (e.g., eating fewer meals per day) (FAO, 2009; Gupta et al., 2015). While the adoption of coping strategies can be explained qualitatively, the CSI measures food insecurity by assigning an ordinal rank to coping strategies based on their severity, and their relative frequencies, which are then combined into a single score (Maxwell, 1996; Maxwell & Caldwell, 2008). There is a general list of coping strategies that are recommended in alignment with various coping domains. However, a locally adapted list is recommended, which can be generated through interviews with stakeholders representing the population of interest (Jones et al., 2013).

Notwithstanding the advantages of the broad categories of measures, some limitations were identified. Firstly, anthropometric measures may not accurately measure food insecurity due to confounding factors, such as the health of participants (Upton et al., 2016; FAO et al., 2019). Secondly, the use of FIEMS enables the measurement of multiple aspects of physical, social and economic access to food, but not other food security dimensions. FIEMS has also been criticized for being subjective and prone to altered scores due to changes in the perceptions of respondents (Jones et al., 2013). Finally, the adoption of proxy measures such as coping strategies is particularly useful within crisis settings in assessing how food insecurity is impacted, although it does not distinguish between the situation before the crisis and those coping strategies informed by the crisis (Haysom & Tawodzera, 2018).

To overcome these limitations, some studies suggest using a combination of tools to increase the precision of food security assessments such as combining Household Dietary Diversity Score (HDDS), Household Food Insecurity Access Scale (HFIAS), Household Consumptions and Expenditure Surveys (HCEs) (Vaitla et al., 2017; Jones et al., 2013). However, the conceptualizations of food security embody a wide range of influences from several disciplines, which continue to evolve and become more complicated due to global environment change factors such as climate change (Ingram, 2011; Ingram et al., 2012). As such, different food insecurity measurement tools and frameworks should be merged synergistically, to avoid the creation of unintended tensions or overlaps (Foran et al., 2014). This has also influenced calls for tools that adequately capture the diversity of food security; for example, tools that distinguish between food access within urban and rural areas, amidst the influence of urbanization on food insecurity in LMICs (Battersby & Haysom, 2018; Crush & Riley, 2017). These underlying challenges in

research reflect the difficulties in addressing food insecurity and the unenviable task of determining appropriate interventions by countries and donor agencies.

The assessment of food insecurity and the decision for the best measure depends ultimately on the purpose for which the assessment is being conducted and the context (Habicht & Pelletier, 1990). Although the comprehensive conceptualization and measurement of food insecurity are challenging, both quantitative and qualitative approaches may be converged and complemented with data from several sources, as a way of cross-referencing measures (Coates, 2013; Jones et al., 2013). Notably, the evolution of quantitative measures of food insecurity (e.g., FIEMS), was underpinned by insights from the work of anthropologists, who qualitatively assessed the experience of food insecurity among rural folk (Webb et al., 2006). Combining both approaches may also help examine interconnected factors that are linked to food insecurity, which may not be captured by standalone approaches. Within high-vulnerability contexts, a nuanced understanding of food insecurity is required, and appropriate measurement may involve complementing quantitative data with qualitative data (Wolfe et al., 1996; Power, 2008; Craveiro et al., 2016).

Addressing urban food insecurity in LMICS is embedded within factors such as extreme climate variability, economic downturns, underlying poverty and social inequalities in accessing food, and a network of distributed authority and multiple stakeholders intervening to reduce food insecurity (Battersby et al., 2014; FAO et al., 2021). With food security, there is a 'no one-size-fits-all approach' as different countries and cities vary in how they are affected by these underlying challenges, especially LMICs. Relevant measures of food insecurity, specifically designed for determining how shocks affect food access are required (Maxwell, 1999; Webb et al., 2006), whilst post-disaster food insecurity research is critically lacking. Within LMICs, little is known about strategies to reduce disaster risk for food system actors, including consumers (Bene, 2020). Understanding the devastating impacts of disasters on household food security in Beira, may benefit from the use of FIEMS quantitative approaches complemented by qualitative approaches.

2.3.1 Assessing Post-Disaster Household Food Insecurity

Climate-related disasters have become the most common on the global disaster risk landscape and constitute about 80% out of all disasters since 2010 (IFRC, 2020). On average, the frequency of extreme weather disasters was 235 events per year between 1993–2004, however, this increased to about 260 events per year between 2005-2016 (FAO, 2017a). In 2019 alone, about 237 climate-related disasters were recorded, including Cyclone Idai (IFRC, 2020). The year 2019 was a record-breaking year, being the second warmest year in both ocean and land temperatures since 1851, with intensified droughts, floods and heatwaves having direct and indirect socio-economic impacts (FAO, 2021). While the mechanism by which climate change influences global weather patterns is unclear, evidence suggests a correlation between climate change and the increased severity and frequencies of droughts, storms, cyclones, heatwaves and cold wave events which cause disasters (HFA, 2005; Repetto & Easton, 2010).

Climate change variabilities and extreme weather disasters have the most significant adverse impacts on the natural resources and ecosystems on which food systems depend and are the main drivers of food system change (HLPE, 2017, 2020). Climate change affects food security in complex ways; through slow onset impacts such as droughts, which develop slowly over time to cause famine disasters, or sudden extreme weather events like cyclones, that occur within a relatively short time frame and create catastrophic disasters (IPCC, 2012; FAO, 2017). The impacts of slow-onset climate change on food production are not a new phenomenon in food security research. Most of the seminal research on food insecurity assessed the impacts of slow-onset events like droughts, which resulted in famines, starvations and mortality (Sen, 1981; De Waal, 1989; Dreze and Sen, 1990).

Food production heavily relies on the climate, weather, soil, and water of an area, and these are extremely vulnerable to variabilities resulting from climate and extreme weather disasters (FAO, 2017; 2021). About a third of the earth's arable land has been lost partly due to climate change and climate-related disasters (IFRC, 2020). Between 2007 and 2008, there was a global food crisis partially attributed to the impacts of droughts and weather-related events in major cereal-producing countries in the European Union and Australia (Mittal, 2009). The crisis brought about skyrocketing food prices, resulting in riots and social tensions in both HICs and LMICs (Mittal, 2009). Additionally, between January 2004 and May 2008, the price of maize increased by 89%, wheat by 108% and rice by 224%, which prompted appeals for food aid from 36 countries (Reliefweb, 2011). During the global food crisis period, low-income households that already spent more than 50% of their income on food, shifted away from nutrient-rich foods towards starchy foods, incurred debts or sold assets for food (FAO et al., 2019).

Beyond climate-related slow-onset events, sudden-onset extreme weather disaster impacts have become more pronounced. Sudden extreme weather disasters affect all dimensions of food security, including food availability, access, utilization and stability (Uitto & Shaw, 2016). The impact of extreme weather disasters on food availability (e.g., the effect on food supply systems and the external food environments) are more visible and have received more research attention on national or local scales than other dimensions (Beer, 2018). This reflects research findings that food insecurity interventions are still food availability focused, despite Sen's 1981 findings and updated food security definitions (Crush & Frayne, 2010; Battersby, 2017). Apart from the dimensions of food security, extreme weather disasters impact human lives, food systems, food entitlements and capabilities (Burchi & De Muro, 2012, 2016; HLPE, 2020; Mbow et al., 2019).

Even countries with food systems that are considered largely food secure experience drastic fluctuations after extreme weather events, thus, testing their food secure status. For example, Australia experienced unprecedented floods and cyclones between 2010/2011, which caused flooding of farms and food distribution depots, crop spoilage, destruction of road networks for food distribution, supermarkets closures, the breakdown of long food supply chains and direct crop losses worth about $792 million (MacMahon et al., 2015; Smith & Lawrence, 2014). Also, Hurricane Florence, a Category 1 storm in North Carolina in the United States, affected food

availability in stores and grocery shops and ready-to-eat foods such as bread, milk, infant formula and supplement drinks used by seniors, were completely depleted in the immediate aftermath. Additionally, relevant supplies (e.g., stoves, cooking fuel and hygiene supplies) for food preparation were lacking after the disaster (Clay et al., 2021).

Other extreme weather disaster impacts include income losses, food system disruptions, food price increases, geographical displacements, disruption of social connections, damaged houses, changes in food preparation activities and consumer behavior, which cumulatively introduce barriers to food access (FAO, 2017; HLPE, 2017; Clay et al., 2021; Clay et al., 2022; Pyle et al., 2021). Extreme weather events also create challenges for food utilization through the contamination of food and water sources, which creates food safety concerns (Beer, 2018). In some cases, extreme weather disasters may cause death or injury to farm workers, whilst destroying the livelihoods of all who depend on agriculture (Israel & Briones, 2012; Garschagen et al., 2015).

Certain households experience increased post-disaster food insecurity than others due to the presence of several vulnerability attributes. Examples of such households include urban households in Mozambique with underlying high levels of poverty and food insecurity (McCordic and Abrahomo, 2019; Stevano, 2019; McCordic and Frayne, 2020), households with livelihoods dependent on low-productivity subsistence agriculture which are susceptible to cyclone impacts (Matyas & Silva, 2013), and living in food deserts, which may become severely impacted by food system disruptions (Pyle et al., 2021). Although disasters come with unique challenges, they also reveal vulnerabilities existing prior to the extreme weather event (Fitzpatrick et al., 2021). Extreme weather events therefore add layers of complexity to underlying food insecurity challenges, which differs among affected households.

Post-disaster food insecurity refers to decreased food access faced by households in the aftermath of extreme weather disasters. The process of obtaining healthy food (how and where) can become a complex puzzle for communities affected by extreme weather events and can last for several weeks and months (Fitzpatrick et al., 2021). Within contexts where extreme weather disasters are recurrent, humanitarian food supply chains have become a reliable source of food supply. Although there are laid down procedures on food distribution, the management of humanitarian food supply chains during disasters is not without challenges. According to Ainehvand et al., (2019), exacerbated states of food insecurity among vulnerable communities after floods in Iran were linked to factors like severity of the disaster, poor coordination among stakeholder relief organizations, and poorly planned distribution approaches and transportation routes. Post-disaster distribution of critically needed food by humanitarian food supply chains, becomes complicated by the inaccessibility of roads after disasters (Perdana et al., 2022).

Improving disaster management processes, including food insecurity interventions, is relevant for post-disaster food insecurity vulnerability reduction, even as disasters have increased. The effects of climate change have become magnified, in direct relation to anthropogenic increases in global warming and surface temperatures, which are projected to increase until at least the mid-century (IPCC, 2012). Consequently, the frequency, intensity, spatial extent, timing and the duration of

climate-related extreme weather events are set to increase by 2050, with dire implications for food insecurity (IPCC, 2012; Mbow et al., 2019). This requires disaster management processes for addressing recurrent post-disaster food insecurity as part of disaster response, which should be informed by data on post-disaster food access (Clay et al., 2021). The merger of disaster management and food insecurity conceptualizations are therefore relevant for assessing factors linked to inequalities in post-disaster food access and differential vulnerabilities.

The 1996 World Food Summit emphasized that food insecurity should be addressed from a vulnerability perspective by determining who, where and why people are food insecure in a population (FAO, 2001). Mozambique can be described as a country with high exposure and high vulnerability to climate-related extreme weather disasters. This is because the country experienced more than 3 extreme events between 2010 to 2019, severely impacting the agricultural sector which employs more than 80% of the people (FAO et al., 2021; USAID, 2020). The experience of a flood or cyclone results in about a 25-30% drop in per capita food consumption among affected households in Mozambique, which also has implications for increased malnutrition and morbidity (World Bank, 2019). The experience of post-disaster food insecurity in Mozambique is recurrent and so assessing factors linked to exacerbated household food insecurity vulnerability, is relevant for understanding and minimizing its occurrence.

2.4 Theorizing Household Food Insecurity Vulnerability

The concept of vulnerability is central to understanding and alleviating household food insecurity. The United Nations International Strategy for Disaster Reduction (UNISDR), defines vulnerability as the characteristics and circumstances of a system, community or asset that make it susceptible to the damaging effects of hazards (UNISDR, 2009). Vulnerability assessments ask questions about characteristics of the community, such as who is exposed to the hazard, who is affected by the exposure and how exposed communities are prepared to cope with the hazard (IPCC, 2014). The term vulnerability means different things to different disciplines and organizations. However, vulnerability of any system, at any scale, reflects the exposure and sensitivity of that system to hazardous conditions and the adaptive capacity of the system (IPCC, 2007; Smit & Wandel, 2006).

Thus, vulnerability is the product of components of exposure, sensitivity and adaptive capacity. These components are not mutually exclusive or all-encompassing of all vulnerability indicators but are context specific. Notably, the geographical location or physical vulnerability of people may make them susceptible to increased exposure and sensitivity which is described as ‘hazards of place’ (Cutter, 1996; Cutter et al., 2003). Physical vulnerability, however, does not determine the adaptive capacities of affected people, which are more social than physical. The connections between the vulnerability components and post-disaster food insecurity are explored using the Onion vulnerability model (Birkmann, 2006, p.28), which has been widely recognized for its focus on social vulnerability rather than an environmental/ physical vulnerability focus.

2.4.1 The Onion Model for Conceptualizing Vulnerability

The Onion model visualizes vulnerability as a multi-layered structure of 3 main spheres of natural, economic and social levels, that experience different impacts of hazards or climate-related disasters (e.g., a flood event). The model illustrates how the spheres interconnect and are differently affected by disasters, based on how the peels of an onion are arranged (Figure 2. 1) (Birkman, 2006, p.28). The model creates distinctions between an opportunity axis (disaster risk) and a reality axis (disaster impact). Using a flood event scenario under the reality axis, the impact of a flood on the outermost sphere (natural events sphere) implies *exposure*. Depending on the severity of the flood, the economic (monetary sphere) adjacent to the natural sphere, can be impacted and result in flood damage and economic losses, indicative of *sensitivity*. The innermost sphere is the social sphere, which contains different *adaptative capacities*. Hence, the impact of floods or natural events that affect from the 'outermost physical layer' to the 'innermost social layer' result in disasters.

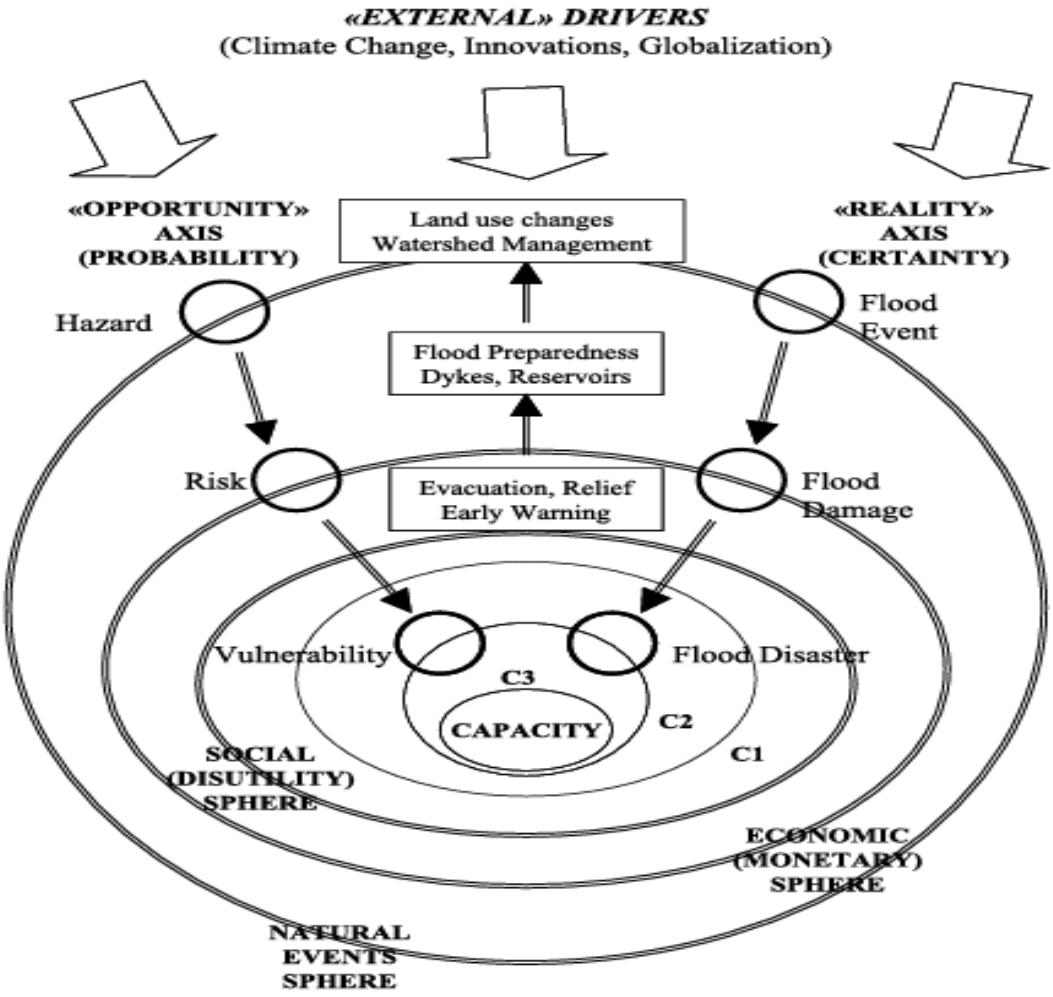

Figure 2. 1: The Onion Model (Birkmann, 2006 pg. 28)

2.4.1.1 *Exposure*

The outermost sphere of the Onion model represents the environment sphere where natural events like floods occur (Figure 2.1). Since the first impact of climate-related disasters begins from the physical environment, this layer is referred to as the exposure layer, although the model does not explicitly call it 'exposure'. The outermost layer reflects the physical exposure of the household, community or a particular system to natural hazards. Vulnerability is usually assessed from an exposure perspective by focusing on the biophysical factors that make people and places vulnerable to extreme weather events. Exposure varies geographically (e.g., coastal cities) (IPCC, 2007; Surjan et al., 2016).

Globally, about 60% of cities with more than 300,000 inhabitants have high risks of exposure to at least one type of extreme weather event (UN DESA, 2019). Coastal cities in LMICs are particularly vulnerable to extreme weather events because of their physical exposure, patterns of urbanization, lack of required physical infrastructure and poor disaster prepared institutions, thus creating hotspots for exposing large numbers of people to the effect of disasters (IPCC, 2014; UN-HABITAT, 2016). The way LMIC cities are planned creates physical divisions and generates spatial inequalities, characterized by the presence of both formal and informal (slum) communities, whereby poor people live in informal communities and have greater exposure to environmental hazards (UN-HABITAT, 2016; UN DESA, 2019). Poor people in cities usually live in neighborhoods (e.g., on hillsides or floodplains) that are exposed to different types of disasters, including flooding and landslides (Surjan et al., 2016).

Urbanization policies can marginalize certain groups by situating them in areas that are more exposed to extreme weather events and where they have access to fewer economic, social and natural resources (Phillips et al., 2013). This has influenced the evolution of environmental justice research to address some of the challenges faced by deprived communities due to their location and exposure to anthropogenic triggered environmental impacts e.g., the siting of toxic waste dumps in predominantly African American communities in the US (Sze & London, 2008). Consequently, communities experiencing geographical disparities in food access characterized poor food environments (e.g., food deserts with few supermarkets and grocery outlets) and exposure to extreme weather events, experience exacerbated food insecurity after disasters (Vu & Van Landingham, 2012; Mundorf et al., 2015).

2.4.1.2 *Sensitivity*

The second layer of the Onion Model focuses on the extent to which the economic properties of a household, community or system may be impacted by disasters, which indicates sensitivity (Figure 2.1)(Birkmann, 2006). Sensitivity is bound up in the livelihoods or income earning opportunities of households. Households involved in agricultural livelihoods or livelihoods linked to long or short food supply chains are more vulnerable to extreme weather disruptions and impacts (MacMahon et al., 2015; FAO, 2020). The model focuses on economic sensitivity, although

sensitivity generally refers to the conditions that determine the degree to which a system, subsystem or component of concern is susceptible to suffer harm (IPCC, 2007; Oppenheimer et al., 2014).

For food insecurity, sensitivity is linked to the possession of entitlements that are necessary for food access and lack of them indicates poverty (Sen, 1981; Dreze & Sen, 1989; Burchi & De Muro, 2016). Some poverty assessments such as the lived poverty index (LPI), which measure the frequency with which people experience inconsistent access to basic needs including food, cash income, water availability, medical care and fuel access (Mattes & Dulani, 2016), are useful indicators for sensitivity. The experience of poverty and food insecurity are mutually reinforcing, as such their indicators are usually applied as determinants of economic sensitivity (Birkmann, 2006). According to Tacoli, (2017), household food insecurity in poor urban areas is largely determined by income and non-income factors like access to markets, time poverty (e.g., time spent purchasing food items, preparing and cooking food), access to food storage facilities and living in slums or informal areas. In most countries, development interventions for addressing poverty include providing access to a bouquet of basic resources such as food, income and housing (Meyer & Keyser, 2016).

Sensitivity is also strongly linked to the ability to adopt adaptations in preparation for disasters, mitigate the impact of disasters, live in safe areas or evacuate. This is described as social sensitivity. Social sensitivity of households refers to the characteristics that make households susceptible to harm, such as demographic characteristics (e.g., gender and age of household head, household size, years of residence in area, education), health (presence of morbidity and food insecurity) and cultural characteristics (e.g., identity and lifestyle) (Pandey & Bardsley, 2015; Thiault et al., 2021). Consequently, highly sensitive households are unable to adapt and experience worsened exposure to disasters (Phillips et al., 2013).

2.4.1.3 *Adaptive capacity*

The third component of vulnerability, adaptive capacity is represented by the core of the Onion model. The core of the model represents the social sphere and highlights 3 levels of capacities (C1-C3), necessary to cope/adapt to a flood and determines whether a flood becomes a disaster or not (Figure 2.1). The impact of floods that end at ‘C1’ show that despite the impact of the flood on the social sphere, there are adequate coping or adaptive capacities. The impact of floods (or extreme weather events) that reach the innermost capacity ‘C3’, indicates that the social capacity of the affected group is completely overwhelmed, resulting in severe disastrous outcomes. This inner core C3, can be overwhelmed based on the nature of the flood event, sensitivity characteristics and adaptations to the disaster (Birkmann, 2006). The Onion model, however, does not provide details on what constitutes the adaptive capacities ‘C1–C3’ in the core, although it emphasizes that social

vulnerability assessments of flood impacts should incorporate tangible economic losses (e.g., monetary) and intangible social losses (e.g., trust, fear) within the core.

The terms coping strategies, coping response, adaptive responses and adaptations have sometimes been used interchangeably in reference to manifestations of adaptive capacity and appear to be context specific, pertaining to different disciplines (Wamsler & Brink, 2014; Garschagen & Romero-Lankao, 2015; Bouché, 2019). Birkmann et al. (2013), describe adaptive capacities as assets available for use in addressing vulnerability, whilst adaptations refer to the strategies applied as an intervention for vulnerability. Adaptation generally refers to the processes, actions or the ability of an individual or socio-ecological systems, to improve their inherent genetic or behavioral characteristics to adapt to changes, based on social learning (Lei et al., 2014; Zhou et al., 2016). The International Federation of the Red Cross describes adaptations to disasters, as the process of adjusting to expected or real climate-related disasters and impacts, to avoid, moderate harm or exploit beneficial opportunities (IFRC, 2020).

Adaptations encompass both short-term disaster risk reduction adjustments in the face of extreme weather events and long-term measures to address increases in temperature and sea level rise with climate change (IFRC, 2020). Short-term adaptations or strategies for disaster risk reduction are applied at different SES levels for disaster management. Disaster management embodies the "organization, planning and application of measures in preparing for, responding to and recovering from disasters" (WHO, 2020, p14). Adaptations to disasters are therefore actions or processes involved in disaster management to mitigate harm from the impact of the disaster during preparedness, response and recovery phases. In the context of climate change, not much is known about adaptation strategies for food security in households in urban LMICs outside the technical improvements towards food production (Ingram et al., 2012; Wamsler & Brink, 2014).

The limited description of capacities within the social sphere of the Onion model can be complemented by the incorporation of access to broad categories of relevant resources. Adaptations to reduce the negative consequences of disasters depend on access to resources, entitlements, basic services such as food, water, and climate information (IPCC, 2007; Garschagen & Romero-Lankao, 2015; Bahadur et al., 2015). Other resources identified from studies include access to different types of social capital networks, which refers to human relations/connections that people can draw on to facilitate adaptations to disasters (Putnam,1995; Bebbington, 1999; Aldrich & Sawada, 2015). Social capital networks include family members, neighbors and community groups, representing bonding and linking social capital networks. Studies have also included access to linking social capital networks (e.g., humanitarian institutions), community cohesion, participation in decision-making and access to information as components of adaptive capacity (Khadka et al., 2022; Thiault et al., 2021).

Adaptations to disasters may sometimes have no impact or lead to a deterioration of conditions. Failed adaptations or failure to adapt, referred to as maladaptation will lead to increased exposure and sensitivity, hence increased vulnerability (Smit et al., 2000; Schipper, 2020). An example from

Fiji, shows that sea walls that were built to protect people from rising sea levels made people living in close proximity to them more exposed to other hazards such as flooding, because the sea walls prevented storm water drainage (Schipper, 2020). Failure to understand vulnerability from a social perspective may lead to the support of adaptations that result in maladaptation and increase vulnerability to the impact of future disasters. This necessitates a focus on adaptations in alignment with the processes of disaster management. Knowledge of climate change adaptations are necessary inputs for informing disaster management plans (IPCC, 2012; Sietz et al., 2011), and relevant for understanding differences in vulnerability.

2.4.2 Establishing Connections Between Adaptations and Disaster Management Phases

The Sendai Framework for Disaster Risk Reduction (2015-2030), adopted at the Third United Nations World Conference in Sendai Japan in 2015, provides guidelines for building the resilience of nations and communities to disasters. The framework has four priorities, namely, understanding disaster risk, strengthening governance for managing disaster risk, investing in disaster risk reduction and enhancing disaster preparedness for effective response and building back better (Sendai Framework, 2015). The Sendai framework therefore complements the 9 SDGs that target disaster risk reduction (e.g., SDG 1, SDG 13) (Bello et al., 2021). 'Disaster risk' refers to potential losses which could be experienced by a particular community or society over a specific future period because of disasters (UNISDR, 2009).

Disaster risks are unevenly distributed, but identifying systematic links between climate change adaptations and disaster risk reduction is important for advancing sustainable development (Birkmann & von Teichman, 2010; IPCC, 2014). Disaster risk hotspots are areas where vulnerability is high, thus creating significant obstacles to adaptation (Garschagen et al., 2015). Whilst disaster risk can be reduced, no society can eliminate it (Tierney et al., 2014). Disaster risk assessment involves determining the nature and extent of disaster risk, using quantitative or qualitative approaches to analyze the potential hazards and components of vulnerability, that could combine to produce disasters (Bosher, 2014). Disaster risk reduction therefore refers to activities aimed at preventing new disasters, reducing existing disaster risk, and managing residual risk, all of which contribute towards strengthening resilience (UNGA, 2016; WHO, 2020).

Disaster risk management involves the application of policies and strategies for disaster risk reduction to prevent new disaster risks, reduce existing risks and manage residual risks, resulting in reduced disaster losses and increased resilience for sustainable development (WHO, 2020). The processes of disaster risk reduction and disaster risk management at different levels signify disaster management. Disaster management refers to the continuous, integrated, multi-sectoral and multidisciplinary processes involved in planning, and implementing measures targeted at reducing disaster risks, mitigating the consequences of disasters, emergency preparedness, effective disaster response, and post-disaster recovery and rehabilitation (Niekirk, 2006). The process of disaster

management is depicted as a cycle consisting of three main interrelated phases: pre-disaster (preparedness), during-disaster (response) and post-disaster (short-term and long-term recovery) (Khan et al., 2008).

Disaster risk reduction is included as a component of the disaster management definition. Thus, some studies use the terms 'disaster risk management' and 'disaster management' interchangeably. For instance, Khan et al. (2008) stated in their paper that "whenever we discuss disaster management, it is basically disaster risk management". However, disaster management is considered to be more focused on disaster response and actions taken during and after a hazardous event, rather than risk reduction prior to the hazardous event (Niekirk, 2006; Sendai Framework, 2015). Regardless, the 'preparedness' component that is included in disaster management provides a disaster risk reduction context. Preparedness depends on sound analysis of disaster risks, early warning systems and capacity building to efficiently manage all disaster risks and ensure orderly transitions from response to recovery (UNGA, 2016; WHO, 2020). Disaster management is therefore made up of various disaster risk management and reduction activities, pertaining to different entities and phases.

To ensure the coordination and accountability of disaster management processes within countries, national-level authorities focusing on disaster management have been set up in most countries (UNDP, 2016). The Government of Mozambique (GoM) is the parent institution that oversees all disaster management activities in Mozambique and is headed by the President. The National Institute for Disaster Management (INGD) in Mozambique is the main institution that coordinates disaster prevention, preparedness actions, emergency response actions, post-disaster recovery and reconstruction plans, by collaborating with humanitarian agencies (Foley, 2007; INGC, 2009). Currently, the overarching program framework for disaster management in Mozambique is the National Disaster Risk Reduction Master Plan (PDRRD) (2017-2030).

The PDRRD outlines five strategic objectives with corresponding actions and results, which mirror the priorities of the Sendai Framework for DRR 2015-2030 (World Bank, 2017). The objectives of the PDRRD are to reduce disaster risk by reducing the impact on human lives, livelihoods and critical infrastructure, to contribute to sustainable development in Mozambique. The objectives of the PDRRD are to be met through disaster prevention, preparedness, response and recovery (World Bank, 2017). The PDRRD is backed by a legal instrument called the Law on Disaster Risk Reduction and Management (Law 10/2020) (2020 DRM Law), which provides a comprehensive legal framework for disaster management and response in the country (UNEP, 2020). The GoM has also taken steps to improve financial protection against disasters by the legal creation of the Disaster Management Fund in October 2017 (Decree No. 53/2017), to increase the availability of financial resources for disaster management.

The GoM and the supporting donor agencies involved in disaster management in the country are aware of the vulnerability of the country to climate risks and have put in some macrosystem adaptations in support of disaster risk reduction. This includes the acquisition of high-resolution

spatial and topographic data for two main river basins that get critically flooded (rivers Zambezi and Limpopo), and the mainstreaming of disaster risk management into urban planning, requiring new public buildings be compliant with resilience and environmental standards (World Bank, 2017). Yet, there are limitations. The GoM lacks a strategic and comprehensive approach for funding all phases of disaster management, whilst INGD faces capacity constraints and lack of clarity in transitioning from post-disaster response to recovery (World Bank, 2019). Additionally, disaster risk management policies in Mozambique contain ambiguities regarding the framing of disaster risk reduction and disaster response (Koivisto & Nohrstedt, 2017).

According to Scott & Tarazona, (2011), the effective decentralization of strategies/adaptations for disaster management from macro to micro scales is constrained by significant challenges in communication, diversion of funds for disaster risk reduction, the lack of robust measures for ensuring accountability, lack of transparency and low capacity and involvement in decision making processes at the local level. Humanitarian agencies support disaster management and climate adaptations in Mozambique; however, the mainstreaming of strategies is challenging, due to limitations in networking, financial, individual and organizational capacities (Sietz et al., 2011). Increased engagements between humanitarian organizations and all sectors of society, for disaster management and the mainstreaming of adaptations, may help address some of the challenges and create an enabling environment for disaster management in Mozambique.

2.4.2.1 *Adaptations to Disasters Aligned with the Disaster Preparedness Phase*

Disaster preparedness involves the equipping of people who may be impacted by a disaster or able to assist those impacted by disasters, with the tools to increase their chances of survival and minimize their losses (Coppola, 2006). Preparedness activities occur within the context of reducing disaster risks, and depend on the knowledge and capacities of individuals, households, communities, government and humanitarian institutions, to effectively anticipate, respond to and recover from potential, imminent or current disasters (UNGA, 2016). At the institutional level, disaster management institutions engage in vulnerability assessments, the formulation of legal instruments backing disaster management, disaster management plans, disaster risk communication and coordination within and across sectors (Sendai Framework, 2015; IFRC, 2021). For food security, disaster management institutions are involved in monitoring the local food environment to assess the likelihood of disruptions, and monitoring populations that are socially vulnerable to food system disruptions due to disasters (Clay et al., 2021).

Disaster risk communication is one of the vital processes that inform most adaptations in preparedness and response to disasters. Risk communication is the intentional effort put in by national and local government, and international institutions, to provide information about the likelihood, impacts and adaptations to hazards, using various channels to reach different audiences within specific at-risk communities (IPCC, 2012; UNGA, 2016). For effective adaptation, risk communication must be timely, provide accurate information from a certain source, contain actionable warnings that are reinforced through repetitions, target and reach specific at-risk groups,

and use terminology and language that is socially accepted (Mileti & O'Brien,1992; IPCC, 2012). Disaster risk communication and early warning systems must be adjusted to the characteristics of different hazards (NRC, 2006). The contents of early warning messages have a significant impact on the adoption of adaptations within households (Mileti & O'Brien,1992).

A rule of thumb among disaster management institutions is that risk communication should promote self-sufficiency by specifying instructions, supplies and adaptations in preparedness for disasters, especially within the first 72 hours after a disaster, when humanitarian institutions may become overwhelmed with the needs of affected people (Russel et al., 1995). However, a review of more than 30 articles on disaster risk communication found a heavy focus on the use of technology for risk communication and there was limited engagement of local communities across elements of risk knowledge, communication, dissemination, monitoring and response capability (Sufri et al., 2020). Failure to engage communities during disaster preparedness restricts the translation of early warning information into concrete adaptations for preventing disaster losses, which results in the increased need for post-disaster response in communities (MacClune & Norton, 2021; Nhamo & Chikodzi, 2021).

Disaster preparedness can be categorized in so many ways. Some examples include institutional preparedness (Shah et al., 2019), household preparedness, business preparedness, public sector and government preparedness (Sutton & Tierney, 2006), mental and emotional preparedness and social embeddedness preparedness (Wang, 2018). For household disaster preparedness, adaptations can be categorized into three main dimensions; *structural preparedness* (e.g., ensuring infrastructure is safe, reinforcing homes, clear drainage), *planning preparedness* (e.g., cognitive preparation on whether to stay and or leave and when during the disaster, and resource allocation) and *survival preparedness* (e.g., packing items like protective clothing, emergency contact details, first aid kit, radio, torchlight and batteries, canned food and long lasting foods and stocks of drinking water) (Russel et al., 1995; Prior & Eriksen, 2012).

Adaptations for household food security fall under survival preparedness, which may differ among different households based on differences in the dimensions of vulnerability. For example, in the Pacific Islands, churches in local communities (bridging social capital networks) instructed members that once disaster warnings were sounded, members should prepare emergency supplies to last for 48 hours and evacuate to the designated shelters (Fletcher et al., 2013). Strenghtening adaptations during the preparedness/pre-disaster phase provides cascading benefits for effective response and 'build back better' recovery approaches (Sendai Framework, 2015). Although adaptations at all SES levels are important during disaster preparedness, those occuring within households are more important. This is because external humanitarian assistance is an add-on to household level adaptations. Underlying household level adaptations are vital for survival, especially within the first 72 hours after a disaster where external/humaitarian assistance is usually lacking (Kohn et al., 2012; Wang, 2018).

Amidst growing population densities and pervasive climate-related hazards, strengthening adaptations and self-sufficiency of individuals and households in preparedness is critically needed. According to (Kapucu, 2008), the disaster and emergency management community must invest significant effort into training households for disaster preparedness, for if individuals and households are not prepared, then nobody is prepared. Proactive adaptations during disaster preparedness are better than reactive adaptations during disaster response, if the exacerbation of vulnerability or maladaptation is to be prevented (Smit et al., 2000; Coppola, 2006).

2.4.2.2 *Adaptations to Disasters Aligned with the Disaster Response Phase*

There has been more focus on the response of communities to disasters, than any of the other phases in the disaster management cycle due to visible disaster impacts (NRC, 2006). Usually, media coverage of a disaster lasts for only days after the event. However, disaster response may unfold over days to months with fundamental elements of search, rescue and emergency relief, to minimize suffering and support early recovery (FEMA, 2011; UMCOR, 2013). Notably, the number of days spent on each element of the response phase is context specific, based on factors such as type of disaster, severity, country, the resources available and disaster management response approaches. In the case of Hurricane Katrina, a category 5 storm, the search and rescue lasted for several weeks while people trapped by floods depended on their stored supplies or food and water from neighbors until humanitarian assistance arrived (UMCOR, 2013).

The disaster response phase requires combined efforts between households, community groups and humanitarian institutions to minimize losses. Usually, it takes days for the first international humanitarian assistance teams to reach disaster scenes, as such family, friends, and neighbors are largely involved in search and rescue activities in the first few days after a disaster (Garschagen et al., 2015). Additionally, households may rely on stored food, or source food from friends, family, or food aid from humanitarian disaster management institutions during the period (Gupta et al., 2015: Fitzpatrick et al., 2020). This reflects household adaptations and adaptations facilitated by social capital networks (bonding, bridging and linking) (Aldrich, 2012; Fletcher et al., 2013;; Pyle et al., 2021). Humanitarian institutions are widely recognized for improving access to safe, adequate and nutritious food through food transfers such as food aid, food vouchers and cash transfers, to prevent undernutrition and the exacerbation of pre-existing vulnerabilities during disasters (World Bank, 2014). For example, during Cyclone Idai disaster response, the World Food Program provided more than 1.8 million people with food assistance across affected provinces, while ‘The World Central Kitchen’ provided hot meals to about 5000 people daily, in displacement centers in Beira (OCHA No. 22, 2019).

The provision of humanitarian food aid can sometimes have unintended consequences, thus worsening the vulnerability of households who are already in acute situations (Ainehvand et al., 2019a; Garschagen et al., 2015). Some adverse effects of the distribution of food aid include,

encouraging donor dependence, disrupting local food systems and reduction in the coping capacity of households, especially in disaster-prone areas (Barrett, 2006; Jackson, 2020; Oskorouchi & Sousa-Poza, 2021). Studies have found that donor dependence influenced failure to prepare for disasters and increased the need of post-disaster aid, while some marginalized groups were socially excluded from receiving food aid (Wiles, 2005; Harvey, 2014). Additionally, there were cases where distributed food aid was low in nutritional quality compared to national guidelines and had long term implications for undernutrition (Ainehvand et al., 2019b; Colón-Ramos et al., 2019; Wentworth, 2020).

The disaster response phase also highlights the vulnerability of internally displaced people and already food insecure households, to exacerbated food insecurity (Tevera et al., 2021). According to IPCC, (2012), displacement and resettlement constitutes a second disaster in the lives of affected households. In 2008, approximately 20 million people were internally displaced by rapid onset climate-related disasters around the world (OCHA & IDMC, 2009). More than 400,000 were displaced because of Cyclone Idai with 164 temporary displacement centers that sheltered 160, 297 people (MISAU et al., 2019). Displaced persons experience severe disaster impacts due to risk of landlessness, joblessness, homelessness, food insecurity, marginalization, increased morbidity, community disarticulation and loss of access to common property resources (Cernea & Mcdowell, 2000). These risks, although distinct, can mutually reinforce each other to exacerbate the impacts of displacement on individuals, households and communities and the social organizations involved. Food insecurity appears to be a latent challenge, receiving less attention than more visible problems such as informal housing in Sub-Saharan African cities (Maxwell, 1999). Regardless, efficiently addressing the combined challenges of loss of housing, displacement and food insecurity within post-disaster contexts, is pivotal in minimizing the devastating impacts of disasters on affected groups (Garschagen et al., 2015; IFRC, 2020).

Depending on the disaster, cultural, socioeconomic and political characteristics of the country within which disasters occur, humanitarian response may be organized, complex, convoluted, or chaotic (Coppola, 2006). The main types of post-disaster responses are 'no effective response', 'response without experience' (e.g., using adaptations that have not been previously tested or disaster exceeded the magnitude predicted), and finally, 'response informed by previous events of similar magnitudes and previously tested adaptations' (Petrosillo et al., 2018). Cyclone Idai response may be described as response without experience even as national and international disaster management institutions became overwhelmed. The GoM declared a State of Emergency in the central region of Mozambique while the WHO declared a humanitarian situation of Grade 3 emergency (highest level of emergency per country) on 25th March, in response to Cyclone Idai (MISAU et al., 2019). When effective response is lacking, or where households fail to adapt during the emergency response phase of a disaster, this may lead to a deterioration of household conditions, resulting in maladaptation (Schipper, 2020). Additionally, some short-term adaptations based on no prior experience may become maladaptive in the long term (Smit et al., 2000).

Recovery begins immediately after the emergency response phase and should be based on a clear road map, informed by knowledge of the failures and successes of the previous phases, which together provide the opportunity to 'build back better' in preparedness for future disasters (UNDP, 2016; Sendai Framework, 2015). A post-disaster needs assessment (PDNA) is the initial step taken during disaster recovery to provide a guided, comprehensive and balanced post-disaster assessment, conducted by multisectoral disaster management and humanitarian agencies (GFDRR, 2013). The GoM in collaboration with the Post-Cyclone Idai Cabinet for Reconstruction (GREPOC), local and donor agencies conducted a PDNA in May 2019, just two months after the cyclone (Government of Mozambique, 2019). One of the top 3 priorities of the GoM-PDNA delineated recovery approach was to address food insecurity classified into short-term support for adaptation (e.g., provision of seeds and tools for field crops and backyard vegetable crops), medium-term adaptations (e.g., rehabilitation of irrigation structures, provision of small ruminants) and long-term adaptations (e.g., replanting of perennial cash crops) (Government of Mozambique, 2019). The city of Beira Mozambique post-Cyclone Idai depicts the co-occurrence of high exposure and high sensitivity. As such, understanding the differences in adaptations to disasters will provide insights into the differences in vulnerability to post-disaster food insecurity.

2.4.3 Assessing Post-Disaster Food Insecurity Based on Social Vulnerability

The social vulnerability approach (onion model) emphasizes a shift in focus from the fragility of the environment sphere and the severity of the extreme weather event (e.g., flood), towards the capacities of societies to adapt to disasters (Figure 2.1). Social vulnerability which refers to the social factors that shape the sensitivity of various groups to disasters and their ability to respond to disasters, has received less attention compared to place-based or physical vulnerability (Cutter et al., 2003; Phillips et al., 2013). Nonetheless, as seen under exposure, physical vulnerability may also be an indicator of social vulnerability, as poor people in society usually live in places with higher exposure. A social vulnerability view of disasters emphasizes that apart from climatic-related events, sensitivity factors (e.g., house ownership or renting), and adaptive capacity factors (e.g., access to different social capital networks) interact, to influence the severity of catastrophic climatic events on food insecurity after disasters (Fitzpatrick et al., 2020).

For example, Klinenberg (1999)'s 'social autopsy' of the 1995 heat waves in Chicago, observed that although there was a general unpreparedness and failure of city departments to provide relief services because they 'naturalized' the heat waves, poor Latino communities in Chicago survived the heat wave more successfully than other impoverished groups. Latino households recorded very few deaths because of their strong social ties, large extended families and the embedding of cultural practices into their socioeconomic conditions (Klinenberg, 1999). In contrast, high death rates were recorded within precarious African American communities in Chicago that were facing poverty, exhibited food desert characteristics, and were experiencing state neglect and social

exclusion (Klinenberg, 1999). As such the deaths from the disaster were due to social processes rather than the 'natural' climate-related heat wave disaster.

From a social vulnerability perspective, the term exposure considers the social and institutional characteristics and processes (e.g., social exclusion) that promote defenselessness and lead to increased risk or danger for households/individuals (Birkmann, 2006). This implies that underlying social factors (socio-economic and political capacities) are the root causes influencing people's vulnerability to disasters and are often modified by disasters in ways that render some people more or less vulnerable to future disasters (Wisner et al., 2004; Tierney et al., 2014; Birkmann et al., 2013). Social vulnerability occupies an important position in household post-disaster outcomes. The Social Vulnerability Index (SoVI) has been a useful measure for assessing the social vulnerability of communities from a spatial or geographical context.

The SoVI quantifies social vulnerability within counties or districts in a country, based on indicators like the density of the built environment, economic dependence on a single sector, income, housing, race, ethnicity, and infrastructure independence (Cutter et al., 2003). Studies have used the SoVI for assessing the adaptive capacity of counties in Mississippi, US to determine their vulnerability to environmental hazards (Sherrieb et al., 2010). The SoVI has also been criticized for being reductionist, due to its use of a single scale to represent social vulnerability which is complex and manifests in various ways (Spielman et al., 2020). Some studies have merged the SoVI with Community resilience tools in assessing vulnerability within counties in the US (Bergstrand et al., 2015; Koks et al., 2015). Regardless, the SoVI indicators may need to be modified to suit different geographic and disaster contexts (e.g., HICs and LMICs), whilst adaptive capacities at the county level do not reflect the adaptive capacity of households.

Social vulnerability is manifested in different forms in different places or to different hazards, as such, measures should be context specific, to obtain results that contribute towards disaster risk reduction for the study communities (Spielman et al., 2020). Studies have assessed social vulnerability qualitatively or quantitatively, using multiple indicators linked to the social construction of disasters. Some indicators used include pre-disaster wellbeing (e.g., nutritional status/food security, health), households characteristics (e.g., gender, age, income, education and literacy, race and ethnicity, disability, health demographics), basic needs (e.g., food, water, electricity, cooking fuel), housing characteristics and self-protection (e.g., capability to build a safe home), knowledge and information (e.g., how climate predictions are received and interpreted), social capital networks (e.g., community leaders, governance, political and institutions support), lived experience of disasters (e.g., loss of livelihoods and difficulty in reconstructing livelihoods post-disaster), access to disaster assistance, adaptations, preparedness, response and recovery from disasters (Blaikie et al., 1994; Cutter et al., 2003; Cannon & Twigg, 2003; Phillips et al., 2013; Cutter, 2017; EU et al., 2019; Thomas et al., 2019; Crowley, 2021).

The different social vulnerability indicators highlight physical exposure, sensitivity (e.g., access economic resources or entitlements), as well as adaptive capacity (e.g., household characteristics),

and adaptations for minimizing post-disaster impacts including food insecurity. Understanding post-disaster food insecurity requires indicators that encompass all components of social vulnerability and not only the physical impacts on food availability. The Onion model is therefore useful for conceptualizing post-disaster food insecurity from a social vulnerability lens, by illustrating that the environment, economic and social spheres are embedded within each other. Interactions within these embedded spheres increase the risk of affected groups, as disaster impacts inch towards the social sphere at the core (Figure 2.1). The onion model also emphasizes that actions taken within the nature and economic spheres during the development of a disaster can reduce the effects of the disaster on the social sphere (Birkman, 2006).

However, the plethora of indicators identified for assessing social vulnerability in relation to disasters and food insecurity and their connections with disaster management appear confusing. This Onion framework approach therefore suggests a 'systems' view, which appears to be different from other vulnerability models, which illustrate vulnerability using several isolated and yet interlinked components (e.g., Pressure and Release models and Access model) (Blaikie et al., 1994). Additionally, the onion framework is limited in its description of adaptive capacities at different levels (C1-C3) or levels of adaptations which need to be addressed. The limitations of the Onion framework can be addressed by adopting concepts from frameworks like the SES framework, which also highlight a systems perspective, but clearly define interactions between different embedded spheres from proximal to distal levels. While the Onion model identifies the multidimensional factors of social vulnerability, the SES framework helps identify the interconnectedness between the factors from micro to macro scales and enables a nuanced analysis of how these factors interact, in influencing post-disaster food insecurity vulnerability.

2.5 The Social-Ecological Systems (SES) Framework

There is no social system that does not have an ecological component, as such, systems with strongly interconnected social (e.g., economic, political, cultural, technological) and ecological components are described as social-ecological systems (Petrosillo et al., 2018). Social-ecological systems consist of multiple smaller subsystems that further consist of internal variables at multiple levels, similar to how organisms are made up of organs, organs are composed of tissues and tissues of cells and cells of proteins, all interacting together (Ostrom, 2009). The social-ecological systems (SES) framework is therefore underpinned by an understanding of how ecological systems behave, specifically how organisms interact with each other and their environment, to conceptualize human-nature or social and ecological systems interactions (Berkes et al., 2003; Berkes, 2017).

The SES approach originated from the discipline of biology but provides a general framework for understanding how people engage with their sociocultural and physical surroundings, and has since then been applied in several other disciplines e.g., sociology, public health, economics and psychology (Stokols, 1992). Early applications of the SES theory were in the field of human health

and wellbeing, by Bronfenbrenner between 1974 to 1979. Bronfenbrenner (1977) proposed the SES approach upon recognizing that the capacities of humans to adapt and restructure their environment was embedded within complexities, and so, simplistic unidimensional research models were inadequate for assessing them. The theory posits that human health, wellbeing and behavior are primarily not dependent on individuals themselves, but rather on multilevel formal and informal interactions between people and the environment in which they are embedded (Bronfenbrenner, 1977; Stokols, 1992).

Using a growing child as an example, the theory explains that a growing child is nested within the innermost core of a social-ecological system that surrounds it. This system surrounding the child was conceptualized as a topological arrangement of interconnected spheres, whereby the spheres closest to the developing individual are enclosed within other spheres of influence that are further away (Bronfenbrenner, 1977; Rosa & Tudge, 2013). All the spheres of influence mutually interact, so that proximal factors within the first level may modify distal factors in other levels, with the combined influence of all factors resulting in overall system changes (Rosa & Tudge, 2013;van Gool et al., 2017). The SES framework has been described using the analogy of the nested 'Russian doll', which are a chain of dolls embedded within each other, to represent a chain of mothers carrying children or child development (Dickson & Darcy, 2021).

The framework is applied by looking at multiple factors, at multiple interdependent levels and how these factors at all levels combine in creating substantial changes (Walker et al., 2004; Ostrom, 2009; van Gool et al., 2017; Berkes, 2017). Bronfenbrenner (1977), conceptualized the multiple levels using 5 interconnected nests/spheres, to depict the 'near to distant' scales of influence in social systems namely, microsystem, mesosystem exosystem, macrosystem and chronosystem which are explained below.

Microsystem: The microsystem describes the complex relations between the developing individual and the immediate environment within which they are situated (e.g., home, workplace, school). This environment has specific physical features within which the individual engages in activities within particular roles (e.g., child, parent, teacher), for specific periods of time. The microsystem is the most proximal setting to an individual and the factors of place, physical features, activities, participants and roles are the constituents of this setting (Bronfenbrenner, 1977).

Mesosystem: The mesosystem consists of interconnections among major 'settings' that contain the developing individual, at a particular point, during the development process or stage of life. For a school going child, the mesosystem will comprise of interactions between family, school, church, or peers. The mesosystem could also be described as a system made up of several microsystems.

Exosystem: The exosystem extends the mesosystem to embrace other specific formal and informal social structures that do not contain the developing individual, but rather act on or encompass the immediate settings within which the individual is contained, and thereby influence outcomes within the microsystem. Examples of these structures are major institutions found within society,

including those with a deliberate structure or those that evolved spontaneously at the local level e.g., informal social networks involved in the distribution of goods and services.

Macrosystem: This sphere refers to the general prototypes that determine the patterns for the structures and activities occurring within the previous levels. The macrosystem encompasses overarching institutional patterns such as the economic, social, educational, political and legal systems. The macrosystem serves as the blueprint of society and may exist in an explicit form through rules and regulations, or in an implicit form, often carried in the minds of the members of society as ideologies that are manifested through customs and everyday practices in life.

Chronosystem: The chronosystem was later added to the existing spheres to enable the assessment of the individual's developmental changes and continuities over time, within the environment in which the person lives. This allows the analysis of the interactions between changes within the individual and the environment over time, to distinguish the use of the model from other longitudinal studies that solely focus on the individual. The chronosystem therefore focuses on transitions and distinguishes between normative transitions such as marriage, entering the labor force or retirement, from non-normative ones such as severe illness or winning the lottery (Bronfenbrenner, 1986).

The SES model has been very useful for health promotion research in helping to identify the multiple levels of influence, including intra-and inter-personal, community, organization, and public policy level influences on health behavior, to inform multilevel interventions (Sallis et al., 2015). Due to the flexibility of the model, several disciplines have used different names for the proximal and distal spheres and a different number of spheres (3-5). Although this depends on the discipline and objectives of the study, the characterization of spheres is similar across studies. Examples of different variations of the SES model used in some studies are outlined below:
Mcleroy et al., (1988), outlined 5 nests of influence, namely,

- *intrapersonal factors* (characteristics of the individual e.g., attitudes, knowledge, skills)
- *interpersonal processes* (formal and informal social support systems e.g., family, friendship networks)
- *institutional factors* (social institutions and organization characters e.g., formal and informal rules and regulations)
- *community factors* (relationships among organizations and institutions within defined boundaries)
- *public policy* (local, state, and national policies and laws);

U.S. Department of HHS & USDA, (2015), outlined 4 levels of influence, namely,

- *individual factors* (e.g., demographics)
- *settings* (e.g., home, school, worksites)
- *sectors* (e.g., systems and organizations)
- *social and cultural norms and values* (e.g., traditions and belief systems);

Story et al., (2008), outlined 4 levels of influence, namely,

- *individual factors* (e.g., demographics, skill)
- *social environment* (e.g., family and friends' networks)
- *physical environments* (e.g., home and work settings)
- *macro-level environments* (e.g., government and political structures and policies);

De Bosscher et al., (2003), outlined 3 levels of influence, namely,

- *micro-level* (genetic qualities and proximal environment)
- *meso-level* (e.g., policies)
- *macro-level* (social, cultural, and climatic circumstances).

Regardless of the names for the different spheres of the SES framework used in any study, the framework characterizes hierarchical levels or embedded nests of the SES from the macro-micro or the micro-macro levels, and the interactions between them from a 'systems perspective'. The SES approach is therefore grounded in the following general systems principles; principle of multiple levels, principle of interdependence, principle of people's experience shaping their reactions and organizational consequences, and the principle of person-environment adaptation which occurs continually based on resources and requirements (Bond & Haynes, 2014).

The SES framework also recognizes that vulnerability occurs within natural ecosystems and translates this into social systems. Vulnerability occurs when individuals or groups of species are stressed, and their thresholds of potentially irreversible changes are exceeded because of environmental changes, whilst resilience refers to the capacity to cope/adapt to imposed stress (Adger, 2000). All SESs experience disturbances, which impact their capacity to absorb disturbances and maintain function (resilience) or become unable to cope (vulnerability) (Berkes et al., 2003; Adger, 2006). Relatively small disturbances within SESs trigger coping or adaptive capacity, which reflects the ability of the SES to learn and adjust to internal changes and external drivers, indicative of their vulnerability or resilience (Berkes, 2017). Vulnerability to the impacts of climate-related stressors on social systems (e.g., human societies) has been assessed by various models, as illustrated by the Onion model, to inform adaptation and disaster management approaches.

An SES becomes vulnerable when it loses its adaptive capacity, indicated by the inability to respond to disturbances (e.g., disasters) within the social domain, whereby even small disturbances cause drastic social consequences (Adger, 2006). However, within resilient SESs, disturbance creates the opportunity for innovation and promotes renewal, reorganization and development (Folke, 2006). An application of the SES framework to the components of vulnerability (exposure, sensitivity and adaptive capacity), can be illustrated as a hierarchical view of factors that cut across proximal micro levels (innermost sphere), to distal macro levels (outermost sphere) (Fig 2.2). Beginning from the innermost sphere, vulnerability entails intrinsic exposure to risk, followed by vulnerability within the 3 middle spheres which encompasses sensitivity based on human-centered and adaptive capacity factors. Finally, vulnerability in the outermost sphere results from multiple physical, social, economic, environmental and institutional factors (Fig 2.2) (Birkmann, 2006).

The implications that climate change has on SESs are broad, unlimited, complex and spatially variable, so assessments underpinned by the SES framework are necessary for identifying different adaptation responses that align with sustainability (Pandey & Bardsley, 2015). Additionally, knowledge of adaptations across levels in human SES' are relevant for informing proactive measures (disaster risk reduction) and not just reactionary measures (crisis management), in working towards sustainable development (Starik & Kanashiro, 2013). The advantages of the SES framework notwithstanding, its limitations are that it does not specify which variables are most important or the sphere with the most influential impact on the core sphere (Sallis et al., 2015).

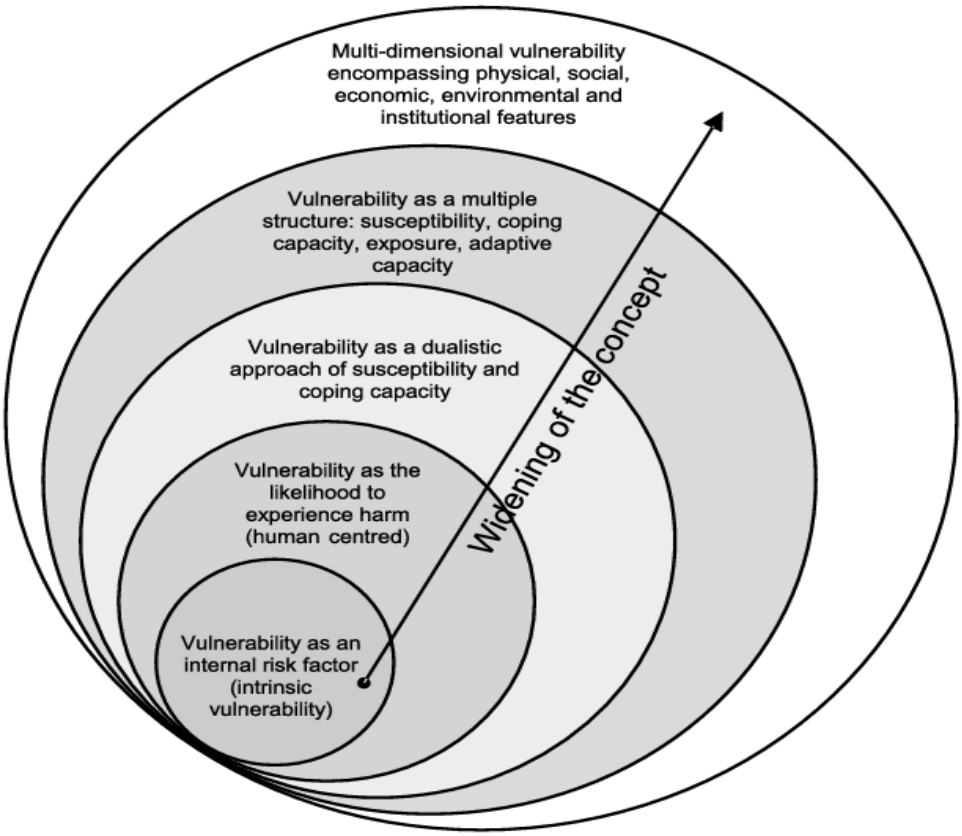

Figure 2:2 SES application to the Vulnerability Concept (Birkmann 2006, p 17)

2.5.1 The SES Framework and Post-Disaster Household Food Insecurity

Household food insecurity vulnerability under the impact of climate-related extreme weather illustrates a socio-ecological systems relationship, where food is made available as an ecological service, whilst food access is based on social interactions. This makes the SES framework a useful guide for research on food insecurity, because it focuses on multilevel linkages and interactions

among the multiple factors that connect people and their environment, and how this influences food access and consumption (Glanz et al., 2005; Keller et al., 2006; Story et al., 2008; Downs et al., 2020). An SES framework is beneficial for understanding the experience of food insecurity after Cyclone Idai in Beira, where several factors are linked to vulnerability (e.g., underlying poverty, food insecurity, spatial exposure). Based on the SES framework, food insecurity can be assessed at the household level (microsystem), whilst focusing on the interactions between households, their environment, mesosystem and macrosystem networks (bonding, bridging and linking social capital) networks), that impact post-disaster food insecurity. This approach helps distinguish between SES sphere interactions and the elements of exposure, sensitivity and adaptive capacity, that interact to moderate or exacerbate post-disaster food insecurity.

2.5.1.1 *Microsystem (Household) Level Assessment*

SES studies with households as the integral unit of study, situate the household within the core of all intersecting SES spheres, to represent the microsystem level where measurements are applied. A household refers to a group of people who live in the same dwelling, eat from the same pot, commonly intermingle their income and production decisions, and acknowledge the authority of one head (man or woman) (Beaman & Dillon, 2010). In certain contexts (e.g., egalitarian households), households may not explicitly or implicitly recognize the authority of a head but may have members act as household representatives when required. The measurement of food insecurity at the microsystem or household level depends on specific FIEM scales designed for households, especially the HFIAS and the HFIAP which are widely used in LMIC contexts, including Mozambique (Coates et al., 2007; FAO et al., 2019).

Since the food insecurity measurement scales only provide point in time measurement of food insecurity, other microsystem factors influencing household food insecurity vulnerability should be incorporated. The household characteristics that influence food access are multifaceted. Indicators identified from some studies include:

- household demographics (e.g., household size, household head age and gender, race or ethnicity, education, ill health and disability) (Maxwell & Frankernberger, 1992; Mango et al., 2014; Sgro et al., 2019);
- household economic factors (income sources, access to jobs, income flow, access to credit, land ownership, land use practices, livestock, sales of food and assets, capital equipment) (Maxwell & Frankernberger, 1992; FAO, IFAD, UNICEF, WFP, 2019);
- food agency factors (food storage, knowledge and skills, food preferences, values and psychosocial factors (U.S. Department of HHS & USDA, 2015; Downs et al., 2020), and;
- family structure e.g., nuclear or single parent families, migrants (Charreire et al., 2010; McCordic & Abrahamo, 2019).

At the microsystem level, food insecurity is also linked to food system factors such as the personal food environment (e.g., accessibility, affordability and convenience), which can be assessed for households. Studies have assessed accessibility using indicators like proximity of food outlets to household area of residence (Glanz et al., 2005; Zhong et al., 2018), whilst convenience indicators considered food preparation capacities (Keller et al., 2006). For affordability, studies considered monthly expenditures for food, housing and healthcare (Shim et al., 2018), and effects of price changes of staple and non-staple food on consumption (Herforth & Ahmed, 2015). In post-disaster settings, studies have incorporated indicators like losses in income and assets, coupled with additional expenses such as repair of homes in assessing food affordability (Clay, 2020; Clay et al., 2021; Pyle et al., 2021). Post-disaster assessment of convenience at the household level has also covered losses in kitchen facilities, electricity, clean water, and the impact on stored food and food preparation capacity (Clay et al., 2023; Clay, 2020; Pyle et al., 2021).

Additionally, insights into the different adaptation to disaster strategies, especially food-sourcing adaptations by households to address disruptions in food access, are relevant for understanding differential household food insecurity outcomes. Examining the use of adaptations for addressing food insecurity at the household level provides an additional layer of measurement to increase the specificity of food insecurity assessments (Maxwell, 1996). Knowledge of household adaptations is also important for identifying households that are left behind (Nhamo & Chikodzi, 2021). Households' adaptations to minimize the impact of food insecurity are based on negotiated decisions, which may be different between rural and urban households (Gupta et al., 2015).

Adaptations to food insecurity in households vary in sequence ranging from small changes such as eating less expensive or less preferred foods to extreme measures such as going an entire day without a meal, based on the type of, and severity of the hazard (Maxwell, 1996; Gupta et al., 2015). A study on adaptation strategies for food insecurity, adopted by people living in urban slums in Delhi, identified reliance on less expensive food, limiting portion sizes, skipping meals during the day and borrowing money from lenders at high interest rates to buy food (Gupta et al., 2015). A post-disaster study on floods and food insecurity in Bangladesh also found that household adaptations like eating food with lower quality, taking loans or buying food on credit, and asking for community help were more likely, rather than selling of assets which may push households into higher levels of poverty even years after the disaster (Oskorouchi & Sousa-Poza, 2021). Notably, extremely poor households may have limited adaptation options if they have no assets to sell and may not be able to borrow money to buy food.

Adaptations for addressing food insecurity at the microsystem level reflect a household's self-initiated adaptations, although, some adaptations rely on networks outside the household (e.g., borrowing food or money for food from lenders). According to Garschagen et al., (2015), pre-existing food insecurity presents significant obstacles in generating resources for adaptations during disaster preparedness and response. As such, addressing household food insecurity should recognize the networks and collective action of SES levels that are outside the microsystem, but

act on the household to influence food insecurity during crisis (Maxwell & Frankernberger, 1992). Pandey & Bardsley, (2015), also identified that in response to household food access challenges post-disasters, households at the microsystem level incorporate and exploit mesosystem (social capital) and macrosystem (institutional) influences.

2.5.1.2 *Mesosystem (Bonding and Bridging Social Capital Network) Influences*

The networks found within a household's mesosystem sphere include social interactions with informal networks (e.g., family and friends) and formal social networks like organization and religious groups (e.g., churches) where people play roles (Bronfenbrenner, 1977; Sherrieb et al., 2010). These networks, referred to as 'social capital' play a vital role in community resilience to disasters, by mobilizing support for the needy after disasters (Norris et al., 2008). According to Bourdieu, (1985), social capital is defined as "the aggregate of the actual or potential resources that are linked to the possession of a durable network of more or less institutionalized human relationships of mutual acquaintance and recognition" (Bourdieu, 1985, p 21).

Social capital networks facilitate access to resources and through them, broader economic, political and social mechanisms controlling the use and transformation of resources are reproduced (Bebbington, 1999). There are three main forms of social capital networks, two of which fall under the mesosystem sphere (bonding and bridging) and the third falls under the macrosystem sphere (linking) (Bebbington, 1999; Vervisch et al., 2013). Under the mesosystem sphere, social capital may act as a bond to connect like-people within the same social class together (e.g., family, friends or people in fraternal organizations), or act as a bridge to connect people across different ends of a social divide (e.g., civil rights groups, religious groups) (Putnam, 2000).

Bonding social capital networks accrue from unceasing efforts of sociability, and acts of exchanges such as giving and receiving of help, which are guided by norms of trust and reciprocity (Bourdieu, 1985). Bonding social capital facilitate different kinds of exchanges such as money, food, favors, gifts, services (e.g., food preparation, babysitting, house repair), important information (e.g., about jobs or humanitarian assistance), clothes and medicine, whilst creating the environment for solving dilemmas through collective action (Putnam,1995; Kuehnast & Dudwick, 2004). These exchanges are particularly useful for food transactions within contexts where food produce is available, and money is hard to come by, for instance within farming communities in Burundi, sweet potatoes and beans were exchanged for other food produce (Vervisch et al., 2013). Bonding social capital networks are usually the first available form of social capital available to people in the immediate aftermath of a disaster (Norris et., al, 2002; Aldrich & Sawada, 2015).

Within deprived neighborhoods, exchanges and reciprocating of help received, which is the lifeline of bonding networks, are limited. This is attributed to poverty, which increases the exclusion of households and individuals from informal helping exchanges, whilst more economically-

advantaged households experience a drain on their resources from giving to poorer households (Phan et al., 2009). For example, within impoverished communities in Accra, Ghana, residents who possessed more assets were stressed about the depletion of their resources due to meeting the needs of economically-disadvantaged residents, who benefitted from receiving social support but did not reciprocate the gesture (Greif & Nii-Amoo Dodoo, 2015). Furthermore, covariate shocks from extreme weather events (e.g., famine) result in 'contraction' of reciprocity, whereby food sharing is restricted within key members of households, if available (Swift, 1993).

According Keuhnast & Dudwick, (2004), though social capital networks may help build social status, an increase in bonding social capital networks that drain resources, is counterproductive to the interests of economically advantaged households, especially under unstable economic conditions. In some cases, the fear of social exclusion may pressurize people to help others even when they do not have the resources (e.g., sharing limited, available food). This results in increased 'shared destitution' and vulnerability as seen among households in a Liberian refugee community (Omata, 2013). The characteristics of a community, and the financial and physical capabilities of its members, determine whether bonding social capital networks become an advantage or disadvantage, which may also be modified by disasters. Households must therefore possess a balance of bonding social capital networks that leverage rather than drain household resources. Thus, the social capital of low-income residents may be simultaneously supportive, strained and limited in providing access to necessary resources (Curley, 2009).

Bonding social capital is supported by bridging social capital, which refers to connections outside fraternal groups (e.g. community groups). Bridging social capital is invaluable in facilitating food-sourcing adaptations in the aftermath of a disaster and for the recovery of communities after disasters (Phillips et al., 2013; Jones & Tanner, 2017; Pyle et al., 2021). After Hurricane Katrina, private citizens mobilized collectively to deploy resources, carry out charitable actions, mutual assistance and support entire communities, to help overcome the coordination challenges of humanitarian organizations (Chamlee-Wright, 2006). The advantages of bridging social capital notwithstanding, bridging social capital networks have been implicated in acts of corruption, favoritism and suppression during the delivery of key services and facilitating access to resources, including food (Szreter & Woolcock, 2004; Harvey, 2014). In particular, bridging social capital networks may reinforce power differentials by increasing the power of certain groups whilst rendering others powerless, thus blocking their access to resources (Vervisch et al., 2013).

The shifts in access to resources based on differences in social capital networks raise key points for policy consideration (Keuhnast & Dudwick, 2004). Policy interventions aimed at reducing the vulnerability of communities amidst the amplifying effects of urbanization and climate change, should focus on programs for managing bridging social capital due to their tendency of reinforcing patterns of discrimination (Aldrich & Sawada, 2015). To reduce acts of opportunism (e.g., by leaders) within community groups, development negotiations should be embedded within a dense network of social interactions (Putnam, 1995). Additionally, increased participation in bridging social capital networks will not result in positive outcomes for communities, unless underpinned

by principles of justice, gender equality and intercultural respect (Arneil, 2006). People with stronger bridging social capital ties are more likely to have access to increased post-disaster assistance than people with weaker ties, given that interactions are more positive than negative.

Bonding and bridging social capital are underutilized resources by practitioners in the field of disaster management and risk reduction but play a critical role in how well households and communities can withstand climate-related disasters or reduce disaster risk through community-facilitated adaptations (Aldrich & Meyer, 2015; Marchezini et al., 2017). Aldrich (2012), argues that although factors such as low levels of damage, increased economic resources and assistance from the government and humanitarian institutions are important (linking social capital networks), higher levels of bonding and bridging social capital are much more important in facilitating post-disaster recovery and effective reconstruction for survivors. Other authors also theorize that bonding and bridging social capital cannot replace linking social capital (government assistance) towards disaster response and long-term adaptation, as it reinforces group disparities (Fletcher et al., 2020). Regardless, social capital plays a key role at different stages in disaster management, particularly during the pre-disaster, immediate response and recovery stages (Cretney, 2016).

2.5.1.3 *Macrosystem (Linking Social Capital Network) Influences*

The macrosystem consists of linking social capital networks, defined as "the norms of respect and networks of trusting relationships between people who are interacting across explicit formal or institutionalized authority or power gradients within society" (Szreter & Woolcock, 2004 p655). Linking social capital networks cut across power differentials, such as relationships between politicians and communities or social networks that allow the leveraging of resources from formal institutions beyond the community (Woolcock, 2002). The capacity of individuals, households or communities to engage with power structures, particularly government representatives appointed over them, comprises their linking social capital (Vervisch et al., 2013). Linking social capital pertaining to post-disaster food insecurity, encompasses local, provincial and federal government disaster management institutions and humanitarian organizations.

Where and how to obtain healthy food in communities affected by extreme weather events may take several weeks and months (Fitzpatrick et al., 2020). Disaster management institutions therefore facilitate food access, by conducting needs assessments to estimate the required food aid supplies and to identify and target the most food insecure households (Bankoff et al., 2004; Barrett, 2006; Ainehvand et al., 2019a; Clay et al., 2021). Food aid is a very important form of adaptation, especially for internally displaced persons, but sometimes due to limited financial capacities, household food aid portions may be insufficient for their needs (Garschagen et al., 2015). Studies also show that prior-to-disaster limitations in the capacity of national/local and community DRR institutions and poor coordination of post-disaster interventions, is linked to exacerbated food insecurity among marginalized groups (Ainehvand et al., 2019a; Nhamo & Chikodzi, 2021).

It is important that the interconnections between local populations and their linking social capital networks are strengthened as part of disaster management, to prevent the exclusion of some vulnerable groups (Phillips et al., 2013). However, Bosher, (2014), identified an apparent disconnect between institutional actors involved in disaster management planning and implementation and key actors, like community disaster management organizations and practitioners. Also, the failure of linking social capital to engage with bonding and bridging capital results in ineffective political and institutional outcomes (Szreter & Woolcock, 2004). Thus, the dominance of linking social capital limits the capacity for collective action by other forms of social capital (Bebbington, 1999), illustrating that top-down disaster management approaches often stifle local involvement. To address linking social capital weaknesses, 'horizontal' or collaborative approaches are recommended through the assignment of roles and responsibilities to other types of social capital (e.g., representatives of local populations and community leaders), during disaster management planning (Shah et al., 2019; Aldrich & Meyer, 2015).

The capacity of communities to positively address the challenges of food insecurity is inherently linked to all types of social capital networks (Crowe & Smith, 2012). Additionally, social capital is recognized as key for facilitating climate change adaptations (IPCC, 2014). Regardless, corrupt tendencies and the abuse of power have been identified in the integration of bridging social capital (e.g., community leaders), for facilitating post-disaster food distribution (Ainehvand et al., 2019a; Habiba et al., 2015). Social processes which deepen inequalities and render some people more vulnerable to disasters than others, are by and large a function of the power relations operating in every society (Bankoff et al., 2004). As such, assessing social capital interactions for disaster management and addressing food insecurity, brings issues of inequality, power and the role of linking social capital into perspective, while highlighting connections with other social capital networks.

According to the Sendai framework for disaster risk reduction (2015), international and national institutions must have extremely strong coordination ability, in order to increase coherence between national disaster management plans and international plans (UNISDR, 2017). Disaster management in Mozambique is led by the government through the National Institute for Disaster Management (INGD), and supported by the Humanitarian Country Team (HCT), consisting of United Nations agencies, international organizations and civil society organizations (OCHA No. 22, 2019; Tevera et al., 2021). However, the sheer number of institutions, multi-disciplinarity and cross-sectoral nature of disaster management, creates a lack of clarity and confusion in the roles played by different organizations (Shah et al., 2019). For example, more than 30 institutions were involved in post-Cyclone Idai disaster management (Government of Mozambique, 2019).

To improve coordination, humanitarian institutions work within 'clusters' to target key areas, such as the provision of water and sanitation (UNICEF), food and logistics (WFP & FAO), shelter (IFRC & UNHCR), health (WHO), displacement camp management (IOM & IFRC) and assisting with the evacuation of households after disasters (UNISDR, 2017; IFRC, 2020; Lequechane et al., 2020; Nhamo & Chikodzi, 2021). The use of the 'cluster approach' addresses some of the

challenges of linking social capital in disaster management. The 'cluster' approach serves to strengthen partnerships and improve accountability and predictability, through better definition and clarification of the areas, roles and responsibilities within key sectors responding to a disaster (OCHA, 2012).

The differences in household adaptations for food access are linked to interactions with different types of social capital, and these differences should be assessed. Linking social capital must effectively work together with bonding and bridging social capital, in building both institutional and community capacities for disaster management (Mathbor, 2007). The SES framework is useful for theorizing social capital interactions at various levels, to explain the differences in household food insecurity vulnerability post-Cyclone Idai. The explicit use of the SES model in assessing household food insecurity in the aftermath of an extreme weather event such as Cyclone Idai was not identified during the literature review, although it is a relevant model for understanding the vulnerability of households in a post-disaster context.

2.6 Conceptualizing Post-Cyclone Idai Household Food Insecurity Using the SES Framework

Post-disaster food insecurity refers to decreases in food access experienced by households in the aftermath of extreme weather disasters. The provision of food for disaster victims is one of the key activities in disaster management and is based on complex operations during the disaster preparedness, response and recovery phases (Perdana et al., 2022). Thus, food insecurity is one of the core indicators used for measuring the impact of disasters on humans (EU et al., 2019). The impact of a disaster and the experience of post-disaster food insecurity are strongly linked to social vulnerability. A social vulnerability lens helps to delineate the multiple factors which are relevant for assessing post-disaster food insecurity.

Social vulnerability considers the social factors that shape the sensitivity of households to the negative impacts of hazards (Cutter et al., 2003). Sensitivity influences the ability of people to reduce 'exposure' to hazards, and to adapt, based on their adaptive capacities (Phillips et al., 2013). Sensitivity to post-disaster food insecurity encompasses a wide category of factors (e.g., possession of entitlements, poverty, demographics, food environments, access to social capital and place inequalities), which interconnect at various levels, to influence the severity of post-disaster food insecurity (Sen, 1981; Cutter et al., 2003; Phillips et al., 2013; Ainehvand et al., 2019; Pyle et al., 2021). However, the plethora of indicators for assessing food insecurity in relation to social vulnerability, and their connections with disasters are confusing.

A conceptual framework is required to provide a logical structure, or a visual display of how different concepts connect to each other within a theoretical framework, to serve as a grounding base for all the parts of a study (Grant & Osanloo, 2014). The conceptual framework of the study is therefore informed by theories on food insecurity, social vulnerability and disaster management,

which are merged under the SES framework. The SES framework served as the broader framework that helped to explore the relationships between the key concepts at various levels, in relation to post-disaster food insecurity among households. According to Sallis et al., (2015), SES models can provide a framework for the integration of multiple theories and serve as an overall model, consisting of other models. Although this may be considered a weakness, it fosters the development of subject-specific models as seen from diverse applications of the SES framework. Notably, the application of the SES model in its complete sense as theorized by Bronfenbrenner (1977), is very challenging and requires input from a wide range of stakeholders and resources which is beyond the scope of such a study.

To support a nuanced analysis of post-Cyclone Idai food insecurity, the SES framework was modified for conceptualizing the study, based on key concepts within three spheres, to depict the multiple influences on post-disaster food insecurity. While a household's food insecurity vulnerability may be easily traced to close factors at the microsystem level, these close factors are in turn connected to distal factors operating at higher levels. As such, microsystem factors (households) are embedded within outer spheres of the mesosystem and macrosystem, all interacting to influence post-disaster household food insecurity. The interconnections between these levels and the phases of a disaster are relevant for understanding household post-disaster food insecurity. The approach adopted by this study for assessing the differences in household food insecurity post-Cyclone Idai is structured according to two components.

The first component focuses on framing household food insecurity (microsystem sphere), using multiple social vulnerability indicators. The assessment of household food insecurity within the microsystem sphere includes the measurement of household food insecurity using an FIEMS, specifically, HFIAS. Since FIEMS only provide point in time measurement of food insecurity, other microsystem factors influencing household food insecurity were considered. These included household characteristics (e.g., household size, income), personal food environment characteristics (accessibility, affordability, and convenience) and adaptations linked to food insecurity post-Cyclone Idai (e.g., food-sourcing adaptations). The microsystem sphere is embedded within the mesosystem sphere (bonding and bridging social capital networks), which is further embedded within the macrosystem sphere (disaster management linking social capital networks). As such, the interactions between the spheres in facilitating household adaptations for post-Cyclone Idai food insecurity are situated within the SES framework (Figure 2.3).

The second component aligns spheres of the SES framework with the disaster preparedness and response phases of Cyclone Idai (Figure 2. 3). This was done based on the recognition that post-disaster household food insecurity outcomes are linked to underlying food insecurity levels and adaptations applied during all disaster management phases. The study, however, restricts the focus to the preparedness and response phases because 'recovery' occurs over a long-time frame. This study theorizes that the SES spheres and disaster management phases interact and influence each other to bring about substantial changes, which pertaining to this study are differences in household

food insecurity after Cyclone Idai. Figure 2.3 depicts the modified SES framework with the household (microsystem) at its core, situated within the nested mesosystem and macrosystem spheres of influence. All the spheres of the SES framework are aligned with the preparedness and response phases of disaster management to contextualize post-disaster food insecurity.

The SES framework and the adopted indicators help to assess post-disaster household food insecurity more wholistically, and from a social vulnerability view. To begin with, the selected indicators reflect snippets from diverse conceptualizations of food security or food insecurity, namely food entitlements, four pillars and food systems concepts. The use of the HFIAS measures the food access dimension of the 4 pillars, the personal food environment measures a food system component, while household characteristics (e.g., income) assess food entitlements. The combination of all these variables is required because on their own, they provide a limited assessment of post-disaster food insecurity. Additionally, the indicators cut across all the components of social vulnerability. The household and personal food environment characteristics reflect both sensitivity and exposure, while adaptations also reflect sensitivity and adaptive capacity. Situating all these interactions within an SES framework helps to merge the different conceptualizations and define the interactions across spheres. The use of SES model in assessing household food insecurity in the aftermath of the extreme weather event Cyclone Idai, was very relevant for understanding the vulnerability of households in a post-disaster context.

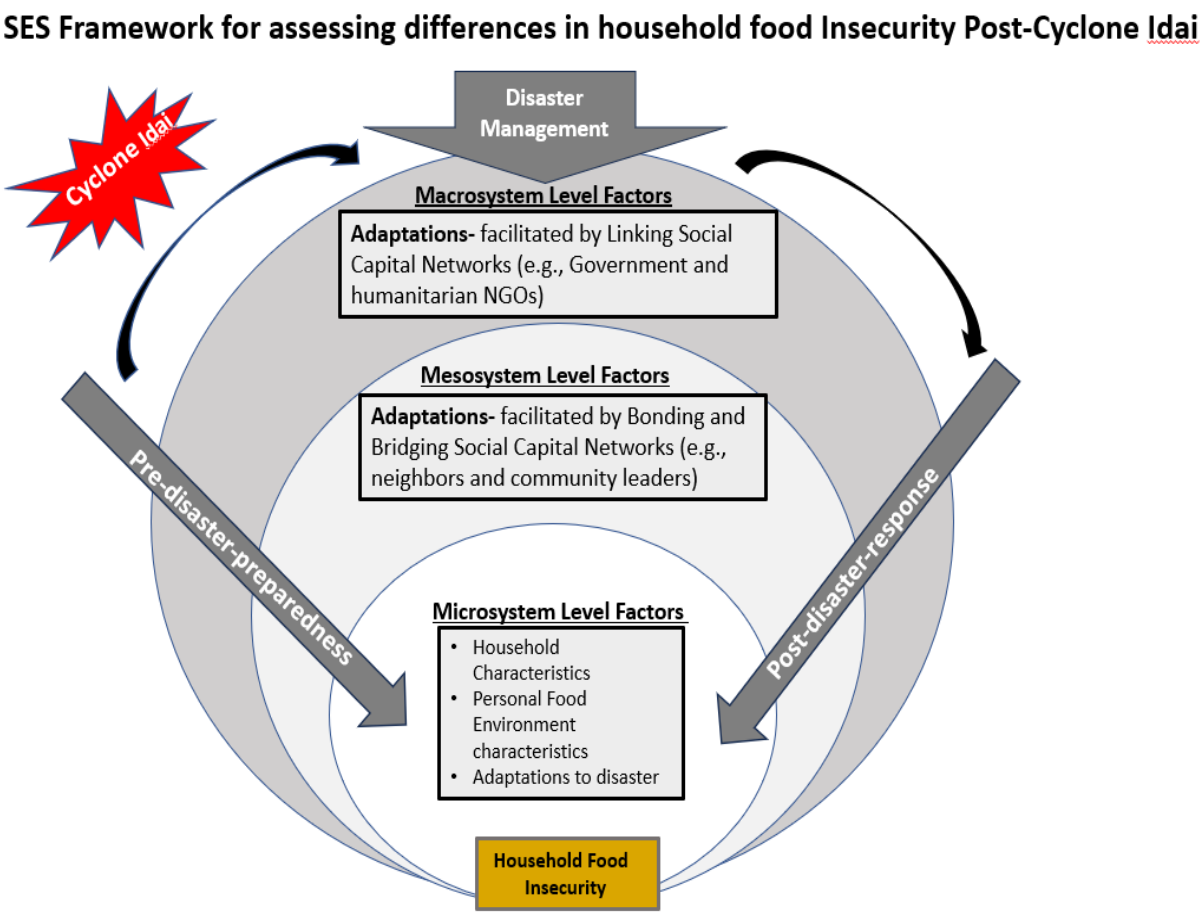

Figure 2.3: Author's construct informed by the Onion Framework (Birkman, 2006) and Disaster Management Phases

2.7 Linkages Between the Study and Sustainability Management Frameworks

The Brundtland commission report (1987), recognized that ongoing global environmental and developmental challenges are inseparable and should be addressed as 'one crisis', to yield sustainable development outcomes (Brundtland, 1987, pg.4). The commission defined sustainable development as "development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987). Sustainability management encompasses the implementation of sustainable development through definition of the concept, goals and development of science and technology to support the goals, supported by multi-level stakeholder engagements (Kates et al., 2005; Starik & Kanashiro, 2013).

At the World Summit on sustainable development in 2002, the concept was operationalized as 3 pillars of economic growth, social equity and environmental conservation (Kates et al., 2005).

However, Griggs et al., (2016), argue that sustainable development should be operationalized as a nested concept, whereby the economy and social spheres are embedded within the environmental sphere to reduce trade-offs associated with focusing on individual pillars as depicted by the 3-pillars approach. This endorses the nested or 'egg of sustainability' concept, which illustrates the relationship between the economic and social dimensions, as smaller spheres embedded within the bigger sphere of nature, just like the yolk is embedded within an egg (Keiner, 2005). As the egg is good, if the yolk and the white are good, so is development sustainable, if economic development and social wellbeing occur within the ecological limits of nature (Keiner, 2005).

In 2015, members of the United Nations including Mozambique, signed 'Agenda 2030' outlining 17 Sustainable Development Goals (SDGs) and 169 targets to address the world's difficult challenges by 2030 (UN SDGs, 2016). Raworth (2017) developed a conceptual framework for the SDGs referred to as the 'doughnut framework,' based on previous nested or egg of sustainability models. The doughnut framework shows 3 nested spheres with the social sphere at its core. The 'social sphere' encompasses 12 goals derived from the 17 SDGs to serve as minimum standards for people's well-being (e.g., poverty reduction, food security, health, education, social equity, gender equality, energy poverty, water, housing, income and work, political voice, peace and justice and networks).

The outermost and biggest sphere of the framework is the 'ecological sphere', which defines the ecological limits of the earth using 9 defined planetary boundaries including climate change, biodiversity loss and land conversion, which regulate the Earth's ability sustain safe life conditions (Steffen et al., 2018; Steffen et al., 2015; Raworth, 2017). The middle sphere sandwiched between the 'inner social sphere' and the 'outer ecological sphere' is the safe space for sustainable development, which ensures that the minimum social standards in the lower sphere are met while respecting the limits of the planetary boundaries in the outer sphere (Raworth, 2017b, 2017a). This puts a strong focus on the social SDGs including poverty and food insecurity, which should be addressed by ensuring that people are engaged in economic and livelihood activities that uphold ecological limits.

Applying the egg and doughnut models to vulnerability assessment and disaster risk reduction suggests a social vulnerability and systems thinking perspective, as indicated by the SES approach. Systems thinking research can enhance the clarification of feedbacks that depeen inequality or strengthen resilience within SESs, and their interconnections across different scales and contexts (Burch et al., 2014). Key research contributions towards sustainable development come from interdisciplinary SES research which recognize that, social and ecological systems interact, coevolve over time and substantially impact one another in both beneficial and harmful ways (Haberl et al., 2016).

The government of Mozambique identifies climate-related hazards as a key threat to the country's development. As such the government has aligned the '2015-2019' Strategic Development Plan of the country with the economic, social and environmental dimensions of sustainable development.

Specifically for SDG 2, one objective is to increase production and productivity in all agriculture-related sectors thereby promoting food security, employment and sustainable economic growth (United Nations & Government of Mozambique, 2018). Some initiatives include investments in climate-smart agriculture projects, such as farming flood-resistant crop varieties, alternative livelihoods and climate adaptations (Government of Mozambique, 2019). Additionally, farmers' access to technical information on climate smart technology has been invested in, by improving agricultural extension services and capacities (CIAT et al., 2017).

Regardless, SDG 2 on 'Zero hunger' cannot be addressed in Mozambique without addressing the impacts of disaster on food access, due to the recurrence of disasters. Marginalized groups are among the most vulnerable (e.g., people with low literacy), because of their limitations in accessing information on humanitarian food assistance availability. A World Food Program supported initiative for SDG 2 in Mozambique, focuses on reducing barriers to post-disaster food access among marginalized groups, by providing information in languages and formats that they can understand (Jagoe et al., 2023). Although climate-related and 'ecological' factors may have had severe impacts on food availability, 'social' factors like communication of information on available food aid, can improve post-disaster food access. Notably, the SDG 2 initiatives should address economic, social and environmental factors from a systems approach. The SES approach adopted in this study therefore upholds the 'systems' view of sustainable development, by recognizing the interplay of social, economic and environmental factors, that influence post-disaster household food insecurity, whilst contributing to research in support of the SDGs ((e.g., food insecurity (SDG 2) and climate action (SDG 13)).

CHAPTER THREE

3.0 METHODS

3.1 Introduction

This chapter describes methods used for the study. The chapter begins with a description of the study design and the philosophical underpinnings for the design. This is followed by a detailed description of the study area providing context on the city of Beira where the study was conducted, the study population, sampling, data collection techniques and ethical considerations. The chapter finally outlines the data analysis procedure and how results will be presented.

3.2 Study Design

This study adopted a mixed-methods sequential explanatory design. The mixed methods sequential explanatory study design enables the collection of both quantitative and qualitative data to provide a contextual and holistic understanding of a subject. The mixed methods sequential explanatory design involves a two-phase data collection approach where the quantitative data is first collected and results analyzed, to inform the types of participants and questions in the second phase qualitative study (Creswell & Creswell, 2018). Depending on the study's objectives, both types of data may be emphasized equally, or one type may be prioritized over the other (Castro et al., 2010). Data from the quantitative study is analyzed separately and triangulated with qualitative data which is also collected and analyzed separately. Quantitative and qualitative data results are then triangulated by contrasts and comparisons during the interpretation (Creswell & Creswell, 2018).

Both quantitative and qualitative data were collected for this study (Figure 3.3). In the initial quantitative study, structured questionnaires were used to elicit data on household food access, household characteristics and proxy indicators for the personal food environment and adaptations to disasters post-Cyclone Idai. Specifically, the quantitative study examined the differences in household food insecurity post-Cyclone Idai at the microsystem level, based on the household and personal food environment characteristics. Additionally, household adaptations for food insecurity that were facilitated by different SES levels were highlighted. This was followed by the qualitative study which collected textual data to further explain the quantitative results. The qualitative study sought to capture details of participants' lived experiences to explain quantitative findings (Creswell et al., 2002). The qualitative study involved key informant interviews (KIIs) and focus group discussions (FGDs) with purposefully selected persons from the microsystem, mesosystem and macrosystem levels of the SES theoretical framework underpinning the study.

In this study, more emphasis is given to the qualitative study. This was because the researcher was engaged in fieldwork in Mozambique for the collection of all the qualitative data unlike during the collection of the quantitative data when travel restrictions were in place due to the COVID-19 pandemic. The quantitative household survey was carried out from 20th September 2021 to 14th October 2021, whilst the qualitative study was conducted between 3rd August to 17th August 2022.

3.3 Philosophical Underpinnings of the Study - Pragmatism

The philosophical underpinning of the study refers to the worldviews or assumptions that guide and shape the research design and methodology. A researcher's decision to use quantitative, qualitative, or mixed methods research methodologies reflects an inclination towards specific worldviews or paradigms. Different paradigms align with different ontologies and epistemologies. Ontology refers to the researcher's view of the world or reality whilst epistemology refers to the researcher's assumptions of how to investigate or know about this reality, which together inform the methodology or research processes (Creswell & Creswell, 2018). Although there are several ontological concepts in social research (e.g., feminism, postmodernism), the two primary ones under which quantitative and qualitative research fall are namely positivism and interpretivism respectively (Crotty, 1988; Arghode, 2012).

Positivist or postpositivist worldviews believe that reality in the world is 'one', which can be measured empirically using scientific methods or deterministic approaches, based on numeric data found in quantitative research (Arghode, 2012). Quantitative research lends itself to objectively collecting and analyzing numerical data. Some examples of quantitative research approaches are experimental research and household surveys (Walker, 2005; Creswell & Creswell, 2018). There are several advantages of quantitative studies, especially the ability to use them within short time frames for reliably collecting data on very large scales (e.g., national scales), for studying relevant phenomena. Nonetheless, quantitative methods tend to be rigid, fail to capture participant emotions, are based on complex models and are also expensive to implement (Queirós et al., 2017). For example, in post disaster contexts, quantitative studies provide numerical data that can be quickly evaluated and facilitate comparisons across groups, however, it does not reflect people's lived experiences (Choy, 2014). People's lived experiences can mainly be assessed qualitatively and cannot be overlooked due to their relevance for post-disaster recovery and future disaster preparedness.

Qualitative studies rely on textual data and focus in-depth to derive essential meanings about subjects like peoples' lived experiences, perceptions and behavior that are difficult to quantify (Neubauer et al., 2019). Some examples of qualitative approaches are case studies, ethnography and grounded theory (Tenny et al., 2017). They are useful for small sample size contexts, whereby interview sessions are guided by data saturation or failure to yield new results regardless of new inputs (Castro et al., 2010; Smith & Mike, 2011). Qualitative study approaches reflect a second type of worldview called interpretivism. The view of interpretivists is that reality in the world is more than 'one' and people develop subjective meanings based on their experiences (Arghode, 2012; Creswell & Creswell, 2018). Qualitative studies are strong in their flexibility and orientation towards knowledge discovery, provision of detailed information about a person or subject, people's experiences, and heavily focus on social norms and social contexts (Queirós et al., 2017). Notwithstanding, qualitative approaches have weaknesses, including; variables being difficult to measure, methods being time-consuming, focus on a small number of participants, may be non-representative of all population and subject to researcher partiality (Choy, 2014; Almalki, 2016).

Positivism (quantitative) and interpretivism (qualitative) ontological worldviews have served as a foundation for various studies. However, within the last century there have been heated debates by both factions pitching one approach over the other, thus leading to a divide between qualitative and quantitative researchers and the promotion of mono-method studies (Onwuegbuzie & Leech, 2005). Notwithstanding the differences in method, there are some parallels between both approaches. For instance, both positivists and interpretivists employ data verification approaches. Positivists employ approaches like random sampling techniques for reducing biases whilst interpretivists use triangulation, comparisons and contrasts (Onwuegbuzie & Leech, 2005). Additionally, both methods seek to arrive at the meaning of data, although in different ways. According to Dzurec & Abraham, (1993), the process of inquiry produces meaning as an outcome, regardless of whether quantitative or qualitative research approaches were used. Meaning depends on how either quantitative or qualitative data is interpreted, and the interpretive framework of disciplines (theoretical and conceptual) within which the inquiry is embedded (Dzurec & Abraham, 1993).

In recent times, some researchers, specifically 'pragmatists', are of the view that both methods can be combined and that 'reality is what works at a particular time' and is not affiliated to any one system of philosophy (Creswell & Creswell, 2018). The ontology of pragmatism is underpinned by the need to see society as one posited within structures of relationships, which are constantly changing through actions, and can be summarized as 'actions and change' (Goldkuhl, 2012, pg 139). Pragmatists place value on actions that can be used to make a meaningful difference in practice, rather than only philosophical deliberations (Dewey, 1931). This indicates a focus on the 'what' and 'how' of conducting research and 'where' research is directed, by combining different assumptions, worldviews and data collection approaches, described as mixed methods (Creswell & Creswell, 2018).

Pragmatism forms the philosophical underpinning for mixed methods, and allows researchers to combine multiple approaches, assumptions, data collection techniques and analysis to understand research problems (Denscombe, 2008). Mixed methods studies may combine exploratory quantitative (e.g., descriptive statistics) and exploratory qualitative (e.g., traditional thematic analysis) or confirmatory quantitative (e.g., inferential statistics) and confirmatory qualitative (e.g. confirmatory thematic analysis) approaches (Onwuegbuzie & Teddlie, 2003; Onwuegbuzie & Leech, 2005). The quantitative and qualitative approaches may be used approximately equally or either the quantitative or qualitative approach may be given dominance (Creswell et al., 2002; Onwuegbuzie &Teddlie, 2003).

Through pragmatism, quantitative data can compensate for qualitative data whilst the qualitative data can help explain relationships identified by the quantitative data (Onwuegbuzie & Leech, 2005). By integrating both quantitative and qualitative approaches, complementary types of data are merged to create a more complete picture of a situation and to compensate for weaknesses from the use of one approach (Denscombe, 2008). However, there are tendencies for pragmatism to be

misconstrued as a commonsense application of the word 'pragmatic' to connote "anything goes" and such meanings are not applicable to mixed methods research (Denscombe, 2008). Other challenges may occur when the combination of qualitative and quantitative data produces contradictory outcomes, which casts doubts on the validity and reliability of the combination (Creswell & Creswell, 2018). The overall difficulty and lengthiness of mixed methods research deters researchers with limited timelines (Dawadi et al., 2021).

However, the use of mixed methods is an area that continues to evolve with the development of new procedures. For food security research, a mixed methods approach is particularly useful, because quantitative food security indicators offer a snapshot of food security at specific points in time (e.g., 24 hours or 1 week), but do not reflect the underlying processes producing food insecurity (Stevano, 2019). In this study, while the quantitative methods provided evidence of food insecurity prevalence, and characteristics associated with household vulnerability, it did not detail the contextual factors influencing them. A qualitative study therefore helped to explain the underlying factors influencing differences in food insecurity vulnerabilities after Cyclone Idai. Hence, the adoption of mixed methods approaches for this study rested on the assumption that the assessment of food insecurity in a post-disaster scenario and the different factors influencing the construct, required both quantitative and qualitative methods to provide a more complete meaning.

3.4 Study Area

3.4.1 Description of Beira, Mozambique

This study was conducted in the city of Beira, where Cyclone Idai made its landfall in March 2019. Beira city covers a land area of 633 km^2 and has a population of 592,090, making it the fourth-largest city by population, behind Maputo, Matola and Nampula (INE, 2017). The city is the second-largest by size in Mozambique and is the capital of the Sofala province, located in the central region of the country (Charrua et al., 2021). The Sofala province has an interconnected system of rivers, lakes and swamps, and is bordered to the North by the Zambezi River, by the Indian Ocean to the East, whilst the rivers Pungue and Buzi flow through the center of the province (Figure 3.1) (Charrua et al., 2021). The city of Beira is located between the Pungue River and the Indian Ocean (Figure 3.1). Due to its location, extensive areas of land in Beira are mostly low-lying marshlands, wetlands and swampy soils, which makes the city prone to recurrent flooding from rainfall induced inundation, and climate-related events (e.g., cyclones) (Shannon et al., 2021).

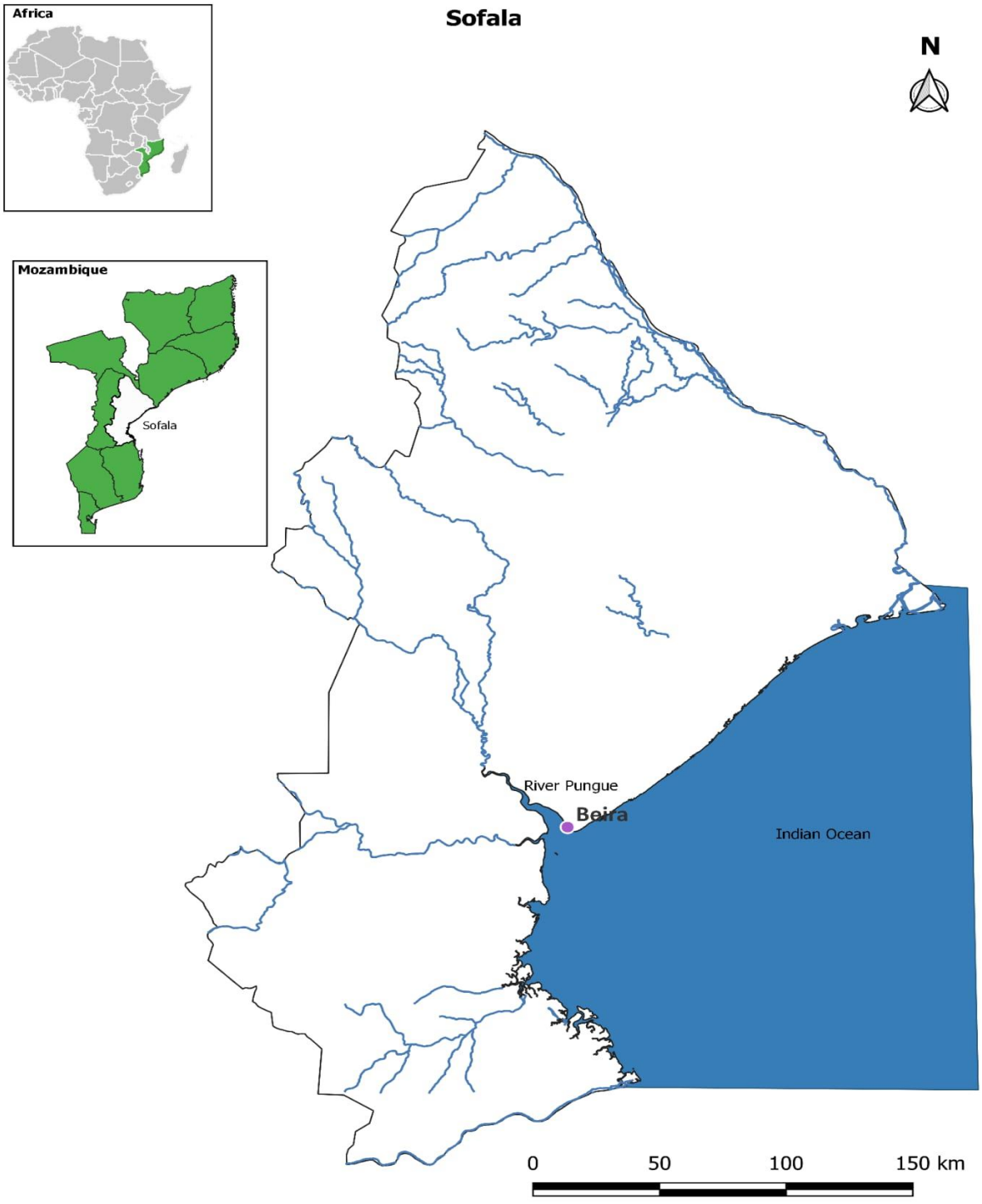

Figure 3.1: Map showing the Sofala Province, water bodies and the location of Beira city

The city of Beira's location (Figure 3.1), apart from the disadvantages of climate-related hazards, has a strong economic potential upon which the city was founded. Beira became a city in the 1890s, because its geographical location was an asset for building a port for Portuguese shipping businesses. The Portuguese established their headquarters in 1892 and governed Biera until 1975 (Sheldon, 1999). The port of Beira is the second largest in Mozambique and has played a vital role in the economy of the province and the country, because it opened the door for merchandise trading to and from Zimbabwe, Zambia, Malawi and Congo (Batista et al., 2018). The port became a lifeline for economic activities like the import and export of tobacco, cotton, agricultural inputs and food products, which fueled the migration of jobseekers into the city (Oliveira, 2018; Anderson & Silva, 2020).

Against the background of colonialism ingrained in the city of Beira's inception, urbanization has been filled with challenges. The early Portuguese settlers built their homes as modern buildings along the coast, in communities with paved roads, electricity and clean water supply, by exploiting indigenous labor. At the same time apartheid laws were rigorously enforced against Mozambican families, who were banned from white communities and settled in areas, which were devoid of roads and other urban amenities, thus creating contrasting developments and racial segregations in Beira (Sheldon, 1999; Sarmento & Linehan, 2019). Urbanization of the city has been characterized by the spread of inequality, informality, poverty, low levels of education, lack of access to roads and urban amenities (Batista et al., 2018). After independence from the Portuguese in 1975, the Sofala province was plunged into a civil war for almost two decades, resulting in mass out-migrations and stalled development, until the mid-1900s (Sheldon, 1999; Oliveira, 2018).

The war also disrupted the movement of food supplies from rural to urban areas in Beira for several years, thus, the government created green zones for urban agriculture to increase food supplies within the city (Sheldon, 1999). Residents of the city of Beira, especially women, have therefore relied on urban farms to support their households, and Beira was considered to have more food availability compared to other cities in Mozambique (Sheldon, 1999). After the war, there have been changes in government, however, subsistence agricultural livelihoods persisted because of its relevance for urban food security (Shannon et al., 2021). Notwithstanding, subsistence farming in Beira remains at the mercy of climate-related conditions, whilst the administrative capacities of the state to support urban agricultural initiatives in the city is limited (Anderson & Silva, 2020). Over the years, Beira has become more urbanized and attracted several young immigrants, whilst its agricultural socio-spatial land-use characteristics are shifting to make room for real estate and market centered development (Shannon et al., 2021).

In view of the frequent exposure to extreme weather events and their impacts, the Beira Master Plan 2035, was created and approved in 2014. The plan sets forth a framework for sustainable development and for reducing the vulnerability of the city to climate-related extreme weather impacts. The plan has three overall goals; namely, harness the economic potential of the city as a strategic port city and transport corridor, improve living conditions for poverty reduction and support adaptations to climate change. Pathways for achieving the first goal include expansion of the port and industrial areas, improving transport infrastructure and investment terms. The second

goal addresses the reduction of urban inequalities by improving access to urban amenities like education, healthcare, drinking water and quality affordable (social) housing. The final goal involves urban development in areas with relatively high ground and expansion of drainage and coastal protection infrastructure (Municipality of Beira, 2019).

The importance and benefits of the Beira Master Plan notwithstanding, it is not devoid of implementation challenges. To begin with, informality in housing continues to be an urban challenge because affordable housing that has been completed so far according to the Master Plan, is unaffordable for low-income households that earn between 2000-5000 Meticals. Affordable housing was intended for households in this income bracket, and yet these households cannot afford it due to poverty and their ineligibility for mortgages (Shannon et al., 2021). Additionally, based on the Master Plan, there is the reallocation of land for affordable housing projects being built in New Towns. Much of the land in Mozambique and Beira are state-owned and leased out to residents for purposes like farming and the building houses through the allocation of 'rights of use and benefit of land' or DUAT (Direito do Uso e Aproveitamento da Terra). The reallocation of land therefore dispossesses poor subsistence farmers of farming land, which they rely on for their livelihoods and for food availability (Shannon et al., 2021).

Most of the population in Beira, especially women are involved in agricultural related livelihoods, which bear the brunt of climate impacts and should be given due consideration. Regardless, the economic initiatives for poverty reduction that are outlined in the Master Plan, are heavily focused on investments linked to the Port (Municipality of Beira, 2019). With climate change, most models predict that Mozambique will be more affected by extreme weather events whilst cyclones will continue to increase in intensity in Beira, with devastating implications for the port of Beira (Neumann et al., 2013; Government of Mozambique, 2019). The Plan is devoid of pathways for improving economic opportunities through climate smart agricultural initiatives, which can potentially complement other economic initiatives and contribute to reducing food insecurity and poverty. Amidst increased urbanization and changes in the agricultural landscape of Beira, the city remains at risk of extreme weather disasters.

Mozambique is ranked among the top three African countries most vulnerable to cyclones, and about two cyclones enter the Mozambique Channel each year, with the Sofala province where Beira is located, being one of the most affected (Lequechane et al., 2020; Kolstad, 2021). Severe cyclones that have made landfall in the Sofala province include Nadia in 1994, Bonita in 1996, Lisette in 1997, Eline in 2000 and Japhete in 2003. Between 2000 and 2012, there have been 19 cyclones in the Sofala province (World Bank, 2018a). About 75% of households in Beira lived in flood-prone informal settlements in 2012, exposed to severe cyclone and flooding impacts (Mixed Migration Centre, 2023). Frequent floods in the city of Beira result in short-term displacements, especially for households living in informal settlements. A displacement tracking matrix assessment carried out in the central region of Mozambique, including the Sofala province and Beira, showed 70% of localities have established evacuation routes, while 82% of localities have

designated public buildings for use as displacement shelters during cyclones and floods (IOM & INGC, 2020).

Evacuation and displacement assistance are central to the work of national disaster management institutions like the INGD in Mozambique. Yet, their capacity is usually stretched, due to multiple climate-related disasters, occurring simultaneously in the country (Foley, 2007). Government authorities therefore support long-term measures like resettlement for recurrently displaced communities. However, resettlement processes are complex, with lasting impacts which are not always positive. Resettlement has been associated with the loss of social capital networks, loss of farmlands, and relocation of urban households who have no farming knowledge, to rural areas solely reliant on farming livelihoods (Wiles, 2005). In most cases, apart from reduced flooding risks, resettled households from Beira did not indicate improved socio-economic conditions, while some lived in uncertainty in makeshift houses, neither resettled nor returned (Mixed Migration Centre, 2023). Overall, there is limited monitoring of displaced and resettled households, to assess the effect of resettlement on them (Arnall et al., 2013).

The 2019, Cyclone Idai which struck Beira city, the Sofala province and Mozambique as a whole, had catastrophic outcomes, including food system impacts, displacement and livelihood losses for households. Beira therefore presents a relevant post-disaster context for assessing household food insecurity after Cyclone Idai, to gain insights for vulnerability reduction.

3.4.2 Description of the Impacts of Cyclone Idai on Beira, Mozambique

Cyclone Idai has been one of the most devastating tropical cyclones recorded in the Southern Hemisphere and there is no historical cyclone benchmark in Mozambique that can be used as a comparison to Cyclone Idai (Nhamo & Chikodzi, 2021). The cyclone affected the central region of the Sofala province, with impacts felt throughout Beira, Chibabava, Dondo, Buzi and Nhamatanda districts (INGD, 2019). However, the city of Beira, Mozambique, was directly in its pathway, thus experiencing some of the most catastrophic impacts (Figure 3.2) (Kolstad, 2021; Fraser & Fitchett, 2021). From the 14th to the 15th of March 2019, the Sofala Province was affected by the intense tropical Cyclone Idai, a category 4 storm, with a pressure of 940 hPa at its center, which generated wind gusts of up to 210 km/h, and widespread flooding (INGD, 2019).

The strong winds and flooding brought by Cyclone Idai were unprecedented, causing considerable socioeconomic damage. Flood waters rose above 6 meters in some areas and over 3, 000km^2 of land was submerged with people left stranded on houses and trees, whilst health, education, communication, and water services infrastructure were destroyed (OCHA et al., 2019). Road networks, electrical and communication infrastructure were completely broken down by the cyclone (Tevera and Raimundo, 2021). More than 90% of commercial buildings were affected and more than 70% of houses were partially destroyed (INGD, 2019; Municipality of Beira, 2019).

The number of people affected by Cyclone Idai in the Sofala region was 1.85 million, 400 000 displaced people, 1600 injured people and 603 deaths (OCHA, 2019; OCHA 2020; National Situation Report, 2019).

The agricultural and forestry sectors recorded the most severe impacts, with losses costing about $ 513 million USD, resulting in widespread food insecurity. Cyclone Idai destroyed thousands of acres of planted crops (beans, rice, cassava, maize), pre-cyclone harvests and seeds (OCHA, 2019). More than 562 aquaculture ponds were destroyed, resulting in more than 375 tons of lost products, whilst about 9700 livestock were killed (INGD, 2019). Cyclone Idai reduced dense vegetation by 58.9% and wetland vegetation by 57.4% (Charua et al., 2021). The cyclone significantly worsened existing conditions of poverty, as many families lost their livelihoods that were linked to these resources and in some cases the lives of productive family members were lost. This influenced the adoption of negative adaptation strategies, like pushing children into child labor (Relief Web, 2019).

Cyclone Idai had a unique pathway of formation which was very different from other past cyclones, resulting in Early Warning Systems challenges and delayed prediction of the strength and location of the cyclone, until a few days before landfall (Kolstad, 2021). As such, there was general unpreparedness to deal with the magnitude of this extreme weather event, at all levels. National humanitarian assistance was completely overwhelmed by the cyclone necessitating the help of international aid, NGOs, businesses, religious organizations and individuals. Additionally, emergency response was complicated due to misty weather, persistent rainfall and winds which impeded transportation to the disaster's epicenter. For example, helicopter flights were stalled due to weather conditions (Nhamo and Chikodzi, 2021).

Whilst Cyclone Idai was being managed in the Sofala Province, another Cyclone Kenneth hit the Cabo Delgado Province on 25th April 2019. This was also a category 4 cyclone with similar devastating effects barely 6 weeks after Cyclone Idai (Nhamo and Chikodzi, 2021; OCHA, 2019). This necessitated the diversion of some government and humanitarian resources towards the Cabo Delgado region, to address the impacts Cyclone Kenneth (Government of Mozambique, 2019). Consequently, disaster management capacities and humanitarian aid were stretched and limited in addressing post-Cyclone Idai needs.

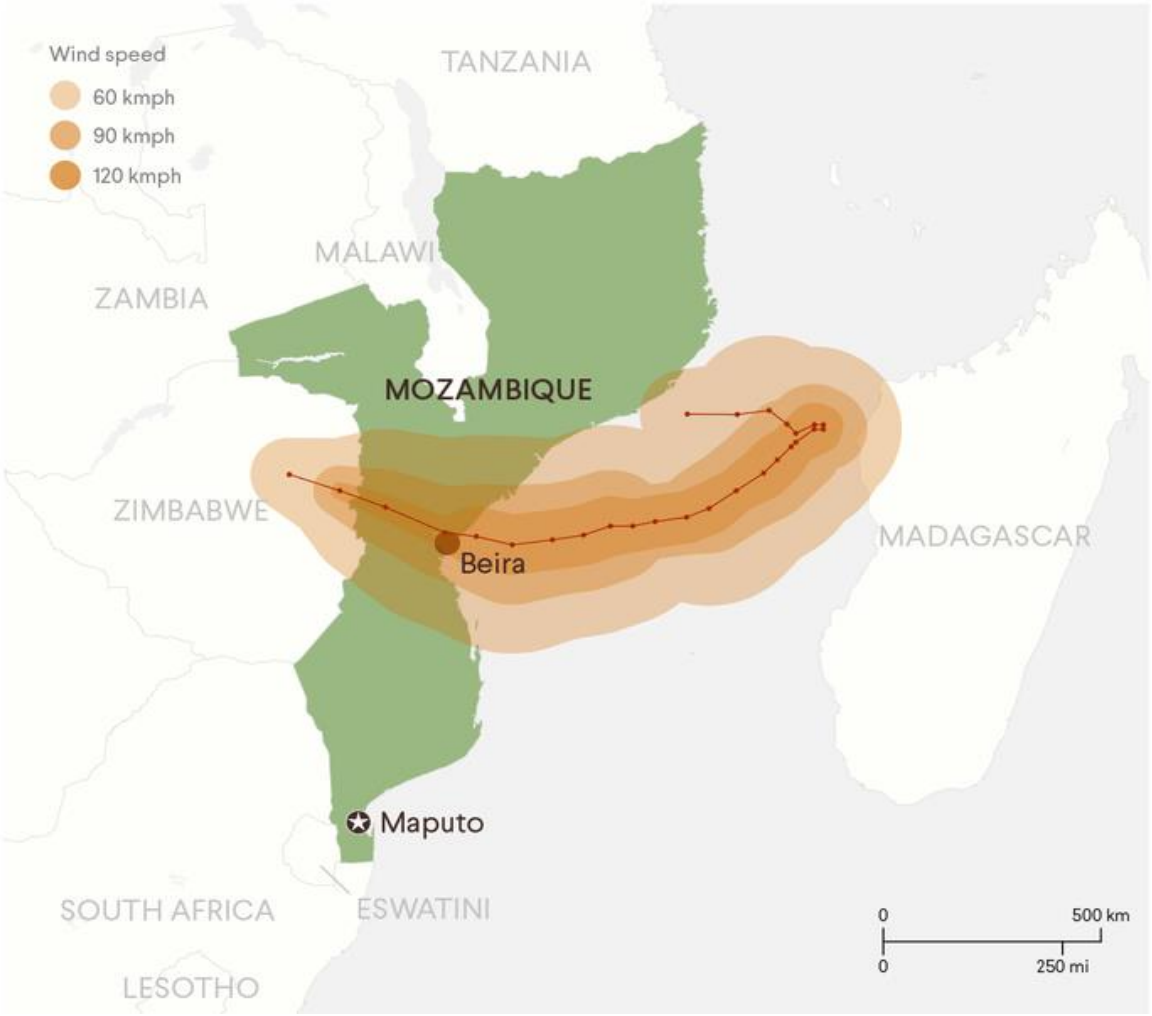

Figure 3.2: Map showing Cyclone Idai's path over Beira Mozambique (CFR, 2019)

3.5 Study Sample-Inclusion and Exclusion Criteria

This study is underpinned by the SES framework, and as such, food insecurity was examined at the household (microsystem) level through quantitative and qualitative analysis. Additionally, data from social capital networks at the mesosystem level (community leaders) and macrosystem levels (disaster management institutions) were collected qualitatively to further explain and complement the quantitative results. The study sample was heterogenous and comprised of respondents who were impacted by Cyclone Idai and were willing to participate.

3.6 Quantitative Study

The quantitative study involved a cross sectional household survey with sampled households that were living in residences hit by Cyclone Idai. This section provides a description of the methods that were employed for the quantitative aspect of the study. It describes the sample size, sampling strategy, data collection approaches, data processing and analysis techniques.

3.6.1 Study sample size

The sample size for the quantitative study included 975 residences (N=975), that were affected by Cyclone Idai and their households (Figure 3.3). Structured questionnaires were used to elicit information from households on the before and aftereffects of the cyclone.

3.6.2 Sampling Method

In settings like Mozambique where inaccurate data on the distribution of sub-national populations exist, novel methods like remote satellite imagery are useful for estimating population distribution and for unbiased survey sampling (Wagenaar et al., 2018). Satellite imagery for such purposes is deposited in an OpenStreetMap database (OSM), that is supported by community driven contributors. In response to Cyclone Idai, the Humanitarian OpenStreetMap, a team of OSM contributors dedicated to mapping humanitarian and community development response, digitized every building within the Sofala province using remote satellite imagery and shared this data in the OSM database (Wagenaar et al., 2018). The process involved the conversion of roofed-like buildings into polygon features, which after deposition into the Mozambique dataset, were made downloadable on Geofabrik, a data extraction platform for OSM available at https://download.geofabrik.de/.

This shapefile for Mozambique was downloaded on September 7th, 2021, and customized for Beira using ArcGIS Pro by members of the research team. After customization, the building file contained 139,027 buildings within the administrative boundaries of Beira city. This was then exported into an excel file for random sampling of 1,000 points, which were converted into a feature layer and used for sampling buildings. The selection of the sample size of approximately 1000 households in Beira city alone supported the intended statistical analyses for the study. This was informed by the work of Wagenaar et al., (2018), who suggested that a minimum target of 1500 households were enough to achieve representation of households in the Sofala Province, as the standard DHS in Mozambique for 2011, had an estimated sample size of 1300 households in Sofala.

3.6.3 Data Collection Tools

The survey used a structured questionnaire for data collection, informed by several standardized scales and questions. The questionnaire included multiple choice questions administered on the impacts of Cyclone Idai on households and food insecurity (SDG 2). The was informed by standardized guidelines such as the Household Food Insecurity Access Scale (HFIAS) designed by the food and nutrition technical assistance project (FANTA) (Coates et al., 2007). There were also questions of the impacts on other SDGs like poverty (SDG 1), water and sanitation indicators (SDG 6), energy and cooking fuel indicators (SDG 7), housing indicators (SDG 11). Relevant adaptations to Cyclone Idai were also assessed using indicators from the SDG framework (UN SDGs, 2016). Multiple scales were included to provide a wide selection of options, from which indicators could be derived for examining the differences in household food insecurity, based on a social vulnerability perspective. The questions for assessing these SDG indicators were adopted from the Lived Poverty Index (LPI) scales (Afrobarometer, 2013), and other modified scales which were derived from the 'Guidelines for Assessing the Human Impact of Disasters' provided by the United Nations Sustainable Development Group (EU et al,, 2019).

To avoid biases in the data collection tools, some measures were adopted. The questionnaire adhered to standardized questions for all households. Additionally, the questions were guided by recall periods of 4 weeks (month) or 1 year (12 months), pre-and post-cyclone Idai. Although these questions were subject to recall biases, enumerators were well trained to explain questions in ways that aided respondent recall. Information on the socio-economic and demographic characteristics of respondents pre-and post-Cyclone Idai was elicited to provide context to answers. Although this was an ex-post analysis, it is potentially useful for understanding post-disaster impacts and informing future predictions and preparedness. Ex-post analysis are relevant when there is limited availability of longitudinal studies that are better suited for pre-and post-shock analysis (Moreno-Serra et al., 2022), as pertains to Cyclone Idai in Beira.

3.6.4 Data Collection Procedure

The data collection covered all sampled households living in residences hit by Cyclone Idai. Household heads willing to participate were interviewed by enumerators. Enumerators excluded non-residential buildings and households not impacted by the cyclone and then moved to the next household for recruitment, provided requirements were met. After this, enumerators administered questionnaires digitally on a tablet, through face-to-face interviews with household representatives that were willing to participate. The survey software 'Kobotoolbox', which was used for the data collection ensured that the survey data was immediately available for analysis after collection. Enumerators further input city-specific codes for the various locations where interviews took place, and input GPS locations of interview to enable easy tracking and follow-up with households. The household respondents were asked about their interest in participating in an FGD and those who affirmed provided contact information for the subsequent qualitative study.

3.7 Quantitative Data Processing

The Statistical Package for Social Sciences (SPSS) (SPSS Inc., Chicago, IL) version 23 was used for data entry and cleaning. Data was entered for all variables and survey answers from the interviews, including "97" (refused to answer), "98" (Don't Know) and "99" (missing). During data input, missing location data for neighborhoods was verified. There was a total number of 975 households after data entry. The data was then cleaned manually by identifying duplicate and empty surveys and deleting them. Enumerators were contacted for accuracy checks to support data cleaning. After data cleaning, survey questions with incomplete responses, coded as "97" (refused to answer), "98" (Don't Know) and "99" (missing) were excluded from the analysis. The data were imported into STATA 16 SE for analysis, which provided preliminary statistical information on the impacts of Cyclone Idai experienced by households.

A complete case analysis approach was adopted, whereby only the responses that have a complete set of data for all variables of interest pre-and post-Cyclone Idai, were included in the analysis. The respondents with a complete set of data for all variables of interest in this study were 709 (n=709) (Figure 3.3). Complete case analysis is valuable when missing data is missing completely at random (Knol et al., 2010). Visual checks on the distribution of the data were therefore carried out to determine that the missing data was missing completely at random, as non-random missing data can potentially affect the representativeness of data from a survey (Christensen et al., 2012). Complete case analysis may also result in biases like the loss of statistical power (Knol et al., 2010). Notwithstanding, the results are not rendered less meaningful when they are backed by other data. The complete cases of quantitative data still provided relevant information about household food insecurity post-Cyclone Idai, and was complemented by the qualitative study, to help overcome the limitations.

3.7.1 Data Analysis

To examine the relationship between the dependent food insecurity variable and the independent variables of household characteristics, personal food environment characteristics and adaptations, descriptive statistics and bivariate analysis were used. Household food insecurity was assessed pre- and post-Cyclone Idai to determine the differences. The comparison of differences in household food insecurity for the same households pre- and post-Cyclone Idai provided methodological strength to the study. The approach was valuable for capturing insights into household factors that were linked to differences in post-disaster food insecurity, by using comparable responses.

3.7.2 Key Variables in Quantitative Survey

3.7.2.1 *Dependent Variable Measures - Food Insecurity (HFIAS and HFIAP)*

Food insecurity has four main dimensions of food availability, food access, utilization and stability. However, the term 'food access' has been used synonymously for 'food security' because all the other dimensions (availability, utilization and stability), are requirements for ensuring adequate 'food access' (Coates et al., 2003; Pinstrup-Andersen, 2009; Jones et al., 2013). The quantitative study therefore assessed food access as a measure of food insecurity, although the other dimensions were explored qualitatively. The study measured household food insecurity as the dependent variable, using the Household Food Insecurity Access Scale (HFIAS) and the Household Food Insecurity Access Prevalence (HFIAP) in the month before and after Cyclone Idai.

Household Food Insecurity Access Scale (HFIAS): The HFIAS measures the household food insecurity based on the access pillar of the food security construct (Coates et al., 2007). The HFIAS scale is a FIEMS that uses 9 Likert questions to help understand the characteristics of, and the changes in household food insecurity in the sampled population (table 3.1). Questions inquire about perceptions of vulnerability and behavioral responses to food access challenges. The HFIAS is useful for distinguishing between food insecurity among households across different cultural and geographic contexts and detecting changes in their food insecurity over time.

Table 3.1: Household Food Insecurity Access Scale (HFIAS) Generic Questions

No.	Questions on the Scale
1.	In the past four weeks, did you worry that your household would not have enough food?
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6.	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
8.	In the past four weeks, did you or any household member got to sleep at night hungry because there was not enough food?
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Source: (Coates et al., 2007)

For this study, all the HFIAS questions were asked for the four weeks before and after Cyclone Idai. This means that respondents were asked:

- *"In the four weeks before Cyclone Idai (February 15, 2019, to March 15, 2019), did you worry that your household would not have enough food?*

- *In the four weeks after Cyclone Idai (March 15, 2019, to April 15, 2019), did you worry that your household would not have enough food?*

For each question, the ranked optional answers were provided, ranging from '0' No (never), to '3' Often (more than 10 times in the past 4 weeks) (Coates et al., 2007). Based on the responses, the scoring algorithm calculated the frequency and severity of food access challenges that the entire household faced, as a continuous variable. The score variable was calculated by summing up the frequency of occurrence question codes where the highest score of '27' implied high levels of food insecurity and the lowest score of '0' implied food security (table 3.2). Households that scored '27' meant that the household responded '3' (often) for all frequency-of-occurrence questions. If the minimum score was '0' then it meant the household responded "no" to all the occurrence and frequency of occurrence questions. Higher scores indicated that the household experienced more food insecurity (access) whilst lower scores implied less food insecurity (access).

Table 3.2 Calculation of HFIAS Score

	Occurrence Question
Main Question	In the past four weeks, did you worry…?
Response Options	0=No (Skip to next question….) 1=Yes
	Frequency-of-occurrence Question
	How often did this happen?
Main Question	1=Rarely (once or twice in the past four weeks)
Response Options	2= Sometimes (three to ten times in the past four weeks)
	3= Often (more than ten times in the past four weeks)
HFIAS Score (0-27)	Sum of the frequency-of-occurrence during the past four weeks for the 9 questions related to food insecurity conditions
	Sum of the frequency-of-occurrence response code (Q1a + Q2a + Q3a + Q4a + Q5a + Q6a + Q7a + Q8a + Q9a)

Source: (Coates et al., 2007)

Although table 3.2 separates the 'occurrence questions' from the 'frequency-of-occurrence questions', these questions were delivered at once during the survey for the study. This was done by adding a "No" option to the frequency of occurrence list to simplify the structuring of the

survey and still maintain the intent of questions. The answer options provided for the HFIAS questions during the survey were as follows:

0	No (answer to question is 'No')
1	Rarely (once or twice)
2	Sometimes (3 to 10 times)
3	Often (more than 10 times)
97	Refused to answer (DO NOT READ OUT LOUD)
98	Do not know (DO NOT READ OUT LOUD)
99	Missing (DO NOT READ OUT LOUD)

Apart from measuring food insecurity as a continuous variable for capturing small changes in food insecurity over time, the HFIAS was also converted into the Household Food Insecurity Access Prevalence (HFIAP), to measure food insecurity as a categorical variable. The changes in the HFIAP status of households, usually does not stand on its own but is reported in addition to the HFIAS Score for evaluating household food insecurity. This study reports the HFIAP status in addition to the HFIAS Score. Reporting the HFIAP in addition to the HFIAS is useful for population level examination of household food insecurity and for targeting purposes but cannot be used to determine the causes of the problem or to guide responses to the problem (Coates et al., 2007).

***Household Food Insecurity Access Prevalence (HFIAP)*:** The Household Food Insecurity Access Prevalence (HFIAP) status categorizes households into four main categories based on the HFIAS Scores. Households are categorized as *food secure* (1), *mildly food insecure* (2), *moderately food insecure* (3) *severely food insecure* (4). A *food secure* household does not experience any of the lack of access conditions that are linked to food insecurity, or rarely experiences worry, which aligns with scores (0-1) on the HFIAS score. A *mildly food insecure* household is one that rarely worries about not having enough food or rarely eats monotonous and less desired food, this aligns with (2-7) on the HFIAS score. A *moderately food insecure* household worries about the quality of food, eats more monotonous diets and cuts back on size and number of meals, which aligns with scores (8-14) on the HFIAS score. *Severely food insecure* households, apart from all that is experienced by moderately food insecure households, experience the most severe conditions of running out of food, going to bed hungry or going the whole day or night without food, which aligns with scores of (15-27) on the HFIAS score. A categorization scheme designed to inform how a household's set of responses were replaced with a single, unique category is outlined in Table 3.3 (Coates et al., 2007).

Table 3.3: Categories of food insecurity (access) used by the HFIAP

Question	Frequency		
	Rarely 1	Sometimes 2	Often 3
1a			
2a			
3a			
4a			
5a			
6a			
7a			
8a			
9a			

- food secure
- moderately food insecure
- mildly food insecure
- severely food insecure

Source: (Coates et al., 2007 p19)

To obtain the HFIAP, an HFIA category variable was first calculated for each household by applying codes, based on the food security category within which they fell. The four food security categories were created sequentially, to ensure that the classification of households is based on their most severe response, in the order shown in table 3.4 below. After calculation of the HFIA, the prevalence of different levels of household food insecurity were calculated (table 3.4).

Table 3.4: Calculation of the Household Food Insecurity Access Prevalence (HFIAP)

HFIA category	Calculate the Household Food Insecurity Access category for each household. 1 = Food Secure, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access HFIA category = 1 if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0] HFIA category = 2 if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0] HFIA category = 3 if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0] HFIA category = 4 if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]
HFIA Prevalence	Percentage of households that fall in each food insecurity (access) category. For example: "Percentage of severely food insecure (access) households." Example: $\frac{\text{Number of households with HFIA category =4}}{\text{Total number of households with a HFIA category}} \times 100$ For example: "Percentage of severely food insecure (access) households" $\frac{\text{Number of households with HFIA category =4}}{\text{Total number of households with a HFIA category}} \times 100$

Source: (Coates et al., 2007 p20)

The HFIAP categories represent both the increasing frequency and severity of food insecurity using scoring algorithms. In this study, the HFIAP was further recategorized into a binary variable for ease of analysis. The households that scored 1 in the HFIAP which indicated that the household is food secure were denoted as *food secure* (0) whilst those who scored '2,3 and 4' in the HFIAP (mildly, moderately, severely food insecure) were merged to indicate *food insecurity (1)*. The application of the HFIAS and HFIAP to meet research objective 1 is outlined in table 3.5.

Table 3.5: Research Objective 1 and the Dependent Variable Measurement

Objective	Dependent Variable Definition	Analysis
1. Assess the differences in household food insecurity pre-and post-Cyclone Idai.	**Household Food Insecurity** • One month before and One month after Cyclone Idai) [continuous variable]	This objective was met through the steps below: • The HFIAS scores for food insecurity were generated for one-month before and one month after Cyclone Idai to assess if there were any differences in the immediate aftermath of Cyclone Idai. • Wilcoxon-signed rank hypothesis tests were used to test the differences identified between the pre-and-post Cyclone Idai HFIAS scores for significance. Results that were significant were further tested for strength of association. • Descriptive statistics, specifically box plots were used to illustrate the differences between pre-and post-Cyclone Idai HFIAS results. • The HFIAP was then used to categorize HFIAS scores into *'food secure, mildly food insecure, moderately food insecure and severely food insecure'* to further explain differences. The responses were recategorized into binary variables where '0' represents *food secure (HFIAP=1)* and '1' *food insecure (HFIAP=2,3,4).* • Differences in household food insecurity pre-and-post Cyclone Idai were also assessed qualitatively.

3.7.2.2 *Independent Variable Measures - Household and Personal Food Environment Characteristics and Adaptations to the Cyclone Idai disaster*

The independent variables adopted in this study comprised of household characteristics, personal food environment characteristics and adaptations to disaster that were related to household food

insecurity post-Cyclone Idai. The household characteristics and personal food environment characteristics were useful for assessing the differences in food insecurity. Additionally, household adaptations to address food insecurity, that were facilitated by their interactions with social capital networks at the microsystem, mesosystem and macrosystem levels pre- and post-Cyclone Idai were assessed. This supported the assessment of differential household food insecurity from a social vulnerability perspective. Descriptions of measurement for the independent variables are detailed below.

Defining Indicators for the Independent Variable 'Household Characteristics'

The household survey was administered to available household heads and adult household representatives who were knowledgeable about the household characteristics, food insecurity and the experience of Cyclone Idai. Specifically, the sociodemographic data like the age, gender and educational level that were captured, represent those of the respondent rather than the household head. The study therefore focused on household characteristics that applied to the whole household rather than household head characteristics to avoid introducing biases into the results. The household characteristics that were considered included household size, household income and presence of chronically ill members, which apply to the household overall and relevant for assessing differences in household social vulnerability (table 3.6). Characteristics unique to household heads such as household head gender and education, which are widely used indicators for assessing social vulnerability were excluded from the quantitative analysis but were considered during the qualitative analysis.

Table 3.6: Research Objective 2 and the Measurement of the Independent Variable

Objective	**Independent Variable Definition**	**Analysis**
2. Identify the differences in household food insecurity by the household characteristics post-Cyclone Idai.	**Household Characteristics** • Household Size • Household Income in the month after Cyclone Idai • Presence of Chronically Ill Members after Cyclone Idai	This objective was met through the steps below: • Continuous variables were recategorized for ease of analysis (household income). • Differences in the dependent variables (HFIAS scores one-month post-Cyclone Idai) in relation to the indicators for household characteristics were assessed. • The Kruskal-Wallis' hypothesis test was then used to test for the differences between the post HFIAS scores (household food security) based on

		household characteristics and their significance. • Differences in food insecurity based on household characteristics were also assessed qualitatively

Defining Indicators for the Independent Variable 'Personal Food Environment Characteristics'

The personal food environment characteristics in this study are comprised of indicators that provide a more comprehensive assessment of household food access in a post-disaster context. The personal food environment is a component of food systems which influences household food acquisition, preparation and consumption. The inclusion of indicators for the personal food environment highlighted the connections between food systems and household food access in assessing household food insecurity. The personal food environment subdimensions (accessibility, affordability and convenience) and the indicators adopted by this study were informed by Turner et al. (2017) and Turner et al. (2018). The indicators for the personal food environment were derived from questions in the household survey, in particular, questions were taken from the Lived Poverty Index (LPI) module, which measured experiential poverty.

The LPI was designed by Afrobarometer, a pan-African Research Institute, for assessing the multidimensional nature of poverty in African countries (Afrobarometer, 2013). The LPI focuses on a wide range of necessities relevant for contextualizing poverty in African countries (e.g., enough food, access to income), that are not included in other international measures, such as the multidimensional poverty index (MPI) of the United Nations Development (UNDP). The LPI has been useful for tracking progress on SDG 1 'No Poverty' implementation, within the African continent. The LPI asks a series of questions about how frequently people are deprived of basic necessities during the course of a year (Mattes, 2003; Mattes & Dulani, 2016). LPI questions that were adopted for the household survey are highlighted below (table 3.7).

Table 3.7: Description of Lived Poverty Index Questions

Lived Poverty Index Questions	**Responses**
In the year before Cyclone Idai (March 15, 2018, to March 15, 2019), how often, if ever, did you or your household go without: *In the year after Cyclone Idai (March 15, 2019, to March 15, 2020), how often, if ever, have you or your household gone without:* • enough food to eat?	-Never

• enough clean water for home use? • an accessible toilet facility? • medicine or medical treatment? • electricity in your home? • fuel to cook your food? • a cash income?	-Just once or twice -Several times -Many times -Always (Select only one answer for this question.)

Each question from the LPI module can be used as a stand-alone question for measuring the experience of consistent or inconsistent access to basic necessities such as food, energy and cash income, to enable comparisons across countries. For example, responses from Afrobarometer surveys show that 4% of respondents in Mauritius and 61% of respondents in Mozambique, reported going without food at least once in the past year (Mattes & Dulani, 2016). The responses for all access questions in the index can also be summarized into an average index score of lived poverty, that runs from 1 (complete satisfaction of basic needs) to 4 (frequent shortages of basic needs), for each country (Mattes, 2003). For example, the average LPI score for Botswana was 1.98 while Lesotho was 2.76, showing that Botswana is lesser impoverished compared to Lesotho (Mattes, 2003). This study adopts the approach of using the questions in the LPI as stand-alone proxy indicators for the accessibility, affordability and convenience characteristics of personal food environment in the year after Cyclone Idai.

The *convenience* subdimension of the personal food environment is related to decision making, time, efforts and resources involved in choosing, cooking and consuming food (Turner et al., 2018; Fernandes et al., 2017). This involves access to a network or resources including energy (e.g., electricity, cooking fuel) and water (Pyle et al., 2021). The proxy indicators for '*convenience'* taken from the LPI included *access to enough clean water for home use, access to electricity and access to cooking fuel)* in the year after Cyclone Idai. The answers options for the LPI questions "never", 'just once or twice", "several times", "many times" and "always" were recategorized into a binary variable. If the household answered "never" for not going without a basic need, this was coded as *consistent access* (0), whilst other responses indicating a lack of access (just once or twice, several times, many times, always) were coded as *inconsistent access* (1).

The *affordability* subdimension of the personal food environment considers whether people have the financial resources, sufficient for purchasing food items needed by their households (Nozhati et al., 2019). For *affordability,* the proxy indicator taken from the LPI was *access to a cash income.* If the household answered "never" for not going without a cash income, this was coded as *consistent access* (0), whilst other responses indicating lack of access (just once or twice, several times, many times, always) were coded as *inconsistent access* (1) (table 3.8). Apart from the LPI another indicator that was used for *affordability,* was a question taken from another section of the household survey on "job loss in the household for at least 3 months after Cyclone Idai". The

answer options were 'Yes' and 'No'. 'No' was recategorized as 0 (Undisrupted Job Access), and 'Yes' was recategorized as 1(Disrupted Job Access).

The *accessibility* subdimension of the personal food environment takes into consideration the location of a household's residence, as relevant for facilitating food access (Glanz et al., 2005; Story et al., 2008). Living in informal settlements in urban areas has been associated with reduced accessibility for the poor and increased exposure to environmental hazards (Tacoli, 2017). The proxy indicators for *accessibility* were not taken from the LPI module but from other questions in the household survey questionnaire. The first question asks about a respondent's perception of their structure of residence, post-Cyclone Idai. Answer options included: 'House in a formal area', 'Apartment in a formal area', 'House in an informal area' and 'Shack in an informal area'. The responses were recategorized into a binary form where the responses 'house or apartment in a formal area' were coded as '*residence in a formal area'* (0), and the responses 'house or shack in an informal area' were coded as '*residence in an informal area'* (1) (table 3.8.). The second question used as proxy indicator was "how Cyclone Idai impacted household's home". The answer options were "destroyed home", "severely damaged home", "partially damaged home" and "unimpacted home". The answer options were recategorized into a binary variable as follows: responses for *"severely damaged home", "partially damaged home" and "unimpacted home"* were recorded as *"House not Destroyed" (0)* whilst *"Destroyed Home"* was recorded as *(1) for "House Destroyed"* (table 3.8).

A challenge encountered while deriving proxy indicators for the personal food environment subdimensions, were the differences in timescales of the questions used from the household survey (e.g., access to cooking fuel in the year after Cyclone Idai and job loss for at least 3 months post-Cyclone Idai). This created limitations in quantitatively assessing the relationship between the personal food environment indicators, which were assessed based on a time duration of one year after Cyclone Idai whilst household food insecurity (HFIAS) was one month after Cyclone Idai. Due to this, the quantitative analysis only focused on descriptive statistics for assessing the differences in the household personal food environment subdimensions post-Cyclone Idai. This was complemented by the qualitative study which examined how household food insecurity in the year after Cyclone Idai differed among households, based on their lived experiences of the impact of Cyclone Idai on their personal food environment.

Table 3.8: Research Objective 3 and the Measurement of the Independent Variable

Objective	**Independent Variable Definition**	**Analysis**
3. Examine the differences in household food insecurity based on the accessibility, affordability, and convenience characteristics of their personal	**Personal Food Environment Characteristics** **Accessibility**	This objective was met through the steps below: • Answer options for all personal food

food environment post-Cyclone Idai.	• Residence in a formal or informal area post-Cyclone Idai (Q13). • Was household's home destroyed, severely damaged, partially or unimpacted by Cyclone Idai (Q23). **Affordability** • Access to cash income in the year after Cyclone Idai (Q62). • Job loss in the household for at least 3 months after Cyclone Idai (Q83). **Convenience** • Access to clean water for home use in the year after Cyclone Idai (Q57). • Access to electricity in the year after Cyclone Idai (Q53). • Access to cooking fuel in the year after Cyclone Idai (Q61).	environment indicators were recategorized into binary variables. • Descriptive statistics (measures of frequency) were used to show the accessibility, affordability and convenience indicators of households after Cyclone Idai. • The differences between the personal food environment indicators and household food insecurity after Cyclone Idai were assessed qualitatively.

Defining Indicators for the Independent Variable 'Adaptations to Disasters'

Post-disaster settings are complex, with overwhelming human needs and high demand for humanitarian assistance. Post-disaster needs assessments (PDNA) are therefore required to assess the full impact of a disaster on a country. Human impact assessments form an essential component of PDNAs (GFDRR, 2013). The human impact assessment seeks to understand, among others, how disasters affect different population groups, which groups are the most affected and why, based on the resources, capacities and adaptation to disaster strategies applied, and the potential future consequences for the vulnerable (EU et al., 2019). The human impact assessment process therefore incorporates a disaster management cycle approach, by considering pre-disaster preparedness, emergency response to immediate impacts and post-disaster recovery phases (Niekirk, 2006; Khan et al., 2008; UNDP, 2016).

The EU, UN, & The World Bank. (2019), created a guideline to support human impact assessment of disasters called '*Guidelines for Assessing the Human Impact of Disasters'*. The guideline helps to track the cascading effects of a disaster based on baseline information, the immediate disaster effects on core indicators (living conditions, livelihoods, food security, gender equality and social inclusion), people's resources, and coping or adaptation capacities of households. For food security, the guideline recommends the consideration of the pre-disaster context, based on the 4 pillars (food availability, access, utilization and stability), the immediate effects of the disaster, household coping or adaptation to strategies and their outcomes (EU et al., 2019). Even though the Guideline used the terms 'coping' and 'adaptations' interchangeably, in reference to short-term strategies to moderate a disaster's impact. Adaptations encompass both short-term disaster risk reduction adjustments for extreme weather events, and long-term measures addressing climate change impacts like sea level rise (IFRC, 2020). This study therefore adopted the term 'adaptations' in reference to short-term measures applied to minimize Cyclone Idai's impacts, including food insecurity.

The Guideline informed questions on household adaptations to disasters, that were relevant for food insecurity in both the quantitative and qualitative components of this study and were aligned with the SES theoretical framework. The adaptations to disasters included: microsystem level (e.g., spending household savings, taking on hazardous work), and food-sourcing adaptations based on interactions at the mesosystem level (e.g., borrowing food from friends and relatives) and macrosystem level (e.g., receiving food aid) (EU et al., 2019). The adaptation to disaster strategies were assessed quantitatively using descriptive statistics and complemented with the qualitative study, to capture both Cyclone Idai disaster preparedness and response phases. The qualitative study also assessed how these adaptations enabled or constrained food access during the disaster phases. The post-Cyclone Idai recovery phase was excluded because recovery was still ongoing at the time of the study. Adaptations refer to short-term strategies to adapt to Cyclone Idai including food-sourcing adaptations. Table 3.9 details indicators for assessing household adaptations to disasters used in this study.

Table 3.9 Research Objective 4 and the Measurement of the Independent Variable

Objective	**Independent Variable Definition**	**Analysis**
4. Assess the adaptations to disasters related to household food insecurity during Cyclone Idai and how they enabled or constrained food access.	**Household Level Adaptations** • Was households displaced or non-displaced by Cyclone Idai (Q107)? • Was there an uptake or no uptake of informal work by household (Q98)? • Did household sell or not sell assets such as livestock (Q93)? • Did household use or did not use savings (Q89)?	This objective was met through the steps below: • Answer options were recategorized into binary variables.

	• Did household members migrate or did not migrate post-Cyclone Idai (Q108). • Did household diversify income or not post-Cyclone Idai (Q101)? **Mesosystem Facilitated Adaptations** • Did household take out any loans (Q102)? • Did household receive assistance from community members or not (Q94)? • Did household receive assistance from relatives outside the city or not (Q95)? • Did household borrow or not borrow in kind (e.g., food) to meet post-Cyclone Idai needs (Q103)? • Did household borrow or not borrow to meet basic needs (Q90)? **Macrosystem Facilitated Adaptations** • Did households receive government relief assistance (Q96)? • Did households receive non-governmental relief assistance (Q97)?	• The original answers and codes, 'Yes =1' and 'No =2' were recategorized into: No=0 adaptation not applied, and Yes=1 adaptation applied. • Descriptive statistics, specifically bar charts, were used to illustrate the uptake of adaptation to disaster strategies among households quantitatively. • This was later complemented with qualitative analysis.

3.8 Qualitative Study

3.8.1 Study Design

A qualitative study was carried out in order to explain the quantitative results on the differences in food insecurity post-Cyclone Idai and the household, personal food environment, and the associated adaptation factors in Beira Mozambique. The data collection procedures combined key informant interviews (KIIs) and focus group discussions (FGDs) to draw on multiple sources of data for interpretating the results (Creswell & Creswell, 2018). All KIIs and FGDs were face-to-face and guided by an interview guide of semi-structured questions (attached in the appendices). A semi-structured interview guide depends on open-ended questions, follow-up questions and probes to collect data on the experiences and perceptions of participants about a subject of interest (DeJonckheere & Vaughn, 2019).

3.8.2 Study Sample

The participants recruited for the key informant interviews (KIIs) included community leaders and officials from disaster management institutions that were involved in the targeting of vulnerable households for post-Cyclone Idai assistance and the provision of food aid. These institutions included the National Institute for Disaster Risk Management and Reduction (INGD), other governmental institutions, members from the Cluster of humanitarian agencies, and partners collaborating on food security and nutrition (table 3.10). Additionally, focus group discussions (FGDs) were conducted with both community leaders and household representatives in communities impacted by Cyclone Idai.

3.8.3 Sampling Method

Participants for the qualitative study were recruited with the help of members of the research team in Beira, Mozambique. All participants were 18 years and older and lived in the City of Beira before and after Cyclone Idai. Purposive sampling was applied in selecting participants for 10 KIIs at the macrosystem level, however, 9 KIIS were conducted because one institution, the World Food Program (WFP), did not agree to be interviewed (table 3.10 and figure 3.3). At the mesosystem level, 1 triad KII and 1 FGD were conducted with the community leaders, whilst 3 FGDs were conducted with household heads and representatives at the microsystem level (table 3.10 and figure 3.3). All FGDs were conducted with 8-10 participants whose characteristics are indicated in table 3.11 below. The Household FGDs conducted were grouped into 3 categories, namely: FGD with participants whose houses were impacted but they were not displaced; participants whose houses were impacted and were displaced; and participants who lived in a resettlement camp and were still displaced by Cyclone Idai (table 3.11). The number of in-depth interviews and FGDs were informed by estimations for reaching saturation points (i.e., points where no new themes are being unearthed during the discussion) (Guest et al., 2006; Guest et al., 2017).

Table 3.10: Summary of Participants for KIIs and FGDs

Type of Interview	Institution	Type of Institution
Macrosystem Level Interviews		
KII	GREPOC-Post Cyclone Reconstruction Office	Government
KII	National Institution of Social Action –(INAS)	Government
KII	National Institute for Disaster Risk Management and Reduction-(INGD)	Government
KII	Ministry of Agriculture	Government

KII	Mozambique's Technical Secretariat for Food Security and Nutrition (SETSAN)	Government
KII	Food for the Hungry-(FH)	Non-Government
KII	Asate Association	Non-Government
KII	Foundation for Community Development -FDC	Non-Government
KII	International Federation of the Red Cross Society	Non-Government
Mesosystem Level Interviews		
TRIAD KII	Churches- Lutheran, Anglican and Nazarene	Social Institutions (3 Community leaders)
FGD	Women Entrepreneurs	Social Institutions (8 Community leaders)
Microsystem Level Interviews		
FGD	Non-resettlement Camp and Non-displaced	Household (heads and representatives)
FGD	Non-resettlement Camp and Displaced Community	Household (heads and representatives)
FGD	Resettlement Camp and Displaced Community	Household (heads and representatives)

Table 3. 11: Summary of Participant Characteristics for Household FGDs (N=28)

Characteristics		**N (%) during FGD**
1.	**Gender**	
	Male	9 (32.14)
	Female	19 (67.86)
2.	**Displacement Status**	
	Non-resettlement Camp and non-displaced FGD	8 (28.57)
	Non-resettlement Camp and displaced FGD	10(35.71)
	Resettlement Camp and displaced FGD	10 (35.71)

3.8.4 Qualitative Data Collection and Tools

Interview guides were used for the KIIs and FGDs (attached in the appendices). The community leaders and institutional KIIs looked into their facilitation of household adaptations that were linked to food access during Cyclone Idai preparedness and response. Examples of questions that were asked during KIIs included "What adaptation measures did your organization put in place to address household food insecurity post-Cyclone Idai? What informed the adaptations? What were

the outcomes?". The FGDs also elicited information on the prevalence of household food insecurity and personal food environment characteristics (accessibility, affordability and convenience) prior to Cyclone Idai. Both KIIs and FGDs delved into the differences in adaptation to disaster strategies employed by households to address household food insecurity, and how they constrained or enabled food access.

All the qualitative interviews were conducted in locations that were convenient for the participants. These included the conference rooms of institutions, a primary school classroom and under a big tree that served as a community gathering place. All the interviews were facilitated by the researcher and a translator who translated questions from English to Portuguese and responses from Portuguese to English. Interviews lasted for about 60 minutes on average. All the KIIs and FGDs were audio-recorded using a digital voice recorder.

The sampling process, design of the survey, training of enumerators and data collection were conducted with research partners from the Eduardo Mondlane University, Maputo Mozambique and the Catholic University of Mozambique in Beira, Mozambique. Such a collaboration was essential because of the bilingual nature of the study and to ensure that there was agreement on translation of research tools. The reliance on digital data collection methods ensured efficient, rapid and clean data collection and made it easier to identify potential errors which were clarified with the research team.

3.8.5 Qualitative Data Processing and Analysis

The qualitative analysis was conducted using the guideline developed by Braun & Clarke, 2006. The guide outlined six steps: *familiarization with data, generation of initial codes, search for themes, review of themes, definition of themes and production of the report*. The steps in the guideline are however not linear from one step to the other but rather recursive and requires several back and forth movements throughout phases as needed (Braun & Clarke, 2006). The 6 steps from the guide were followed in this study and are outlined below.

- *Familiarizing with the data*

All the interviews were transcribed verbatim into Microsoft Office Word by the researcher. All transcribed interviews were imported into NVivo Version 12 qualitative analytical software after which each transcript was read line by line. To ensure that the absolute content of the interviews and the original meaning of statements were maintained, the transcripts were read and cross-checked with the recorded audios.

- *Generation of initial codes*

This process involved the identification of codes based on the research questions and thorough, repeated readings of the transcripts. A code book was developed which was then used to guide the

development of nodes in NVivo software. Coding was informed by structural and concept coding methods where coding was based on research questions and theoretical concepts, and supported with verbatim quotes (Saldana, 2016). After coding, the codes were constantly reread and iteratively compared to the original transcript whilst similar codes were combined, and redundant codes were dropped. The final number of codes after this process was 30 codes.

- *Search for themes, review of themes, definition of themes*

The codes were re-coded into fewer categories or themes and operationally defined to answer the research questions. The use of auto-coding and categorizing features in the NVivo 12 software were helpful for this process. The themes were narrowed down to between 3-5 overarching themes under each objective (Saldana, 2016). The recategorization and development of themes for the study involved both deductive and inductive approaches. The deductive approach of theme generation relied on the use of existing theoretical concepts to create themes whilst the inductive themes are driven by the data (Braun & Clarke, 2006). The main themes, developed, which reflect the deductive approach, included: 'underlying food availability and limited food access pre-Cyclone Idai'; 'post-Cyclone Idai household adaptations to food insecurity during disaster response'; and 'macrosystem facilitated adaptations for household food insecurity in preparedness for Cyclone Idai'. In addition, sub-themes identified from within the data were developed inductively, including: **'**Increased Bonding Social Capital Networks that drain household resources'; **'**Emergency and Non-emergency phase household food-sourcing adaptations'; and 'Interconnected SES-level coordination challenges and household food insecurity'. The themes were reviewed and the connections between them were then presented as narratives for the results.

- *Production of report*

Narratives were constructed from the themes, sub themes and codes in relation to the research objectives. The narrative for objectives 1 to 3 examine the differences in household food insecurity post-Cyclone Idai and the differences in the household and personal food environment characteristics. These were from the perspectives of respondents representing microsystem, mesosystem and macrosystem SES Levels. For objective 4, the narrative assesses the types of adaptations to disaster adopted by the various SES levels in addressing microsystem household food insecurity and their leveraging or constraining outcomes for food insecurity post-Cyclone Idai. Under this section the qualitative results were used for explaining the quantitative results iteratively to be consistent with mixed methods analysis. A summary of all identified factors is displayed visually using a mind map that connects findings from all objectives.

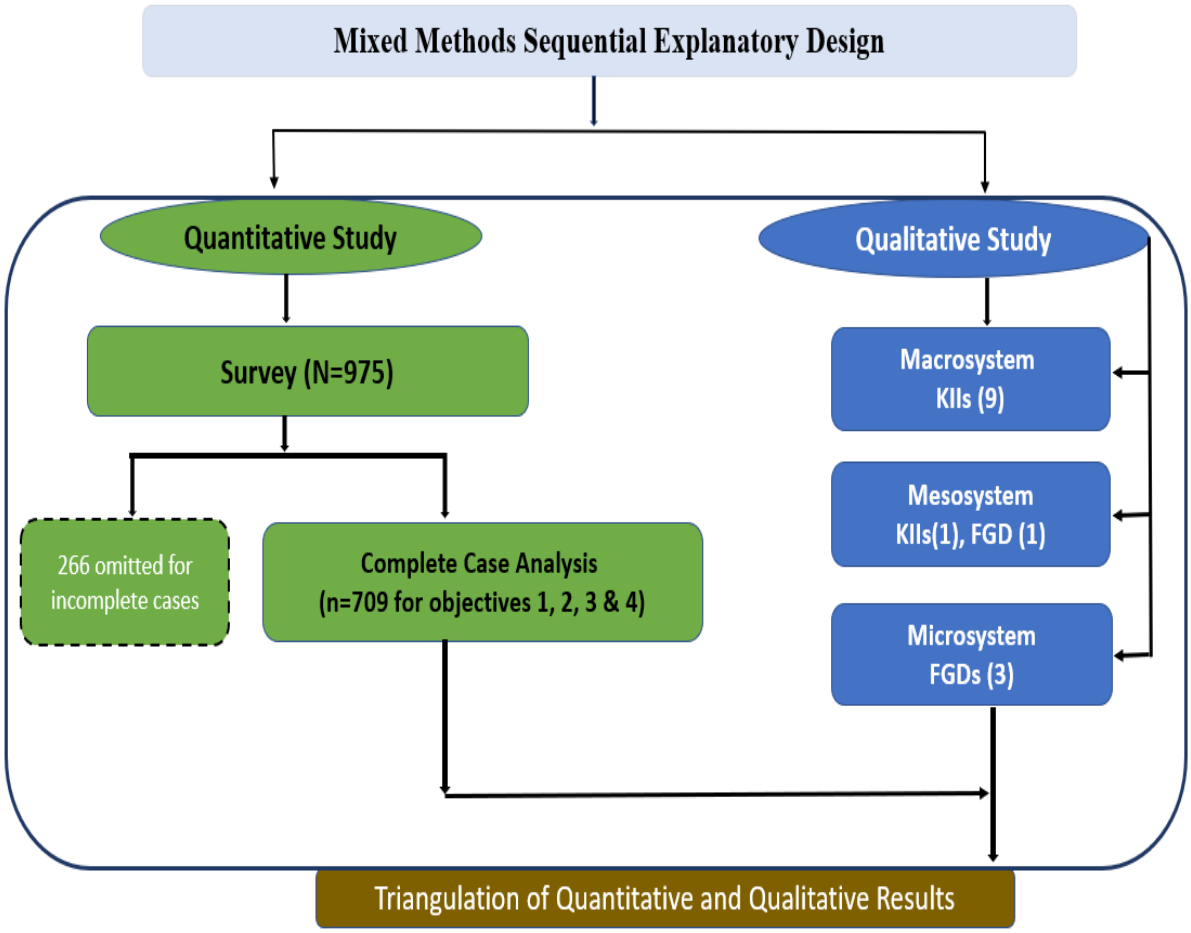

Figure 3.3 Overview of Study Design showing Quantitative and Qualitative Phases

3.9 Validity of Methods and Results

The scales that the study adopted for the quantitative analysis, such as the HFIAS and HFIAP for measuring food insecurity and indicators from the LPI, are standardized scales and questions that have been established by accredited institutions and applied in previous research (Coates et al., 2007; Mattes, 2003; Coates, 2013; Frayne & McCordic, 2015; Mattes & Dulani, 2016). Additionally, the adaptations to disasters that were considered were taken from the established 'Guidelines for assessing the human impact of disasters', designed by United Nations agencies (EU, UN, & The World Bank, 2019). Finally, both the Stata software used for the quantitative study statistical analyses and the NVivo software for the qualitative analyses are established on well-tested algorithms and are widely used.

3.10 Ethical Clearance and Permission

Ethical approval for the study was obtained based on requirements for research with human participants from the University of Waterloo Research Ethics Board (REB #43049). Additional permissions for community entry were obtained in Beira Mozambique, the location of the research. Participation in the study was voluntary and there were no consequences for participants who chose to withdraw from the study. The study participants were made aware that they will not be remunerated for their participation. However, participants were assured the information provided was important for understanding household food insecurity vulnerabilities post-disasters in Beira city, and relevant for informing preparedness for future disasters.

Participants were informed that they may feel stress at the recollection of stressful events and were permitted to skip any questions that they felt uncomfortable answering. Written informed consents were obtained from each participant for the study. To ensure anonymity, only institution names and pseudo names were adopted for communities and not respondent names. The data has also been handled with confidentiality and only accessible to members of the research team and used purely for research and academic purposes. A letter of appreciation has been sent to participants, and preliminary findings and publications will later be shared with them, and the Beira municipal assembly.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

This chapter presents the results of the study which have been structured based on the objectives. The socio-demographic characteristics of the study respondents for the quantitative study are first presented. After this, the quantitative results from the survey data are also presented and then followed by the qualitative results for each objective. The quantitative study presents findings on household food insecurity differences and the differences in the household and personal food environment characteristics after Cyclone Idai. Additionally, results on the types of adaptations to disaster employed and their association with differences in household food insecurity are presented. Textual data from the KIIs and FGDs of the qualitative study that help explain and complement the quantitative results are presented under each objective. For objectives 1 to 3 textual data were taken from the SES level interviews to explain quantitative results. However, for objective 4, textual data is structured under microsystem, mesosystem and macrosystem subthemes in explaining quantitative results. A summary of all identified factors is displayed visually using a mind map (figure 4.7). Throughout this chapter the quantitative and qualitative results are discussed iteratively to be consistent with the mixed methods analysis.

4.2 Characteristics of Study Respondents

4.2.1 Characteristics of Survey Respondents

For the quantitative analysis, only households with complete responses for all variables of interest from the household survey (n=709), were included. The demographic and socioeconomic characteristics of the respondents and the households represented, are provided in table 4.1 below. Almost half (48.66%) of household respondents were young (18-34 years), and a majority being female (65.87%). Respondents with a senior secondary school education were about 42 percent (41.89%), followed by a primary school education (34.27%), whilst a few were either highly educated with Post-Secondary Education (11.42%) or had no formal or informal Education (12.41%). Most of the respondents represented large households with more than 5 members (68.40%). Additionally, almost 50 percent (49.37%) of the households fell within the low-income category, and more than half of households (56.42%) had at least one person who was clinically diagnosed with a chronic illness. These characteristics provide some context for understanding the results on household food insecurity in subsequent sections of the chapter.

Table 4.1: Demographic and Socioeconomic characteristics of Respondents (n=709)

Characteristics	Frequency	Percentage (%)
Age groups		
Young (18-34yrs)	345	48.66
Early Middle-aged (35-49yrs)	191	26.94
Late Middle-aged (50+ yrs)	173	24.40
Gender		
Male	242	34.13
Female	467	65.87
Education		
No formal/informal Edu.	88	12.41
Primary School Education	243	34.27
Secondary Education	297	41.89
Post-Secondary School Education	81	11.42
Household Size		
Less than 5	224	31.59
5 and above	485	68.40
Chronic Illness		
No Chronic Illness	309	43.58
Chronic Illness Present	400	56.42
Household Income		
Low Income	350	49.37
Middle Income	252	35.54
High Income	107	15.09
Homeownership		
Home Not Owned	283	39.92
Home Owned	426	60.08

4.3 OBJECTIVE 1

4.3.1 Assessment of Household Food Insecurity HFIAS Scores Pre-and Post-Cyclone Idai

The first research objective sought to assess the differences in household food insecurity pre-and post-Cyclone Idai. Household food insecurity was assessed using the HFIAS Scores which examined changes in food insecurity, based on the food access of households pre-and post-Cyclone Idai. The HFIAS scores range between '0-27', whereby households that scored '27' experienced the highest level of food insecurity, whilst households with the lowest score of '0' were food secure and experienced no lack of access to food.

The results from the pre-and-post-Cyclone Idai HFIAS are presented using a box plot below. The pre-Cyclone Idai boxplot shows an almost symmetrical shape, with the central 50% of the scores falling between '8-19' on the HFIAS and a median of 14. In the post-Cyclone Idai boxplot, the central 50% of the scores were between '14-23' with a median of 18. This signifies that food insecurity increased after Cyclone Idai. The post-Cyclone Idai HFIAS boxplot is negatively skewed showing that, overall, more households recorded higher HFIAS values, indicating more severe forms of food insecurity post-Cyclone Idai compared to the pre-Cyclone Idai box plot. However, an outlier was present on the food secure end of the post-Cyclone Idai HFIAS boxplot. This showed an extraordinary value of food security for some households post-Cyclone Idai, compared to other households. Outlier was checked to ensure it was an actual data point and not an error.

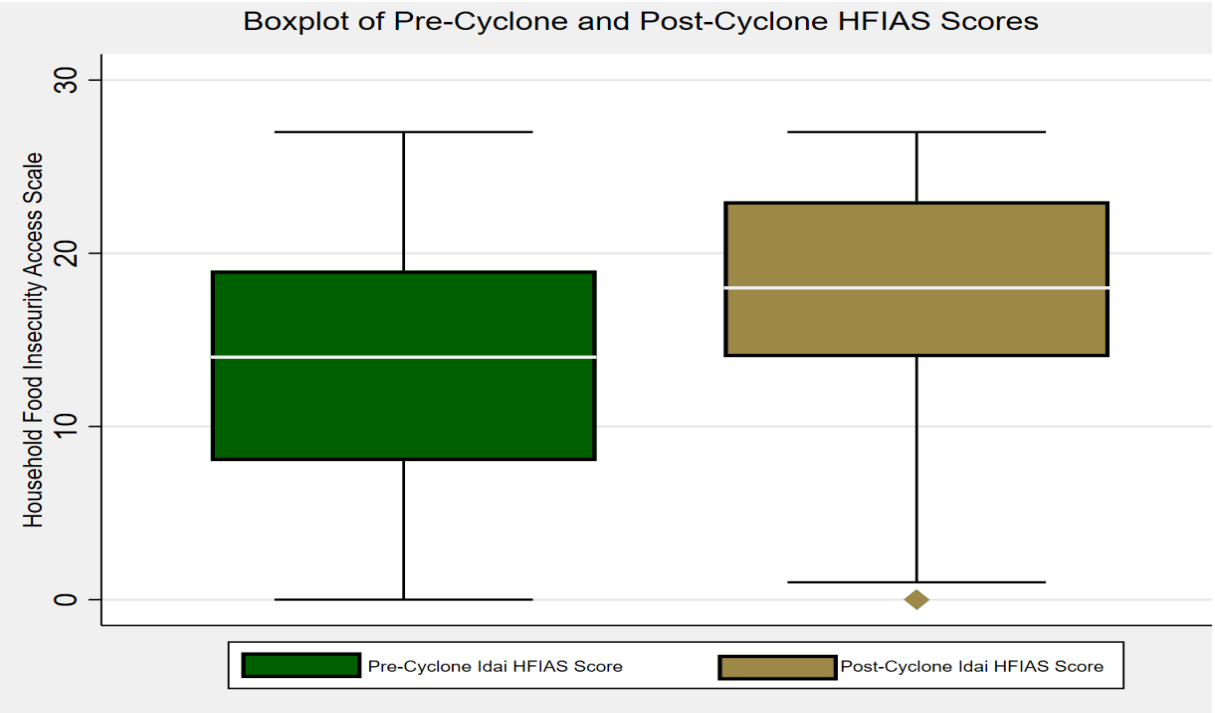

Figure 4.1: Boxplot of Pre-Cyclone and Post-Cyclone HFIAS Scores

To determine if the changes between pre-and post-Cyclone Idai HFIAS scores are statistically significant, tests of significance were conducted. However, to inform the type of 'tests of significance', a normal distribution condition, which underlies most data collection and statistical analyses (parametric or non-parametric), had to be determined through skewness and kurtosis tests (details in the appendix E). For the skewness and kurtosis tests, the Null hypothesis H_0 states that the distribution is normal, while the alternate hypothesis H_a indicates that the distribution is not normal.

The results of skewness and kurtosis for pre-and-post-Cyclone Idai HFIAS scores are presented below (table 4.2). For the pre-Cyclone Idai HFIAS scores, the values were: skewness=-0.11, $p>0.05$; and kurtosis=2.07, $p<0.001$ at the 5% significance level. This indicated no skewness; however, the kurtosis value was significant. The null hypothesis was accepted that the distribution is normal but exhibits kurtosis. For the post-Cyclone Idai HFIAS scores, the values were: skewness=-0.68, $p<0.001$; and kurtosis=2.92, $p>0.05$, at the 5% significance level. This indicated moderate skewness, which was statistically significant, while there was no kurtosis. We therefore reject the null hypothesis but accept the alternate hypothesis that the distribution is skewed but does not exhibit kurtosis. This means that the pre-and-post-Cyclone Idai HFIAS scores show some deviations from a perfectly normal distribution.

Table 4.2 Summary of Pre-and Post-Cyclone Idai HFIAS Scores (n=709)

	Pre-Cyclone HFIAS	**p-value**	**Post-Cyclone HFIAS**	**p-value**
Observations	709	-	709	-
Min (Food Secure)	0	-	0	-
Max (Severely Food Insecure)	27	-	27	-
Median	14	-	18	-
Mean	13.25388	-	17.33286	-
Std. Dev.	8.287754	-	7.668949	-
Variance	68.68687	-	58.81277	-
Skewness	-.112879	0.05	-.6818399	<0.001
Kurtosis	2.073387	0.001	2.921424	>0.05

From the results (table 4.2), the pre-cyclone HFIAS scores were normally distributed but showed kurtosis, while the post-cyclone HFIAS Scores are skewed but do not show kurtosis. So further tests were conducted to determine if the change between the pre-cyclone and post-cyclone HFIAS scores were skewed. The 'difference' between the pre-and post-Cyclone Idai HFIAS were tested for both skewness and kurtosis (POST_HFIAS_Score- PRE_HFIAS_Score). The results from the test using the 'difference' between the pre-and post-Cyclone Idai HFIAS scores, significantly deviated from those of normally distributed data, with p-values=0.000 for both tests at the 5% significance level (table 4.3). The results exhibited significant skewness and kurtosis. Thus, the

distribution of data was not normal and required non-parametric methods of analysis, that are not based on assumptions of normal distribution.

Table 4.3: Skewness test for Difference Between Pre-Idai and Post-Idai HFIAS Scores

Variable	Obs	Pr (Skewness)	Pr (Kurtosis)	Adj chi2(2)	Prob>chi2
Difference [Post Cyclone HFIAS - Pre-Cyclone HFIAS]	709	<0.0000	<0.0000	.	<0.0000

4.3.2 Test of Significance for the Differences in Household Food Insecurity Pre-and Post-Cyclone Idai

Based on the previous results, a non-parametric 'test of significance' analysis, using the Wilcoxon signed-rank test was conducted (details in appendix E). This test was used to assess if the increases in HFIAS scores between pre-and post-Cyclone Idai HFIAS were statistically significant. The Null hypothesis, H_0, states that there is no difference between pre-Cyclone Idai food insecurity and post-Cyclone food insecurity. The alternate hypothesis, H_a, indicates that there is a significant difference between pre-and post-Cyclone Idai household food insecurity. The results from the Wilcoxon Signed-Rank Test are indicated below (Table 4.4).

Table 4.4: Results of Wilcoxon Signed-Rank Test on Pre-and Post Cyclone HFIAS Scores

Sign	Observations	Sum ranks	Expected
Positive	85	30951	113022
Negative	398	195093	113022
Zero	226	25651	25651
All	709	251695	251695

unadjusted variance: 29762934

adjustment for ties: -24189.875
adjustment for zeros: -968325.25
---
adjusted variance 28770419
Ho: PRE_HFIAS_Score = POST_HFIAS_Score
z = -15.301
Prob > |z| = 0.0000

In the summary of analysis (table 4.4), there were 85 comparisons for which the pre-Cyclone Idai HFIAS scores were greater than post-Cyclone Idai HFIAS scores. Additionally, there were 398 comparisons where the pre-Cyclone Idai HFIAS scores were less than post-Cyclone Idai HFIAS scores, and 226 comparisons where the pre-and post-Cyclone Idai HFIAS scores were equal. The adjusted variance which had been corrected for ties and zeros was 28770419 and the z-score was -15.301. The probability of obtaining the z-score value if H_0 were true, was highly significant with p-value=0.000, at the 5% significance level. Hence, the difference between pre-and post-Cyclone Idai HFIAS scores is highly significant at the 5% significance level. As such, the null hypothesis (H_0: PRE_HFIAS_Score = POST_HFIAS_Score) was rejected, as there was strong evidence to accept the alternate hypothesis that there is a significant difference between pre-and post-Cyclone Idai household food insecurity. In other words, the occurrence of Cyclone Idai was linked to significant increases in household food insecurity in the month after Cyclone Idai.

A follow up test was conducted to determine the strength and direction of association, for the statistically significant outcomes using a non-parametric test. Kendall's tau-b correlation coefficient, a non-parametric test (details in appendix E), was used to test for the association between pre-Cyclone Idai HFIAS scores and post-Cyclone Idai HFIAS Scores (table 4.5). Kendall's tau-b outcomes range from -1 to +1, where -1 shows a perfect negative association, 0 shows no association and +1 shows a perfect positive association (Akoglu, 2018).

Table 4.5: Summary of Association between Pre-and Post-Cyclone Idai HFIAS Scores

Variables	Kendall's tau-b	p-value
PRE_HFIAS_Score and POST_HFIAS_Score	0.5294	<0.0000

There was a moderately strong and positive association between pre-and post-Cyclone Idai HFIAS scores, and this was statistically highly significant (Kendall's tau-b=0.5294, p<0.0000) (table 4.5). The increases in the post-Cyclone Idai HFIAS scores were therefore not random but were linked to the occurrence of the Cyclone. These results thus confirm that households with high underlying food insecurity before Cyclone Idai, likely experienced more severe forms of food insecurity post-Cyclone Idai.

4.3.3 Household Food Insecurity Access Prevalence (HFIAP)

To further understand the differences between the pre-and post-Cyclone Idai food insecurity results, the prevalence levels are assessed categorically based on the HFIAP. The HFIAP indicator classifies households into four levels of household food insecurity incrementally, based on the HFIAS scores which range from '0-27', whereby higher scores denote more severe food insecurity. A *food secure* household is denoted by '1' which means the household did not experience any of the food insecurity conditions (0-1, HFIAS). A *mildly food insecure* household, with a score of '2',

is one that worries about not having enough food and eats monotonous and less desired food but only rarely (2-7, HFIAS). A *moderately food insecure* household, with a score of '3', worries about the quality of food, eats more monotonous diet, and cuts back on size and number of meals (8-14, HFIAS). Finally, *severely food insecure* households, with a score of '4', apart from all that is experienced by moderately food insecure households, experience the most severe conditions of running out of food, going to bed hungry or going the whole day or night without food (15-27, HFIAS) (table 4.6).

Table 4.6: Categorization of HFIAP of Pre-and Post-Cyclone Idai

	Pre-Cyclone Idai	**Post-Cyclone Idai**
HFIAP	**Frequency (%)**	**Frequency (%)**
Food Secure	95 (13.40)	49 (6.91)
Mildly Food Insecure	43 (6.06)	20 (2.82)
Moderately Food Insecure	21 (2.96)	18 (2.54)
Severely Food Insecure	550 (77.57)	622 (87.73)
Total	709 (100)	709 (100)

Based on the HFIAP classifications, the number of households that were food secure pre-Cyclone Idai was 95 (13.40%) and that number decreased to 49 (6.91%) post-Cyclone Idai. Additionally, the number of households categorized as severely food insecure increased by more than 10 percent from 550 (77.57%) pre-Cyclone Idai, to 622 (87.73%) after Cyclone Idai. Even before Cyclone Idai, most households in the survey were severely food insecure (table 4.6).

The HFIAP results were further simplified by recategorizing them into a binary variable (table 4.7). The 'food secure' households that scored 1 in the HFIAP, were denoted as '*food secure* (0)', whilst those who scored '2,3 and 4' in the HFIAP (mildly, moderately, severely food insecure) were merged to create a new variable '*food insecure (1)'*.

Table 4.7: Binary Recategorization of HFIAP Pre-and Post-Cyclone Idai

	Pre-Cyclone Idai	**Post-Cyclone Idai**
Food Secure	95 (13.40)	49 (6.91)
Food Insecure	614 (86.60)	660 (93.09)
Total	709 (100)	709 (100)

There was a 6.5% decrease in the number of food secure households based on the HFIAP post-Cyclone Idai. Hence, these households that were food secure before Cyclone Idai slid into food insecurity post-Cyclone Idai. The results further highlight significant increases in household food insecurity post-Cyclone Idai.

4.3.4 Qualitative Findings on Differences in Food Insecurity Pre-and Post and Cyclone Idai

The first research objective sought to assess the differences in household food insecurity in Beira pre- and post-Cyclone Idai. Textual data for addressing the objective and explaining the quantitative results were taken from the household FGDs (microsystem), community leaders (mesosystem) and disaster management institutions (macrosystem) SES level interviews. The qualitative findings were consistent with quantitative HFIAS scores and HFIAP results on pre-and post-Cyclone Idai food insecurity.

4.3.4.1 *Severity of household food insecurity with or without Cyclone Idai*

From the qualitative responses, food insecurity among households in Beira was perceived as a normal phenomenon even before Cyclone Idai occurred. Questions about the differences in household food insecurity before and after Cyclone Idai were given responses to indicate ongoing and persistently severe household food insecurity. During the FGDs with community leaders and household heads, coping strategies mentioned included skipping meals and going without food for days, or extended periods of time. This indicated the severity of household food insecurity both before and after Cyclone Idai. Findings are illustrated by the quotes below from community and household level interviews.

Skipping Meals During the Day or for a Whole Day

> *"In my community in Beira, most households have just 1 meal a day and it is difficult to have. They best live by what they can get on a day-to-day basis. There are households that stay 2 or 3 days without eating anything because they do not have money to buy. In some households, not having 3 meals a day is the general norm" (Community leaders, Meso_FGD_1).*

Eating Less Preferred Foods

> *"Most of the time households just eat what they get. It does not necessarily mean healthy. Some very poor households can get money for 'Xima' a maize flour-meal, and this is mixed with salt water and eaten like that without any accompaniment. Actually, people die because they taste different types of plants to see if they are edible or not in their search for food and die through the process" (Community Church Leaders triad- Meso_KII_1).*

Limited Physical Activity

> *"When we are hungry, we just stay home. You get food or you do not get food it is your own trouble" (Resettlement Community and displaced, Micro_FGD_2)."*

Food Exchange

> *"The most common way of getting some food item that you did not plant is to negotiate an exchange with someone else. We will exchange sweet potato for beans" (Non-Resettlement Community and displaced, Micro_FGD_3)*

Food Borrowing

> *"We help each other. For example, if I do not have rice, I can borrow a cup of rice from my neighbor and return it when I get some rice" (Resettlement Community and displaced, Micro_FGD_2).*

The responses above highlight the relevance of the HFIAS questions from the quantitative study on severity of household food insecurity, such as "did any member of the household go a whole day or night without eating anything because there was no food". The responses also captured other coping strategies like 'food borrowing' which indicates household food insecurity but were not included in the HFIAS questions. Since respondents used coping strategies on an on-going basis, regardless of Cyclone Idai, further clarifications were sought to distinguish between pre-and post-Cyclone Idai. Responses to the differences in household food insecurity were based on food availability and food access, which are highlighted below.

4.3.4.2 *Pre-Cyclone Idai – Unlimited Food Availability within Beira, but limited Household Food Access*

While the quantitative results indicated high levels of severe household food insecurity pre-Cyclone Idai, KII responses further established that food insecurity pre-Cyclone Idai was not linked to limited food availability, but rather, limited food access. Beira, compared to rural areas in the Sofala province, did not have challenges with food supply and food availability. Food has always been available within the city of Beira because of multiple food supply chains, through the port, supermarkets, local markets, urban agriculture, food exchange markets and food assistance from donors. Respondents explained this through the quotes below:

> *"If we compare Beira with other districts in Sofala, Beira does not solely depend on food production, because it has the Port located here which allows the import of food from other districts solely dependent on agriculture, and there are other organizations also responding when it comes to food insecurity. So, there is food available on the city level or macro level, but when it comes to the per capita or household level there is vulnerability to food insecurity and food purchasing power is the issue because some people do not have it. Most of the people living in other districts of the province come to Beira to find better lives for themselves in the city. However, there is unemployment in Beira which makes people more vulnerable" (Ministry of Agriculture, Macro_KII_4gov).*

"In terms of availability, about 80% of households are into agriculture, and Beira has markets where households can sell or buy food. Households that do not have money save some food produce and go to the market where they can exchange for other foods too. This happens in specific sections of the market on specific days. Normally communities meet together and decide on days that they can meet and exchange everything between them including clothes and food. For availability it is not a problem because these exchange markets help with this by exchanging other things for food" (INGD, Macro_KII_3gov).

"In my opinion in terms of availability, there are a lot of options. Basically, most of these foods can be found in the shops. We also have some households that are producing food here in the peri-urban Beira areas where it is possible to do farming and people farm something like rice. But the extent of this production is not of such a substantial amount that it can be considered as an important resource of food for the local population. This is because the area of food production for Beira city has been reducing over the years because of urbanization. Areas previously used for rice production are now being used for building houses and other infrastructure and this increases vulnerability because this is an avenue for people to obtain food, but they are no longer able to do so" (FH, Macro_KII_6ngo).

The contribution of food availability through urban agriculture notwithstanding, there were challenges identified, including the decline of agricultural land in favor of urban development, which rendered households' food insecure. Urban agricultural practices were mainly subsistence-based according to the farming seasons, and were also rooted in traditional knowledge and poverty, whereby produced food was mainly consumed and not stored for other seasons. Failure to store food also limited the food availability within households during disruptions like disasters.

"*At the level of the household, what they produce is not enough for them because they are still involved in traditional subsistence farming where they do not store food but only produce for eating. Beira does not export anything. They just produce for families to eat" (Ministry of Agriculture, Macro_KII_4gov).*

"*Households produce food to eat. As such someone who produces rice and grows nothing else may eat rice porridge for lunch and may have boiled rice for dinner. Beira has fish but most households do not have the financial power to buy the fish because the fish is expensive. This goes back to poverty…In terms of agriculture systems, technology to process some food products is not available and this is linked to the lack of household education on where to keep produced food" (Community Leaders triad, Meso_KII_1).*

"There was food insecurity in Beira before Idai because the households in Beira are poor and do not have the power to buy what they want to eat. Most people are poor and not in

the condition to afford food" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

"Another challenge is related to how the community can store the food produced because they do not have the infrastructure to store food" (FDC, Macro_KII_9ngo).

"Households do not have a habit or space where food can be saved for other seasons as such they produce to eat and do not store food. This is what actually makes households food insecure, because they do not store food to sell to be able to buy other things like items for school for their children" (INGD, Macro_KII_3gov).

Whilst the responses indicated the availability of food within the city of Beira, it did not translate into the availability of food within households due to limitations in the type of urban agriculture that was practiced. However, one KII response considered households in Beira as more food secure compared to districts outside Beira that experience both limited availability and limited access. Households in the city of Beira that are neither involved in urban agriculture nor have the financial ability, experience severe food insecurity, although they live within the city and not in rural areas.

"At the level of the city of Beira, Beira does not have a lot of vulnerability in terms of access to food. Normally in the big cities like in Beira people who live there have the financial ability to buy food and their conditions of life are usually better than people who live outside the city. The vulnerability starts in communities about 10 km out of Beira city where the households depend on subsistence agriculture and their plots of land for farming are destroyed by floods" (Red Cross, Macro_KII_7ngo).

"*There are a considerable number of people in the city of Beira that do not have access to employment or income generating opportunities. Of this number of people who do not have access to these opportunities, most of them also do not have the opportunity to produce crops, obviously the way they should get food is reduced" (FH, Macro_KII_6ngo).*

"Even before Cyclone Idai, we did not have jobs or businesses. We just wake up and stay at home. We do not have a means of income…We do not have work. We also do not have plots of land for farming" (Resettlement Community and displaced, Micro_FGD_2).

The relevance of urban agriculture for food availability and access for several households in Beira strongly featured in the responses across all levels of interviews. Access to land for farming was very vital for food security in the city of Beira, even before Cyclone Idai. However, the loss of access to farmlands in the city (e.g., because of urbanization) was linked to reduced food availability, whilst unemployment further limited food access, even before Cyclone Idai. Urban

agricultural practices and knowledge within the city of Beira appeared not to have evolved with changes in urbanization, amidst climate triggered disruptions.

4.3.4.3 *Post-Cyclone Idai – Limited Food Availability within Beira and Limited Household Food Access*

Although severe household food insecurity which was linked to limited food access existed before Cyclone Idai, both food availability within Beira and household food access became disrupted immediately after the cyclone. According to some KII respondents and household heads during the FGDs, Cyclone Idai completely wiped-out urban agriculture, which most households heavily depended on for food availability and food access in Beira.

> *"I think one of the things was that this Cyclone Idai was very devastating and due to the combination of winds and floods, this destroyed a lot of things. When there is this combination of floods and winds even the small farms that some people have were completely wiped out" (FH, Macro_KII_6ngo).*
>
> *"Most of the households live dependent on agriculture and after Idai they lost their plots of land together with the produce. Unfortunately, some people lost their lives because they could not get to places of safety during the Idai and their bodies were washed away" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*
>
> *"In terms of food availability, mainly after Idai households lost their produce and there was no food for the households in the first days until the donations arrived" (Community leaders, Meso_FGD_1).*
>
> *"To emphasize, agriculture is the base of most households here especially in the peri-urban areas of Beira, most residents have access to land for agriculture which was not available after Idai" (Community Church Leaders triad- Meso_KII_1).*
>
> *"Most of the farmlands were inundated by floods and could not be used for agriculture for a very long time after Idai…After Idai the sea level increased and flowed inland disrupting the chemistry of local streams leading to the losses of some indigenous fish. Fishing is a very important source of income for the people of Beira" (Ministry of Agriculture, Macro_KII_4gov).*
>
> *"When we returned from the displacement center after the cyclone, everything was destroyed, the farms were completely gone. Even the trees in the community were felled by the cyclone" (Non-Resettlement Community and displaced, Micro_FGD_3).*

After Cyclone Idai, urban agriculture was disrupted, food availability was reduced in the city, households did not have the means for food exchange, and there was limited ability to pay for

food. Also, poverty conditions became worse as agriculture-related livelihoods were destroyed, which adversely affected food insecurity.

> *"Even before Idai the poverty here was extreme. In the city, the population does not have the financial condition to survive or buy food and this is worse in the rural areas. Post Idai till now, this is the condition of households" (Community Church Leaders triad-Meso_KII_1).*

> *"Cyclone Idai destroyed a lot of things. It affected the economy of the whole population in Beira. There was inflation and the prices of food increased making it difficult for households to buy anything" (Community leaders, Meso_FGD_1).*

The pre-Cyclone Idai responses indicated that humanitarian food aid was recognized as a food supply avenue that ensured food availability in Beira. Thus, the increase in household food insecurity after Cyclone Idai was also explained as a situation that occurred because already vulnerable and food insecure households, did not receive the needed support. Responses, as contained in the quotes below illustrate the extent of destruction occasioned by Cyclone Idai, and the challenges with the implementation of post-disaster food insecurity interventions by donor organizations.

> *"Post-cyclone Idai food insecurity is linked to politics and the government. Because every food that is donated to the households in Beira always goes through the government before getting to the households and the food sometimes does not get to the households" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *"When Cyclone Idai struck Beira, we did not receive the help needed within Mozambique. It is complicated because the government also depends on donations from other countries. WFP, Save the Children, World Vision, UNICEF, and most of the organizations brought some plans to address household food insecurity but when they applied these plans in risk areas, they did not change their plans to attend to the local problem... When Idai happened, there was a lot of work by the international community and the movement of charities but unfortunately there appeared to be a lack of techniques in allocating care in terms of food security…despite all the techniques applied by the 'Cluster' of organizations, the care did not get to the people who needed it" (Community leaders, Meso_FGD_1).*

> *"After Idai, the transportation access was disrupted as the roads were destroyed. People could not leave the city because of this, and neither could help come into the city because of this same reason" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *"After Cyclone Idai the support was not enough because we found some vulnerable households that did not receive any help. When we talk about help, nothing was enough.*

So, households must learn to produce food and store food and not just rely on help/aid because when disasters occur it is difficult to receive help" (Community Church Leaders triad- Meso_KII_1).

Responses from the qualitative interview helped provide a more detailed understanding of differences between household food insecurity pre- and post-Cyclone Idai. Prior to Cyclone Idai, households were already food insecure, and the situation became worse after the cyclone.

"Essentially, the people in Beira did not have anything and then in addition to that they end up losing everything that they have after Cyclone Idai" (GREPOC, Macro-_KII_1gov).

Although most households were experiencing severe food insecurity prior to Cyclone Idai, food insecurity was mainly addressed through food availability interventions, which favored households with entitlements such as land. The destruction of urban agriculture after Cyclone Idai thus destroyed agriculture-related entitlements necessary for food access and availability. The underlying conditions in the city of Beira served to compound the effects of Cyclone Idai on household food insecurity and deepen cycles of poverty. The damage from Cyclone Idai and the resulting food insecurity was widespread. As such, disaster response interventions for food insecurity, in the immediate aftermath of the disaster were inadequate and beset with challenges. The increase of household food insecurity post-Cyclone Idai in Beira, exemplifies a complex issue, resulting from social and ecological system interactions at various levels.

4.4 OBJECTIVE 2

4.4.1 Differences in Post-Cyclone Idai Household Food Insecurity Based on Household Characteristics

This objective assesses how household characteristics are associated with post-Cyclone Idai household food insecurity. The previous analysis under objective one, highlighted the exacerbation of underlying food availability and food access limitations, which were linked to increased household food insecurity outcomes post-Cyclone Idai. The second objective further analyzes the differences in post-Cyclone Idai food insecurity outcomes based on household characteristics, including household size, income and the presence of chronic illness. These characteristics apply to 709 households, selected from the household survey for the quantitative study (details under objective 1). The household survey was administered to available household heads or adult household representatives, who were knowledgeable about the household characteristics, food insecurity and the experience of Cyclone Idai. To avoid introducing biases into the analysis, the objective focused on the characteristics that applied to the whole household rather than the

household head, since not all respondents were heads. The household characteristics adopted by the study and their descriptions are detailed in table 4.8.

Table 4.8 Description of Independent Variables- Household Characteristics

Household Characteristics		**Description**
1.	Household Size	Recorded as: 0(Less than 5) and 1 (5 and above)
2.	Household Income	Recorded as: 0(Low Income-0/5000), 1(Middle Income-5001/10000=1) and 2(High Income-10001/max=2)
3.	Chronically Ill Members	Recorded as: 0(No chronic illness) and 1(Chronic Illness)

To assess how household food insecurity in the month after Cyclone Idai differed based on the selected household characteristics, the relationship between the characteristics and the HFIAP and HFIAS scores from objective 1 were used.

4.4.2 Differences in HFIAP based on Household Characteristics Post-Cyclone Idai

The first analysis involved the differentiation of household characteristics by the binary HFIAP variable post-Cyclone Idai. According to the HFIAP, households were '*food secure (0)*' if they experienced no food access challenges and scored '0-1' on the HFIAS, while other households that scored from '2-27' on the HFIAS, indicative of mild, moderate or severe food access challenges, were denoted as '*food insecure (1)'.* Results from the bivariate analysis are below (table 4.9).

Table 4.9. Differences in HFIAP based on Household Characteristics Post-Cyclone Idai

Household Characteristics	**Food Secure (%)**	**Food Insecure (%)**	**Total**
Household Income			
Low Income	12 (3.53)	328 (96.47)	340
Middle Income	13 (5.39)	228 (94.61)	241
High Income	24 (18.75)	104 (81.25)	128
Presence of Chronic			
No chronic illness	26 (8.41)	283 (91.59)	309
Chronic illness	23 (5.75)	377 (94.25)	400
Household Size			
Less than 5	23(10.27)	201 (89.73)	224
5 and above	26 (5.36)	459 (94.64)	485

Overall, household food insecurity levels were high (more than 80%), regardless of the household grouping. Among the low-income household group, 96.47% were food insecure, 94.61% of the

middle-income group were food insecure, and approximately 81% of households in the high-income group were food insecure post-Cyclone Idai. Almost 50% of respondents in the study were in the low-income group (see table 4.1). More than 53% of respondents had a member of their household with chronic illness (see table 4.1). Of the households with chronic illness, 94.25% of them were food insecure compared to 91.59% of those who had no chronic illness. For household size, approximately 70% of respondents in the quantitative study belonged to households with 5 members and above, and 94.64% of these households were food insecure compared to 89.73% of households with less than 5 members.

Apart from the bivariate relationships between household characteristics and the HFFIAP which summarized all food insecurity categories, the full HFIAS scores were also used to differentiate between household categories in the subsequent section.

4.4.3 Differences in HFIAS based on Household Characteristics Post-Cyclone Idai

To assess the differences in HFIAS scores based on household characteristics, further tests were carried out using the Kruskal-Wallis H test (details in appendix E). The tests were run for the independent variable indicators' household size, household income post-Cyclone Idai, presence of chronic illness in households and the dependent variable, post-Cyclone Idai HFIAS scores. Two competing hypotheses, a null hypothesis H_0 and an alternative H_a were formulated for each Kruskal-Wallis H test.

Household Size

For determining food insecurity differences across household sizes using the Kruskal-Wallis H test, the null hypothesis H_0 states that there is no significant difference between post-Cyclone Idai HFIAS scores across household sizes. The alternate hypothesis H_a indicates that there is a significant difference between post-Cyclone Idai HFIAS scores across household sizes. Table 4.10 shows the distribution of HFIAS observations across the sizes of households and the corresponding rank sum values after running the tests.

Table 4.10 HFIAS Distribution Across Household Size Post-Cyclone Idai

Household Size	Observations	Rank Sum	X^2	p-value	X^2 with ties	p-value
Post-Cyclone Idai						
Less than 5	224	77929.00	0.394 (1 d.f.)	0.5303	0.400 (1 d.f.)	0.5271
5 and above	485	173766.00				

In the post-Cyclone Idai outcome, the chi-squared with ties statistic 0.400 (1.d.f) and p-value=0.5271 suggests that there are no significant differences between the median household food insecurity scores across household sizes post-Cyclone Idai. We fail to reject the null hypothesis at the significance level p-value>0.05 as the difference was not statistically significant. Based on the Kruskal-Wallis H test, there is no evidence to suggest that household size was associated with significant differences in median household food insecurity scores post-Cyclone Idai.

Household Income

For determining food insecurity differences based on household income, the null hypothesis H_0 states that there is no significant difference between post-Cyclone Idai HFIAS scores across household income levels. The alternate hypothesis H_a states that there is a significant difference between post-Cyclone Idai HFIAS scores across household income levels. Table 4.11 shows the distribution of post-Cyclone Idai HFIAS observations across post-cyclone household income and the corresponding rank sum values.

Table 4.11: HFIAS Distribution Across Household Income Post-Cyclone Idai

Household Income	Observations	Rank Sum	X^2	p-value	X^2 with ties	p-value
Post-Cyclone Idai						
Low income	340	145877.50	102.062 (2 d.f.)	<0.0001	103.635 (2 d.f.)	0.0001
Middle income	241	76756.00				
High income	128	29061.50				

In the post-Cyclone Idai outcome, the chi-squared with ties statistic 103.635 (2 d.f.) and p-value =0.000, suggests that there is a statistically significant difference between the median HFIAS score post-Cyclone Idai across post-Cyclone Idai household income levels. We reject the null hypothesis at the significance level p<0.05. Based on the Kruskal-Wallis H test, the relationship between household income levels and the median HFIAS score is not a coincidence as there appears to be a significant relationship between these variables.

Presence of Chronic Illness in Household

For determining food insecurity differences using the presence of chronic illness within household, the null hypothesis H_0 states that there is no significant difference between post-Cyclone Idai HFIAS scores based on the presence of a member with chronic illness within a household. The alternate hypothesis H_a indicates that there is a significant difference between post-Cyclone Idai HFIAS scores based on the presence of a member with chronic illness within a household. Table

4.12 shows the distribution of HFIAS observations across households with at least one chronically ill member and the corresponding rank sum values post-Cyclone Idai.

Table 4.12: HFIAS Distribution Across Chronic illness in household Post Cyclone Idai

Presence of Chronical Illness	Observations	Rank Sum	X^2	p-value	X^2 with ties	p-value
Post-cyclone						
No chronic illness	309	101947.50	8.208 (1 d.f.)	0.0042	8.334 (1 d.f.)	0.0039
Chronic illness	400	149747.50				

The chi-squared with ties statistic 8.334 (1d.f.) and p-value=0.0039 suggests that there is a statistically significant difference between the median household food insecurity score post-Cyclone Idai based on the presence of a member with chronic illness in household. We reject the null hypothesis at the significance level $p<0.05$. Based on the Kruskal-Wallis H test, the relationship between the presence of a member with chronic illness in household and the median HFIAS score is not a coincidence as there appears to be a significant relationship between these variables.

4.4.3.1 *Strength and Direction of Relationship between Differences in Household Characteristic Indicators and HFIAS Scores Post-Cyclone Idai*

A follow up test was conducted to determine the strength and direction of association for statistically significant outcomes. Kendall's tau-b correlation coefficient, a non-parametric test (details in appendix E), was used to test for the strength and association between post-Cyclone Idai HFIAS scores and the variables, household income post-Cyclone Idai and presence of chronic illness, that showed statistically significant differences.

Table 4.13: Strength and Direction of Relationship between Differences in Household Characteristic Indicators and HFIAS Scores Post-Cyclone Idai.

Variables	Post-cyclone HFIAS Score	
Household characteristics	**Kendall's tau-b**	**p-value**
Household Income	-0.3148	0.0000
Presence of Chronic Illness	0.0925	0.0039

For household income post-Cyclone Idai, the Kendall's tau-b analysis suggests a moderate strength and negative direction of the association between the HFIAS scores and household income (Kendall's tau-b=-0.3148, $p<0.0000$). The $p<0.000$ indicates that the observed association did not

occur by chance and the null hypothesis is rejected at $p<0.05$. Notably, as household income level increases, the HFIAS Scores (food insecurity) post-Cyclone Idai decreases. This suggests that low-income households were more likely to experience higher HFIAS scores, indicating increased household food insecurity.

For the presence of a member with chronic illness within household, the Kendall's tau-b analysis suggests a relatively weak but positive association between post-Cyclone Idai HFIAS scores and the presence of chronic illness (Kendall's tau-b=0.0925, $p<0.0100$). This indicates a statistically significant positive correlation between the presence of chronic illness in households and the increase of household food insecurity post-Cyclone Idai. Although the relationship is relatively weak, the $p<0.000$ shows that the observed association did not occur by chance and the null hypothesis is rejected at $p<0.05$.

The weak to moderate strength of the relationship between HFIAS scores and the household characteristics suggests that there are other factors that may confound these relationships. The qualitative study gathered more details to help identify factors that contributed to these associations among the variables.

4.4.4 Qualitative Findings on Differences in Household Food Insecurity Post-Cyclone Idai by Household Characteristics

The second objective examined the differences in household food insecurity experiences based on household characteristics post-Cyclone Idai. The qualitative study expounds on the quantitative analysis by highlighting how household characteristics; household size, income and the presence of chronic illness were associated with household food insecurity after Cyclone Idai. Responses from the qualitative study were consistent with the quantitative association between income and household food insecurity post-Cyclone Idai. The most referred to household characteristic that appeared as a link, connecting household food insecurity and other household characteristics, was household income. The interconnections between the household characteristics and food insecurity elaborate on social vulnerability and post-disaster food insecurity, which was not evident from the quantitative analysis. Apart from the disruptions in household income after Cyclone Idai, the other household characteristics existed pre-Cyclone Idai.

4.4.4.1 *Interconnections between household income and household sizes*

The quantitative analysis showed a significant relationship between household food insecurity and household income, but no significant relationship with household size post-Cyclone Idai. However, the qualitative study elaborated on the commonality of large household sizes within the city of Beira, which was found to be closely connected with household income and food insecurity

even before Cyclone Idai. Polygamy and cultural perceptions on the benefits of having many children, were described as reasons for large household sizes in the city of Beira. The interviews also highlighted that pre-Cyclone Idai household-livelihood limitations became worse after Cyclone Idai, due to losses in household incomes and jobs. Households within the low-income bracket, and yet with large household sizes and women heads, appeared to experience more severe food insecurity outcomes. This is illustrated by the quotes below:

> *"We know that poverty is linked to having many children. In Africa we believe that when you have a lot of children one may become a president or another important figure to support you in the future. Households are mostly composed of 8-10 or more members with only one member providing financial resources for the household and this does not improve the conditions of households in terms of vulnerability. The patriarchal system and the system of polygamy practiced here means the men can marry more than 1 wife. He can marry one woman, make babies with her and abandon her, and he can go marry another woman and do the same, so households are mostly headed of women" (Community leaders, Meso_FGD_1).*

> *"There are very large households where only one person may be working. This is a big problem contributing to poverty. We are talking about households with 8, 9, 10 members. Some heads of households have more than 2 wives. Sometimes some sons in these households impregnate people whilst jobless and then bring these girls home to live in these same big households" (Community leaders' triad, Meso_KII_1).*

> *"Opportunities for the households to get some means of income and business were all drastically affected by Cyclone Idai. We also had some areas of Beira where people normally practice peri-urban agriculture and animal husbandry on the outskirts of the city, and they lost those animals as well during the cyclone and all these contributed to food insecurity after cyclone Idai. When it comes to Beira, the chances are small in terms of the choices that people/households have and in terms of activities they can do to recover or return to a situation like prior to Cyclone Idai, where their food security is better balanced" (FH, Macro_KII_6ngo).*

The FGD responses found larger households to have more basic needs, which required diverting income for food access to address those other needs. Additionally, women heads of large households may experience limited ability to earn an income due to caregiving roles. With almost 70% of households in the quantitative study having 5 or more members, the sheer sizes of households rendered household income insufficient to meet the food security needs of the members. The household income classified as low income in the quantitative analysis was 5000 Meticals/month, and for large households, 5000 Meticals was considered insufficient to meet household needs.

"If someone receives 5000 Meticals a month and has a large household and probably with teenage daughters who may be pregnant as well, thus, creating more mouths to feed, 5000 Meticals will be insufficient. So, I think that large households and teenage pregnancy contribute to food insecurity" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

"For households that have someone who works a monthly job, the salary is not up to USD 100/month (6200 Meticals) for those in low-income and since Cyclone Idai things have become expensive. Most households live on less than $1 a day. Minimum salary in Mozambique was just increased in July 2022 (minimum wage was 5200 Meticals in 2022 and lower in 2019)" (Community leaders, Meso_FGD_1).

"Even if you have a small business but have 5 children it is difficult to manage the money that you can get from this business to sustain your family. So, we need other means of employment" (Resettlement Community and displaced, Micro_FGD_2).

The ability of households to earn an income after Cyclone Idai losses was also linked to pre-Cyclone Idai challenges of low education and high unemployment among households, although these characteristics were not explored in the quantitative study.

"Most of the people in Beira have little education and once they do not have education this makes them unemployable, and they do not have the money to buy food such as proteins that is vital for survival" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

"Most of these households have teenagers who abandon school; thus, they do not have the education to get them better jobs and Idai came and worsened the situation" (Community leaders, Meso_FGD_1).

"In Beira we have high levels of no education and high levels of unemployment. Children finish secondary school and cannot continue to college whilst others also finish college and have no jobs. These conditions contribute to making the people poor, which was a big problem even before Cyclone Idai (Cyclone Idai worsened underlying conditions for livelihoods in Beira)" (Community leaders' triad, Meso_KII_1).

The quotes highlight the strong connections between household income and household size with the differences between household food insecurity post-Cyclone Idai. The interconnections between disruptions in livelihoods, incomes, unemployment and large household sizes may have created complexities for increases in household food insecurity post-Cyclone Idai in Beira.

4.4.4.2 *Chronic Illness and Increased Diversion of Resources to Address Bonding Social Capital Needs Post-Cyclone Idai*

The presence of chronic illness within households was significantly correlated with post-Cyclone Idai household food insecurity, as evidenced by the quantitative study and supported by the qualitative findings from a KII at the National Institute for Social Action (INAS). The response below acknowledged that households with members who are chronically ill were more vulnerable to food insecurity pre- and post-Cyclone Idai, and as such the support for such households had increased post-Cyclone Idai.

> *"The beneficiaries of social assistance programs including the children, old people, people with chronic diseases and disabled people the ministry oversees, have received additional payments as their vulnerability always existed, but it increased after Idai. With a disaster like Idai, the situations of households have worsened" (INAS, Macro_KII_2gov).*

Except for one KII response above, chronic illness was not associated with increased household food insecurity post-Cyclone Idai. However, the increase in vulnerable groups such as the elderly, orphans and the disabled were found to be a drain on resources like food, of their bonding social capital networks, who were also food insecure.

> *"After Idai, we did what we were supposed to do. However, there are so many widows, so many children taking care of families, elderly people, sick people we have to deal with". (GREPOC, Macro_KII_1gov).*

> *"The children, elderly people and orphans were the most affected after cyclone Idai" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *"The oldest and the disabled amongst us are particularly vulnerable because they cannot work or farm and this makes them more vulnerable… We have a lot of orphaned children and widows in the community" (Resettlement Community and displaced, Micro_FGD_2)."*

> *"There are widows looking after orphaned grandchildren in the community. Old people, widows and disabled people were the most vulnerable. After Cyclone Idai we divided what each household has to give to those who do not have (this included food if available)" (Non-Resettlement Community and displaced, Micro_FGD_3).*

The limited income of already food insecure households appeared to be further stretched by the additional burden of caring for other people, such as orphans and widows outside the household (bonding social capital networks), but within the community. This burden of caring for other needy people may vary for different households and communities in contributing towards reduced food access. This implies that households with more of such networks experienced increased food insecurity vulnerabilities post-Cyclone Idai. During the FGDs, there was no mention of support

from INAS for vulnerable groups or households being supported within their community. Notably, the more the characteristics of social vulnerability found in any household, the higher the levels of food insecurity experienced. The summary of findings on household characteristics associated with increased post-Cyclone Idai food insecurity are summarized at the end of chapter.

4.5 OBJECTIVE 3

The previous objective focused on household socio-demographic characteristics linked to more severe post-Cyclone Idai food insecurity. This objective, however, assesses the differences in household food insecurity post-Cyclone Idai, based on differences in the personal food environment, a component of food systems which influences household food acquisition, preparation and consumption. The personal food environment characteristics considered were *accessibility, affordability* and *convenience,* and how their disruptions were linked to differences in household food insecurity post-Cyclone Idai. The indicators helped to highlight personal food environment disparities that were associated with Cyclone Idai impacts, household food insecurity and social vulnerability. The quantitative analysis involved descriptive statistics of indicators representing the accessibility, affordability and convenience characteristics of households' personal food environment. This was later followed with the qualitative analysis which elaborated on how these characteristics were linked to differences in household food insecurity in the year after Cyclone Idai. The indicators used for each personal food environment characteristic, and their description are outlined in table 4.14. The responses were recategorized into a binary form.

Table 4.14: Description of Independent Variable Indicators for Personal Food Environment Characteristics Post-Cyclone Idai

Personal Food Environment Characteristics		**Description of Indicators**
1.	**Accessibility**	*Impact on House* Recorded as: 0(House not Destroyed) 1(House Destroyed)
		Household's Area of Residence Recorded as: 0(Resident Formal Area) 1(Resident Informal Area)
2.	**Affordability**	*Job Access* Recorded as: 0(Undisrupted Job Access) 1(Disrupted Job Access)
		Income Access Recorded as: 0(Consistent Income Access)

		1(Inconsistent Income Access)
3.	**Convenience**	*Clean Water Access* Recorded as: 0(Consistent Clean Water Access) 1(Inconsistent Clean Water Access)
		Cooking Fuel Access Recorded as: 0(Consistent Cooking Fuel Access), 1(Inconsistent Fuel Cooking Access)
		Electricity Access Recorded as: 0(Consistent Electricity Access) 1(Inconsistent Electricity Access).

4.5.1 Differences in Personal Food Environment Characteristics Indicators

To begin with, the differences among households' personal food environment characteristics post-Cyclone Idai were described using descriptive statistics, specifically pie charts.

4.5.1.1 *Personal Food Environment Characteristic – Accessibility*

The *accessibility* characteristic of the personal food environment considered factors relevant for facilitating household access to available food. The indicators for *accessibility* therefore assessed whether households lived in formal or informal areas based on their own perceptions, as well as the impact of Cyclone Idai on their houses. The formality or informality of household residence is linked to household access to food and exposure to hazards or disasters. The percentage distributions on households living in formal and informal areas, and the impact of Cyclone Idai are illustrated using pie charts below (figure 4.2).

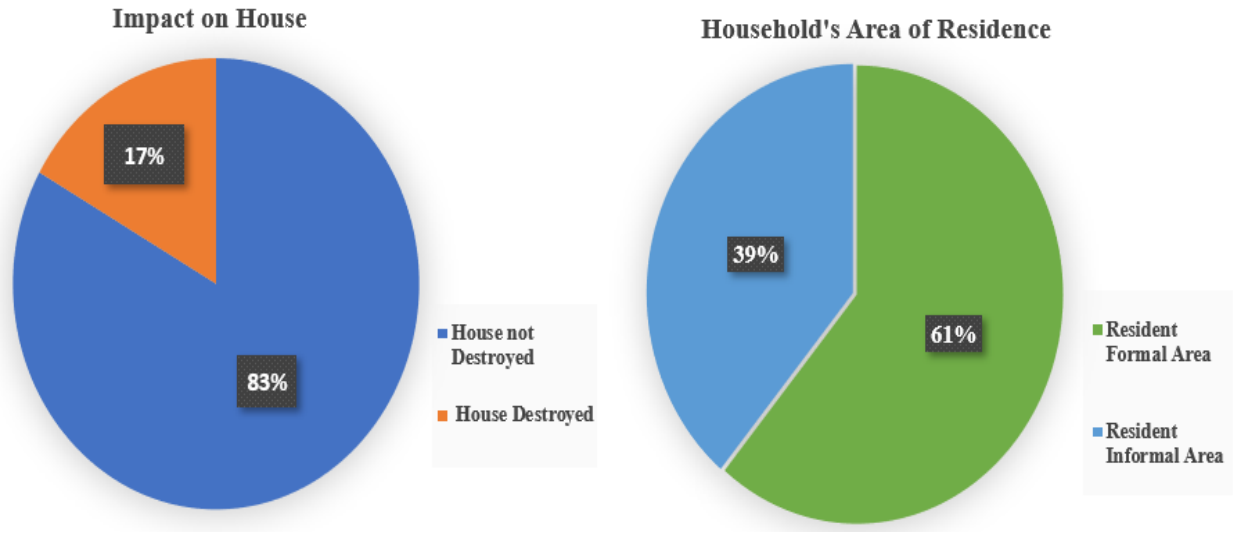

Figure 4.2: Pie Chart showing results for Accessibility Indicators Post-Cyclone Idai

Overall, 39% of households perceived that their homes were located within informal areas whilst 17% of households had their homes destroyed by the impact of Cyclone Idai. The qualitative study in latter sections of the chapter elaborate on the relationship between these results and household food insecurity post-Cyclone Idai.

4.5.1.2 *Personal Food Environment Characteristic – Affordability*

The *affordability* subdimension of the household personal food environment focused on whether households had the economic resources necessary for food access following Cyclone Idai. The indicators included household access to jobs and incomes post-Cyclone Idai. The percentage distributions of household access to a job and income post-Cyclone Idai are illustrated using pie charts below (figure 4.3).

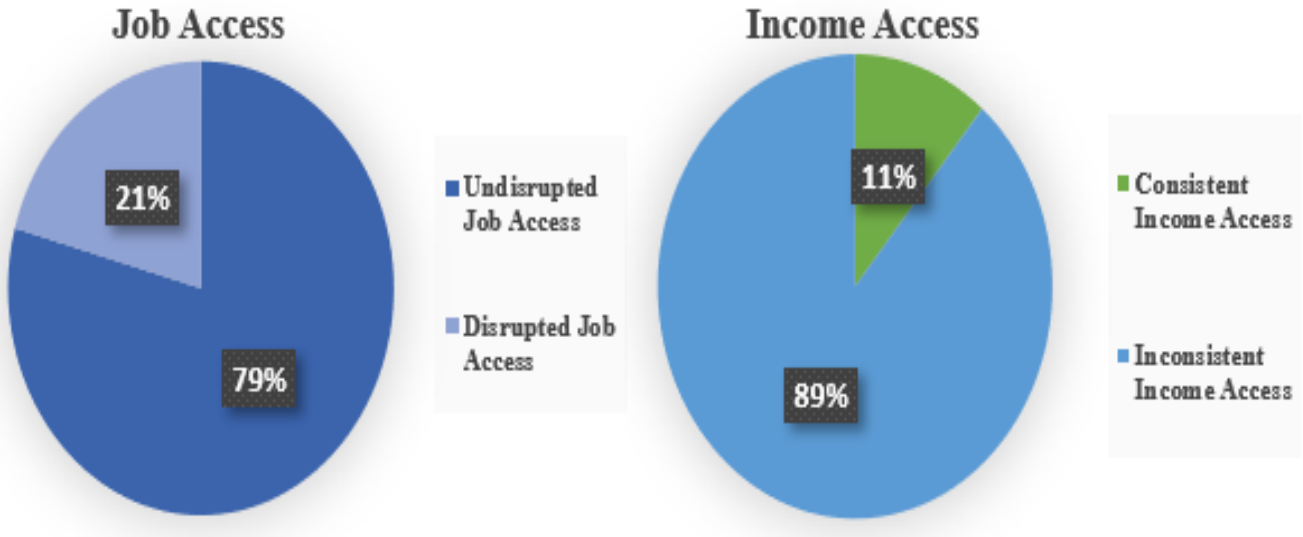

Figure 4.3: Pie Chart showing results for Affordability Indicators Post-Cyclone Idai

For the affordability indicators, only 21 % of households experienced disruptions in jobs post-Cyclone Idai (3 months after Cyclone Idai), whilst 89% of households experienced inconsistent income access in the year after Cyclone Idai. The qualitative study in the latter sections of the chapter elaborate on the relationship between these results and household food insecurity post-Cyclone Idai.

4.5.1.3 *Personal Food Environment Characteristic – Convenience*

The *convenience* characteristic of the personal food environment focuses on resources necessary for food preparation and consumption, which are also relevant for examining food access and food utilization post-disasters. The proxy indicators for *convenience* included access to clean water, access to cooking fuel and access to electricity, which were essential for food preparation and storage. The percentage distributions of household access to clean water, cooking fuel and electricity, are illustrated using pie charts below (figure 4.4).

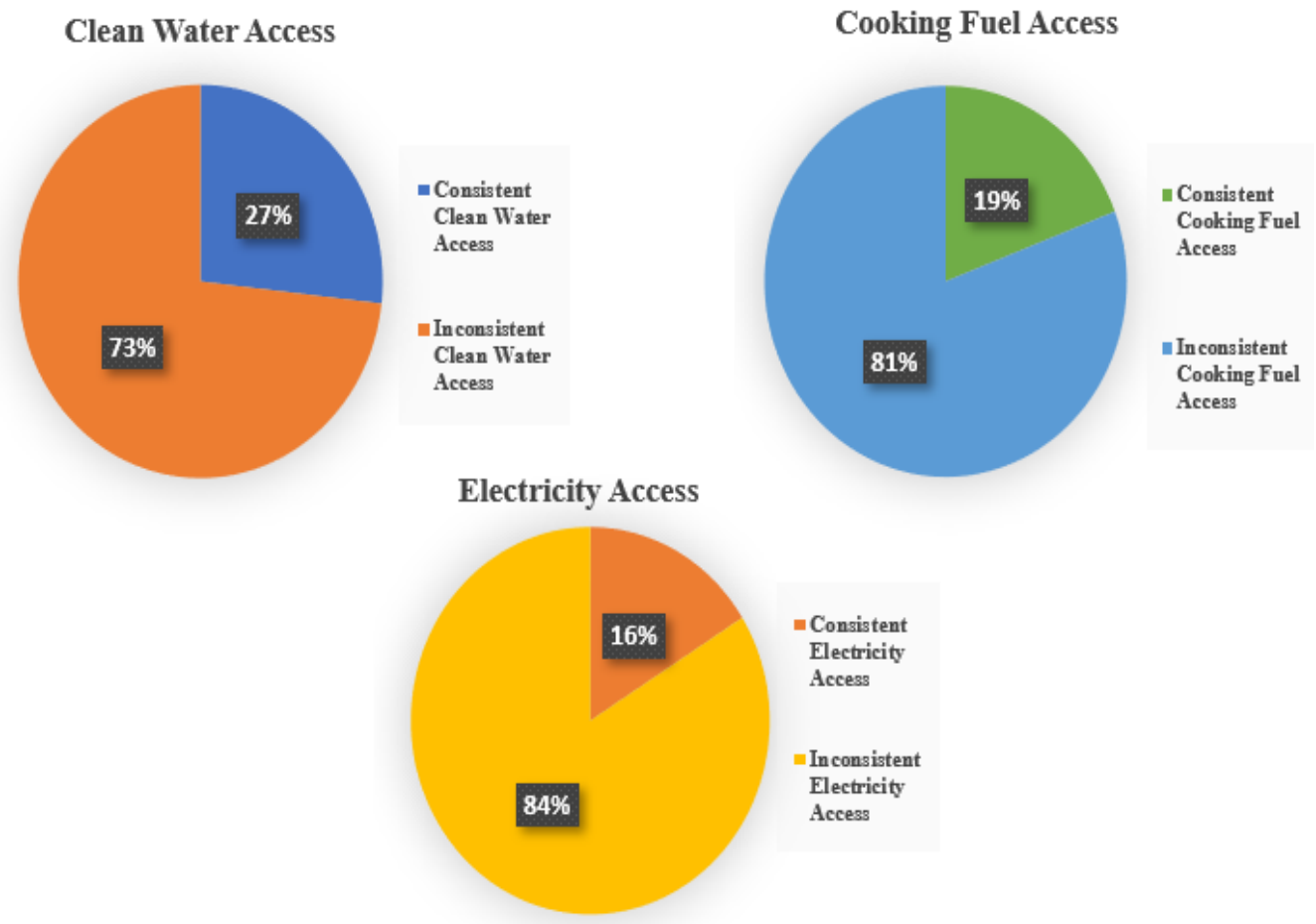

Figure 4.4: Pie Chart showing results for Convenience Indicators Post-Cyclone Idai

For access to clean water, 73% of respondents experienced inconsistent access to clean water in the year after Cyclone Idai. A higher number of respondents, 81% experienced inconsistent access to cooking fuel, and 84% experienced inconsistent access to electricity in the year after Cyclone Idai.

Overall, the quantitative analysis only described the differences in *accessibility, affordability and convenience* using proxy indicators, but did not establish their relationship with food insecurity, due to the differences in the timelines of measurement. As such, the qualitative study was relied on to explore the relationships between the indicators for *accessibility* (impact of Cyclone Idai on house and living in a formal or informal area), *affordability* (access to jobs and incomes post-Cyclone Idai), *convenience* (access to clean water, cooking fuel and electricity) and post-disaster food insecurity in the year after Cyclone Idai.

4.5.2 Qualitative Findings on Personal Food Environment Disruptions and Household Food Insecurity Post-Cyclone Idai

The qualitative study explored the relationships between the personal food environment variables, *accessibility*, *affordability*, and *convenience* from the quantitative study, and household food insecurity in the year after Cyclone Idai. Household responses about the indicators for accessibility, affordability and convenience highlighted underlying disparities prior to Cyclone Idai, which influenced food access post-Cyclone Idai.

4.5.2.1 *Accessibility and Household Food Insecurity Post-Cyclone Idai*

The proxy indicators for *accessibility* from the quantitative study were 'living in formal or informal areas and the impact of Cyclone Idai on house'. The responses highlighted contexts of underlying 'informality' within the 2 displaced communities of the study, prior to Cyclone Idai. Firstly, the households from the 2 displaced communities experienced difficulties in accessing available food because there were no food markets in their community prior to Cyclone Idai. Thus, these communities exhibited food desert tendencies and were limited in food availability and food accessibility prior to the cyclone. The quotes below reflect household food availability and accessibility challenges prior to Cyclone Idai.

> *"Although some families are earning some money there is no food available because of the absence of markets. Walking to the market takes about 30 minutes for a young person and more than an hour for the seniors in our community. The distance from the market means that access to food is a big problem for households. This also affects how much a person can carry from the market to the house even if they can afford it. To have access to transport is to walk about 11 or 12 km to be able to get transport to anywhere. We do not have work. We also do not have plots of land for farming" (Resettlement Community and displaced, Micro_FGD_2).*

> *"Currently some members of the community (referring to resettlement and displaced community) are doing some business, but the market is very far away from the community. Although some families are currently doing some small farming there is no food available because of the absence of the markets" (Asate, Macro_KII_8ngo).*

> *"We need a market here where we can sell some food produce in order to support our husbands. The most common way of getting some food item that you did not plant is to negotiate an exchange with someone else" (Non-Resettlement Community and displaced, Micro_FGD_3).*

Secondly, most of the houses within the two displaced communities were tent-like structures prior to Cyclone Idai, and so were heavily impacted by the cyclone (Appendix F, Pictures 2 and 3).

Within the resettlement and displaced communities, all the houses were completely destroyed and swept away by Cyclone Idai.

> *"Some people in this community (resettlement and displaced community) have been living in makeshift and worn-out tents for the past 6 years… Idai took everything, everything that we had, it left nothing for us. It completely destroyed our houses. Idai left all of us downcast" (Resettlement Community and displaced, Micro_FGD_2).*

> *"All the households in the resettlement (resettlement and displaced community) needed to go to the displacement centers because their houses were destroyed. Before Idai the communities were poor and after Idai the households are poorer than before because the Idai destroyed their houses. If someone does not have a house, all their human dignity is exposed...Most of the households lived in tents which were destroyed by Idai. Those families who were not in displacement centers did not receive any support. After Idai each household started to rebuild their lives" (Asate, Macro_KII_8ngo).*

The households from the two displaced communities in the study moved to displacement centers, where they lived for 1 month. At the displacement center, households received food aid which addressed their accessibility to food access challenges in the immediate aftermath of the disaster. However, households returned in the month after Cyclone Idai to more severe deprivations in food access due to the destruction of their homes, unlike non-displaced households. Addressing household food insecurity was relegated to the background upon their return because of the urgent need for housing after the cyclone. This is illustrated by the responses below when participants were asked about household food insecurity after returning from the displacement center.

> *"I am a widow. I was trying to build my house and then Idai came and destroyed what I was building. So, after Idai till now I have not had a house. Until now most of us are still using tents for houses. It is impossible for us to rebuild our houses because we do not have a means of income. I was not worried about food because for food you may get it one day and not the next day. I was worried about a house" (Non-Resettlement Community and displaced, Micro_FGD_3).*

> *"Having a house was more important to me right after Idai till now because we needed to have somewhere to stay. For food, we could get it day by day by putting some ingredients together and have something to eat but it was not the same with building a house" (Non-Resettlement Community and displaced, Micro_FGD_3).*

In contrast, the FGD with non-displaced households in the city revealed that they did not have limitations with food accessibility before Cyclone Idai due to the presence of markets.

"There was no difficulty in terms of availability and accessibility of food because we have markets. For example, the market of Maquinino is nearby where households can find food that they need to buy. The difficulty was money to buy the food" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

Non-displaced households appeared to have experienced less cyclone-related impacts on their houses. However, their food accessibility was disrupted immediately after the cyclone (*refer to disruption in food availability and food access under objective 1*). Non-displaced households did not receive food aid because they were non-displaced.

"The displacement centers were treated in a special way. The treatment of the displacement center was different because they had a specific number of households living there and everything they needed from tents to food was provided for them. One of the things that INGD did was to support people who were mainly in the displacement centers" (INAS, Macro_KII_2gov).

"The government should have made plans to help all of us. Because even though we did not move to the displacement center we were in need of help" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

Whilst accessibility in terms of access to food was improved for households that were at the displacement center, non-displaced households experienced reduced food accessibility in the immediate aftermath of Cyclone Idai, but this was later restored. The qualitative responses help explain the relevance of the indicators used for assessing accessibility (residence in a formal or informal area and the impact of Cyclone Idai on house) and the linkages with food availability, food access and exposure to disasters. The qualitative study also highlights the relevance of proximity to markets for food accessibility and food access, which was not captured in the quantitative analysis.

4.5.2.2 *Affordability and Household Food Insecurity Post-Cyclone Idai*

The affordability characteristic of the personal food environment considers household access to the financial resources necessary for purchasing food. The proxy indicators for affordability under the quantitative study were household access to a job or income after Cyclone Idai. However, affordability also refers to the cost of available food. Responses from the KIIs and FGDs explain that reduced food access after Cyclone Idai was not only due to livelihood losses but also due to disruptions in food availability and increased food prices. The responses reflect differences in affordability immediately after the cyclone and in the year after. Low food prices are particularly important for households with limited financial resources, whilst price hikes in food and

income/job losses after the disaster limited how much food households could afford. This is explained through the quotes below.

> *"After Cyclone Idai, the prices of food products increased. Most of the residents did not have the money or the condition to afford the food. As such, Idai impacted a lot of households, in particular those who had low purchasing power. The cyclone destroyed all properties households had accumulated over the years. It affected the economy negatively and people's salaries were reduced, and people lost their jobs as businesses were affected. All this increased food insecurity as people did not have money to buy food" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *" We had the situation in Beira where people lost their jobs and for some time the prices of food increased because availability was reduced due to the cyclone …Right after the cyclone, the situation was really bad and there were a lot of people that, even with some money, could not afford to get food because of high food prices. The situation became a bit stable later in 2019 but from 2020 up till now the prices of food are increasing again due to the increase in the price of fuel that is reducing how much food households can obtain from the same amount of money" (FH, Macro_KII_6ngo).*

Some FGD responses associated reduced affordability post-Cyclone Idai with the unfulfilled donation promises for low-income households which did not arrive. This sheds light on the dependence of the city of Beira on donor support to moderate household food insecurity.

> *"The households were supposed to receive some money, 7000 Meticals from the government but until now we are still waiting. The government announced that all households in Beira should receive this" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *"If everything that was promised to Beira was done, most of the challenges faced after cyclone Idai would have been solved. Some of the promises were processed, some we are still waiting for" (Community leaders, Meso_FGD_1).*

The responses also support findings from objective 1 and 2 on the differences in household food insecurity post-Cyclone Idai. Household food insecurity was related to the loss of income and livelihoods within households, which combined with the increase in food prices had adverse severe impacts on affordability.

4.5.2.3 *Convenience and Household Food Insecurity Post-Cyclone Idai*

The convenience characteristic of the personal food environment refers to the ease with which households acquire, prepare or consume food, based on access to key resources like water, cooking

fuel or kitchen equipment. The proxy indicators for 'convenience' in the quantitative study were access to clean water, access to cooking fuel and access to electricity, which are essential for food preparation and storage. The qualitative study responses highlighted the differences in access to clean water, electricity and cooking fuel, based on the formality or informality of household residence.

Access to clean water

Households relied on the same sources of water for drinking, cooking and personal hygiene. Households living in the resettlement community that was displaced, did not have access to FIPAG (Main Water Service Provider) water in the community pre-Cyclone Idai. The community relied on water from a well for their daily needs before the cyclone (Appendix F, Picture 4), and this did not change after Cyclone Idai. Their condition before the cyclone is illustrated in the quotes below.

> *"The community has no potable water, so we use water from a well for drinking, cooking and personal hygiene. We walk about 3 km to be able to fetch water from a well to use for our daily activities which makes it difficult" (Resettlement Community and displaced, Micro_FGD_2).*

> *"I am old and not strong enough. I use a 5-litre container to make several trips to the well each day until I have enough to use for my activities. Sometimes my ankles ache very badly, and I may only go for one trip on those days" (Resettlement Community and displaced, Micro_FGD_2).*

The task of fetching water from the well for daily activities was arduous and unfairly distributed, which may have limited the amount of water that more vulnerable households could collect (seniors), and the types of meals they prepared. Although households did not experience inconsistencies in their water supply after Cyclone Idai, the cleanliness of the water or water quality reduced because of contamination. Households were exposed to water related illnesses, further deepening their vulnerability to food insecurity.

> *"We are close to the beach, the floods from the cyclone affected our water and with this cyclone the water was very bad and not appropriate to drink. After Idai, most households got sick, diarrhea, malaria, colds, fevers. Some health and sanitation officials came and showed us how to boil water and add sugar and salt to address problems like diarrhea" (Resettlement Community and displaced, Micro_FGD_2).*

Households living in the city that were non-displaced relied on formal water supply through FIPAG (Main Water Service Provider) prior to Cyclone Idai. FGD responses show these households experienced disruptions in water access after Cyclone Idai. The restoration of water access to households depended on the ability to pay. This is illustrated in the quotes below.

"After cyclone Idai, the infrastructure of FIPAG for distributing water was impacted and the access to water of households was disrupted. Due to disruption of water from FIPAG after Idai, richer households bought water from other private water providers whilst poorer households resorted to local or traditional systems of water sources such as wells for drinking and personal hygiene" (Community leaders, Meso_FGD_1).

"Before Idai households did not have to worry about the washing of vegetables before cooking, however right after Idai we had to wash vegetables very well with clean water to avoid depositions on them that were not good for our health especially with salads because of cholera. There was a cholera outbreak and the impact on hospitals and sanitation worsened the situation. With water, we started to boil water before drinking even though we were not doing this before the cyclone. Unfortunately, there was less access to potable water and most households used water from the wells for their cooking and other household activities" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

The use of private water suppliers and water processing (e.g., boiling) to make water safe for drinking and cooking may have introduced additional costs and limitations to food preparation and household food insecurity after Cyclone Idai. Overall, the responses indicate that all households regardless of area of residence were concerned about clean water access and food safety after Cyclone Idai.

Access to electricity

The responses from the FGD with the non-displaced households in the city revealed that disruptions in access to electricity affected food storage and food access for various actors within the food system in Beira, immediately after the cyclone.

"After Idai because of the interruption of electricity, some markets and shops needed to reduce the price of frozen foods and sell them off quickly before they went bad. Families lost food stored in the fridges. The electricity to households was disrupted and we did not have the ability to preserve our foods in the refrigerators" (Non-Resettlement Community and non-displaced, Micro_FGD_1).

Access to electricity improves food storage. Limited food storage was identified as contributory to limited food access under objective 1. Inconsistent access to electricity affected stored food, and households lost food supplies that they may have had prior to the cyclone, whilst the prices of some frozen foods became reduced. This may have been applicable to only high-income households that had access to electricity, fridges or money to take advantage of reduced food prices.

Responses from the FGD with households in the non-resettlement but displaced community revealed a protracted length of time of living with disrupted electricity after cyclone Idai, shown in the quote below.

> *"We stayed close to 6 months after the cyclone before the electricity was restored" (Non-Resettlement Community and displaced, Micro_FGD_3).*

Households living in the resettlement community that were displaced had no electricity access prior to Cyclone Idai and so did not experience inconsistent access after the cyclone (Appendix F, Picture 5 shows a household's solar lamp within the resettlement community).

> *"It is difficult to move around this area at night because it does not have electricity" (Resettlement Community and displaced, Micro_FGD_2).*

Access to cooking fuel

Access to cooking fuel depended on the formality or informality of residence, and the income of households. Households that lived in the central area of the city and were non-displaced had access to different types of cooking fuel. The type of cooking fuel that was most referred to was charcoal.

> *"There are some households that used electricity for cooking their meals prior to Cyclone Idai. However, most people used charcoal after the cyclone when electricity was disrupted. The people that did not have money to buy gas used charcoal for cooking which is cheaper" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Charcoal was perceived as the cheapest form of cooking fuel that low-income households could access. Households that experienced disruptions in access to cooking fuel may have changed from clean cooking fuel options like electricity to charcoal, which is associated with ambient air pollution. The increased demand for charcoal after Cyclone Idai also made charcoal production an income-earning opportunity for some households.

> *"Apart from traditional agriculture, some households in Beira practiced charcoal production after Cyclone Idai as a means of income to buy food and support themselves which helps increase their resilience" (Community leaders, Meso_FGD_1).*

Apart from charcoal, households living in the resettlement and displaced community mostly depended on firewood for cooking before and after Cyclone Idai. Households picked firewood from nearby bushes, and as such did not appear to experience inconsistent access to cooking fuel post-Cyclone Idai.

"We use firewood for cooking, and we cook our meals outside. We are at the mercy of the weather whenever it rains and we have to carry everything inside" (Resettlement Community and displaced, Micro_FGD_2).

"After the cyclone Idai, particularly, for people in Beira when you go to the countryside you can find some firewood and people can use to cook when they have some pots, but when it comes to the city like this where people lost their pots and fuel for cooking, it became challenging for them to cook" (FH, Macro_KII_6ngo).

Although using firewood is associated with indoor air pollution, preparing meals outside may reduce exposure to such pollution, but expose households to other weather conditions that limit their food preparation abilities. Households on the outskirts of Beira had better access to cooking fuel after Cyclone Idai, by using firewood, compared to households within the city (Appendix F, Picture 5 shows fuelwood and charcoal cooking fuel).

4.5.2.4 *Interactions between the Accessibility, Affordability and Convenience Characteristics*

Households within the resettlement and displaced community appeared not to have experienced disruptions in terms of access to water (not potable water), cooking fuel and electricity post-Cyclone Idai. They were already food insecure before Cyclone Idai, relying on fuelwood and well water (see pictures 3 and 4 in Appendix F) for meal preparation, rather than metered water and electricity systems, that became disrupted after Cyclone Idai. Apart from concerns with water safety and additional costs related to water treatment, households returned after weeks of displacement to pre-Cyclone Idai sources of water and cooking fuel. The qualitative findings also shed light on the interconnections between the indicators for accessibility, convenience and affordability characteristics of the personal food environment of households. For instance, differences in access to cooking fuel were associated with household incomes, whilst cooking fuel access was necessary for clean water access as households needed to boil water for drinking post-Cyclone Idai. The differences between the underlying personal food environment characteristics of households and post-Cyclone Idai disruptions illustrate a complex web of interactions associated with household food insecurity and poverty in the year after Cyclone Idai.

4.6 OBJECTIVE 4

This section presents findings on adaptations to Cyclone Idai, their relatedness to food insecurity and how they enabled or constrained food access during the disaster preparedness and response phases of Cyclone Idai. Household adaptations to disasters influence the severity of post-disaster food insecurity and reflect the social vulnerability of households. Adaptations include both short-

term and long-term measures to adjust to impacts of extreme weather events while securing access to resources like food, water and social capital. The adaptation to disaster strategies were categorized based on household's self-initiated adaptations at the microsystem level and those facilitated by social capital networks at the mesosystem and macrosystem levels to improve food access. The indicators for adaptations to disaster used for the quantitative study are outlined below (table 4.15). The responses were recorded in a binary form where 'adaptation was not applied' implied 'No=0', and 'adaptation applied' implied 'Yes=1'.

Table 4.15 Description of Independent Variable Indicators for Adaptation to Disaster strategies

SES Levels		Description of Adaptation to Disaster Indicators	
1	**Microsystem**	Household Displacement	No=0 adaptation not applied Yes=1 adaptation applied
		Household Sold Assets.	
		Household used Savings.	
		Household Diversified Income	
		Household Adopted Informal Work.	
		Household Member Migrated	
		Household took Formal or Informal loan	
2	**Mesosystem**	Household supported by Relatives or Community Members within the City	
		Household Remitted by Relatives Outside City	
		Household Borrowed In-Kind	
		Household Borrowed for basic needs	
3	**Macrosystem**	Household Received Government Assistance	
		Household Received NGO Assistance	

4.6.1 Adaptation to Disaster Strategies and Household Food Insecurity Post Cyclone Idai

The post-Cyclone Idai adaptations were initially quantitatively assessed and followed by the qualitative study. Percentage distributions of the uptake of adaptation to disaster strategies among households from the quantitative study are illustrated using a bar chart below (figure 4.5). The use of household savings at the microsystem level was the most adopted adaptation by 78.8% of households, followed by borrowing for basic needs adopted by 45% of households at the mesosystem level. The least adopted strategies were at the macrosystem level where only 12.6% of households indicated they received government assistance, whilst 11% received NGO assistance

despite the heavy presence of macrosystem humanitarian and donor agencies involved in post-disaster response (Figure 4.5).

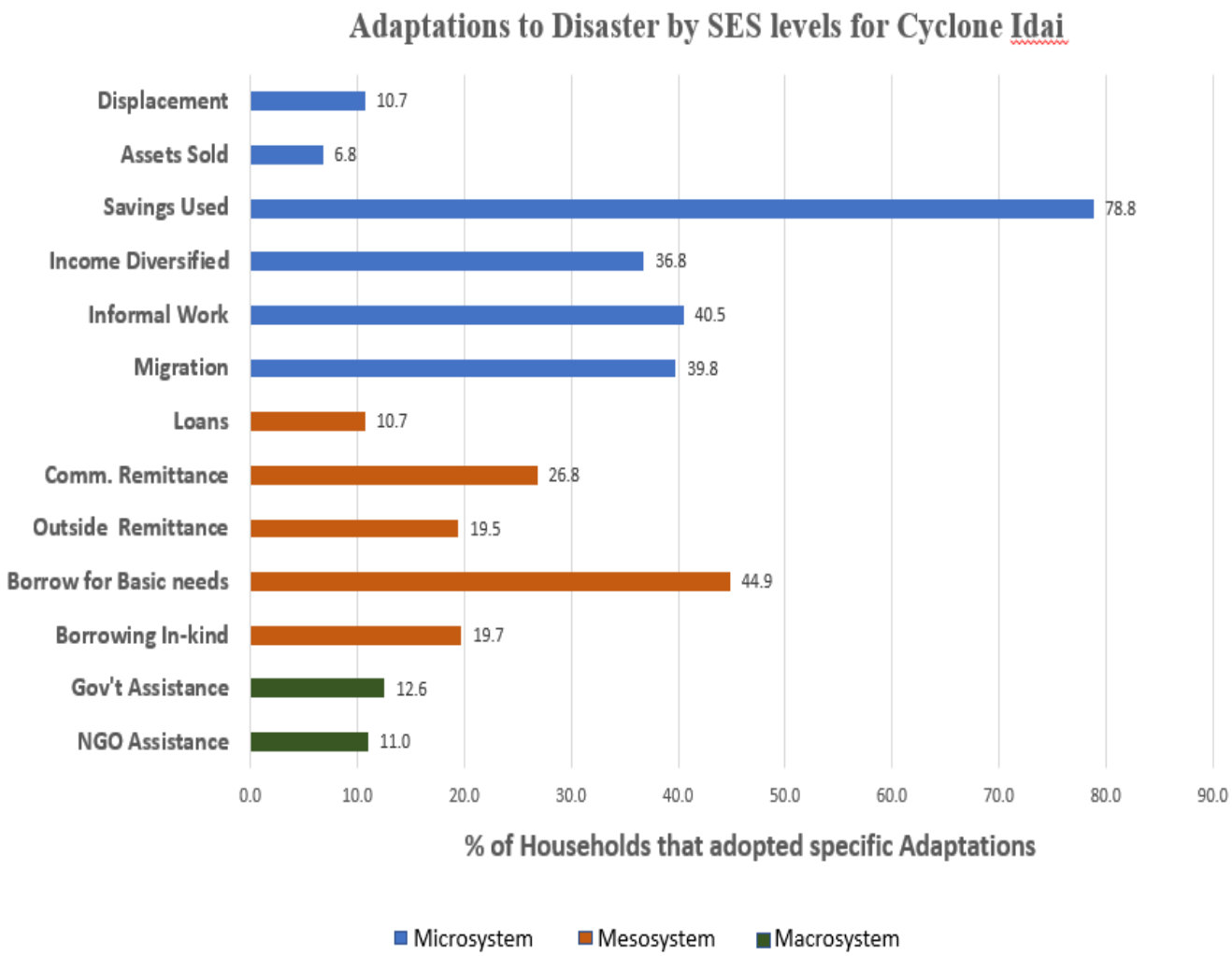

Figure 4.5: Household Adaptations to Cyclone Idai by SES level

4.6.2 Qualitative Findings on Adaptations to Disaster Strategies Post-Cyclone Idai and Household Food Insecurity

The qualitative study presents how the different adaptations from the quantitative study were adopted during Cyclone Idai disaster preparedness and response phases. The analyses below are therefore sectioned into disaster preparedness and response phases aligned with the microsystem, mesosystem, and macrosystem SES levels. The results reflect multilevel interactions within SESs, whereby changes in one level influenced changes in other levels during Cyclone Idai disaster

preparedness and response. Additionally, the perspectives of participants shed light on the adaptations that enabled or constrained food access post-Cyclone Idai.

4.6.2.1 *Adaptations Linked to Food Access During Cyclone Idai Disaster Preparedness*

Disaster preparedness refers to measures put in place before the disaster to reduce associated losses which may occur. Findings from all SES levels indicate that the preparedness phase began with disaster risk communication and the issuance of early warning information about Cyclone Idai to households.

Microsystem level adaptations

The FGDs responses revealed that different households received and used the information based on their perception of the risk of flooding. There were differences between the adaptations applied in preparedness for Cyclone Idai, based on whether households lived in high-risk areas or not. Non-displaced households indicated that early warning information was received through various media, but no adaptation strategies were adopted in preparedness for Cyclone Idai.

> *"We received a lot of information about this. Yes, we heard on the TV and Radio, but we did not believe it. We have heard about so many other cyclones before that never occurred or turned out to be very weak. The information coming with this cyclone also sounded very new to us and we did not take it seriously. We heard that the cyclone coming would destroy our buildings. We assumed this Cyclone Idai was going to be like the previous cyclones and as such we were unprepared" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Non-displaced households did not consider their residence flood-prone, neither did they regard early warning information. Familiarity with early warning information from past less catastrophic cyclones, influenced their lack of preparedness actions, and thereby made them susceptible to increased post-disaster food insecurity post-Cyclone Idai.

For households that were displaced, the approach was different. Households living in high-risk areas of the study evacuated their communities to displacement centers as the flood waters started rising and based on early warning information. These households followed processes to evacuate their communities as an adaptation, because of the awareness that they lived in high disaster risk areas. All surrounding communities were aware of this protocol.

> *"The community knows that that nearby school is a safe place so whenever there is a natural disaster, we take cover there. It is about a 10 min walk from the community. The school has boarding facilities for students. There is a kitchen, washroom and toilets for*

hygiene purposes. The school was on break for the holidays when Idai happened" (Non-Resettlement Community and displaced, Micro_FGD_3).

"We heard that the cyclone coming would destroy our buildings …We moved from here to a nearby Secondary School in the other neighborhood. The whole community moved to the school to wait" (Resettlement Community and displaced, Micro_FGD_2).

Apart from just-in-time evacuation to the displacement center, which is indicative of preparedness planning, responses show that there were no other adaptations for survival preparedness, such as stocking of food and water before Cyclone Idai. This is indicated in the quotes from different FGD participant responses below:

"Some of us did not get to take anything. I just ran with my children and husband to the safe place" (Non-Resettlement Community and displaced, Micro_FGD_3).

"We did not take food along. The rains were coming in and it was getting flooded so we evacuated as quickly as we could' (Non-Resettlement Community and displaced, Micro_FGD_3)

Additionally, other adaptations such as reinforcement of buildings, which would be indicative of structural preparedness before Cyclone Idai were not identified from the household interviews. A quote from the resettlement and displaced community illustrates this.

"We had only tents, for our homes and we did not know how to protect the tents before going to the center. When we came back here, from displacement after Idai, all the tents were washed away" (Resettlement Community and displaced, Micro_FGD_2).

Although this community was a previously resettled community, they exhibited a lack of knowledge on other types of adaptations during disaster preparedness apart from evacuation. The resettlement and displaced community in this study is a unique example of a previously poorly planned resettlement, prior to Cyclone Idai, that increased the vulnerability of the community to further displacement. This reveals that households that were previously resettled for other reasons, also added to the numbers of people at the Cyclone Idai displacement center who needed to receive food assistance. The case of the community is explained by the quotes below.

"The Terra de Prometida is a resettlement community made up of 48 families which were resettled in 2016. In 2016 they had floods, and it was necessary for the government to resettle these households. The government resettled them and gave them tents to live in and initially supported them with food and then they left them" (Asate, Macro_KII_8ngo).

"We had our own houses in our previous community even though some of the houses were made from traditional materials. We were promised new block houses only to come here and realize that conditions were even better in our former community. In the beginning, the government minister of Social Affairs and Gender (INAS,) promised us that we will be given complete houses in the resettlement and also give us the DUAT ((Direito do Uso e Aproveitamento da Terra) or (rights of use and benefit of land')) *for the new buildings, which has not happened after 6 years" (Resettlement Community and displaced, Micro_FGD_2)."*

Poorly planned resettlement can trap households in a recurring cycle of displacement with each disaster, causing disaster management organizations to continually respond to the same households' needs including food assistance, which becomes a maladaptation.

Mesosystem level facilitated adaptations

Interviews with community leaders about adaptations support household FGD responses, indicating that although households received early warning information, adaptations were minimal. At the community level, households were supported by community leaders and their wider community members representing bridging social capital networks to facilitate adaptations. Two types of adaptation strategies were recommended to households by early warning communications before Cyclone Idai. The strategies were mainly "stay at home" or "evacuate based on residence" (location) within a flood risk zone". Within non-displaced communities, community leaders spread early warning information and urged households in non-flood risk zones to "stay at home" to protect themselves. Apart from that, non-displaced households were not advised on other types of adaptations in preparedness for post-disaster food security while staying at home.

"Before Idai we were told something big is coming so we need to prepare so just like other times we prepared our members by telling them not to leave their houses. Unfortunately, people are curious and want to know how intense a cyclone can be, how it would affect us as such they did not prepare themselves properly" (Community leaders' triad, Meso KII_1).

For communities that were displaced in this study, community leaders and members facilitated evacuation of all households to displacement centers, as an adaptation in preparedness for Cyclone Idai. Responses from the FGD with households illustrate this.

"During this confusion with each household scrambling to reach a safe place, we helped the old and disabled people to make it to the safe place as well. The whole community evacuated to the safe place. No one was left in the community. There are 650 households in this community, and we all stayed in the school because the school is big. Households

from other communities were also in the school. There were people from Matongolo, Muavi, Terra de Prometida. The school was in no condition to receive all households, but it had enough space" (Non-Resettlement Community and displaced, Micro_FGD_3).

The responses highlight the role of bridging social capital networks in facilitating information sharing and evacuation, however, no other types of adaptations were mentioned for addressing household food insecurity during the preparedness phase of Cyclone Idai.

Macrosystem level facilitated adaptations

The macrosystem institutions appeared to follow general disaster management plans in the lead up to Cyclone Idai. Apart from preexisting measures, there appeared to be no additional Cyclone Idai specific adaptations within institutions, or recommendations for households, although Idai was potentially more disastrous than previous cyclones in Beira. Preexisting institutional adaptations in preparedness for all disasters in Beira include conducting risk assessments (e.g., food insecurity risks), and developing early warning and disaster risk communication systems. Additionally, during preparation for cyclones there are Cluster meetings between the INGD and other disaster management organizations. The Cluster meetings are more focused on how to respond in the aftermath of the cyclones rather than how to mitigate the impact of cyclones on households and in this study food insecurity.

"The way the INGD provided information about the cyclone Idai that was coming was the same just like for every other disaster although the first disaster which destroyed everything in Beira city and in the Sofala Province was Cyclone Idai" (Red Cross, Macro_KII_7ngo).

"INGD is the institution that manages disasters at the National and Provincial level. The INGD coordinates the disaster alert, and the Red Cross comes in to support with the use of their volunteers to further spread the word among the communities. The INGD usually works with SETSAN which is a public institution that addresses food insecurity vulnerability in Mozambique. The INGD, in partnership with other organizations which provide technical advice, respond to these kinds of disasters when they occur. We have meetings to discuss interventions for households which can be affected. INGD works with WFP, FAO, SETSAN and some civil societies to respond to disasters" (INGD, Macro_KII_3gov).

"All activities in disaster preparedness occur within a cluster of organizations where INGD is the leading institution. Other institutions include INAS, WFP, Provincial government, district government, Mozambique Red Cross, IFRC, UNFPA, IOM and several others. INGD shares the disaster alert within the 'Cluster', after it has been shared within the Commission of Emergency. Then within the Cluster it is determined where each

institution will make their interventions to prevent the duplication of efforts. Our institution provides first help to communities which involves training and capacity building of volunteers to help the households before, during and after a disaster, to ensure that the household is prepared to respond to disasters. The Red Cross supports local disaster management committees in the communities by providing them with a preparedness kit consisting of a radio, phone, bicycle, first aid kit and other items" (Red Cross, Macro_KII_7ngo).

"SETSAN is a department of the Ministry of Agriculture, which is situated here in Beira, but has a central office at the provincial level. SETSAN works with institutions including the INGD, INAS, WFP, UNICEF, GREPOC. SETSAN carries out on-going household food insecurity assessments through surveys and produces a report to show the numbers of food insecure people and administrative areas where household food insecurity is prevalent. The report is circulated among institutions who work with SETSAN to help the people who are in the situation. These reports inform pre-disaster preparedness as donors know which communities are more vulnerable and can then go to these communities' post-disaster, to identify and assist households after disasters" (SETSAN, Macro_KII_5gov).

Only one institution mentioned that they took some Cyclone Idai specific measures, because they had access to other sources of disaster risk communication from outside Beira.

"Apart from internal information about the Cyclone Idai, we were also receiving information from our office in the United States. They have a safeguarding department there that was also providing information to us. When the cyclone was approaching, regular information was being spread around among staff. Just for safety, the office was closed, and all our staff were at home and working from home. Although we were a little bit prepared for the cyclone because we knew from the information shared, we were not aware that the impact would be the worst possible. For example, we had a satellite phone and also took some money from the bank and kept it in the office so that we could use it when there is no access to the bank but not in big amounts but rather for small things. I don't think that it was a lack of information but probably the way the information came to us was not sufficient to understand the possible impact Idai" (FH, Macro_KII_6ngo).

The disaster management institutions were responsible for planning and spreading disaster risk communication during the disaster preparedness phase, to enable effective response for Cyclone Idai. This involved equipping volunteers to spread early warning information within communities and recommendations to 'stay at home or evacuate to a safe place'. However, households were not advised on adaptations such as food storage practices before Cyclone Idai.

"For Cyclone Idai, we did our best in alerting the local communities. We sent the volunteers and the local committee to alert the communities 6 hours before the event happened. Red Cross does not have specific information to provide to the communities with

the alert on how households should prepare in terms of food or this or that. It was a general message that people living in the high-risk areas must rescue themselves and their families by moving to a secure area. After the alert, volunteers were sent to their stations to wait and assist households" (Red Cross, Macro_KII_7ngo).

"Households were not warned on how to store food. Not only in terms of where to store food in their buildings but it could also just have been the use of hermetic bags that are useful to store food without wind or water damaging it. I think this should have been done prior to the disaster" (FH, Macro_KII_6ngo).

Across all SES levels, low risk perception was linked to the low uptake of adaptation during preparedness for Cyclone Idai. Early warning information issued before Cyclone Idai was not detailed enough to inform other types of household adaptations apart from evacuation to displacement centers. The low uptake of adaptations among households to address food insecurity appeared correlated with the disaster risk communication received from disaster management organizations. The use of the preparedness kit mentioned by the Red Cross was not identified at the mesosystem and macrosystem levels. Similarly, disaster management institutions prepared for Cyclone Idai just like previous cyclones and as such, were not prepared for Cyclone Idai's impact and response. This is reflected by the results from the quantitative study on the low levels of macrosystem facilitated adaptation strategies (less than 13% of households received assistance from NGOs or government institutions).

4.6.2.2 *Adaptations Linked to Food Access During Cyclone Idai Disaster Response*

During the Cyclone Idai response phase, there were different food-sourcing adaptations by households to ensure food access, and this varied between displaced and non-displaced households. Non-displaced households mainly relied on themselves or their social capital networks (bonding and bridging) at the mesosystem level for food access. Most households in the study (83%) were non-displaced as seen from the quantitative results, and sourced food through bonding and bridging networks where applicable. The displaced households in the study relied on food aid provided by both governmental and NGO humanitarian agencies at the displacement centers. This was indicative of food access provided by 'linking social capital' networks at the macrosystem level. Findings on the adaptations and how they enabled or constrained food access are presented under the various SES levels below.

Microsystem level adaptations

From the quantitative study, the most adopted adaptation by 78.8% of households was the use of household savings (figure 4.5), indicative of households' self-initiated adaptations. The qualitative study supports findings from the quantitative study as the quote below highlights how access to savings provided food access amidst food shortages post-Cyclone Idai. Households with

substantial access to money bought the food available and stockpiled it, which limited food access for other households. This may have contributed to further reductions in food availability and increases in the cost of food immediately after Cyclone Idai.

> *"There were some households with the power to buy something and could buy for their families, so they bought everything and hoarded it because they had money and there were food shortages. Some of the households went to bakeries to buy all the bread. There was not enough bread for the whole city and poor households were not able to find and even afford bread (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Households with available cash were able to source food for themselves at a time when there were food shortages and food price hikes after Cyclone Idai. Accessing available cash appeared more important during the response phase than accessing savings in the bank which could not be retrieved for some time after the disaster.

> *"Cyclone Idai affected even the banks and they were closed for some time… People with money in the bank could not even access their money… it is not wise to save money in the bank during disasters, because during the disaster even the banks suffered and were closed. People with money in the bank could not even access their money" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Mesosystem level facilitated adaptations

Of all the mesosystem-facilitated adaptations from the quantitative study, the most utilized by 45% of households was 'borrowing for basic needs', whilst 27% received remittances (cash or in-kind) from within the community. The qualitative study further highlighted the reciprocal and non-reciprocal interactions between non-displaced households and their neighbors for food access post-Cyclone Idai. Reciprocal interactions between households and their neighbors enabled the mobilization of available food resources to address food insecurity for the contributory households.

> *"In my neighborhood, households brought together whatever ingredients they had at home after the cyclone, for example onions, chicken and cooked food and distributed it among themselves" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

However, non-reciprocal interactions enabled food access for households on the receiving end but constrained food access for households that were giving to others. 'Giving' households within bonding social capital networks may have experienced exacerbated levels of food insecurity which they otherwise may not have experienced if they did not support others for a long duration after Cyclone Idai. The loss of housing after Cyclone Idai was also linked to increased household food insecurity, which was moderated by access to bonding social capital networks that provided both temporary housing and food access. Non-displaced households that lost their houses and

everything else, but could not rely on bonding social capital networks, were limited in their food-sourcing adaptations.

> *"In my house, my family received the neighbors who lost everything during the cyclone. During the beginning, we shared everything with them including our food. But after some time, we felt like we had to share what food we did not have with these families, and it was putting a burden on us. We hosted them for about a month" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

> *"People opened up their homes to house other community members whose homes were destroyed. But this did not happen in all neighborhoods. For instance, in my neighborhood there was a lot of selfishness as households focused on their own losses and challenges rather than those of their neighbors" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Apart from bonding social capital networks, some non-displaced households sourced their food through bridging social capital networks as an adaptation. Such networks included religious organizations that mainly provided emergency relief for the households of their members before reaching other households. This is illustrated by the quote below.

> *"The Lutheran World Foundation helped the churches with donations in partnership with the INGD. For example, when we receive donations, and we want to go to any community and INGD realizes that the community already received donations, the INGD will recommend that we go to a different community. However, in these communities that have already received assistance, there are small groups which are members of the church, and we still go ahead and give these small groups donations before moving to other communities. All members of the church received a kit which included, roof, cement, blankets and buckets. Other churches were also involved in distributing cheques for money and food such as rice, oil, maize to their members and affected households" (Community leaders' triad, Meso KII_1).*

The households affiliated with these religious organizations exhibited stronger social capital networks and were supported with food-sourcing adaptations, compared to households without these bridging networks. Apart from religious organizations, being affiliated with community leaders also proved to be a strong bridging social capital network. Community leaders played a crucial role in assisting humanitarian organizations to identify the most vulnerable households within their communities, to be given emergency supplies, including food aid.

> *"We go to the local authorities in communities and ask them who are the most vulnerable families here. The local authorities will tell you 'This gentleman here or that lady there'. However, the solidarity within the communities was high so even people who did not have anything were able to say 'ok, I do not have but that person needs it the most. Or you can*

help that old man…he is my neighbor… I am young and can rebuild but he is old and cannot" (GREPOC, Macro_KII_1gov).

"Some indicators we used to identify vulnerable households for food aid were household size, number of members in the household that had a job, what type of work they were involved in, monthly income, type of building household lived in, widows, households headed by children among others" (Community leaders, Meso_FGD_1).

"We organized meetings with community leaders to guide them on how to select vulnerable households then we allow them to do the selection for us. Indicators used included households led by pregnant women, households led by children, elderly people, people without a farm, households with more than 5 children. However, we realized community leaders were selecting their neighbors and relatives" (FH, Macro_KII_6ngo).

Being affiliated with community leaders may have given some households unfair increases in household food access compared to households without such networks. Households with stronger bridging social capital networks also had access to information about where food distribution would take place, which they took advantage of.

"We realized community leaders were selecting their neighbors and relatives" (FH, Macro_KII_6ngo).

"There were some types of corruption at the level of the community. For example, some community leaders will bring their own family members 3 or 4 times to receive the same donations" (Community leaders' triad, Meso KII_1).

"Some households know of the communities or neighborhoods that will be receiving donations, they go to these other communities to receive aid again and again. Aid included food, seed, cement, clothes, tents" (Community leaders' triad, Meso KII_1).

"Some households received 3 times as much and will not say they have already received help so it should be given to others" (Ministry of Agriculture, Macro_KII_4gov).

Access to bonding and bridging social capital either moderated or exacerbated household food insecurity among some vulnerable households from the non-displaced communities after Cyclone Idai. The role of community leaders was relevant for targeting vulnerable households for increased food access, but also influenced unequal distribution of food aid as their work was not audited.

Macrosystem level facilitated adaptations

Macrosystem institutions represent linking social capital networks on which displaced households depend for food-sourcing adaptations. Displaced households stayed at displacement centers during

the Cyclone Idai emergency response phase and received food aid from humanitarian organizations. Despite the discomfort associated with being at the displacement center, there was consistent access to food and emergency aid. This was considered an incentive for even some non-displaced households who strived to be at displacement centers. Non-displaced households were also expecting to receive food aid just like displaced households as indicated by the responses below.

> *"There were a lot of people in Beira that were fighting to go to the displacement centers during the disaster response phase even though they did not suffer a lot from the impacts of the cyclone. People were fighting to go to these displacement centers because they felt that they would receive food and other benefits from there" (FH, Macro_KII_6ngo).*

> *"The government prioritized people who moved from high-risk areas to the displacement centers so in my neighborhood we did not receive any support. Only people at the displacement centers got help although all the residents in Beira should have received it. In my neighborhood we did not receive any support. Not even from the government. All we got were promises from the government" (Non-Resettlement Community and non-displaced, Micro_FGD_1).*

Households at the displacement centers were from communities that were completely destroyed by the cyclone. At the displacement center, households were assured of food access and received 3 cooked meals daily, which most households could not even afford pre-Cyclone Idai. Responses appeared to be split when describing food access at the displacement center. There was general satisfaction with receiving meals daily, but dissatisfaction with dietary diversity and food portions. Different responses from participants from the same FGD illustrate this.

> *"We had breakfast, lunch and dinner. We had 3 meals most of the days. The food was nutritious. In terms of portions, they were small. We eat but no satisfaction. We depended on donations such as maize, rice, beans through food aid that was given. The food was cooked in large pots and then divided among all the households that were staying there. The women did the cooking, and we created a roster for ourselves to ensure that the workload was divided equally. After the women have cooked the meals, the food was distributed on a household basis. The women call out the heads of each family to know how many members they have before serving their food. Sometimes larger households did not get enough portions. I have 4 children and the food we were given was never enough" (Non-Resettlement Community and displaced, Micro_FGD_3).*

> *"We were fed the same meals every day. Rice and beans for lunch or pasta, rice and beans for dinner. For the children, aged, sick, we all ate the same foods" (Non-Resettlement Community and displaced, Micro_FGD_3).*

Responses showed that larger households were disadvantaged in terms of food portions which indicates that even at the displacement camp, differences in household food insecurity were still linked to household characteristics, whilst bonding social capital networks facilitated meal preparation.

4.6.2.3 *Facilitations and Limitations of Food Access Adaptations Between Displaced and Non-Displaced households- Emergency and Non-Emergency Cyclone Idai Response Phases*

The processes put in place by disaster management organizations at the macrosystem level (linking social capital) for facilitating household food access differed between the emergency and non-emergency response phases of Cyclone Idai. Regardless, these processes not only enabled food access but, in some cases, constrained household food access. Displaced households at the various displacement centers were those supported by humanitarian institutions during the emergency phase.

Emergency response phase facilitations

The distribution of food at the displacement center during the emergency phase seemed organized and several institutions worked together in addressing the needs of displaced households. To assist households, a register was made of all household members, whilst households split into different displacement centers were reunited at same centers. This was because emergency support was given on a household rather than an individual basis. The Red Cross provided relief at the center on a household basis and were also involved in reuniting households into the same displacement centers. The KII with the Red Cross and INAS explained the process.

> *"During the disaster, people ran for their lives and households got separated and were lost to themselves. So, different household members were located at different displacement centers across the city. The Red Cross operates on a household basis and is experienced in such emergency environments such as during wars, refugee situations. The Red Cross brought this component on board and worked with INAS who had the list of households in Beira and helped to identify and reunite separated households in the same centers. A specific number of households lived at displacement centers and everything they needed from tents to food was provided for them at these centers. We distributed food to households like rice, maize, beans, and oil to address household food insecurity. We also gave kits for each household at the displacement center. They included Dignity Kits (hygiene and sanitary items) and Shelter Kits to enable them to go back to their homes and restart their lives. The Shelter Kits included tent, tools for building tents, blankets, mosquito nets, pots for cooking, plates, cups and other items" (Red Cross, Macro_KII_7ngo).*

"INAS is a governmental institution which is a subordinate of the social services, children and gender ministry based in Maputo. The mission of INAS is to provide social assistance to vulnerable households, who do not have the means to satisfy their necessities. INAS has community representatives, who live in the communities and provide a list of vulnerable households (e.g., aged, orphans, widows) in their communities to INAS even before Cyclone Idai. The technical department of INAS then inputs their names into the database so that they can receive support" (INAS, Macro_KII_2gov).

Reuniting households to the same displacement center was very important for reducing the duplication of emergency relief and ensuring equity in the distribution of aid. The Red Cross engaged with INAS because the institution has a database for vulnerable households in the city and this was useful for reuniting households within the same displacement centers. Households that were at the displacement center were also given kits to help them resettle at home after weeks of staying at the displacement center. This was confirmed by the response from one of the FGDs with displaced households.

"To prepare the households to return home from the displacement camp, we were given a kit of sugar, rice, oil, maize, beans before coming back home. This food lasted for about a month. When we came back, the Asate organization provided us with seeds and tools to start producing food on our farms again. We were also given tents by the Asate organization. Most of us are still using tents for houses" (Non-Resettlement Community and displaced, Micro_FGD_3).

Non-emergency response phase facilitations

After the emergency response phase, INGD collaborated with several other institutions to facilitate adaptations for food access within non-displaced households. However, the process was beset with poor coordination challenges between macrosystem-macrosystem institutions and macrosystem-mesosystem institutions, especially around creating a list of most vulnerable households who should be provided with food aid in Beira. This resulted in unequal food distribution and few households receiving food aid. From the quantitative study, only 12.6% of respondents indicated they received support from the government, 11% received support from humanitarian NGOs, whilst only participants from displaced communities indicated that they were supported by macrosystem institutions. The responses from the macrosystem KIIs highlight challenges that resulted in constrained food access among vulnerable households during the non-emergency phase of Cyclone Idai response.

"The INGD works from the government side and receives everything that organizations donated to households. Once they receive this package from the international institutions, they have the maps of the areas and what is needed, and they distribute the specific care or help for these areas. INGD usually works in a limited number of households, that is why

INGD partners with WFP who have a list of households and preexisting channels or strategies for distribution of food in the areas" (Community leaders, Meso_FGD_1)".

"The household selection was guided by the WFP and the municipality authorities. So, we just received the list of beneficiaries in order to distribute food to them. This included cereals, beans, oil and salt. That was basically in Beira city, that was what we did in 2019. We provided this service for 2 months from March to May. But unfortunately, we had to interrupt this service in June, and we continued this activity outside of the city of Beira" (FH, Macro_KII_6ngo).

"The INGD would go to any specific neighborhood and say that today, we would distribute food in this neighborhood and then move to other communities based on what they decide. This approach started to create confusion among households in each neighborhood as people also moved from their neighborhoods to receive food in others. Most old people who were part of the INAS list of vulnerable households before Cyclone Idai did not have access to the food aid benefits because of the approaches by the INGD and partners, WFP and FH. The government upon seeing this asked that these institutions put a stop to this type of distribution and let INAS lead because INAS already has a lot of experience in working with vulnerable people. So INAS became responsible for collating the lists for food distribution into an electronic database E-INAS. During the setting up of the E-INAS we identified several instances of more than one person in a household included on the same list. The processes involved were very long and it took more than 6 months and donors were ready to distribute aid, so INAS was pressured by donors to provide a list with all the errors which favored several households" (INAS, Macro_KII_2gov).

"Both the municipal and provincial government wanted to lead the process of compiling lists of vulnerable households and have some kind of political gains from this as the ruling political party at the municipality in Beira is different from that of the ruling government. After lengthy discussions, the government agreed to let the municipality prepare the list but then after seeing the huge number of people listed, there were doubts about the list. The number of beneficiaries on the list was so numerous that there were doubts in terms of whether these were people really in need or not. It took a long time trying to resolve the confusion regarding the list" (FH, Macro_KII_6ngo).

"Miscommunication and misinformation between partners and the agricultural department resulted in more than one partner visiting a district and providing support to households" (Ministry of Agriculture, Macro_KII_4gov).

"Some affected people ended up having more than they need, whilst others ended up not having any form of assistance" (GREPOC, Macro_KII_1gov).

Poor coordination at the macrosystem level cascaded into poor coordination of the work of community leaders (mesosystem level), who were responsible for identifying vulnerable households for food assistance post-Cyclone Idai. At the same time, poor mesosystem coordination influenced the delayed provision of food aid for non-displaced households at the microsystem level. Community leaders contributed to the challenges involved in compiling the lists of beneficiaries and this affected many households in the city of Beira. The KII with the Red Cross highlighted the incentive for community leaders to engage in these practices illustrated in the quote below.

> *"Community leaders sold food donations in some of the communities although it was free. They were able to do this because they had access to the list of households of their community because they produce the list of households. They produce the list and share it with INAS as well. The technical officers from the Red Cross and INAS need help from the community leaders in identifying vulnerable households. What happens is that as these leaders compile the list of vulnerable households to receive aid, they ask people for money or sexual favors to put their names on the list. This means that some people who cannot afford to bribe these corrupt community leaders will not find their names on the list of beneficiaries to receive aid" (Red Cross, Macro_KII_7ngo).*

Such activities may discourage some vulnerable households from seeking food assistance, whilst creating tensions within community networks that are vital for addressing food insecurity. For instance, being forced to engage in sexual activities to obtain food assistance for large households may lead to increased psychological and physical harm. The Red Cross created posters to inform households and protect them from such exploitations in exchange for food aid (figure 4.6).

Figure 4.6: Posters to inform and control the exploitation of households for food aid.

Within the post-Cyclone Idai context in Beira where almost everybody was vulnerable, the work of targeting vulnerable households was difficult as acknowledged by the response below.

> *"From statistics, Mozambique is number 3 from the bottom in terms of quality of life. So go there and ask for vulnerability; everyone is vulnerable. How to decide among poor people is hard, particularly among the world's poorest. The PDNA for Cyclone Idai indicated that addressing the needs of the people including food insecurity will cost about 3.2 billion USD but we were only able to get 1.2billion USD. I know that there are so many people, but we gave what we had available, and it has been hard for us to explain why I should select him instead of her and vice versa" (GREPOC, Macro_KII_1gov).*

The length of time it took for the compilation of a comprehensive list to support the distribution of food aid means that households were left to rely on their self-initiated adaptations or on their bonding and bridging social networks to help address household food insecurity after Cyclone Idai.

Some coordination challenges were also attributed to the impact of Cyclone Idai on the disaster management institutions involved in post-Cyclone Idai response. Cyclone Idai caused extensive damage to the buildings, supplies, computers, furniture, paper documents and the lives of the staff

of disaster management institutions. This reduced the capacity of the disaster management institutions and timeliness in addressing household food insecurity during post-disaster response. The quotes below highlight the impacts of Cyclone Idai on institutions.

> *"Cyclone Idai started to destroy things from our houses before arriving at the institution. We lost a lot of things here in terms of equipment-computers, printers, furniture, documents for beneficiaries and till today we are rebuilding the documents lost. We lost a lot of things" (INAS, Macro_KII_2gov).*

> *"As an institution we lost a lot of things. Our department has a warehouse for storage of seeds and agricultural input. After Idai the warehouse became exposed because the roof was taken off and until now, we have not been able to recover. We lost computers, files, furniture and even the toilet was destroyed" (Ministry of Agriculture, Macro_KII_4gov)".*

> *"It was a tragic morning for us. The whole roof of our building is new because our roof was destroyed, and the water came in. We lost our computers as well. Some of our volunteers lost their homes" (Red Cross, Macro_KII_7ngo).*

4.6.2.4 *Summary*

This chapter demonstrates that the extent of damage and food insecurity after Cyclone Idai was not expected. Additionally, there appeared to be no plans to facilitate adaptations, other than those at the displacement centers during the emergency response phase. The processes for identifying vulnerable non-displaced households for food assistance post-Cyclone Idai seemed fragmented between the various SES levels. The responses above highlight the complex interconnections between SES levels, the impact of Cyclone Idai, multiple-level coordination challenges, inadequate resources and poor vulnerability targeting, which was associated with exacerbated post-Cyclone Idai food insecurity for certain groups of vulnerable households. This group of vulnerable households included those that did not have savings (microsystem), those with weak social capital networks (mesosystem) and no access to macrosystem-facilitated food access, as well as households that experienced serious damages to their homes but were non-displaced. It appears increased food insecurity in the month after Cyclone Idai identified from the quantitative HFIAS results was associated with these multiple challenges summarized in figure 4.7. The differences in responses between displaced and non-displaced households provide insights into underlying household vulnerability, vulnerable institutions, general donor dependence and poor resilience within disaster-prone Beira City.

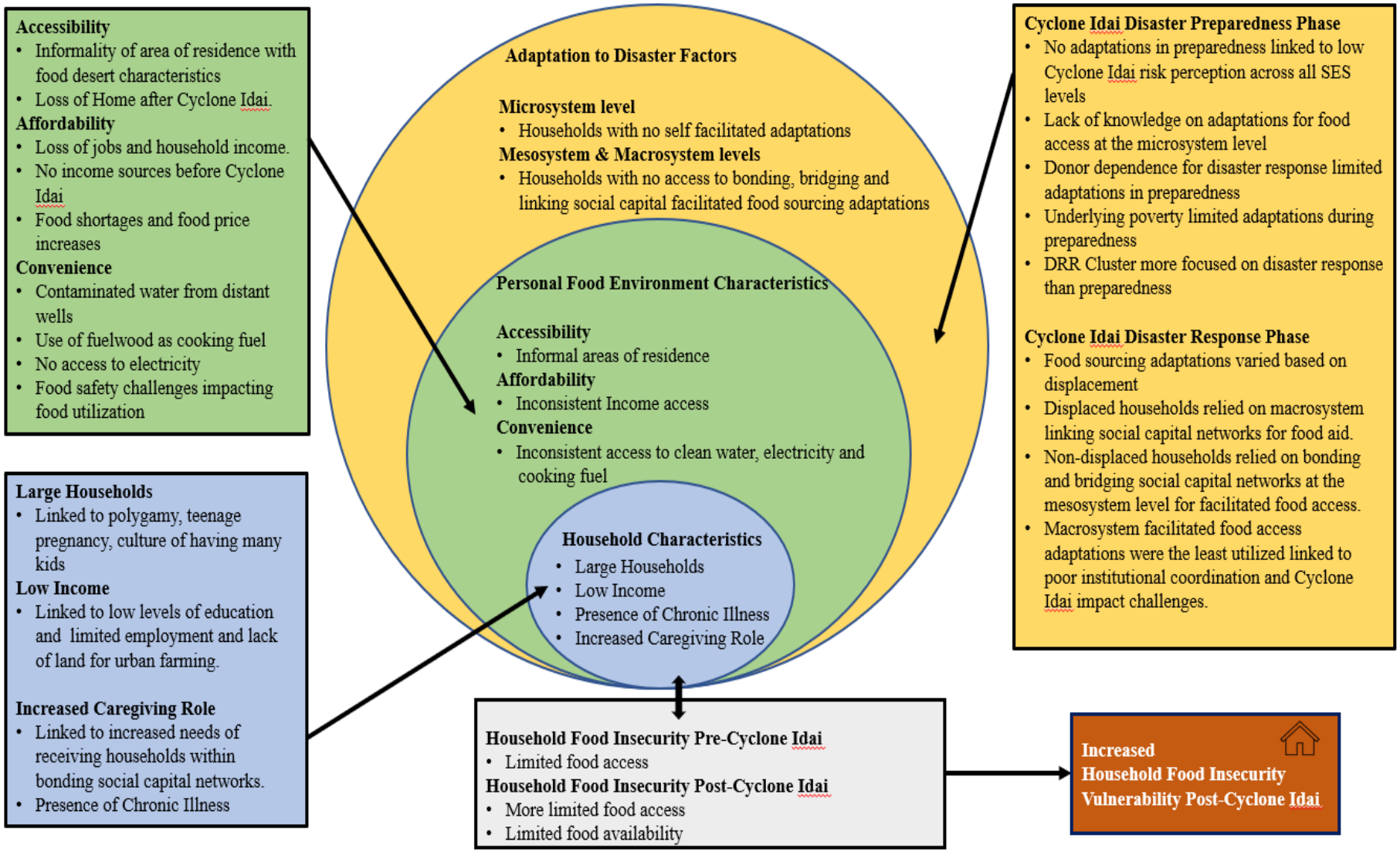

Figure 4.7: Summary of Household, Personal food environment and Adaptation to Disaster Factors linked to Increased Household Food Insecurity Post-Cyclone Idai

CHAPTER 5

5.0 DISCUSSION

5.1 Introduction

This study aimed to assess the differences in household food insecurity after Cyclone Idai in Beira, Mozambique, based on indicators of social vulnerability namely: household characteristics, personal food environment characteristics and adaptation to disaster factors. A mixed-methods sequential explanatory study design was adopted for collecting quantitative and qualitative data across 3 SES levels, namely the household level (microsystem), community level (mesosystem) and disaster management institutions level (macrosystem). The data collected was then triangulated to present the results. This section discusses the results in relation to findings from existing literature and similar studies. The discussion is structured under the broad themes of pre- and post-Cyclone Idai differences in household food insecurity and distinctions based on household and personal food environment characteristics. The section further discusses adaptations by the different SES levels (microsystem, mesosystem and macrosystem) for addressing household food insecurity during Cyclone Idai disaster preparedness and response phases, with considerations for the differences between displaced and non-displaced households.

5.2 Pre-and Post-Cyclone Idai Differences in Household Food Insecurity

The combined use of the HFIAS and HFIAP, provided a more detailed evaluation of the severity, and frequencies of household food insecurity before and after Cyclone Idai. Although severe household food insecurity levels were high one month before the Cyclone, there were statistically significant increases one month after Cyclone Idai. The HFIAS scores highlighted distinct increases in the median score value from 14 in the month before Cyclone Idai, to 18 in the month after the cyclone. The HFIAP further highlighted that the percentage of severely food insecure households in the month before Cyclone Idai increased by more than 10% in the month after Cyclone Idai (77.57%-87.73%). Scoring higher values on the HFIAS scale, which runs from 0-27 is indicative of increased household food insecurity (Coates et al., 2007). This supports assertions that cyclones are associated with differences in household food insecurity between affected and unaffected households in Mozambique (World Bank, 2018a).

Food insecurity before Cyclone Idai was associated with a lack of food access due to multiple factors. Food access challenges were associated with the lack of money to purchase food, high levels of poverty, unemployment, and most households' being dependent on subsistence farming for livelihoods and food consumption. Also, household food production was mainly subsistence-biased, and produce quantities were generally small, insufficient quantities which discouraged storage, whilst food storage knowledge appeared lacking among households. Even before Cyclone Idai (including 1 month before the cyclone), coping strategies of skipping meals during the day,

going without food for whole days, eating less preferred foods, food exchange (e.g., exchange beans for potatoes), and food borrowing, were commonly practiced among respondents. This illustrates pre-existing severe food insecurity before Cyclone Idai, which set the stage for increased post-disaster food insecurity.

Even though food access was limited, food availability was not limited within the city of Beira prior to Cyclone Idai. Beira was stocked with a variety of food options, mostly through food production, food imports and food aid. Beira, being a Port city with an influential geographical location, receives food from either local or international sources. Regardless, the location of Beira exposes the city to extreme weather events which disrupt the functioning of the Port and food supply (Oliveira, 2018; GAIN, 2021). After Cyclone Idai the Port of Beira was heavily impacted and food supply/availability was disrupted. Food transport corridors connecting the Port of Beira to food sources were destroyed as floodwaters washed away roads and bridges which affected the food supply to the city (Tevera et al., 2021). The entire food system and society of producers, market vendors and consumers, were affected and there were food price fluctuations in Beira post-Cyclone Idai (GAIN, 2021; Tevera et al., 2021).

After the cyclone shocks in 2019, the price of food kept rising, and by September 2019 the price of maize grains in Beira market had increased by 35%, an increase that was more than 29% above the 5-year average maize price (USAID, 2020). These price increases severely impacted the food insecurity of households, especially because maize is one of the main staples in Mozambique. Maize is such important staple food in Mozambique that some households in Xai-Xai Mozambique, a city that was greatly impacted by the 2000 floods, consider themselves food secure when they have money to buy a bag of maize or a dish of 'Xima' for food (Raimundo & Caeser, 2023). Some households described as food insecure in the qualitative study ate the maize meal 'Xima' with salted water, even when they had no accompaniment, whilst several households skipped meals or went without food for days after Cyclone Idai. Measures like skipping meals and going days without food portray extreme levels of food insecurity and hazard exposure (Gupta et al., 2015; Maxwell, 1996).

The increased levels of household food insecurity in the month after Cyclone Idai were drastic due to the intensity of the Category 4 cyclone and its impact on food availability and food access. The experience of a flood, cyclone, or drought has been associated with about a 25-30% drop in per capita food consumption among impacted households in Mozambique (World Bank, 2018a; World Bank, 2019), which shows high food insecurity volatility. About 1 month after Cyclone Idai, aid agencies were still finding hundreds of thousands of people desperately in need of water, food and shelter, in areas which had been cut off by floods, whilst humanitarian resources were dwindling and needed to be redirected to reach the most needy (Devi, 2019). The reductions in the overall food availability within Beira's food system post-Cyclone Idai fueled food price hikes, such that people with money could not afford to buy food. This likely explains the heightened increases in the HFIAS scores in the month after Cyclone Idai.

The impact of Cyclone Idai on agricultural livelihoods, food supply, and increased food prices, pushed already vulnerable households into unprecedented and severe forms of food insecurity. Household food insecurity in Beira prior to Cyclone Idai was 'chronic' and associated with deprivation, whereby lack of monetary and production entitlements restricted food access. Households already experiencing chronic food insecurity (linked to poverty), were exposed to an extreme weather event, Cyclone Idai, which exacerbated their underlying food insecurity in the month after the cyclone. Therefore, already severe forms of chronic food insecurity were compounded by the impact of Cyclone Idai, thus, creating new and more severe forms of chronic household food insecurity in Beira. Additionally, the percentage of food-secure households 13.4%, reduced to 6.9% in the month after Cyclone Idai. This suggests that even food-secure households became transitorily food insecure after the cyclone.

Although some studies show that a close relationship exists between chronic and transitory food insecurity, whereby successive experiences of transitory food insecurity create increased vulnerability to chronic food insecurity (Maxwell & Frankernberger, 1992), this study further indicates even chronically food insecure households may transitorily experience more severe forms of chronic food insecurity due to disasters. When households already experiencing chronic food insecurity frequently sink into more severe forms of food insecurity due to disasters, households may never be able to escape chronic food insecurity, which could become generational. Repeated experiences of transitory food insecurity can have permanent impairment effects on children, who may transmit it to their own children, fostering intergenerational chronic poverty and food insecurity (Barrett & Lentz, 2010). About 7 out of 10 Mozambicans experience deprivations in access to food and more than 50% are chronically food insecure (World Bank, 2018).

These findings are particularly important, because they show that recurrent cyclones in Beira expose households to frequent episodes of more severe food insecurity, further deepening chronic food insecurity. A nuanced understanding of the close ties that exist between chronic and transitory food insecurity among households in Beira, requires the identification of processes that deepen household vulnerability to experiencing more severe forms of chronic food insecurity after every disaster. The combined use of the HFIAS and HFIAP is therefore useful for monitoring shifts in food insecurity overtime or pre-and-post disasters, to serve as a guide for tailored interventions by households and local governance systems. Without interventions, households may accept food insecurity as 'normal', which can create conducive conditions for persistently worsening malnutrition and negative health-related impacts among households in Beira, amidst frequent disasters.

Cyclone Idai significantly worsened existing conditions of poverty and food insecurity as many families lost everything, including the lives of productive family members (Relief Web, 2019). Post-Cyclone Idai food insecurity in Beira is complex, with interconnections between disruptions in overall food availability within the city and disruptions in already limited household food access.

Sen (1981) identified that deprivations in entitlements or resources for food access, rather than just food unavailability, led to starvation (food insecurity) during famines in India. Entitlements refer to resources obtained through trade, own production, own labor, inheritance or transfer which are at the disposal of households and can be used for food access (Sen, 1981). Since extreme weather events cannot be prevented from occurring, and are becoming more frequent, the impact of extreme weather disasters on household entitlements or resources (e.g., livelihoods) necessary for food access should be minimized in Beira.

Subsequent fluctuations in the supply and price of food also show that the food stability dimension of food security is challenged in Beira and Mozambique. Food stability is dependent on continuous food availability and food access (HLPE, 2017; García-Díez et al., 2021), and successive fluctuations may be reduced through stocking up of food. Countries or cities may stockpile food for extended periods using specially built storage facilities, that can withstand extreme weather disasters. Such storage facilities are particularly relevant for reducing food availability disruptions and price volatility in disaster-prone countries (Islam & Kieu, 2021). Apart from large food storage reserves for cities, households in disaster-prone communities in India and the Philippines, have created storage places in their homes, using high shelves or upper floors where food is preserved in waterproof containers, to reduce disruptions and support household food access post disasters (Schilderman, 2004; Revilla, 2019). Although food storage is important, it requires technical expertise and financial investments across all SES levels, which appeared lacking in Beira.

The duration of post-disaster food availability and food access disruptions vary for different disasters and different countries. Post-extreme weather inflation or food price increases may last for about 6 months in developed countries, but it persists for several years in developing countries where poor households spend more than 50% of household expenditure on food (Kianersi et al., 2015; Parker, 2018). Although Cyclone Idai occurred in 2019, households were still living with exacerbated food insecurity at the time of data collection in 2022, because of the impact of the disaster on their livelihoods and income entitlements, which had not been fully restored. It appears that households already experiencing severe food insecurity were the most likely to experience exacerbated food insecurity post-Cyclone Idai, which differs with different household characteristics like household income.

5.3 Differential Food Insecurity Based on Household Characteristics

Household income was one of the most significant household characteristics linked to food insecurity. Cyclone Idai caused disruptions in access to household livelihoods, cash incomes and jobs, whilst there were food price hikes. As such, it was unsurprising that households with higher incomes were associated with reduced food insecurity. Of the three household characteristics namely household income, presence of chronic illness and household size that were considered,

only household income had a moderately strong but negative statistically significant relationship with the HFIAS (Kendall's tau-b= -0.3148, $p<0.0000$). Increases in household income were therefore associated with decreases in household food insecurity and vice versa. The HFIAP also shows fewer high-income households experienced food insecurity in the month after Cyclone Idai compared to the middle-income and low-income categories.

Household income was a key determinant of access to food after Cyclone Idai and is a recognized entitlement for food access in urban areas. Before Cyclone Idai, food in urban Mozambique was already 18% more expensive than in several other urban areas of the world and Mozambican households spend 56% of their income on food (World Bank, 2018a). Low-income households earning '5000 Meticais' per month (about 100 CAD), were found to be particularly limited in their food access, amidst post-Cyclone Idai food price increases in the study. Almost 50% of the households represented in the household survey were in the low-income category. This suggests that low-income households with post-disaster income losses likely experienced higher levels of food insecurity after Cyclone Idai. For households in the low-income bracket, the price of food prior to Cyclone Idai limited their purchasing power, which became worse after the cyclone.

The prices of food staples in Beira increased drastically after Cyclone Idai, which worsened the food insecurity plight of low-income households. For instance, the price of a 25 kg bag of maize meal cost more than 1200 Meticais after Cyclone Idai, although it previously cost 850 Meticals before the cyclone. The price of rice also increased by almost 100% in the first 3 months after the cyclone (Eisenhammer, 2019; Tevera et al., 2021). Maize represents just 1 ingredient out of the many required for a meal in Mozambique, and yet, the cost is about a quarter of the low-income household's monthly earnings. This quantity of food may last for different time durations based on household size and number of meals per day. Large household sizes which fall in the low-income bracket are indicative of accumulative dependents, mouths to feed, and shared poverty. Almost 70% of households had more than 5 members in this study. Although the relationship between household size and household food insecurity access (HFIAS) in the month after Cyclone Idai were not significant, the qualitative study showed that respondents perceived household size as a strong determinant of food insecurity.

Even for households in the higher income bracket (10001 Meticals and above), the size of the household will determine if the food purchased was enough for all the members. The culture of polygamy, having many children and social problems of teenage pregnancy were implicated in the normalcy of larger households in Beira City. Apart from household size, there were indications of external household dependents such as seniors and orphans in the community who were included in household meals. Supporting more vulnerable members of the community may have granted 'giving' households social credibility, but also decreased their resources and food access (Curley, 2009). This study, however, avoids the assumption that larger households are poorer and more food insecure than smaller households. This is because there are divided views on household size and poverty in existing literature.

In a study by Randall and Coast, (2015), a larger household with multiple people working implied investment in people, which had benefits for higher incomes and potential long-term (reciprocal) benefits. Among households in Nigeria and other countries who depended on subsistence agriculture for food availability and food access, keeping per capita resources constant amidst per-head increases was linked to increased food insecurity (Deaton & Paxson, 1998; Anyanwu, 2014). However, smallholder farming families with larger households showed improved food insecurity in Zimbabwe (Mango et al., 2014). In urban Southern Africa, correlations have been identified between household size and poverty amidst simultaneous increases in urbanization and reduction in land for subsistence farming (Frayne et al., 2010; Meyer & Nishimwe-niyimbanira, 2016). This suggests that the influence of household size on household income and food insecurity differs based on whether households are rural or urban based, farming or non-farm livelihoods, and the number of members gainfully employed.

In this study, reasons for large families in Beira were linked to cultural norms of polygamy and the perception that having many children increases the likelihood of at least one child growing up to help break the cycle of poverty. Poor rural households with subsistence livelihoods and low education levels in Mozambique often have more children than other groups (World Bank, 2018a). Larger households and the agricultural labor they provided were assets in pre-industrial times when the land was abundant, which implied household wealth and food security. In recent times there has been a shift from scarcity in labor to scarcity in land for farming because of increased population and urbanization, as seen in Mozambique. Furthermore, agricultural livelihoods are susceptible to destruction by climate change impacts, and as such, urban household income must be diversified from subsistence farming livelihoods.

Smaller households and higher incomes would allow investment in other development initiatives such as higher education which can attract higher incomes, thereby decreasing household food insecurity. Factors such as low levels of education were associated with reduced employability and restrictions in access to higher incomes among households during the study. For instance, the demographics of participants in the quantitative study showed only about 12% had a post-secondary education. Investing in higher education can break the cycle of chronic food insecurity and poverty for households, which has long-term reciprocal benefits. Interventions seeking to reduce household vulnerability to post-disaster food insecurity in the long-term cannot be detached from discussions about cultural preferences for large household sizes, especially when households depend on subsistence agriculture for their livelihoods and food security.

Although the qualitative study did not discount the quantitative results that chronic illness was linked to increased household food insecurity (Kendall's tau-b=0.0925, $p<0.0100$), a heavier emphasis was laid on the relationship between caring for vulnerable bonding social capital networks and household food insecurity post-Cyclone Idai. Households acted as social safety nets for the many widows, orphans, seniors and the sick, who were impacted by the Cyclone Idai in their communities. The people who needed help in the communities by proxy became extended

family members who added on to the household size. Large households headed by women likely experienced increased post-Cyclone Idai food insecurity due to increased caregiving roles. Increased caregiving roles of women heads of households limit their ability to earn incomes and access food, for their households (Stevano, 2019). Invariably, the coverage of household incomes post-Cyclone Idai extended beyond households, to include vulnerable bonding social capital networks (mostly networks that receive rather than give).

5.4 Differential Food Insecurity Based on Personal Food Environment Characteristics

The previous section mainly focused on the demographic characteristics of households associated with post-Cyclone Idai food insecurity at the microsystem level. Thus, the household personal food environment characteristics extended the microsystem level characteristics to include household living conditions which influenced food acquisition, preparation and consumption post-Cyclone Idai. Notably, place-based inequalities underpinned differences in the personal food environment characteristics (affordability, accessibility and convenience) and household food insecurity post-Cyclone Idai. The findings highlight the importance of a broader interpretation of household food insecurity based on socioecological factors which provide clarity on the social vulnerability of households in Beira.

Affordability

Drawing from previous sections, increases in the prices of food after Cyclone Idai affected food affordability. Post-Cyclone Idai job disruptions and inconsistent access to income further reduced food affordability for most households in Beira. The percentage of households that experienced disruptions in their jobs 3 months after Cyclone Idai was 21%, whilst 89% of households experienced inconsistent access to income in the year after Cyclone Idai. This reflects both short-term and long-term disruptions in household income not only from jobs but encompasses other livelihoods and sources of household income (e.g., cash remittances). The findings on disruptions in access to income by the majority of the population were expected, because more than 80% of the population in Mozambique are engaged in agricultural-related livelihoods and income-earning opportunities (USAID, 2021), whilst the agricultural sector and food systems bore the most devastating impacts and losses due to Cyclone Idai (Tevera et al., 2021).

Although there were limited employment options within the city of Beira, pre-Cyclone Idai, urban agriculture was described as a source of livelihood and food availability for most households. The City of Beira was founded based on urban development plans which had agriculture as an integral component. Historically, after Mozambique's independence in 1975, the socialist regime of governance supported urban agricultural initiatives within cities like Beira, by allocating lands in green zones for household farms (Sheldon, 1999). Sheldon (1999), described the city of Beira

between 1982 to 1984, as a striking spatial distribution of modern buildings interspersed with urban farms like small backyard gardens, rice fields, fruit farms and small ruminant farms, belonging to wage earning and non-wage earning households alike.

However, later democratic governments followed models of development that favored the engineering of such green zones into flood-resilient real estate communities owned by private property developers (Murtah et al., 2021). These developments were linked to limitations in access to land for farming among households, even before Cyclone Idai. Consequently, households that were solely dependent on agriculture for income and food likely experienced the most increased food insecurity risks. During data collection for this study in Beira, new developing urban housing projects were identified whilst the lack of land for susbsistence farming was continuously re-echoed. Urban agriculture has been promoted for increasing livelihoods, food availability and food access in cities. Notwithstanding, poverty and municipal bye-law restrictions limit access to land for farming, especially for poor households within African cities (Frayne et al., 2022; Frayne, McCordic, et al., 2014; Zezza & Tasciotti, 2010).

After Cyclone Idai, some households started charcoal production as a means of earning an income which improved their food access. Apart from charcoal production, other new sources of livelihoods and income were not identified. Charcoal production was a preferred income-earning option for households after Cyclone Idai, as it only takes 7 days to be completed, resulting in an abundance of charcoal on the market and concerns about charcoal price drops (Eisenhammer, 2019). Charcoal production and fuel wood collection are off-farm income sources that are based on local environmental resource extraction (Weldegebriel & Prowse, 2013). Although charcoal production provides increased income for food access, it may have negative implications for the environment, and deforestation, especially if multiple households depend on charcoal production.

Households were also assured of assistance from donors and the government, to moderate the post-disaster food price increases, which did not materialize and further compounded entitlement failures. From the GREPOC KII, only 1.2 billion USD out of the 3.2 billion USD estimated from the PDNA to address post-Cyclone Idai needs was received. Donor-funded interventions towards food system disruptions may have helped reduce food price hikes and made food more affordable. The impact of Cyclone Idai on farming livelihoods, fluctuations in the prices of food, and reduced purchasing power of households increased food insecurity and instability. Furthermore, losses in jobs and income are indicative of entitlement failures which reduced food affordability and food access in alignment with Sen's theory. Even without the loss of jobs and income experienced, the increase in the price of food post-Cyclone Idai would have reduced the rate of exchange of entitlements for food, especially among low-income households. Increases in climate-related change extreme weather events will reduce affordability for most households in Beira through impacts on livelihoods and food price increases.

Accessibility

There were variations in food accessibility based on the areas of residences of study respondents and the impact of Cyclone Idai on houses. In the quantitative study, 39% of households perceived that their homes were located within informal areas, while the qualitative study revealed distinct differences between the residences of displaced and non-displaced households, reflecting formal and informal urban contexts. Some informal area attributes identified within the displaced communities of this study included spatial limitations in access to food markets. Spatial accessibility has been identified as a key facilitator of household access to food consumed in several countries (Glanz et al., 2005; Story et al., 2008; Downs et al., 2020). Before Cyclone Idai, households in the displaced communities of the study did not have food markets in their communities, and so walking was the main mode of transportation to the market, not because of proximity but due to the lack of public transport linkages.

Although walking is the cheapest mode of transportation, walking for long distances creates limitations for bulk food purchases (even if money was available), because of the difficulty in carrying heavy weights in the arms or on the head over long periods and distances. It takes about 30 minutes for a young person to walk to the market, but this usually extends to more than an hour for seniors in the two displaced communities. Distance to grocery stores and transportation access have also contributed to increased food insecurity risks for seniors by limiting the number of items they can purchase and carry from grocery stores in the Global North countries (Keller et al., 2006; Shim et al., 2018). The lack of markets and transport networks therefore created challenges for all households, whether they had money for food or not, whilst seniors were the most impacted within displaced communities. Similar studies have found that communities with transport access were privileged and exhibited improved food access compared to underprivileged communities that had no or limited transport access, and high transportation costs (Charreire et al., 2010; Sharkey & Horel, 2008; Bhawra et al., 2015).

The displaced, informal communities illustrate that the lack of access to food markets is associated with reduced food availability and food access in households. For example, the presence of a market within or close to the community may increase access to livelihoods which is needed for food access. Studies indicate that local food markets in Mozambique are important not just for food access, but also provision of jobs and income for deprived urban populations (McCordic & Raimundo, 2019; Raimundo et al., 2020). Accessibility factors like location and type of house have been identified as obstacles for urban livelihoods, food purchasing in bulk, buying at a lower cost, and food preparation for households in Sub-Saharan African cities (Cohen et al., 2009; Tacoli, 2017).

The findings in this study align with calls for an increased focus on the relationship between spatial distance and food access (HLPE, 2017; Zhong et al., 2018), which has several implications for social vulnerability. To illustrate, spatial distance appeared to be a more significant impediment to food access rather than poverty within Matola, where both poverty and lack of spatial access co-

exist (McCordic et al., 2022). The displaced communities exhibit food desert characteristics because of spatial limitations in access to food. Food desert categorizations in LMICs should therefore not be based on the lack of access to supermarkets or formal food outlets as seen in the Global North, but rather on factors like mobility, accessibility and time spent purchasing food (Battersby & Crush, 2014; Wagner et al., 2019).

These preexisting accessibility challenges within displaced communities were exacerbated by Cyclone Idai because of the overall adverse impacts of the disaster on food systems in Beira city. Thus, households within the displaced communities likely experienced more severe forms of food insecurity compared to non-displaced households. However, all the households within the displacement communities of this study lived in displacement centers for about a month after Cyclone Idai and were cushioned from the severe food insecurity impacts in the immediate aftermath of Cyclone Idai because of access to food aid. Disruptions in accessibility after an extreme weather disaster like Cyclone Idai may perpetuate pre-disaster accessibility disparities for the households after food aid. For instance, the impact of Hurricane Katrina on physical food access was evident in deprived communities 10 years after the disaster (Mundorf et al., 2015).

For the non-displaced households in the qualitative study, there were no indications of challenges with accessibility because of the presence of markets (e.g., the Maquinino market) and public transportation in proximate areas. Access to transportation has positive effects for improved food access but has also been implicated in increasing access to processed food, which has contributed to ongoing nutrition transition in rapidly urbanizing African cities. Nutrition transitions create conditions for obesogenic populations and increases in non-communicable diseases which are widely spreading across sub-Saharan African cities (Popkin et al., 2020; Reardon et al., 2021). After Cyclone Idai, the accessibility of households in non-displaced areas was temporarily disrupted by floods, road destruction, disrupted food supply and lack of access to food aid in many areas.

Cyclone Idai impacted food accessibility through the total and partial loss of access to markets due to floods, and the destruction of roads and market infrastructure (Government of Mozambique, 2019). Roads and transport networks are critical for food supply chains and emergency food aid distribution. So, their destruction by floods and cyclones prevent food from being moved from farms into cities, as identified in Iran, Bangladesh, Australia (Smith & Lawrence, 2014; MacMahon et al., 2015; Ainehvand et al., 2019a; Perdana et al., 2022). Disrupted accessibility also reduces food diversity in post-disaster settings (Clay et al., 2021). Food systems in rural areas are generally considered vulnerable to extreme weather impacts, however, in post-disaster contexts, they are more reliable by providing proximity to food production rather than long food supply chains in urban areas (MacMahon et al., 2015; FAO, 2020). However, this may not apply to disasters like Cyclone Idai which had highly devastating impacts on both urban and rural agriculture and cut off several communities from accessing food.

The stark differences between the displaced and non-displaced communities reflect disparities in the siting of food markets and transport systems, that favored households in certain parts of Beira city over others. Studies have identified that urban planners usually situate modern food markets in high-income areas of the city, rather than low-income areas, thus undermining the food security of low-income households (Pothukuchi & Kaufman, 2000; Battersby, 2017). This study therefore provides evidence that poor people live in less desired areas of cities, with limited access to public utilities and greater exposure to disasters. Just like Beira, urbanization challenges occur in growing sub-Saharan African cities, where poverty creates spatial divisions between consistent and inconsistent access to public resources including transportation, while poor households are located in more climate-related disaster-prone areas of cities (UN-HABITAT, 2016; UN DESA, 2018).

Under accessibility, the second indicator assessed was the impact of Cyclone Idai on household homes. There were 17% of respondent houses that were destroyed by Cyclone Idai, while the qualitative results indicated that the destruction of homes was not evenly spread across Beira but was exacerbated based on house location within formal or informal areas and the type of house. Almost all houses in the displaced communities were completely destroyed, apart from a few concrete structures. Housing did not become a challenge after Cyclone Idai as living in tents and temporary wooden structures was common in the displaced communities of the study before Cyclone Idai. Some households still lived in wooden tents during the qualitative study (2 years after Cyclone Idai). Most households in the displaced communities returned after their one-month stay at the displacement center to houses that were not in a livable condition and as such continued to live in tents or damaged houses.

Some households in the displaced communities of the study were in the process of building or repairing damaged homes from previous cyclone impacts, before Cyclone Idai occurred to erase all building progress that had been made. Damage or destruction of housing has both short-term and long-term implications for food insecurity susceptibility in the displaced communities which had almost all houses destroyed. The loss of housing was associated with the loss of kitchens and food preparation utensils, such as pots and pans. The destruction of a home created heightened food insecurity risks because of the diversion of resources towards rebuilding or repairing homes rather than for food access.

Findings from the US indicate that the impact of a disaster on a house increases food insecurity by restricting food preparation abilities and also increases household expenses on damaged property which could have been used for food access (Clay et al., 2021;Clay, 2022; Pyle et al., 2021). Likewise, after Hurricane Katrina and Hurricane Harvey in the US, displaced households and households with damaged houses experienced higher food insecurity risks even 5 years after the disaster compared to households without these challenges (Clay, 2022; Clay, 2020). Households in the study with minimum damage to their houses were worried about food in the year after Cyclone Idai whilst households with destroyed houses were worried about housing which they considered more important than access to food.

Within contexts where both housing challenges and food insecurity are prevalent, housing appears to be a more pressing need. This correlates with Maxwell, (1999)'s findings that housing is a more visible urban challenge than household food insecurity in Southern African cities, which attracts the attention of both city planners and urban residents, unlike food insecurity which is less visible or latent. Housing presents an immense challenge to rapidly urbanizing areas in both Global North and Global South contexts. In the Global South a key challenge is the spread of informal housing settlements and precarious housing conditions which expose people to environmental harm (UN DESA, 2014, 2019).

For households in the displaced communities that experienced house loss or house damage after Cyclone Idai, it may take years to restore their homes even if they do not experience any other cyclone, which is unlikely in disaster-prone Beira city. This puts such households within a continuous cycle of vulnerability and food insecurity if they continue to live in their current communities without any interventions. Although not assessed in this study, factors like frequent exposure to cyclones, lack of land ownership and access to a pre-planned displacement center appear to stifle efforts towards building more durable housing structures in displaced communities apart from poverty. Fitzpatrick et al., (2020), identified a similar relationship in their study where the decision to evacuate or remain during Hurricane Harvey varied based on homeownership or renting status, whilst displaced renters experienced heightened post-disaster food insecurity after the hurricane.

Household lack of access to the 'rights of use and benefit of land' or DUAT (Direito do Uso e Aproveitamento da Terra) in the resettlement and displaced community appeared to be a drawback for the building of more permanent housing structures. Land tenure insecurity has been implicated in housing instability, as poor people resort to building temporary structures for squatter settlements rather than permanent structures as identified in Accra (Adarkwa & Poku-boansi, 2011; Nyametso, 2012). Mozambique has a dysfunctional land market which restricts cities from proactively coordinating investments in housing and urban infrastructure, resulting in widespread informal and distant semi-urban settlements within cities (World Bank, 2017). Housing remains a challenge in Mozambican cities, while the lack of technical and labor support for building durable housing, has been identified as an obstacle in communities that are frequently displaced (IOM, 2022).

Additionally, the isolation of the displaced communities from transportation routes has implications for disaster recovery and the mitigation of future disaster impacts. Transportation access, plays a key role in climate change mitigation, disaster management and the differences in disaster impacts (Mi et al., 2019; Rouhanizadeh & Kermanshachi, 2020). For instance, the lack of key road infrastructure connections to houses across provinces in Indonesia before the 2004 tsunami, created transportation bottlenecks for post-disaster rehabilitation works by NGOs and local government institutions (Chang et al., 2012). Cyclone-resistant housing must be a key

component of urban planning for Beira city and should be supported by investment in local, affordable housing materials and road networks for informal displaced communities.

Durable houses in proximity to food markets are relevant for both pre-and post-disaster food access. Although having a house reduces the impacts of disasters, it also provides an opportunity to engage in small home-based livelihoods, such as preparing and selling homemade foods, which can provide additional income for improved household food access. Homemade street food is abundant in Maputo and forms a large part of the informal economy, which employs urban poor households (Skinner & Haysom, 2017; Sousa et al., 2019). Households within informal communities (e.g., the displaced communities of the study) may also harness their social capital networks, to collectively set up a market within the community where they live, for improved food availability and food access.

Convenience

There were variations in access to clean water, cooking fuel and electricity, which were indicators for the convenience subdimension of the household personal food environment. Access to these resources facilitates food acquisition, preparation, and consumption within households. In the year after Cyclone Idai, only 27% of respondents had consistent access to clean water, 19% had consistent access to cooking fuel and 16% had consistent access to electricity. These results reflect the devastating impact of Cyclone Idai on access to basic necessities among households which varied based on the formality or informality of household residence, just like the affordability and accessibility subdimensions. Within the displaced communities in this study, households already experienced inconsistent access to clean water, cooking fuel, and electricity, prior to Cyclone Idai.

Apart from the destruction of their houses, households in the displaced communities did not appear to experience disruptions in access to electricity, water (although not clean), and clean cooking fuel, but rather a continuation of their lack of access post-Cyclone Idai. The households in the displaced communities relied on water from a well rather than tap water from FIPAG (Main Water Service Provider), which was still available after Cyclone Idai. Additionally, most houses were not connected to the electricity grid, while the main cooking fuel used was fuelwood before and after Cyclone Idai. Households' lack of access to these multiple resources is indicative of high levels of lived and multidimensional poverty (Mattes & Dulani, 2016; World Bank, 2018a). Household dependence on these off-grid resources also results in an unquantifiable use of time on household chores or time poverty.

Households experience time poverty when they spend more time on house chores (e.g., fetching water and meal preparation) or on low-productivity activities rather than high-productivity activities (e.g., income earning). In the resettlement and displaced community of the study, more than an hour was spent on fetching water each day, as women walked about 3 km to fetch water from a well for their household needs. Older women were likely to make several trips with smaller water quantities based on their limited ability to carry heavy weights over long distances.

Cumulative time use may be higher for large member households (5 and above members), who constituted almost 70% of households in the quantitative study. High levels of time poverty in the displaced and resettlement community were associated with increased food insecurity. A study conducted on more than 6000 households in 21 LMICs across Africa, Asia, Americas and the Middle East demonstrated that food insecurity increased as household water quality/quantity decreased, and time spent on water management for the home increased (Brewis et al., 2020).

Fetching water has implications on the health and personal development of female household members who usually undertake this chore and indicates gender-differentiated time poverty. Women and girls spend more than twice the amount of time spent by men on house chores (e.g., fetching water and fuelwood), and have almost 40% less time for personal care in Sub-Saharan African countries (Abdourahman, 2010; Bardasi & Wodon, 2010). Daily, the amount of time spent by women and girls all over the world collecting water for home use and other uses is 200 million hours (8.3 million days and more than 22, 800 years), with the Global South accounting for a higher proportion of this time loss (UNICEF, 2016). Having consistent access to clean water precedes the preparation of nutritious and healthy food for households and is necessary for food utilization.

There were water safety concerns after Cyclone Idai for both the displaced and the non-displaced, and most households had access to unclean water than those who did not. Clean water was compromised due to increased open defecation and other human contaminants in surface water causing diarrheal diseases and the need for water treatment before use (Government of Mozambique, 2019; Lequechane et al., 2020). Boiling water before drinking and cooking added to household time poverty and expenses as access to cooking fuel played a relevant role in water treatment. Studies in Kenya have also identified that inconsistent access to clean water poses challenges to food security. These challenges included the diversion of money away from food access to purchase water or for water treatment, meal plan adjustments, and increased meal preparation time within poor households (Collins et al., 2017; Collins et al., 2019).

The main types of cooking fuel that households used before and after Cyclone Idai for both water treatment and cooking was fuelwood and charcoal. These cooking fuel types provided cheap alternatives for poor households but also had adverse health implications especially for households using fuel wood. Apart from the households in the displacement centers that solely relied on fuelwood, most other households relied on charcoal in the year after Cyclone Idai. This highlights findings from Luz et al. (2015), who identified that the main source of cooking fuel used by urban households in Mozambique was charcoal. Apart from Mozambique, low-income households in LMICs mostly rely on cheap unclean or traditional fuels (e.g., charcoal and fuelwood), unlike high-income households from HICs that rely on expensive clean fuels like LPG or electricity (Anenberg et al., 2013; Gill-Wiehl et al., 2021; Karimu, 2015; Fadly et al., 2023). Compared to charcoal, fuelwood had higher time-poverty and adverse health implications which further compounded the food insecurity risks of households in displaced communities.

The use of traditional or unclean fuels exposes people to concentrations of fine particulate matter ($PM_{2.5}$) found in household air pollution (HAP), which refers to the total burden from exposure to the cooking fuel and increases risk factors for mortality and morbidity (e.g., cardiovascular disease) (Smith et al., 2014; Hystad et al., 2019). Ellegård (1996), identified increased health risks among women from low-income households in Maputo, who used fuelwood for cooking and experienced significantly more symptoms of coughing than those who used other fuels including charcoal. As identified previously, female household members spend more time on house chores including cooking which implies increased exposure to HAP and its adverse health effects.

The WHO estimates indicate that household air pollution (HAP) caused more than 33% of all deaths from chronic obstructive pulmonary disease, 25% of all deaths from stroke, and 17% of all deaths from lung cancer in LMICs, while women and children accounted for more than 60% of premature deaths from HAP in 2012 (WHO, 2016). Poor and rural community households in LMICs in Africa, Asia, and Central-South America that rely on the use of traditional fuels are disproportionately affected by the associated health risks (Shupler et al., 2018). Although the number of people without access to clean cooking fuel has stagnated across some regions in Asia for the past decades, the number in Africa has increased by more than 50% since 2000 (IEA et al., 2022).

Higher health risks within LMICs have been linked to the simultaneous use of clean and unclean fuels (e.g., charcoal and gas), even among high-income households (Lee et al., 2022), probably to increase their cooking fuel alternatives and reduce disrupted access. Even before Cyclone Idai, the increased use of charcoal had been identified amidst increased urbanization in Mozambique, as it provided an income for rural households who supplied the urban areas (Zorrilla-Miras et al., 2018). Some households in the study were involved in charcoal production to earn an income for food access after Cyclone Idai. Traditional fuels have only about 5-15% conversion efficiency, and high demand locally can exceed the sustainable capacity of the forests, bringing consequences such as deforestation (IEA, 2021). Some allusions were made during the study about the contribution of charcoal production towards deforestation in Beira, which influenced the devastating impact of Cyclone Idai on the city.

Most households used charcoal because it was cheap and readily available after Cyclone Idai. In comparison, households in displaced communities did not have to buy charcoal but exchanged their time for collecting fuelwood. Additionally, most households in the informal community were not connected to the existing electricity grid and so did not have electricity access for cooking or food storage before Cyclone Idai. For non-displaced households who had access to electricity before the cyclone, this became disrupted after Cyclone Idai, and there were occurrences of food spoilage and inconveniences in food preparation. Their access to electricity was later restored months after Cyclone Idai. Access to basic amenities like electricity had implications for improved food security in the year after Cyclone Idai, unlike for households in the informal and displaced areas where there was a perpetuation of pre-disaster lack of access to electricity and inequalities.

From all indications, households within the displaced communities of the study experienced higher food insecurity risks as shown by compounded limitations in accessibility, affordability and convenience subdimensions of the personal food environment after Cyclone Idai. Households that experienced inconsistent access in one of the subdimensions of the personal food environment indicators (non-displaced households), appeared less food insecure than displaced households that were marginalized in all the dimensions after Cyclone Idai (apart from their 1-month stay at the displacement center after the cyclone). Similar studies found that inconsistent access to resources (e.g., clean water, cooking fuel, sanitation, healthcare, electricity) in the year after Cyclone Idai were correlated, and it was more likely for households who experienced inconsistent access to one resource to experience inconsistent access to several other resources, thereby creating a compounding effect on such households (Williamson et al., 2023).

The convenience and accessibility dimensions are related to affordability, as households living in the informal displacement communities will likely opt not to live there, given the ability to afford other places in the city devoid of the challenges that impact food insecurity. The experience of more severe forms of post-disaster food insecurity is therefore linked to inequality and exacerbated by the compounded lack of several entitlements. The assessment of post-disaster food insecurity using the accessibility, affordability and convenience characteristics of households' personal food environment helps to portray the vicious cycle of the relationship between social inequality and climate change impacts. This is consistent with the findings of Islam & Winkel (2017), which point out that the initial inequality of disadvantaged groups makes them suffer disproportionately from the adverse effects of climate change-triggered disasters, which creates subsequent greater and compounded post-disaster inequality.

The main implications of the differences identified in accessibility, convenience and affordability and household food insecurity, are that households located in different parts of Beira reflect 'place-based' inequalities, which influenced household sensitivity to harm from Cyclone Idai. Identifying these relationships is important for minimizing post-disaster food insecurity, as post-disaster reports usually portray generic impacts without highlighting these nuanced differences. The differences in vulnerability before the disaster, such as the location and informality in household residences (e.g., resettled and displaced households), increased exposure and sensitivity to households' asset losses, thereby exacerbating their post-disaster food insecurity. Ensuring flood-proof resettlement of displaced households, should be the first step among many in providing access to basic services and livelihood opportunities (Jacobs & Almeida, 2021), which is key for their food access and vulnerability reduction. The findings of the study support the theory on hazards-of-place, which underscores the critical role that geographical locations and environmental conditions play in shaping inequalities in health (Cutter et al.,2003), and in this study, household post-disaster food insecurity.

Additionally, the SES framework has been very useful in highlighting the interactions between the socioecological conditions of microsystems (households), that are linked to varying outcomes of

household food insecurity. Thus, addressing social inequalities linked to geographical locations (e.g., inequalities in market and transportation access, housing, access to clean water, cooking fuel and electricity), is critical for reducing the severity of household food insecurity in Beira. Access to housing infrastructure is strongly linked to food insecurity and the impacts on houses should be minimized, using different forms of house reinforcement strategies. For example, Schilderman (2004), noticed basic forms of housing infrastructure protection in Andrapradesh, India where fishermen threw fishing nets weighed down with stones over their thatch roofs, to protect them from strong winds during cyclones.

Furthermore, disruptions in access to jobs and income reduce affordability and food access for households. As such, climate-smart agricultural technologies or alternative income opportunities that are not reliant on agriculture or environmentally destructive (e.g., uncontrolled charcoal production), are required. Community-based Forest management, coupled with agroforestry and aquaculture initiatives can serve multiple purposes of providing livelihoods, addressing food insecurity and maintaining forest cover to reduce cyclone impacts (CIAT et al., 2017). These considerations are important for sustainable development which cannot be achieved without reducing inequalities and addressing the extent to which people fall short on life's essentials, such as food, water, incomes, energy poverty, gender inequality, housing and healthcare within environmental constraints (Raworth, 2017).

5.5 Adaptations to Disasters, Disaster Management and Household Food Insecurity

Adaptations Related to Household Food Insecurity during Cyclone Idai Preparedness – Pros and Cons

Well-planned and implemented disaster preparedness adaptations have been found to precede reduced disaster impacts and inform effective post-disaster response. Pre-disaster adaptations addressing food insecurity are considered survival preparedness, and encompass the preparation of emergency supplies (e.g., stocks of drinking water and food in waterproof bags), that can last for 72 days after a disaster (Russel et al., 1995; Kohn et al., 2012). Additionally, planning preparedness involves planning an evacuation destination, while structural preparedness involves reinforcing homes and infrastructure, and clearing waterways (UN-HABITAT, 2010). Response to disaster risk communication and different combinations of planning, structural and survival preparedness (e.g., reinforcing structures, have emergency food supplies and an evacuation plan), have been correlated with disaster preparedness and risk reduction among households in the US, Pacific Islands and Australia (Russel et al., 1995; Prior & Eriksen, 2012; Fletcher et al., 2013). Before Cyclone Idai, households planned their evacuation to displacement centers based on early warning recommendations. However, other adaptations of survival and structural preparedness, which are relevant for disaster risk reduction, were not identified in this study.

Although early warning information about Cyclone Idai was widely received, these messages appeared discounted and did not elicit the preparedness for an intense cyclone like Idai and the resulting increases in post-disaster household food insecurity. Possible reasons for limited preparedness across all SES levels, were perceptions that Cyclone Idai was just like previous cyclones, and familiarity with frequent cyclone warnings for low-impact cyclones. Other reasons included perceptions of the inability to prepare and mitigate cyclone impact because of poverty, already high levels of underlying food insecurity, and general lack of knowledge on preparedness. Additionally, there was a general reliance on donor agencies for post-disaster response adaptations, while the DRR cluster of organizations and households appeared heavily focused on adaptations for the disaster response phase (e.g., food aid), rather than during the preparedness phase for mitigating disaster impacts.

Several studies have attributed poor disaster preparedness to different combinations of these factors. For example, the frequent experiences of early warnings and near misses of disasters were found to create complacency and limit household adaptations in preparedness for disasters in the US and Kenya (Kapucu, 2008; Frazier et al., 2010; Wang, 2018; Odero & Mahiri, 2022). Others have identified mixed findings. For instance, in some areas in Japan, frequent low-impact natural disasters among households translated into better adaptations for survival preparedness whilst households in areas with a low frequency but at risk of high-impact earthquakes showed poor preparedness (Onuma et al., 2017). Also, there was more collaboration on adaptations for disaster preparedness in Miami, although the city experiences infrequent but high-impact climate-related disasters, compared to cities like New York which experience frequent low-impact natural disasters and exhibit low disaster preparedness (Oetzel & Oh, 2021).

Long-term reliance on donors for humanitarian aid has also been linked to low preparedness for disasters. For example, Mozambique has a long history of donor support for extreme weather and war-related disasters (Hanlon, 2009). However, an assessment of the 2000-2001 tropical storms that affected millions in Mozambique highlighted a distinct lack of adaptations for disaster preparedness within resettlement communities, and a rather heavy dependence on external donors for disaster response and recovery (Wiles, 2005). Hendriks & Boersma, (2019), noted that heavy reliance on donor support for disasters appeared to stifle the development of local disaster risk reduction initiatives in Malawi, a country which has an equally long history of donor support for disasters, just like Mozambique. Similarly, in Papua New Guinea, donor dependent communities failed to plant whilst communities without donor assistance looked for alternative crops to plant, and ended up being more food secure amidst the drought (Mogina, 2001).

Apart from donor support, high levels of underlying poverty and general lack of hazard knowledge have been found to limit adaptations in preparedness for disasters. In most cases, adverse economic conditions and poverty are the factors implicated in the failure to adapt for disaster preparedness. Studies have identified that poverty, income and cost are the main influencers of the inability of households to afford adaptations for disaster preparedness, mitigate the impact of disasters, live in

safe areas, evacuate or set money aside for disasters (Phillips et al., 2013; Shukla et al., 2022). Also, household disaster preparedness depends on knowledge of hazards and ongoing mitigation activities rather than a one-time activity, especially for households living in disaster-prone areas (Sutton &Tierney, 2006).

Adaptations for preparedness at all SES levels are important, however, those occurring at the microsystem level (household) are of fundamental importance and will likely occur due to the trickling down of disaster preparedness from higher SES levels (macrosystem to mesosystem levels) to the household level. Members of the DRR Cluster in Mozambique, were involved in spreading early warning information and building the capacities of communities to respond to Cyclone Idai through planning for evacuation. However, information prompting households on survival preparedness (e.g., storing emergency food and water) was critically lacking. The engagement of households and communities in the preparation of emergency supplies (e.g., food and water in waterproof areas) pre-disaster, is required for food availability and food access in the immediate aftermath of the disaster.

Emergency food and water supplies are particularly important within the first 72 hours of a disaster, when external assistance may likely be unavailable and humanitarian systems are overwhelmed (Kapucu, 2008; Wang, 2018). Additionally, inaccessible conditions after a disaster may render it impossible for food-sourcing for several weeks, like what happened after Cyclone Idai. Emergency aid started to come into Mozambique almost 1 week after the disaster and were airlifted because of inaccessible road conditions (Nhamo & Chikodzi, 2021). As such, households were limited in their food access for weeks post-Cyclone Idai, evidenced by the drastic increases in food insecurity denoted by the HFIAS and HFIAP results. In addition to the traumatizing experience of the disaster, vulnerable groups (e.g., children under 5 years), were likely exposed to severe food insecurity with implications for undernutrition.

The reasons above provide explanations for the few adaptations identified during preparedness for Cyclone Idai, including the lack of knowledge on survival and structural preparedness. The accumulation of these reasons combined with the unprecedented and devastating nature of Cyclone Idai, created severe negative implications for post-disaster food insecurity and disaster losses. Addressing barriers such as complacency and a general lack of knowledge on types of adaptations may improve the combined use of different adaptations in preparedness for disasters. The findings on the effective use of adaptations for planning preparedness (specifically evacuation), adopted by households in displaced communities in this study, indicate that communities (social capital networks) can be engaged in other adaptations.

Households and communities should be engaged in the communication of disaster risks and types of adaptations in preparedness for addressing household food insecurity in Beira. Community led adaptations promote disaster preparedness when communities are engaged face-to-face, rather than the use of mass media campaigns that only hand out disaster preparedness information (Ryan et al., 2020; Sufri et al., 2020). Amidst the increasing complexities of climate change triggered

disasters like Cyclone Idai which can worsen household food insecurity vulnerability for years, close interactions between all SES levels are required for improving disaster preparedness. Improved disaster preparedness minimizes a disaster's impact on household food insecurity, reduces post-disaster losses and supports more effective disaster response.

Adaptations Related to Household Food Insecurity during Cyclone Idai Response – Pros and Cons

The emergency phase was the most critical for Cyclone Idai response, rather than the non-emergency phase. Among the multiple people in need of humanitarian assistance after search and rescue efforts, only households from communities that were completely destroyed by the Cyclone Idai floods were at the displacement centers. These displaced households sourced food aid and emergency relief from humanitarian institutions like the INGD, RED CROSS and WFP, indicative of access to linking social capital networks (macrosystem). About 13% of households in the quantitative study were in this category. At the displacement center, 3 meals were provided daily to all households for 1 month, thereafter, a kit containing one month's worth of food supplies was given to households to help them settle back home.

Sourcing food through the humanitarian agencies ensured that three out of the 4 main dimensions of food security, namely food availability, food access and food stability, were assured for households while at the center. Apart from crowded and uncomfortable conditions at the center, the only challenges were issues with food utilization because of the limited food diversity given to all age groups during the 1-month stay. Additionally, food portions were given on a household size basis, and larger households got smaller food portions after splitting apportioned food among themselves. Other studies have identified food utilization challenges with post-disaster food aid. Wentworth (2020), found that survivors of Cyclone Pam who depended on food aid for about two months after the cyclone ate the same foods every day. Households affected by floods in Iran were also concerned about the high salt content of canned emergency food aid, and the implications for the health of chronically ill seniors who were fed with it daily for weeks after the floods (Ainehvand et al., 2019b).

Reduced food diversity and food portions may result in unintended health outcomes for certain groups, such as children and the elderly, in displacement camps. Some recommendations have been provided for addressing such post-disaster food utilization challenges. For example, there have been calls in the US for improving post-disaster food aid through the improvement of meal plans, to align with the health needs of survivors (Colón-Ramos et al., 2019). Additionally, humanitarian institutions may provide energy and protein-dense nutrient bars to prevent post-disaster malnourishment (Zahra et al., 2014). However, the severity of the disaster, the number of people in the displacement camp and access to humanitarian resources will determine the applicability of these recommendations. Since household size appears to be a relevant subject for

food insecurity in both disaster and non-disaster settings in Beira, due consideration should be given to seniors and children from large households, to prevent them from being marginalized.

Although the distribution of food aid is pivotal in reducing food insecurity in the immediate aftermath of disasters, several studies have considered the adverse effects of the distribution of food aid in the long term after the emergency phase. Relying on food aid for the long-term has been associated with encouraging donor dependence, disrupting local food systems and reducing the coping capacity of households (Barrett, 2006; Garschagen et al., 2015; Jackson, 2020; Oskorouchi & Sousa-Poza, 2021). The disruption of local food systems by food aid was not identified in this study, however, findings from the resettlement and displaced community on pre-Cyclone Idai food insecurity showed high donor dependence for food access, as food insecurity was continuously linked to poverty and the lack of donations.

Apart from food aid, displacement management is challenging, and a too-long or too-short stay has implications for the vulnerability of affected households and their ability to survive outside the displacement center. Wiles (2005), identified that after the 2000-2001 flooding disasters in Mozambique, temporary displacement centers were quickly shut down without preparatory assessments of resettlement sites, resulting in increased vulnerability among affected households who were being resettled. Similarly, one of the displaced communities in the study was a resettled community after the 2016 floods in Beira and was still displaced by Cyclone Idai, although resettlement implies reduced susceptibility to displacement. The community was characterized by entitlement failures due to lack of access to land for farming, jobs, food markets, transportation, basic urban utilities (e.g., clean water) and temporary housing structures before Cyclone Idai. These underlying conditions became compounded by Cyclone Idai which completely destroyed their houses and their already limited assets.

Communities like the resettlement and displaced communities could have received support for extended periods at the displacement center. However, the post-Cyclone Idai humanitarian resources were stretched as both displaced and non-displaced households in all parts of Beira suffered greatly. Parts of Mozambique 4 weeks after Cyclone Idai were described as a war zone with thousands of people in desperate need of food and water, even within areas that were not hard hit (Devi, 2019). Households forced into displacement are faced with homelessness, food insecurity, increased morbidity, community disarticulation and loss of access to common property resources (Cernea & Mcdowell, 2000). Communities displaced by disasters should be monitored by humanitarian agencies when they return home, and their capacities built to reduce susceptibility to future displacements. This is particularly important because displacement may likely increase amidst increases in climate change and climate-related extreme weather events.

These challenges with displacement notwithstanding, most households were non-displaced and were limited in food-sourcing adaptations, because they did not receive humanitarian assistance and food aid through the government and macrosystem agencies during Cyclone Idai emergency

response. For such households, there were donations from within and outside Mozambique that were available through local faith-based and community NGOs within Beira. It appeared that non-displaced households with strong bridging social capital networks, such as being affiliated with a church or community leaders, benefited by sourcing food through these networks. Similarly, a post-disaster study after Hurricane Harvey in the US identified that survivors who had strong social ties and connectedness to their communities were associated with lower food insecurity odds (Fitzpatrick et al., 2020).

Community leaders were pivotal in facilitating access to information about food aid distribution and identifying vulnerable households to receive food aid. Although local organizations had a guideline for determining household vulnerability (e.g., widows, orphans, pregnant women, seniors, households with many children), the final decision was made by community leaders based on their judgement of pre-Cyclone Idai conditions and household post-Cyclone Idai losses. A theme that was emphasized throughout the study was the difficulty of targeting the 'most vulnerable among the vulnerable', and this was due to the generally high levels of vulnerability among households in Beira after Cyclone Idai. As such, giving community leaders' the authority for selecting households to receive food aid, without any auditing and accountability checks created power imbalances that increased food access for some people and marginalized more vulnerable households who did not have bridging social capital contacts.

Some of the most cited challenges arising from the power imbalances were community tensions, unequal food distribution, favoritism towards the family members and close associates of community leaders and exchange of food aid for monetary and non-monetary favors (e.g., sexual favors). These findings are not unique to households in Beira as similar results were identified in Burundi where bridging social capital networks reinforced power differentials by favoring certain groups whilst blocking the access of vulnerable groups to resources (e.g., food aid) (Vervisch et al., 2013). Also in Ethiopia, the processes of targeting households for food aid were marred by nepotism and favoritism involving ad hoc committee members and community administrators (Harvey, 2014); Likewise, after the Great East Japan Disaster in 2011, some vulnerable groups (mostly women) were sexually exploited in order to receive life-sustaining basic necessities such as food (Yoshihama et al., 2019). There were also conflicts in Papua New Guinea, over disparities in the amount of food aid received, while the vulnerability statuses of households receiving food aid were questioned (Jackson, 2020).

Although helplines were created to report such exploitation for food aid, the high poverty and socially vulnerable contexts in Mozambique likely limited access to phones and communication services, as such efforts should be made to prevent such instances from occurring in the first place. The disadvantages of bridging social capital networks (e.g., community leaders) notwithstanding, they are important for disaster management in Mozambique, because they have easier access to vulnerable households than the external humanitarian agencies. Thus, maximizing the strengths and minimizing the weaknesses of bridging social capital networks has positive implications for

the facilitation of food-sourcing adaptations among households in Beira. Additionally, the capacities of communities can be built on vulnerable household targeting procedures to create strong communities, instead of strong community leaders, to prevent misguided decisions and power imbalances.

Regulatory frameworks should be in place in preparedness for disasters, supported by simple tools for verifying vulnerability lists and auditing the quantities of food aid distributed. Studies indicate that engaging a more dense network of community member interactions, guided by principles of justice, gender equality and intercultural respect and inclusive development may reduce acts of opportunism (Putnam, 1995; Arneil, 2006). Strong bridging social capital networks determine how well households and communities can withstand climate-related disasters, but are an underutilized resource by practitioners in the field of disaster management and risk reduction (Aldrich, 2012; Aldrich & Sawada, 2015; Aldrich & Meyer, 2015; Marchezini et al., 2017). The use of bridging social capital networks for addressing household food insecurity, particularly among non-displaced households, should be keenly considered in disaster management as they are relevant in connecting households to resources outside their communities.

There were some households that did not have access to wider bridging social capital networks but relied on closer networks of bonding social capital networks (e.g., neighbors) for food access. This study identified reciprocal relationships between households before Cyclone Idai (e.g., food exchanges). However, mostly non- reciprocal relationships were identified after Cyclone Idai, which facilitated food access for non-displaced and yet heavily impacted households. For example, some less impacted households housed and shared their already limited available food with their neighbors who were more impacted by Cyclone Idai, for about 4 weeks after the disaster. Reciprocity, and social trust are the underlying values that govern the functioning of social capital networks, especially bonding networks, by fostering opportunities for exchanging money, food, gifts, information and services (e.g., food preparation, house repair) (Putnam, 1995; Kuehnast & Dudwick, 2004).

However, the length of time and the overall tangible and intangible help provided to ensure food access for more impacted households, created heightened food insecurity for the hosting households. This was because the more impacted households that were being hosted lacked the ability to reciprocate. The greater the incidence of shared poverty and vulnerability among both ‘giving’ and ‘receiving households’, the more reduced reciprocity becomes. Non-reciprocal bonding relationships have mostly been identified in post-disaster and impoverished or deprived settings. Greif & Nii-Amoo Dodoo (2015), identified that within impoverished neighborhoods in Accra, ‘giving’ households stressed about the depletion of their resources in meeting the needs of ‘receiving’ households. Likewise, widespread poverty and low reciprocity resulted in shared destitution between both ‘giving’ and ‘receiving’ households within a Liberian refugee community, dependent on food exchanges for food access (Omata, 2013). Thus, the bonding social

capital networks of low-income residents can be simultaneously supportive, strained and limited in providing access to necessary resources (Curley, 2009), as identified in Beira.

The restrictions in reciprocity within bonding social capital networks identified in this study may become detrimental for future food-sourcing adaptations, especially if 'giving' households choose to withhold their limited resources from others. Within deprived neighborhoods, low reciprocity from receiving households promotes the exclusion of poorer households and individuals from informal helping actions within their bonding social capital networks (Phan et al.,2009). The findings therefore support assertions that the conditions of poor people is a reflection of their possession of intensive close-knit bonding social capital, modest stocks of bridging social capital and almost no linking social capital, which restricts their access to resources like credit or food aid (Woolcock, 2002). It appears that households required more combinations of bridging and linking social capital networks, rather than bonding social capital for food-sourcing adaptations after Cyclone Idai.

Apart from access to social capital networks, access to savings, especially cash-in-hand proved very important for addressing household food insecurity after Cyclone Idai. The underlying factor is that households should have had savings prior to the shock or disaster. Almost 79% of respondents in the quantitative study used household savings as an adaptation for Cyclone Idai. Although the relationship between use of savings and household food insecurity were not quantitatively determined, qualitative findings indicated that amidst food shortages and price hikes, access to savings improved food access for those who had it after Cyclone Idai in Beira. Likewise in Haiti, households that had access to credit immediately before Hurricane Matthew experienced reduced food insecurity one year after the hurricane, compared to those who did not (Kianersi et al., 2015).

Households without access to cash (and no social capital networks), likely experienced more severe forms of food insecurity after Cyclone Idai. The combined occurrence of bank closures, food shortages, and price hikes in the immediate aftermath of Cyclone Idai fueled the panic buying. Due to the fear of food shortages, households that had substantial cash in hand bought and hoarded food, which further affected food availability and food access (e.g., bread shortages). This type of consumer behavior deepens social vulnerability as highlighted during the COVID-19 pandemic where food, water, and essentials like sanitizers and toilet paper were bought in large unneeded quantities by few people and hoarded, thus creating market shortages.

This finding in Beira mirrors studies on post-disaster panic buying which are mostly from HICs and within formal food environments. The impact of disasters on consumer behavior was also identified among survivors of the Christchurch earthquake in New Zealand where the purchase of items for survival (e.g., food, drinking water), cleaning items (e.g., mops, wipes) and supplies such as batteries and torches increased in the immediate 4 weeks after the earthquake (Forbes, 2017). Evidently, applying household savings towards stockpiling of food, as an adaptation for preparedness rather than post-disaster response may have reduced panic buying and inequalities

in food access after Cyclone Idai. The adaptations to address household food insecurity across all SES levels were focused on the response phase of Cyclone Idai and thus were in reaction to the catastrophic impacts. This approach of disaster management is very important, however, without adaptations taken during the preparedness phase, there will be significant shortages in food availability and food access for affected people.

Across all levels, the storage of food for emergency purposes should be encouraged among households in Beira, which will turn out to be a less costly adaptation than disaster response adaptations. Similarly, due to the cost and challenges in addressing recurrent post-disaster food insecurity in Japan, 'disaster preparedness food' was recommended as an on-going adaptation. 'Disaster preparedness food' refers to food stocked up in safe places pre-disasters, by the government, institutions and households in disaster prone areas (Nakazawa & Beppu, 2012). Disaster preparedness adaptations can be promoted using tools like the media, to reduce post disaster panic buying and food shortages during response. Shifting the post-disaster response adaptations towards the pre-disaster preparedness phase will likely reduce the vulnerability of households to food insecurity, however, this requires a rethinking of disaster management processes.

Disaster Management Challenges in Addressing Post-Disaster Household Food Insecurity

The activities of disaster management and addressing household food security after Cyclone Idai were embedded within macrosystem, mesosystem and microsystem SES level interactions. In Mozambique, disaster management is led by the government through the National Institute for Disaster Management (INGD), which has managed several cyclones and national disasters. The disaster management approach appeared heavily focused on the disaster response phase of Cyclone Idai, rather than disaster risk reduction prior to the cyclone. Also, the management of Cyclone Idai response was different because there was no previous experience managing a cyclone of this magnitude. Cyclone Idai was the deadliest storm ever recorded to hit the Southern Hemisphere, impacting 90% of infrastructure in Beira (NASA, 2019). As such, disaster management institutions, communities and households (all SES levels) were caught in the web of addressing the impacts of an unprecedented intense cyclone, with inadequate preparedness (including disaster risk reduction), and amidst high underlying social vulnerability.

There were some key challenges of Cyclone Idai disaster management at the macrosystem level that reverberated throughout the mesosystem and microsystem levels, which require key consideration. To begin with, a vital component of disaster management is disaster risk communication, initiated by macrosystem institutions, to warn households about the characteristics of impending disasters, and to provide quality information for adaptations (IPCC, 2012; Mileti, & O'Brien, 1992). Across all levels, disaster risk communication on Cyclone Idai appeared not to reflect the intensity of the cyclone or inform macrosystem, mesosystem, and households on adaptations in preparedness and response for the cyclone impacts (e.g., disruptions

in basic necessities such as food), apart from alerting households to 'stay at home or evacuate'. The intensity of Cyclone Idai and its impacts took all SES levels by surprise. As such, disaster management institutions should have the ability to adapt to unfolding disaster situations and improve risk communication to correspond with different disasters and elicit preparedness from the macrosystem to household levels.

In the second place, Cyclone Idai, apart from destroying houses, affected and destroyed the infrastructure of all the humanitarian agencies interviewed in the study, causing colossal losses which some institutions had not recovered from. Macrosystem institution offices, warehouses and logistics like computers and the data stored on them, paper files and vehicles were all destroyed. The staff of all these institutions were also affected. These challenges created setbacks for post-disaster response which is reflected by the low numbers of respondents who received emergency supplies and food aid in the study. Local disaster management institutions therefore require resilient buildings and logistical infrastructure to withstand disaster impacts in the first place, so that their capacity to manage disasters in the long-term and address food insecurity in disaster-prone Beira does not become compromised.

Lastly, the coordination of different institutions for disaster management was overwhelming and created challenges for disaster response. There were more than 30 formal institutions involved in post-Cyclone Idai disaster management, which included the federal, provincial and local government institutions, and humanitarian organizations working in clusters for the different areas of need (e.g., WFP and FAO worked on food and logistics) (Government of Mozambique, 2019). While the presence of multiple actors involved in post-disaster response is a good indication of more aid, there were some coordination challenges that restricted the overall effectiveness in addressing the food needs of impacted households. To illustrate, autonomous institutions that had not collaborated on disaster management before had to do so (INAS and INGD), a process that was confusing and resulted in delayed distribution of food for vulnerable groups.

There were challenges also in the coordination of responsibilities between the federal, provincial and the local government regarding the targeting of vulnerable households for aid. This resulted in the creation of several lists of vulnerable households by different stakeholders using different indicators. The coordination challenges further influenced duplications in the work of humanitarian agencies as multiple donors worked in some communities, while other communities received no help. Additionally, the engagement of community leaders for targeting vulnerable households was poorly coordinated, leading to unequal food distribution and unintended reductions in food access for marginalized groups in many communities. Similar setbacks have been found in disaster prone areas in Iran and Pakistan where the apparent lack of authority and poor coordination by local disaster management institutions limited their ability to decide how donors should distribute aid (Ainehvand et al., 2019a; Shah et al., 2019).

Prior to Cyclone Idai, one main limitation identified within the National Disaster Risk Reduction Master Plan (2017-2030), was the lack of role clarity in the collaborations between different local

actors and international humanitarian aid organizations, involved in disaster management in Mozambique (IFRC, 2021). Without clearly defined legal backing, strong local institutions and well-articulated coordinating plans, engaging with over 30 organizations for disaster response within a relatively short time will be overwhelming. This was evident in post-Cyclone Idai management. Some of the coordination challenges necessitated the creation of the Post-Cyclone Idai Reconstruction Cabinet (GREPOC) for coordinating non-emergency post-disaster response. The role of GREPOC involved directing resources from donor agencies towards specific needs of reconstruction (e.g., rebuilding houses), but their role excluded addressing other social needs like poverty and food insecurity. The work of GREPOC was also limited by inadequate finances as only about 38% of the money pledged for post-disaster response and recovery was received from donors.

Apart from improved coordination between macrosystem humanitarian agencies, there must be improved coordination between macrosystem-mesosystem levels (communities and community leaders), and also between households and all the SES levels above them. Improved disaster coordination at the macrosystem level will create stronger linking social capital and efficient management of resources that will reverberate to bridging social capital and bonding capital interactions. Improved coordination will support adaptations for disaster preparedness and response, which are relevant for minimizing the occurrence of post-disaster household food insecurity and/or restrict actions that deepen the vulnerability of already vulnerable households. According to Kim & Marcouiller (2016), well-established disaster management processes within economically strong countries are correlated with less post-disaster losses, while weak disaster management processes in poor countries are correlated with higher post-disaster losses and increased vulnerability to subsequent disasters. Thus, establishing coordination mechanisms, backed by formal institutional, budgetary and legal capacities, constitutes a fundamental component of disaster preparedness and disaster risk reduction (UNGA, 2016; WHO, 2020).

This analysis has important implications for adaptations in addressing household food insecurity, as part of improving the disaster risk reduction component of disaster management. The findings emphasize that the majority of adaptation to disaster strategies for addressing food insecurity depend on access to social capital networks (bonding, bridging and linking). Fostering social cohesion between the various social capital networks is crucial for understanding climate risks and mobilizing resources for adaptations, thereby reducing disaster risks and improving disaster management. The experience of food insecurity alone after disasters has dire implications for the health of survivors, as such, it is important to address SES interactions that mutually reinforce the exacerbation of household food insecurity post-disasters. Cyclone Idai has created a new baseline for informing disaster management and adaptations in preparedness for future disasters in Beira and Mozambique.

5.6 Summary

Post-disaster household food insecurity is an add-on to underlying household food insecurity, which has food availability, food access, food utilization and stability dimensions. Food insecurity is a multidimensional construct that is complicated to assess because of the multiple variables, tools and approaches involved. Thus, all the objectives and the theoretical and conceptual frameworks underpinning this study helped to assess the differences in post-Cyclone Idai food insecurity experienced by households and provided insights on the different dimensions. Notably, all the dimensions of food security are necessary for ensuring adequate food access, hence, food access has been used synonymously with food insecurity (Jones et al., 2013; Pinstrup-Andersen, 2009), which was also adopted by this study.

There appeared to be few challenges with food availability pre-Cyclone Idai, however, the main challenges were with food access and food utilization. For food availability, there were food markets in 'formal' areas of the city and several households were involved in subsistence farming, food exchange and food borrowing strategies. However, the HFIAS and the HFIAP revealed high levels of severe household food insecurity based on food access limitations, pre-Cyclone Idai, which increased significantly after Cyclone Idai. For pre-Cyclone Idai food utilization, there was limited dietary diversity among poor subsistence farming households as they mostly lived off their produce, while post-Cyclone Idai impacts were linked to water contamination, food safety challenges and limited dietary diversity in food at the displacement centers. These underlying challenges were compounded by the physical impacts of Cyclone Idai, such as the destruction of food availability sources and entitlements necessary for food access, reduced food utilization and disrupted food stability.

Regardless, this study assessed post-Cyclone Idai food insecurity through a social vulnerability lens, which does not consider only physical factors, but identifies that there are differences in vulnerability to a disaster's impacts based on social factors. The social vulnerability approach associates the increases in post-disaster impact and food insecurity with the differences in household sensitivity. Sensitivity to post-disaster food insecurity encompasses a wide category of factors (e.g., possession of entitlements, poverty, demographics, food environments, access to social capital and place inequalities), which interconnect at various levels to influence the severity of post-disaster food insecurity (Sen, 1981; Cutter et al., 2003; Phillips et al., 2013; Ainehvand et al., 2019; Pyle et al., 2021). The more 'sensitive' a household, the more socially vulnerable and susceptible they were to more severe forms of post-Cyclone Idai food insecurity. Thus, a broad range of indicators were adopted for assessing the differences in post-Cyclone Idai food insecurity to reflect social vulnerability.

The inclusion of household and personal food environment characteristics, and adaptation to disasters, highlighted underlying social inequalities that influenced exacerbated food insecurity post-Cyclone Idai. For household characteristics, low-income households with large household sizes were associated with severe food insecurity pre-and-post-Cyclone Idai because of limitations

in their entitlements for food access. The indicators for the affordability variable of the personal food environment further highlighted income losses and food price hikes that compounded food access challenges and food availability shortages. As such, the use of cash savings was a relevant adaptation for food-sourcing post-Cyclone Idai, despite the widespread affordability challenges. The indicators for accessibility and convenience highlighted the conditions of households living precariously in informal areas where they were no food markets and basic necessities (e.g., electricity and clean water), which limited their food acquisition and food preparation pre-Cyclone Idai. Living in informal areas, exposed households to displacement and more intense physical impacts of Cyclone Idai on their houses and farming livelihoods. Aside the physical impact of Cyclone Idai, household food access in the aftermath of Cyclone Idai was linked to adaptations facilitated by different social capital networks, whereby poor households without these networks were limited in adaptations to address post-Cyclone Idai impacts including food insecurity.

To explore the interactions between the multiple social vulnerability indicators, an overarching SES framework was adopted. This helped to systematically assess how each indicator influenced post-disaster food insecurity and allowed the incorporation of influences from disaster management stakeholders at the mesosystem (bonding and bridging social capital networks) and macrosystem (linking social capital networks) levels. The SES framework was additionally modified by aligning it with the phases of disaster management, particularly the preparedness and response phases. Although food stability disruptions due to extreme weather disasters may not be preventable, the assessment of Cyclone Idai preparedness and response, highlighted some strengths and weaknesses of disaster management processes associated with the differences in household food insecurity after Cyclone Idai. The inclusion of multiple indicators and the merger of the SES framework and disaster management phases revealed social vulnerability factors and socio-ecological relationships that influenced post-Cyclone Idai household food insecurity, specifically in Beira, Mozambique.

The findings reaffirm that increased social vulnerability serves to influence the severity of the physical impacts of hazards (Birkmann, 2006; Birkmann et al., 2013; Phillips et al., 2013). The severity of the physical impact of disasters may be mitigated by understanding the dynamics of vulnerability, including the multidimensional factors influencing food insecurity and adopting adaptations to manage them (Ingram et al., 2012; FAO, 2021). The conceptualization of this study supports the use of ‘systems’ approaches for exploring context-specific social vulnerability, to inform the reduction of disaster risk and household food insecurity. By understanding the interactions between the multiple variables linked to post-Cyclone Idai food insecurity, leverage points have been identified whereby interventions can be applied for minimizing post-disaster food insecurity in Beira.

5.7 Limitations of the Study

Despite the study's pertinent findings on the differences in household food insecurity after Cyclone Idai in Beira, Mozambique, there were some limitations. The first limitation was that while the research team tried to sample respondents from the quantitative study for the qualitative study, this could not be done because most participants from the quantitative study did not consent to participating in the qualitative study, which was conducted later. This was later linked to the general cautious nature of the residents and liability concerns in providing their contact information to strangers. As such, there were concerns that there may be differences in the perspective of qualitative study participants. Notwithstanding, findings from analysis of the quantitative and qualitative data complemented each other and served as confirmation of a true reflection of the study outcomes.

A second limitation is related to the context-specific nature of the study using a small size of participants to assess household food insecurity post-Cyclone Idai in Beira. To address this, participants for the qualitative study were purposefully selected from households, communities and humanitarian institutions in Beira that were valuable in providing the information needed on post-Cyclone Idai household food insecurity in Beira. Although WFP, a key humanitarian institution for addressing post-disaster food insecurity declined the interview, other participants contributed information on WFP's role. Findings cannot therefore be generalized unless comparative studies within other communities are carried out to validate them. Notwithstanding, findings provide insights into SES interaction factors associated with post-disaster food insecurity, to inform the readership who may decide on the applicability to other post-disaster contexts.

The third limitation was linked to the quantitative and qualitative study. In the quantitative study, some data collected was solely focused on post-Cyclone Idai (e.g., job access), restricting a pre- and post-cyclone quantitative assessment. Also, the qualitative study was liable to qualitative research limitations, such as researcher bias and subjectiveness. Nonetheless, integrating both quantitative and qualitative data provided complementary insights into pre-Cyclone Idai contexts, and supported cross-verification to reduce qualitative data biases. The data collection and thesis writing processes were also guided by debriefing sessions with research team members, to identify potential biases and to challenge assumptions and interpretations. Overall, all research methods were transparent, and the questions and the interpretation of the study's findings was grounded in guidelines provided by validated and established constructs of food security, SES and Disaster Management Approaches to limit researcher bias in interpreting the findings.

Lastly, the time spent on the collection of qualitative data (approximately 2 weeks), could be considered a limitation to the study. However, the time spent was based on the logistical allocations available for the qualitative study. Regardless, the use of extensive networks in Mozambique allowed ample coverage of respondents to address the key objectives of the study despite the short-time frame. Also, the merger of both quantitative and qualitative data lends strength to the study to address this limitation.

CHAPTER 6

6.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

6.1 Introduction

This chapter summarizes the findings of the study based on the objectives, presents the conclusions for each objective and provides the study's implications for addressing post-disaster food insecurity. The chapter concludes with recommendations for the study and suggestions for future research.

6.2 Summary of Findings

This study adopted a mixed methods sequential explanatory study design, for assessing the differences in household food insecurity vulnerabilities post-Cyclone Idai, in Beira Mozambique. Data was collected across three levels of the SES framework. At the household (microsystem) level, data were collected quantitatively using structured questionnaires to elicit data on food insecurity and proxy indicators for the personal food environment and adaptations to disasters post-Cyclone Idai. The sample size for the quantitative study was 975 households, however, only the complete set of data for all variables of interest n=709, was used for the analysis. This was later followed by qualitative data collection approaches using FGDs and KIIs. At the household level, 3 FGDs were conducted, while 1 triad KII and 1 FGD were conducted with community leaders at the mesosystem level. Additionally, 9 KIIs were conducted with representatives of governmental and NGO disaster management institutions at the macrosystem level. The main findings of the study according to the objectives are summarized below.

Objective 1

There were significant increases in household food insecurity one month after Cyclone Idai, although severe household food insecurity levels were already high before the cyclone. The month before Cyclone Idai, median HFIAS score of 14 increased to a median score of 18 after the cyclone, which was a statistically significant increase. According to the HFIAP, 77.57% of respondents experienced severe food insecurity in the month before Cyclone Idai, which increased to 87.73% in the month after Cyclone Idai. From the qualitative study, food insecurity pre-Cyclone Idai was mainly linked to limitations in food access. However, both food availability and food access became limited after Cyclone Idai. This was associated with disruptions in food supply, inadequate humanitarian food supply, and the destruction of agriculture-related livelihoods, thus exacerbating underlying severe food insecurity.

Objective 2

Of the three household characteristics namely household income, presence of chronic illness and household size that were considered, only household income had a moderately strong but negative statistically significant relationship with the HFIAS (Kendall's tau-b= -0.3148, $p<0.0000$). As such, increased household income was associated with decreases in household food insecurity and vice versa. The presence of chronic illness had a weak but positive, statistically significant relationship with the HFIAS (Kendall's tau-b=0.0925, $p<0.0100$). Thus, the presence of chronic illness was associated with increased household food insecurity. Although household size did not have a statistically significant relationship with food insecurity, the qualitative study highlighted a strong relationship between household size, household income and food insecurity. Large households with 8-10 members in the low-income bracket (5000 Meticals and below) were considered the most food insecure pre- and post-Cylone Idai. Additionally, the added-on burden of sharing food with vulnerable bonding social capital networks reduced food access within 'giving' households.

Objective 3

Place-based inequalities between the displaced and non-displaced households underpinned differences in the underlying personal food environment characteristics (affordability, accessibility and convenience), required for food acquisition, food preparation and consumption. These inequalities became compounded by Cyclone Idai. Under accessibility, 39% of respondents perceived that they lived in informal residences, while 17% of respondent houses were destroyed by Cyclone Idai. Households from the 2 displaced informal communities experienced the most difficulties in food accessibility because there were no food markets in their communities, and most of the houses were completely destroyed by the cyclone, resulting in more severe food insecurity compared to non-displaced households. Under affordability, 89% of households experienced inconsistent income access which combined with increases in food prices and reduced food affordability post-Cyclone Idai. Under convenience, more than 70% of households experienced disruptions in access to clean water, cooking fuel and electricity in the year after Cyclone Idai. Households in the resettlement and displaced community had no access to electricity and potable water pre-Cyclone Idai, and as such, they had no disruptions post-Cyclone Idai. However, their water sources became contaminated which impacted food utilization and food preparation post-Cyclone Idai.

Objective 4

Most adaptations were applied during disaster response, as poor disaster risk perception influenced the low uptake of adaptations for addressing household food insecurity during preparedness for Cyclone Idai. After the cyclone, the use of household savings at the microsystem level was the most adopted adaptation by almost 78.8% of households. This

was followed by mesosystem (bonding and bridging social capital) supported adaptations of 'borrowing for basic needs' used by 45% of households. Furthermore, only 10.7% of households moved to displacement centers, while 12.6% and 11% of households received assistance from the government and NGOs respectively, representing macrosystem interactions (linking social capital). Only households at the displacement centers during emergency response received food assistance from 'linking social capital' networks. Most households were non-displaced and sourced food from bonding and bridging social capital networks respectively, where applicable. Constraints with the different food-sourcing adaptations included, non-reciprocity of interactions that enabled food access for households on the receiving end, but reduced food access for the 'giving' households. Additionally, bridging and linking social capital networks' distribution of food aid was associated with unequal food access due to difficulties in targeting the most vulnerable households, poor food distribution coordination and community leaders' biases. Poor non-displaced households with no social capital networks were associated with the most severe forms of food insecurity post-Cyclone Idai.

6.3 Research Contributions

6.3.1 Empirical Contributions towards Post-Disaster Food Insecurity Research

The connections between underlying food insecurity and post-disaster food insecurity have been little researched, especially in Sub-Saharan African cities. However, frequent transitory post-disaster food insecurity experiences catalyze the perpetuation of chronic household food insecurity. Post-disaster food insecurity has adverse health implications for households including increased susceptibility to diseases because of weakened immune systems, undernutrition and the exacerbation of chronic diseases (Garschagen et al., 2015). Most efforts in response to the needs of survivors after extreme weather events revolve around minimizing the lack of access to food or post-disaster food insecurity. This post-disaster analysis of Cyclone Idai, one of the most intense cyclones in Mozambique, provides the opportunity to learn about the relationship between underlying food insecurity and post-disaster food insecurity and also provides key lessons for addressing household food insecurity as part of disaster management.

The multiple indicators adopted for the study explored factors associated with the differences in household food insecurity post-Cyclone Idai from a social vulnerability perspective. The interactions between the indicators, namely household and personal food environment characteristics, and adaptations to disasters, revealed high levels of food insecurity among most households post-Cyclone Idai. However, households in the informal displaced communities of the study were associated with more severe forms of food insecurity after displacement, because of existing food accessibility challenges, compared to non-displaced households. The analysis also

identified different social capital-facilitated food-sourcing adaptations, which either exacerbated or reduced household food insecurity. The study therefore provides insights into post-Cyclone Idai food insecurity, by presenting characteristics associated with the increased impact of the cyclone on household food insecurity, alongside social capital factors that either minimized or exacerbated it, to inform vulnerability reduction.

Reduced social vulnerability in Beira would begin when post-disaster losses are reduced, and disasters do not deepen pre-disaster food insecurity. Since household food insecurity levels are already high in Beira, disaster preparedness at all SES levels will prevent baseline food insecurity levels from being exceeded due to protracted disruptions by disasters. A heavy focus on disaster response seems counterproductive as failure to prepare for disasters creates catastrophic disaster outcomes that wipe out recovery from previous disasters. Findings from the study, therefore, necessitate disaster management processes and adaptations that mitigate the impact of disasters on food insecurity as part of on-going preparedness rather than disaster response. This is important because humanitarian aid can become limited and is not always available for households as was experienced after Cyclone Idai.

The study's findings support effective multi-stakeholder coordination for disaster management and post-disaster food insecurity interventions, as revealed after Cyclone Idai. Against the background of colonization, and urbanization challenges (e.g., informality, food insecurity lack of access to roads and urban amenities) which underlie Beira city's foundation, improved stakeholders' engagement across SES levels (households, communities, donors and local disaster management institutions) can create pathways for addressing some challenges in reducing disaster risks and food insecurity. The findings of the study emphasize the importance of 'coordination' for implementing the Beira Master Plan 2035, which acts as a framework for reducing the vulnerability of the city to climate-related extreme weather impacts, in support of sustainable development. Without coordination, the interventions of different stakeholders may become counterproductive, as identified with the activities of community leaders and increased charcoal production and their implications.

6.3.2 Methodological Contributions to Post-Disaster Household Food Insecurity Assessment

The study contributes methodologically to the assessment of household food insecurity in a post-disaster environment. The measurement of food insecurity is usually focused on food access scales (e.g., FIEMS), which apart from measuring food access, cannot identify points of interventions for addressing post-disaster food insecurity. As such, the application of mixed methods (quantitative and qualitative approaches) enabled the assessment of other dimensions and constructs relevant for post-disaster food insecurity (e.g., personal food environment and food availability), apart from the HFIAS. The food security constructs notwithstanding, the indicators for the study were informed by the Onion framework (Birkmann, 2006), which underscores the contribution of

intangible (social) factors to the creation of disasters, rather than just tangible (e.g., geographical or physical) factors. The indicators selected for assessing post-disaster household food insecurity therefore support a social vulnerability perspective rather than a prevalent physical vulnerability perspective.

Interactions between the selected indicators of household characteristics, personal food environment characteristics and adaptation to disaster factors were assessed in relation to post-Cyclone Idai household food insecurity. Furthermore, interactions between the selected indicators were situated within an SES framework and aligned with the phases of disaster management. This helped to explain the differences in food insecurity among households exposed to the same disaster and the microsystem, mesosystem and macrosystem influences contributory to the differences in outcomes. Additionally, embedding the indicator interactions within the SES framework helped to highlight socio-ecological interactions associated with the increased risk of post-disaster food insecurity vulnerabilities among households.

The multiple indicators adopted by the study (household and personal food environment characteristics and adaptation to disaster factors), and the merger of multiple frameworks (Onion and SES frameworks) aligned with the phases of disaster management provided a comprehensive way of assessing post-disaster household food insecurity in Mozambique, that was not identified in other studies. The study therefore responds to calls for assessing household food insecurity from a system's perspective and the necessity of post-disaster food insecurity measurement especially in a disaster-prone city like Beira.

6.3.3 Theoretical Contributions Towards the Concept of Post-Disaster Household Food Insecurity

The study contributes towards the theoretical framing of post-disaster food insecurity among households in LMIC cities. Differences in urbanization trends in LMICs compared to HICs requires nuanced approaches in understanding post-disaster food insecurity. Existing research indicates that apart from entitlements, food access depends on access to resources including education, clean water, sanitation, health care, cooking fuel, and energy (Drèze & Sen,1989; Frayne & McCordic, 2015; Burchi & De Muro, 2016; HLPE, 2017). As such, the incorporation of personal food environment variables of accessibility, affordability, convenience, and their indicators expand on the concept of resources required for food access, e.g., living in a formal or informal area, which is relevant for LMIC post-disaster contexts.

The inclusion of the personal food environment revealed inequalities in household food system interactions that influenced food acquisition, preparation and consumption, and how their disruptions influenced differences in food insecurity post-Cyclone Idai. This is an important contribution, because it reaffirms the need to reduce the social inequality of households living in informal communities, given that predicted increases in climate-related extreme weather events,

have adverse implications for food system interactions (Mbow et al., 2019). The displaced communities of the study had food desert characteristics because of the absence of food markets which, combined with their inferior housing structures, resulted in the disproportionate effects of Cyclone Idai (e.g., loss of houses), deeper inequality, and food insecurity for months after the disaster.

Another component of this study relevant for explaining post-disaster food insecurity is the inclusion of disaster management phases for Cyclone Idai in the analysis. This further revealed social factors like discounted disaster risk warnings, which inadvertently influenced post-disaster food insecurity increases. Across all SES levels there were warnings about Cyclone Idai, however, adaptations to address food insecurity were largely not considered in preparedness for the cyclone. Thus, the study provides evidence of how failure to prepare for disasters is associated with the differences in post-disaster impacts, including post-disaster food insecurity. Living in informal communities and discounted disaster risk perceptions reflects social vulnerability to disasters (Birkmann et al., 2013; Phillips et al., 2013).

The study contributes to the theorizing of post-disaster food insecurity as social vulnerability, which reaffirmed the vicious relationship between social inequality and disasters. Although the findings are Beira-specific, they are useful for conceptualizing post-disaster food insecurity in other LMIC disaster-prone cities. A social vulnerability lens therefore supports addressing food insecurity from a disaster risk mitigation perspective whereby households are involved in adaptations for reducing vulnerabilities before disasters, rather than the current emergency response approach in a disaster-prone city.

6.3.4 Policy Contributions Towards Implementation of Sustainable Development Goals

Implementing the ambitious sustainable development goals, including SDG 2 on ending hunger and food insecurity, requires research-based evidence to inform policymaking (Kates et al., 2005). The study's findings highlighted spatial inequalities in urban development and limitations in access to resources and entitlements (e.g., livelihoods, access to clean water, and cooking fuel), which contributed to increased post-disaster impacts and food insecurity. The study therefore supports policies for the equitable implementation of the social SDGs; notably SDG 1(no poverty), SDG 6 (access to water), SDG 7 (clean and affordable energy), and SDG 11 (inclusive development within cities). The social SDGs are considered to be the foundation upon which sustainable development will materialize, and yet, there has been little progress made (Raworth, 2017a).

The implementation of different SDGs by different policymakers, and institutions operating in silos creates challenges with policy coherence, which hinders SDG integration and progress (Nilsson et al., 2016). This is illustrated by the efficient collaboration of the Cluster of humanitarian agencies at the displacement center which assured food access for households during

Cyclone Idai emergency response compared to the non-emergency response phase, where there was an apparent disconnect between different institutions and stakeholders across SES levels, resulting in multiple incidences of inequitable food distribution and exacerbated vulnerability for some households. Additionally, the plight of the resettlement and displaced households in the study who have become exposed to recurrent disaster losses and more severe forms of food insecurity after Cyclone Idai, because of their resettlement within flood prone areas, reflects poor coordination among urban planning and disaster management institutions.

Thus, the study informs policies to facilitate improved collaboration between institutions addressing food insecurity, urban planning, and disaster management. Policies for improved collaborations can guide conversations between different levels of government and diverse stakeholders for adaptations in preparedness for disasters. Without such collaborations, extreme weather events can erode successes in SDG achievement and cause vulnerable households to slide deeper into poverty and vulnerability. Improved coordination, backed by formal institutional, budgetary and legal capacities, are key components of adaptations for disaster risk reduction and disaster preparedness (UNGA, 2016; WHO, 2020). Thus, the study contributes knowledge by clarifying the balancing and reinforcing interactions between SDG 2 on food insecurity, climate action and disaster management (SDG 13), and SDG 17 on partnering for SDG implementation. Recurrent extreme weather disasters can compound social vulnerabilities in Beira, as such, integrated and comprehensive studies to clarify SDG interactions are required for long-term sustainable development.

6.4 Conclusion

The interactions between household characteristics, place-based inequalities in the personal food environment and discounted early warning information, contributed towards the general lack of adaptations in preparedness for household food insecurity and disaster risk reduction, during one of the most intense cyclones in Beira, Mozambique. Thus, Cyclone Idai affected all the dimensions of food insecurity, namely food availability, food access, food utilization, and food stability resulting in exacerbated food insecurity and underlying vulnerability factors within households. Vulnerability characteristics at the microsystem level included large household sizes, underlying severe food insecurity, low-income, reliance on subsistence farming for food and income, limited accessibility (living in informal residences, house destroyed by cyclone), limited food affordability, and limited convenience in food preparation.

Households that possessed a combination of all these characteristics were more vulnerable to post-disaster food insecurity in the month after Cyclone Idai, which applied to most households from the resettlement and displaced communities in the study. The households from displaced communities would have experienced the highest forms of food insecurity vulnerability due to destroyed homes and displacement. However, the interventions of humanitarian institutions and

the INGD helped to moderate the exacerbated food insecurity of these households by supporting their food-sourcing adaptations during disaster response. Notably, after the supported adaptations ended, households from the displaced and resettlement communities experienced exacerbated household food insecurity in the year after Cyclone Idai.

Non-displaced households had no support or food aid from humanitarian agencies after Cyclone Idai, but rather relied on limited bonding and bridging social capital networks, provided it was available to them. The 'giving' households within the bonding social capital networks experienced reduced food access than they ordinarily would have, due to the non-reciprocal acts of food sharing with the 'receiving' households. Non-displaced households with severe Cyclone Idai impacts on their buildings and yet, had no social capital networks, experienced the most severe post-disaster food insecurity during disaster response. Amidst increased post-Cyclone Idai food insecurity, access to household savings especially cash-in-hand, and mesosystem and macrosystem social capital networks influenced differential household food insecurity in the aftermath of Cyclone Idai.

6.4 Recommendations

Based on the study's findings, a set of recommendations, arranged in order of priority from high to low, have been provided, to guide post-disaster food insecurity interventions in Beira. The recommendations and the suggested implementing sectors are detailed below (table 6.1). The institutions highlighted are not all inclusive of the required institutions.

Table 6.1: Recommendations for Addressing Post Disaster Food Insecurity

Recommendations		**Implementation Sectors**
High Priority		
1	***Improve Disaster Risk Reduction During Disaster Management*** • Improve disaster risk communication to include information about how to prepare for disasters, especially household food storage (disaster food) and home infrastructure reinforcement practices. This will help to reduce post-disaster losses and provide temporary food access and food availability amidst post-disaster disruptions. • Post-disaster needs assessment (PDNA) should highlight coordination challenges across all SES levels. This will support the mobilization of resources to specifically improve the coordination of disaster management and reduce disaster risks.	*INGD* *Ministry of Telecommunication/ Media* *GREPOC* *Emergency Commission/ Cluster Of Humanitarian Organizations/* *Ministry of Agriculture* *INAS*

	• Improve the articulation of both local and donor agency specifications, to manage and optimize available resources, for the highest possible vulnerability reduction outcomes. • Resettlement of households should be based on well planned, coordinated and thorough assessment of basic needs for food, housing, livelihoods, education and healthcare.	*Communities and Households* *Federal and Local Government* *Urban Planning* *Ministry of Land and Environment* *Local Government*
2	***Emergency Food Aid Distribution*** • The distribution of food aid should be equitable, transparent, and based on the engagement of multiple community members as part of community-based disaster risk reduction, rather than only a few community leaders and non-transparent processes. • Emergency food should be stockpiled at the government or city level, in storage structures that are resilient to cyclones and floods. Storage structures should be in areas where food can be easily deployed without transportation disruptions during disasters. • Improve food portions for large households and food diversity during displacement because of the implications for young children and people with chronic diseases	*INGD/ SETSAN/ INAS* *Cluster Of Humanitarian Organizations* *Communities and Households* *Local NGOs* *Religious organizations* *FH* *Ministry of Roads and Transportation* *Ministry of Health and Nutrition (MISAU)*
Medium Priority		
1	***Capacity Building for Disaster Management*** • The capacity of local disaster management institutions should be improved for disaster preparedness to mitigate losses among institutions and households. • Capacity building should include vulnerability targeting strategies to help address targeting biases. This can include the use of technology to map households that have received assistance and to quickly detect inconsistencies in vulnerability lists. • Create legal frameworks to back the engagement of community bridging social capital networks in disaster management. There should be formal guidelines and	*GREPOC* *INGD* *INAS* *Emergency Commission* *Cluster Of Humanitarian Organizations/* *Ministry of Agriculture* *Ministry of Education* *Local NGOs* *Religious organizations* *Local Government* *Law Enforcement*

	auditing processes to address disaster management malpractices such as the sale of food aid.	
2	***Social Protection and Development Plans*** • Support livelihood diversifications such as small businesses apart from agriculture. Vocational training in fields like carpentry, brickmaking and construction can be provided to the youth to promote livelihood opportunities that facilitate food access but are also relevant for building resilient housing infrastructure. This can be complemented by developing and providing training on climate-resilient agricultural practices as agriculture employs most households in Beira. • Support the building of strong bonding and bridging social capital networks for addressing chronic food insecurity through community-led initiatives for nutrition. This could be seeded by linking social capital, providing cash transfers and supporting food storage initiatives that are run by small community cooperatives. • Community interventions supporting groups of widows, orphans and people with disabilities, should be supported by linking social capital to reduce the burden on already vulnerable households.	*Ministry of Agriculture* *FH* *Ministry of Environment* *Ministry of Education* *Universities* *Colleges* *INAS* *Technical and Vocational Training* *Cluster Of Humanitarian Organizations* *Religious Organizations* *Communities* *Households*
3	***Nutrition Education*** • Educate households on alternative sources of nutrition that can be used during emergencies, especially for the vulnerable, including children and seniors. • Improve meal planning for the provision of meals at the displacement centers. • Offer guidance on local food production and improve subsistence farming to reduce chronic food insecurity in communities.	*FH* *SETSAN* *Min of AGRIC* *WFP* *Ministry of Health & Nutrition (MISAU)* *Ministry of Education* *Telecommunication & Media*
4	***Promote Disaster Preparedness Knowledge and Culture*** • Provide ongoing education on different adaptations in preparedness for disasters, especially for post-disaster household food insecurity at the household level. This approach will reduce post-Cyclone Idai losses and the high levels of humanitarian assistance needed during the response phase.	*INGD/INAS/ASATE/ Community NGOs* *SETSAN* *Ministry Of Education*

	• Invest into building climate resilient infrastructure, especially for disaster management institutions to reduce the impacts of cyclones on their logistics	*Ministry of Health & Nutrition* *WFP* *Religious Organizations* *Local Government* *Urban Planning*
Lower Priority		
1	***Integrating DRR into Urban Planning*** • Integrate Disaster Risk Reduction and Urban Planning policies to address social inequalities, land dispossession, food accessibility and food convenience challenges. Ensure that all new houses and developments are climate resilient and within flood safe areas. • Reduce urban place-based inequalities by improving transport access and increasing access to water, electricity, and clean cooking fuel utilities. These are linked to improvements of the external and personal food environment of households, which can provide food availability and support livelihoods. • Implement a systematic approach to elevate and fortify houses within flood plains to increase flood resistance. In severe flood-prone cases, consider relocating houses to safer areas during non-disaster seasons. Relocation should be backed by comprehensive plans and engagement with affected groups, to reduce unintended resettlement consequences.	*INGD* *Local Government* *Ministry of Water and Sanitation* *Ministry of Planning Transport and* *Housing* *FIPAG* *Ministry of Land, Environment and Rural Development* *Energy Regulatory Authority*
2	***Promote Research into Local Adaptations*** • Encourage research into improving informal local adaptations for disaster preparedness and response.	*Ministry of Education* *Universities* *Colleges* *Technical and Vocational Institutions*
3	***Disaster Prediction Improvement*** • Support technological advancement such as the use of artificial intelligence to help with the early detection of extreme weather events and improve timely and accurate weather forecasts and preparedness.	*Emergency Commission* *INGD* *Cluster Of Humanitarian Organizations*
4	***Household Socio-economic Development*** • Support initiatives to promote the retention of students in school to enable higher education achievement.	*Health*

	• Advocate for managing household sizes, through engaging communities on cultural beliefs. This can help shift beliefs on having multiple children and address teenage pregnancy issues linked to large household sizes.	*Gender and Childhood Ministry* *UNFPA*

6.5 Future Research

Even though this study has provided some explanations for post-disaster food insecurity vulnerabilities, longitudinal studies assessing underlying food insecurity before and after several cyclones, are required to validate the findings and further inform interventions for reducing household food insecurity in Mozambique. Non-longitudinal studies can also examine how disaster risk communication and the coordination for disaster management can be improved across SES levels, to contribute towards addressing post-disaster food insecurity. Studies assessing the effectiveness of post-disaster food assistance programs and how to improve vulnerability targeting for aid are also relevant. Overall, cross-disciplinary research involving urban planning, public health, emergency commission, local government, humanitarian agencies and other institutions can build on the preliminary framework of this study, to provide a more holistic understanding of factors influencing post-disaster food security.

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APPENDICES

APPENDIX A: QUALITATIVE DATA COLLECTION TOOLS -In-Depth Interviews

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

In-Depth Interviews- Governmental & Non-Governmental Organization

Region: .....District: .....
Name of organization……Title and qualification of (e.g., Director of Food aid) …….
.....) Years of working in this capacity……

Introduction (allow 10 minutes for introductions)

- Introduce yourself and the Graduate Research Assistant
- Review the overall study research objective.
- Review the topic, structure and duration of the interview.
- Provide a copy of the informed consent form and allow the respondent time to read and ask questions about the form before signing.
- Ask if the respondent has any further questions before beginning the interview.

Questions and Probes

Introductory questions

- Q1. Tell me about your policy, roles and interventions in addressing food insecurity?
    - Before disasters and after disasters
    - Staff, logistics
    - Partners
    - Processes-- involved in providing aid and households accessing aid.
    - Others

Factors Associated with Food Insecurity in Beira Before Cyclone Idai

- Q2. Kindly tell me about food insecurity among households in Beira Mozambique and the factors associated with it
    - Increasing, decreasing, how is it manifested?
        - Food availability (when required, food sources, food contribution to health, access to health care)
    - Household food environment characteristics of the personal subdomains
        - Accessibility--access to food, time spent and distance obtaining food.
        - Affordability--money to buy food, jobs providing money.
        - Convenience-cooking spaces, appliances, water and fuel to cook.
        - Desirability--are foods culturally and socially acceptable?
    - Household vulnerability--HH size, income, gender, education, age, chronic illness

    - Underlying conditions; environmental, social, cultural, political, economic, historical?
    - Others?
- Q3. Tell me about your previous experiences with Cyclones and food insecurity.
    - What standard preparations did you put in place to address food insecurity prior to the cyclone?
    - Did this include food aid for some households?
    - What was involved in identifying and targeting such households?
    - What were the outcomes of those preparations?
    - What was involved in addressing post cyclone food insecurity?
    - What were the outcomes post-cyclone?

After Cyclone Idai

- Q4. Kindly tell me about how Cyclone Idai has impacted household factors and food insecurity
    - Post-disaster household characteristics
    - Post-disaster household food environment-displacement, income losses
    - Post disaster food insecurity
    - How different was this compared to previous cyclones
    - Were there households that were not impacted? If so, why?
- Q5. What adaptation measures/responses did your organization put in place to address household food insecurity after Cyclone Idai.
    - Food aid, cash, food for work?
- Q6. Kindly explain how households were selected to receive such support. What was it based on?
    - Organization's criteria?
    - Household characteristics, food environment characteristics and adaptations?
    - Community or household affiliations?
    - Spatial demarcations-rural/urban?
    - State of Communities impacted by disasters?
    - Others?
- Q7. How different was addressing post Cyclone Idai food insecurity compared to previous cyclones?
    - Types of adaptation measures implemented.
    - In selection of households for support.
    - Partners
    - Duration of support
    - Others
- Q8 What do you think about the support provided towards food security?
    - Was it adequate?
    - Did the most vulnerable households receive it?
    - Was it healthy, culturally, quality, acceptable?

- How long was it available for the length of time required – weeks/months?

Effects of adaptation responses on household food insecurity after Cyclone Idai?

- Q9. What factors contributed to reduced food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid)? [Refer to features highlighted in Question 1]
- Q10. What factors contributed to increased food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid)? [Refer to features highlighted in Question 1]
- Q11. What assessments were carried out to monitor and evaluate household food insecurity?
    - What indicators were used?

Disaster Management Operations

- Q12. How was your organization affected by Cyclone Idai?
- Q13. What are some of the barriers and opportunities of your organization in addressing post-disaster household food insecurity?
    - Organizational -partners, planning, leadership, logistics
    - Geographical
    - Households
    - Communities
- Q14. What would you say are the most important factors to consider in addressing household food insecurity?
    - Pre-disaster?
    - During the disaster
    - Post-disaster?
    - What adaptation responses if any are geared towards long term recovery/ preparation for future disasters with regards to food insecurity?
    - Household level, Community level and governmental or NGOs level?
- Q15. How can humanitarian organizations build resilience in addressing in addressing pre and post disaster food insecurity?
    - System level adaptive capacities -micro, meso and macro?
- Q16. What modifications you would recommend for addressing food insecurity in a disaster-prone area?
    - As part of on-going pre-disaster preparedness
    - Post disaster food insecurity management?
    - Is there anything that is missing? If so, what?

Conclusion (allow 10 minutes for wrap up)

- Ask if there is anything that the respondent would like to add that was not covered in the interview so far.
- Thank the respondent for their time and discuss the approximate timeline for:
    - Receiving any notes or transcripts from the interview
- Ask if the respondent has any remaining questions about the study or the interview process

In-Depth Interviews- Community Leaders

Province: ..... Title of community leader……
Years of living in community…… Date: **……**

Introduction (allow 10 minutes for introductions)

- Introduce yourself and the Graduate Research Assistant
- Review the overall study research objective
- Review the topic, structure and duration of the interview
- Provide a copy of the informed consent form and allow the respondent time to read and ask questions about the form before signing.
- Ask if the respondent has any further questions before beginning the interview.

Questions and Probes

Household Factors Associated with Food Insecurity Before Cyclone Idai

- Q1. Kindly tell me about food insecurity among households in Beira Mozambique and the factors associated with it
    - Increasing, decreasing, how is it manifested?
        - Food availability (when required, food sources, food contribution to health, access to health care)
    - Household food environment characteristics
        - Accessibility--access to food, time spent and distance obtaining food
        - Affordability--money to buy food, jobs providing money
        - Convenience --cooking spaces, appliances, water and fuel to cook.
        - Desirability--are foods culturally and socially acceptable?
    - Household vulnerability--HH size, income, gender, education, age, chronic illness
    - Underlying conditions; environmental, social, cultural, political, economic?
    - Others?
- Q2. Tell me about your previous experiences with Cyclones and food insecurity.
    - What preparations did you put in place to address food insecurity prior to the cyclone in your community?
    - What was the outcome of those preparations?
    - What community adaptation responses were usually implemented to address food insecurity after cyclones?
        - Hazardous work?
        - Reducing consumed food?
        - Sale of Assets?
        - Borrowing?
        - Requesting assistance from government or NGOs?
        - Requesting assistance from friends, family and community assistance?
        - Others?
- Q3. What informed the type of responses adopted by households?

- What were the outcomes for households

Cyclone Idai and Food Insecurity

- Q4. How was Cyclone Idai different from those previous disasters?
- Q5. Kindly explain how Cyclone Idai has impacted the household factors mentioned and food insecurity (refer to Question 1)
    - Post-disaster household characteristics
    - Post-disaster household food environment characteristics
    - Were there households that were not impacted? If so, why?
- Q6. Kindly tell me about the adaptation responses (e.g., food aid assistance) your community put in place to address food insecurity after Cyclone Idai.
    - Food aid
    - Borrowing and lending food?
    - Friends and family assistance?
    - Provision of water, cooking spaces or equipment?
    - Rebuilding of kitchens?
    - Food for jobs?
    - Others
- Q7. What were the outcomes of those adaptation responses?
    - Did they go right or wrong, increase resilience or vulnerability?
- Q8. What was your role as a community leader in assisting the community and households after Cyclone Idai regarding food insecurity?
    - What was done in households?
    - What about liaison with macro level-Local Gov't and NGOs?
- Q9. Kindly explain what determines the type of support for food security received by households in the community.
    - Household reaching out asking for assistance.
    - Household characteristics?
    - Household food environment characteristics?
    - Social level influence?
    - Spatial demarcations-rural/urban?
    - State of communities impacted by disasters.
    - Macro level influence.
- Q10. What are some of the barriers and opportunities to households in receiving support?
    - Barriers
    - Opportunities
- Q11. What do you think about the support received towards food security?
    - Was it adequate?
    - Did the most vulnerable households receive it?
    - Was it easy to access aid?
    - Was it culturally acceptable?
    - Was it available for the length of time required – weeks/months?

How are household factors and adaptations related to food insecurity after Cyclone Idai?

- Q12. What factors contributed to reduced food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid) [Refer to features highlighted in Question 1]?
- Q13. What factors contributed to increased food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid)? [Refer to features highlighted in Question 1]?
- Q14. What do you think should be considered in determining households that are the most vulnerable to food insecurity?
    - Before disasters
    - During the disaster
    - After Disasters

Pre-preparedness for Future Events

- Q15. How can households build resilience in addressing in addressing pre and post disaster food insecurity?
- Q16. What modifications would you recommend for addressing food insecurity in a disaster-prone area?
    - As part of on-going pre-disaster preparedness/
    - Post disaster food insecurity management?
    - Is there anything that is missing? If so, what?

Conclusion (allow 10 minutes for wrap up)

- Ask if there is anything that the respondent would like to add that was not covered in the interview so far.
- Thank the respondent for their time and discuss the approximate timeline for:
    - Receiving any notes or transcripts from the interview
    - The publication of the final report
- Ask if the respondent has any remaining questions about the study or the interview process.

Focus Group Discussion– Household Heads

Region: .....Province: .....Category: Men/Women……
Number of Participants…… Start Time: ……End Time: ……
Date: …….

Room Setup

- Arrange the chairs in a semi-circle and place the voice recorder equidistant from all participants
- Test the voice recorder from different areas of the room and at different volumes

Introduction (allow 10 minutes for introductions)

- Introduce yourself and the Graduate Research Assistant
- Introduce the Sustainable Development Goals and addressing SDG 2-reducing food insecurity
- Review the overall study research objective
- Review the topic, structure and duration of the interview
- Provide a copy of the informed consent form and allow the respondents time to read and ask questions about the form before signing.
- Ask if the respondent has any further questions before beginning the interview.

Questions and Probes for Focus Group Discussions with Household heads

Introductory questions

- Q1. Kindly tell me about food insecurity among households in Beira Mozambique and the factors associated with it
    - Increasing, decreasing, how is it manifested?
        - Food availability (when required, food sources, food contribution to health, access to health care), Access, Utilization, Stability.
    - Household food environment characteristics
        - Accessibility--access to food sources, time spent and distance obtaining food
        - Affordability--money to buy food, jobs providing money
        - Convenience --cooking spaces, appliances, water and fuel to cook.
        - Desirability--are foods culturally and socially acceptable?
    - Household vulnerability--HH size, income, gender, age
    - Underlying social, cultural, environmental, historical, political factors?
- Q2. Tell me about your previous experiences with Cyclones and food insecurity.
    - What preparations did you put in place to address food insecurity prior to the cyclone?
    - What was the outcome of those preparations?
    - What adaptations did households in your community usually implement to address food insecurity after the Cyclone?
        - Hazardous work?

- Reducing consumed food?
- Sale of Assets
- Borrowing?
- Requesting assistance from government or NGOs?
- Requesting assistance from friends, family and community assistance?
- Others?

Cyclone Idai and Food Insecurity

- Q3. How was Cyclone Idai different from those previous disasters?
- Q4. Kindly explain how Cyclone Idai has impacted the household factors mentioned and food insecurity (refer to Question 1)
    - Post-disaster household characteristics
    - Post-disaster household food environment characteristics
    - Underlying factors
    - Were there households that were not impacted? If so, why?
- Q5. Kindly tell me about the adaptation measures addressing food insecurity after Cyclone Idai.
    - Hazardous work?
    - Reducing consumed food?
    - Sale of Assets
    - Borrowing?
    - Receiving assistance from government or NGOs?
    - Receiving assistance from friends, family and community assistance?
    - Others?
- Q6. Why these specific adaptations? / What factors determined the support received for food insecurity after Cyclone Idai.
    - Household reaching out asking for assistance.
    - Household characteristics?
    - Household food environment characteristics?
    - Household level adaptations?
    - Social level influence?
    - Spatial demarcations-rural/urban?
    - Severity of disaster impact on households?
    - Relationship with governmental and non-governmental organization staff
    - Others?
- Q7. What do you think about the support received towards food security?
    - Was it adequate?
    - Did the most vulnerable households receive it?
    - What were the processes involved in accessing aid?
    - What do you think about the aid received – culturally, quality, acceptability?
    - How long was it available for the length of time required – weeks/months?
- Q8. What are some of the barriers and opportunities to households in receiving support/ adaptations?
    - Organizational- lack of knowledge and means of communication to get support?

- Spatial- living far from support, roads damaged by Cyclone?
- Household- characteristics, displacement?
- Communities- lack of logistics?
- Others?

How are household factors and adaptations related to food insecurity after Cyclone Idai?

- Q9. What factors contributed to reduced food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid) [Refer to features highlighted in Question 1]?
- Q10. What factors contributed to increased food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid)? [Refer to features highlighted in Question 1]?

Pre-preparedness for Future Events

- Q11. What are the most important factors to you in addressing household food insecurity?
  - Aid from governmental and non-governmental organizations
  - Support from community and other households
  - Post-disaster and pre-disaster
  - Household characteristics—e.g., improved incomes, access to health
  - Food environment improvement—accessibility, affordability, convenience, and desirability
  - Others?
- Q12. What modifications would you recommend for addressing household food insecurity in a disaster-prone area?
  - As part of on-going pre-disaster preparedness
  - Post disaster food insecurity management?
  - Is there anything that is missing? If so, what?

Conclusion (allow 10 minutes for wrap up)

- Ask if there is anything that the respondent would like to add that was not covered in the interview so far.
- Thank the respondent for their time and discuss the approximate timeline for:
  - Receiving any notes or transcripts from the interview
  - The publication of the final report
- Ask if the respondent has any remaining questions about the study or the interview process

APPENDIX B: QUALITATIVE DATA COLLECTION TOOLS – Focus Group Discussions

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

Focus Group Discussions - Community Members

Region: .....Province: .....Category: Men/Women……
Number of Participants…… Start Time: ……End Time: ……
Date: …….

Room Setup

- Arrange the chairs in a semi-circle and place the voice recorder equidistant from all participants
- Test the voice recorder from different areas of the room and at different volumes

Introduction (allow 10 minutes for introductions)

- Introduce yourself and the Graduate Research Assistant
- Introduce the Sustainable Development Goals and addressing SDG 2-reducing food insecurity
- Review the overall study research objective
- Review the topic, structure and duration of the interview
- Remind everyone that there are no right or wrong answers and that the research team is interested in the group's opinions.
- Provide a copy of the informed consent form and allow the respondent time to read and ask questions about the form before signing.
- Ask if the respondent has any further questions before beginning the interview.

Questions and Probes for Focus Group Discussions

Introductory questions

Household Factors Associated with Food Insecurity Before Cyclone Idai

- Q1. Kindly tell me about food insecurity among households in Beira Mozambique and the factors associated with it
    - Increasing, decreasing, how is it manifested?
        - Food availability (when required, food sources, food contribution to health, access to health care)
    - Household food environment characteristics
        - Accessibility--access to food, time spent and distance obtaining food
        - Affordability--money to buy food, jobs providing money
        - Convenience-cooking spaces, appliances, water and fuel to cook.
        - Desirability--are foods culturally and socially acceptable?

- Household vulnerability--HH size, income, gender, age
- Others?

- Q2. Tell me about your previous experiences with Cyclones and food insecurity.
  - What preparations did you put in place to address food insecurity prior to the cyclone?
  - What was the outcome of those preparations?
  - What adaptations did households in your community usually implement to address food insecurity after the Cyclone?
    - Hazardous work?
    - Reducing consumed food?
    - Sale of Assets
    - Borrowing?
    - Requesting assistance from government or NGOs?
    - Requesting assistance from friends, family and community assistance?
    - Others?

Cyclone Idai and Food Insecurity

- Q3. How was Cyclone Idai different from those previous disasters?
- Q4. Kindly explain how Cyclone Idai has impacted the household factors mentioned and food insecurity (refer to Question 1)
  - Post-disaster household characteristics
  - Post-disaster household food environment characteristics
  - Were there households that were not impacted? If so, why?
- Q5. Kindly tell me about the adaptation measures addressing food insecurity after Cyclone Idai.
  - Hazardous work?
  - Reducing consumed food?
  - Sale of Assets
  - Borrowing?
  - Receiving assistance from government or NGOs?
  - Receiving assistance from friends, family and community assistance?
  - Others?
- Q6. Why these specific adaptations? / What factors determined the support received for food insecurity after Cyclone Idai.
  - Household reaching out asking for assistance.
  - Household characteristics?
  - Household food environment characteristics?
  - Household level adaptations?
  - Social level influence?
  - Spatial demarcations-rural/urban?
  - Severity of disaster impact on households?
  - Relationship with governmental and non-governmental organization staff
  - Others?
- Q7. What do you think about the support received towards food security?

    - Was it adequate?
    - Did the most vulnerable households receive it?
    - What were the processes involved in accessing aid?
    - What do you think about the aid received – culturally, quality, acceptability?
    - How long was it available for the length of time required – weeks/months?
- Q8. What are some of the barriers and opportunities to households in receiving support/ adaptations?
    - Organizational- lack of knowledge and means of communication to get support?
    - Spatial- living far from support, roads damaged by Cyclone?
    - Household- characteristics, displacement?
    - Communities- lack of logistics?
    - Others?

How are household factors and adaptations related to food insecurity after Cyclone Idai?

- Q9. What factors contributed to reduced food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid) [Refer to features highlighted in Question 1]?
- Q10. What factors contributed to increased food insecurity after Cyclone Idai considering household factors (characteristics and food environment) and adaptations (e.g., food aid)? [Refer to features highlighted in Question 1]?

Pre-preparedness for Future Events

- Q11. What are the most important factors to you in addressing household food insecurity?
    - Aid from governmental and non-governmental organizations
    - Support from community and other households
    - Post-disaster and pre-disaster
    - Household characteristics—e.g., improved incomes, access to health
    - Food environment improvement—accessibility, affordability, convenience, and desirability
    - Others?
- Q12. What modifications would you recommend for addressing household food insecurity in a disaster-prone area?
    - As part of on-going pre-disaster preparedness
    - Post disaster food insecurity management?
    - Is there anything that is missing? If so, what?

Conclusion (allow 10 minutes for wrap up)

- Ask if there is anything that the respondent would like to add that was not covered in the interview so far.
- Thank the respondent for their time and discuss the approximate timeline for:
    - Receiving any notes or transcripts from the interview
    - The publication of the final report
- Ask if the respondent has any remaining questions about the study or the interview process

Paraverbal Guides

- Keep an open and engaged posture while maintaining appropriate eye contact
- Allow pauses so that the respondents have time to formulate their answers
- Maintain constant positive regard and be aware of your nonverbal responses to answers
- Speak sparingly and use prompts to focus the attention of the respondents
- If you notice the respondents going on a tangent off-topic, redirect the conversation to the interview focus using prompts or questions
- Watch for anyone dominating the discussion and redirect the discussion if needed
- Watch for anyone who is not engaged in the discussion and incorporate them in the discussion
- Delegate note-taking responsibilities to the individual who is not facilitating the focus group
- Be cognizant of the time and be sure to not go over the promised timeline

APPENDIX C: QUALITATIVE DATA COLLECTION TOOLS – Consent Forms

Informed Consent Form - In-depth Interview
Expert Interviews - Humanitarian Organizations & Community Leaders

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

General Information about Research

The effect of climate change is impacting the ability of countries to achieve the United Nations Sustainable Development Goals (SDGs) including Goal 2 on reducing food insecurity among vulnerable groups. This is evident particularly in Sub-Saharan African cities due to the frequency of climate change triggered extreme weather events and cities in Mozambique are not exempt. This study seeks to assess household food insecurity after Cyclone Idai in Beira, Mozambique based on household factors and adaptations. The study will support addressing urban household food insecurity by improving targeting of vulnerable households in a disaster-prone area. This study is being conducted by Dr. Cameron McCordic (the Principal Investigator) at the University of Waterloo in Canada in collaboration with Dr. Ines Raimundo at the Eduardo Mondlane University in Mozambique. This research project is being funded by the Social Sciences and Humanities Research Council of Canada and Employment and Social Development Canada.

The purpose of the study is to answer the following question:

1. What are the household characteristics, food environment characteristics and adaptations that influenced household food insecurity after Cyclone Idai in Beira Mozambique?

Procedures

The study will be conducted mainly among households and communities impacted by Cyclone Idai and the humanitarian organizations involved in addressing food insecurity. If you are eligible and willing to participate, this face-to-face in-depth interview will last between 30 to 60 minutes. We would like to hear your views about factors influencing household food insecurity and your experience of adaptation measures to address it after Cyclone Idai in Beira. A voice recorder will be used during this interview and the interview recording will be summarized in notes or transcribed. This voice recorder is necessary so that I can ensure that I have accurately heard your responses. All notes and transcriptions from this interview will be shared with you for you to review and modify/clarify. Unless you choose to be identified by direct quotation or anonymous quotation in this interview, your contributions to this study will only be noted in aggregate form in any reports derived from this interview (no information will be directly associated with your name in any report or paper derived from this study). For translation purposes, an anonymous version of your interview transcript may be shared via an encrypted file transfer with Dr. Ines Raimundo Eduardo Mondlane University to verify any translation of your responses (the interview transcript will not be linked to you when shared for translation verification). With your consent, the report or paper may note that you were consulted in the process of the study. All completed interviews will be stored on a secure, password-protected, and encrypted hard drive. All data will be retained for at least six years. Your decision to participate will not in any way affect your current or future participation in activities with the

University of Waterloo. To withdraw from the study, please contact Naomi Sunu at the University of Waterloo (nsunu@uwaterloo.ca) to request withdrawal from the study. Please note that you may only withdraw from the study before the publication of the final report (to be published on December 1, 2022).

Benefits/Risks of the study

Please note that you will not be remunerated for your participation in this study and your participation in this interview is voluntary. However, the information provided will help understand urban household food insecurity prevalence and the barriers and facilitators involved thus informing reducing household vulnerability to future disasters. You may feel stress at the recollection of stressful events. You are permitted to skip any questions that you are not comfortable answering. You may also stop the interview at any time and/or withdraw from the entire study. If you decide to withdraw from the study, all notes, transcripts and recordings of your interview will be permanently deleted.

Anonymity and Confidentiality

Given that this interview may be transmitted over the internet, privacy of information transmitted over the internet cannot be guaranteed. There is always a risk your responses may be intercepted by a third party (e.g., government agencies, hackers). Please note that the University of Waterloo researchers will not collect or use internet protocol (IP) addresses or other information which could link your participation to your computer or electronic device without first informing you.

Contact for Additional Information

If you would like further information on this study, please contact Naomi Sunu at the University of Waterloo (nsunu@uwaterloo.ca). This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #43049). If you have questions for the Board, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I acknowledge that I have read and understood the information and consent form and have received a copy to keep for future use.

☐ Agree ☐ Disagree

I understand the purpose of this interview and I agree to participate.

☐ Agree ☐ Disagree

I agree to the use of direct quotations based on the information collected in this interview (your name and title will be attached to the quotation).

□ Agree □ Disagree

I agree to the use of anonymous quotations based on the information collected in this interview. (your name and title will not be attached to the quotation. The quote will be attributed to "participant").

□ Agree □ Disagree

I consent to being identified as a participant in this study.

□ Agree □ Disagree

By signing this consent form, I agree of my own free will to participate in the study.

Name (please print): _____

Signature: _____ Date: _____

Informed Consent Form - Focus Group Discussion
Household Heads

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

General Information about Research

The effect of climate change is impacting the ability of countries to achieve the United Nations Sustainable Development Goals (SDGs) including Goal 2 on reducing food insecurity among vulnerable groups. This is evident particularly in Sub-Saharan African cities due to the frequency of climate change triggered extreme weather events and cities in Mozambique are not exempt. This study seeks to assess household food insecurity after Cyclone Idai in Beira, Mozambique based on household factors and adaptations. The study will support addressing urban household food insecurity by improving targeting of vulnerable households in a disaster-prone area. This study is being conducted by Dr. Cameron McCordic (the Principal Investigator) at the University of Waterloo in Canada in collaboration with Dr. Ines Raimundo at the Eduardo Mondlane University in Mozambique. This research project is being funded by the Social Sciences and Humanities Research Council of Canada and Employment and Social Development Canada.

The purpose of the study is to answer the following question:

1. What are the household characteristics, food environment characteristics and adaptations that influenced household food insecurity after Cyclone Idai in Beira Mozambique?

Procedures

The study will be conducted mainly among households and communities impacted by Cyclone Idai and the humanitarian organizations involved in addressing food insecurity. If you are eligible and willing to participate, this focus group will last between 30 to 60 minutes. We would like to hear your views about factors influencing household food insecurity and your experience of adaptation measures to address it after Cyclone Idai in Beira. A voice recorder will be used during this focus group and the focus group recording will be summarized in notes or transcribed. This voice recorder is necessary so that I can ensure that I have accurately heard your responses. All notes and transcriptions from this focus group will be shared with you for you to review and modify/clarify. Unless you choose to be identified by direct quotation or anonymous quotation in this focus group, your contributions to this study will only be noted in aggregate form in any reports derived from this focus group (no information will be directly associated with your name in any report or paper derived from this study). For translation purposes, an anonymous version of your interview transcript may be shared via an encrypted file transfer with Dr. Ines Raimundo Eduardo Mondlane University to verify any translation of your responses (the interview transcript will not be linked to you when shared for translation verification). With your consent, the report or paper may note that you were consulted in the process of the study. All completed focus groups will be stored on a secure, password-protected, and encrypted hard drive. All data will be retained for at least six years. Your decision to participate will not in any way affect your current or future participation in activities with the University of Waterloo. To withdraw from the study, please contact Naomi Sunu at the

University of Waterloo (nsunu@uwaterloo.ca) to request withdrawal from the study. Please note that you may only withdraw from the study before the publication of the final report (to be published on Dec 1, 2022).

Benefits/Risks of the study

Please note that you will not be remunerated for your participation in this study and your participation in this focus group is voluntary. However, the information provided will help understand urban household food insecurity prevalence and the barriers and facilitators involved thus informing reducing household vulnerability to future disasters. You may feel stress at the recollection of stressful events. You are permitted to skip any questions that you are not comfortable answering. You may also stop the focus group at any time and/or withdraw from the entire study. If you decide to withdraw from the study, all notes, transcripts and recordings of your focus group will be permanently deleted.

Anonymity and Confidentiality

Unless you choose to be identified by direct quotation or anonymous quotation in this focus group, your contributions to this study will only be noted in aggregate form in any reports derived from this focus group (no information will be directly associated with your name in any report or paper derived from this study). With your consent, the report or paper may note that you were consulted in the process of the study. Given that this discussion is occurring in a focus group setting, please note that we cannot guarantee the anonymity of your contributions amongst the focus group participants. The researchers will ask focus group participants to keep what was said during the focus group confidential but cannot guarantee that this will be done.

Contact for Additional Information

If you would like further information on this study, please contact Naomi Sunu at the University of Waterloo (nsunu@uwaterloo.ca).

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #43049). If you have questions for the Board contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I acknowledge that I have read and understood the information and consent form and have received a copy to keep for future use.

☐ Agree ☐ Disagree

I understand the purpose of this focus group and I agree to participate.

☐ Agree ☐ Disagree

I agree to the use of direct quotations based on the information collected in this focus group (your name and title will be attached to the quotation).

□ Agree □ Disagree

I agree to the use of anonymous quotations based on the information collected in this focus group. (your name and title will not be attached to the quotation. The quote will be attributed to "participant").

□ Agree □ Disagree

I consent to being identified as a participant in this study.

□ Agree □ Disagree

By signing this consent form, I agree of my own free will to participate in the study.

Name (please print): _____

Signature: _____ Date: _____

APPENDIX D: QUALITATIVE DATA COLLECTION TOOLS – Invitation Letters

Letter of Invitation for In-Depth Interviews - Disaster Management Organizations

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

Greetings!

My name is Naomi E. Sunu. I am a PhD candidate in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Canada. I am contacting you on behalf of Dr Cameron McCordic, an Assistant Professor in SEED and also the Principal Investigator of a study titled "The Sustainable Development Goals under a Changing Climate: Understanding the SDG-Relevant Urban Impacts of and Adaptations to Cyclone Idai". As part of the main study, the current study focuses on the impacts of Cyclone Idai on household food insecurity, related sustainable development goal 2. The Co-investigators of the research project include Dr. Brent Doberstein (Associate Professor, University of Waterloo, Geography and Environmental Management) and Dr Ines Raimundo (Professor, Center for Policy Analysis at Eduardo Mondlane University, Maputo, Mozambique).

Being the Director for the municipal local government in the (Sofala) Province and in charge of food security, I would like to invite you to a 30-60min interview on the impacts of Cyclone Idai on household food insecurity in Beira, Mozambique. The interview will be focused on understanding the household characteristics, food environment and adaptations influencing the differences in food insecurity experienced by urban households after the cyclone. The study will support efforts towards targeting and addressing food insecurity among vulnerable households in a disaster-prone urban area.

The interviews will either be facilitated by myself and members of the research team in Maputo, Mozambique. The exact date of the interview will be based on your availability, but we hope to conduct interviews in August 2022.

If you are willing to participate in these interviews, kindly reach out to contact me by email (nsunu@uwaterloo.ca) to discuss your availability as well as any questions or comments you may have. This research has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board.

Best Regards!

Naomi E. Sunu

Letter of Invitation for In-Depth Interviews – Community Leaders

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

Greetings!

My name is Naomi E. Sunu. I am a PhD candidate in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Canada. I am contacting you on behalf of Dr Cameron McCordic, an Assistant Professor in SEED and also the Principal Investigator of a study titled "The Sustainable Development Goals under a Changing Climate: Understanding the SDG-Relevant Urban Impacts of and Adaptations to Cyclone Idai". As part of the main study, the current study focuses on the impacts of Cyclone Idai on household food insecurity, related sustainable development goal 2. The Co-investigators of the research project include Dr. Brent Doberstein (Associate Professor, University of Waterloo, Geography and Environmental Management) and Dr Ines Raimundo (Professor, Center for Policy Analysis at Eduardo Mondlane University, Maputo, Mozambique).

Being a leader within this community in Beira City affected by Cyclone Idai, I would like to invite you to a 30-60min interview on the impacts of Cyclone Idai on household food insecurity in Beira, Mozambique. The interview will be focused on understanding the household characteristics, food environment and adaptations influencing the differences in food insecurity experienced by urban households after the cyclone. The study will support efforts towards targeting and addressing food insecurity among vulnerable households in a disaster-prone urban area.

The interviews will either be facilitated by me and members of the research team in Maputo, Mozambique. The exact date of the interview will be based on your availability, but we hope to conduct interviews in August 2022.

If you are willing to participate in these interviews, kindly reach out to contact me by email (nsunu@uwaterloo.ca) to discuss your availability as well as any questions or comments you may have. This research has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board.

Best Regards!

Naomi E. Sunu

Letter of Invitation for Focus Group Discussions – Household heads in Community

Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique

Greetings!

My name is Naomi E. Sunu. I am a PhD candidate in the School of Environment, Enterprise and Development (SEED) at the University of Waterloo in Canada. I am contacting you on behalf of Dr Cameron McCordic, an Assistant Professor in SEED and also the Principal Investigator of a study titled "The Sustainable Development Goals under a Changing Climate: Understanding the SDG-Relevant Urban Impacts of and Adaptations to Cyclone Idai". As part of the main study, the current study focuses on the impacts of Cyclone Idai on household food insecurity, related sustainable development goal 2. The Co-investigators of the research project include Dr. Brent Doberstein (Associate Professor, University of Waterloo, Geography and Environmental Management) and Dr Ines Raimundo (Professor, Center for Policy Analysis at Eduardo Mondlane University, Maputo, Mozambique).

Being a household head in this community impacted by Cyclone Idai in the city of Beira, I would like to invite you to a 30-60min focus group on the impacts of Cyclone Idai on household food insecurity in Beira, Mozambique. The focus group discussion will be focused on understanding the household characteristics, food environment and adaptations influencing the differences in food insecurity experienced by urban households after the cyclone. The study will support efforts towards targeting and addressing food insecurity among vulnerable households in a disaster-prone urban area.

The in-person focus groups will be facilitated by myself and members of the research team in Maputo, Mozambique. The exact date of the focus group will be based on your availability, but we hope to conduct focus groups in August 2022.

If you are willing to participate in these focus groups, kindly reach out to contact me by email (nsunu@uwaterloo.ca) to discuss your availability as well as any questions or comments you may have. This research has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board.

Best Regards!

Naomi E. Sunu

Appreciation Letter for the Study

Greetings!

I would like to thank you for your participation in the study titled "Household Food Insecurity Vulnerability Post Cyclone Idai: Household, Food Environment and Adaptation Factors in Beira Mozambique". This study focused on understanding the impacts of Cyclone Idai on household food insecurity, related sustainable development goal 2. The study will support efforts towards targeting and addressing food insecurity among vulnerable households in a disaster-prone urban area.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board (REB #43049). If you have questions for the Board, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca. For all other questions, please feel free to reach out to contact me by email (nsunu@uwaterloo.ca).

Your identity will be confidential. Once all the data is collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please provide your email address, and when the study is completed, anticipated by ***Dec 1, 2022,*** I will send you the information. To withdraw from the study, please contact Naomi Sunu at the University of Waterloo (nsunu@uwaterloo.ca) to request withdrawal from the study. Please note that you may only withdraw from the study before the publication of the final report (to be published on December 1, 2022). In the meantime, if you have any questions about the study, please do not hesitate to contact me by email as noted below.

Best Regards!

Naomi E. Sunu, PhD Candidate

School of Environment, Enterprise, and Development

University of Waterloo

nsunu@uwaterloo.ca

APPENDIX E: STATISTICAL TEST DISCUSSIONS FOR THE QUANTITATIVE ANALYSIS

Skewness and Kurtosis Tests

For further description, summary statistics on the means and standard deviation of the pre-and-post-Cyclone Idai HFIAS scores are provided (table 4.2). The pre-Cyclone HFIAS scores had mean=13.25 and standard deviation (SD)=8.29, whilst the post-Cyclone HFIAS scores mean increased to 17.33 and SD=7.67. The standard deviation values of both the pre-and-post-HFIAS scores had high variabilities from the mean. In other words, the HFIAS score values were widely spread out, and suggested deviations from normally distributed data, which had to be investigated. Normally distributed data conditions must be satisfied for parametric analysis, whilst non-parametric analysis is useful for data that deviate from normality.

For the assessment of normal distribution, hypothesis tests for skewness and kurtosis were conducted to determine how the data aligns with normal distribution assumptions (Sheskin, 2011). Skewness and kurtosis measures assess the height and spread of data, to determine normal distribution. Additionally, these tests were conducted to avoid commonly cited statistical errors such as the violation of data distribution or the assumption of normal distribution for skewed data, resulting in wrong statistical analyses (Olsen, 2003). The Pearsonian coefficient of skewness test, which assesses the asymmetry in a distribution was used. This test shows values ranging between +3 and -3, where the value '0' implies that the data is symmetrical and values between -0.5 and 0.5 indicate that data is approximately symmetric. Additionally, kurtosis describes the shape of a distribution's tails, relative to its overall shape. Using the same test, a kurtosis of less than 3 shows a low peak and a distribution that is spread further from the mean (Sheskin, 2011).

Wilcoxon signed-rank Test

The Wilcoxon signed-rank hypothesis test is used to compare the median values of two related or paired samples, to determine whether there is a significant difference between them based on the variable of interest and ranks the differences between each subject's score and the hypothesized median population value (Sheskin, 2011). However, the presence of ties in the results can reduce the precision of the test as ties can occur in the results, due to the same value being recorded for many respondents, which applies to the HFIAS score being used. When there are tied scores in the data, tie correction is applied by assigning the averages in the ranks involved to all difference scores, which are tied for a given rank (Sheskin, 2011). As such, the Wilcoxon signed-rank test with the adjustment for 'ties' corrected such limitations and provided more robust results.

The assumptions underlying the Wilcoxon signed-rank test are that the sample should be randomly selected from the population, and data should be continuous and should not be normally distributed (Sheskin, 2011). These assumptions were satisfied for the HFIAS scores.

Kendall's tau-b

Kendall's tau-b test was used to test for the association between pre-Cyclone Idai HFIAS scores and post-Cyclone Idai HFIAS Scores. For distributions that are not normal, have extreme values, outliers or many ties, (e.g., the pre-and-post-HFIAS scores), the correlations coefficients should be calculated from the ranks. Kendall's tau-b correlation coefficient was designed for this purpose. This correlation coefficient is a non-parametric measure of the strength and direction of relationship between two variables measured on an ordinal scale. Kendall's tau-b outcomes range from -1 to +1, where -1 shows a perfect negative association, 0 shows no association and +1 shows a perfect positive association (Akoglu, 2018).

The Kruskal Wallis H test

The Kruskal-Wallis H test is a rank based non-parametric test used to determine if the differences between the medians of two or more groups of an independent variable are statistically significant (Sheskin, 2020) The Kruskal-Wallis H test is based on assumptions that the sample was randomly selected from the population, the k-samples are independent, and the dependent variable data is continuous, which applies to the study's dataset. After the Kruskal-Wallis H test is run, outcomes that are statistically significant indicate that there is a significant difference between at least two sample medians of the independent variables (Sheskin, 2020).

APPENDIX F: PHOTOS FROM FIELDWORK

1. A farm in the displaced and non-resettlement community

2. 2 Pictures of Houses from the Resettlement and Displaced Community

3. 2 Pictures of Houses from the Non-Resettlement and Displaced Community

4. Pictures of Water sources accessed by the two displaced communities of the study

Picture of the Well used by Resettlement and Displaced community-2- some kilometers away from the community

Picture of a Well in Non-Resettlement and Displaced Community-3

5. Pictures of types of cooking fuel used in resettlement and displaced community

Pictures of fuel wood (left) and charcoal business (right), from Resettlement and Displaced community-2

6. A household charging their solar lamp (resettlement and displaced community)

7. Signpost for the resettlement and displaced community in Beira