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The Role of Small-scale Inland Capture Fisheries for Food Security in Lake Chilwa

by

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ABSTRACT

Inland capture fisheries are an important source of food, nutrition, employment and income for millions of people globally, but primarily in developing countries. In Africa, where inland fisheries constitute the major supply of fish in some countries, there are regional variations in production. For example, East Africa has the highest production levels of fish, yet some countries, such as Malawi, experience one of the lowest per capita fish production level. Fish contributes to food security and nutrition through two main pathways. Fish can act as a cash crop generating income, which can increase purchasing power for other food items. In addition, fish directly consumed can improve food and nutritional security. Understanding the role and value of small-scale capture fisheries to livelihood and food security is a key challenge in conserving fisheries resources and livelihoods. This is particularly true for small-scale inland capture fisheries, which are one of the most under-reported and under-valued fisheries sectors. Evidence highlights the lack of understanding of the pathways by which fisheries contribute to food security, particularly by men and women along the value chain. In addition, the effects of climate change on local food security is poorly understood. Shallow lakes, such as Lake Chilwa in Malawi, have been shown to be sensitive to climate change where experiences of water level fluctuation are common. The aim of this thesis is to investigate the contribution of small-scale capture fisheries to food security, using the case study of Lake Chilwa, Malawi. To investigate the temporal stability of fish availability and the contributions of fisher livelihoods to income and food, the thesis employs the Sustainable Livelihoods Approach and the four pillars of food security. The study finds evidence that Lake Chilwa's fishery is influenced by the environment. Fish producing households consumed more fish and more diverse and nutritious diets, and had higher overall levels of food security compared to non-fishing households, which was achieved through direct and indirect pathways. The study contributes to the call for local level assessments of the impact of climate variability on inland small-scale fisheries and their value to food and nutritional security in rural communities. The findings are important for promoting effective fisheries management, climate adaptation and poverty alleviation development.

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Abbreviations

ATTZ	Aquatic-Terrestrial Transition Zone
BVC	Beach Village Committees
CGIAR	Consultative Group for International Agricultural Research
DFID	UK Department for International Development
FAO	Food and Agriculture Organization of the United Nations
FCS	Food Consumption Score
FCGs	Food Consumption Groups
FGD	Focus Group Discussion
FPC	Flood Pulse Concept
HLPE	High Level Panel of Experts
HIV/AIDS	Human immunodeficiency virus infection and acquired immune deficiency syndrome
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
HHS	Household Survey
LEAD SEA	Leadership for Environment and Development, Southern and Eastern Africa
LIFDCs	Low-Income Food-Deficit Countries
MEI	Morpho-Edaphic Index
MKW	Malawian Kwacha
NGO	Non-Governmental Organisations
PCA	Principal Components Analysis

Abbreviations

PRA	Participatory Rural Appraisal
RVI	Rainfall Variability index
RLLF	Relative Lake Level Fluctuation
rCSI	Reduced Coping Strategy Index
SDG	Sustainable Development Goals
SPI	Standardized Precipitation Index
SSA	Sub-Saharan Africa
SLF	Sustainable Livelihoods Framework
SSF	Small-scale Fisheries
STARS	Sequential T-Test Analysis for Regime Shifts
SPSS	Statistical Package for the Social Sciences
UN	United Nations
WFP	World Food Programme

Academic Thesis: Declaration of Authorship

I, Fiona Simmance

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. **This work was done wholly or mainly while in candidature for a research degree at this University;**
2. **Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;**
3. **Where I have consulted the published work of others, this is always clearly attributed;**
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6. **Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;**
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Signed:

Date: 01 / 09 / 17

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Zikomo Kwanbiri.

Chapter 1 Introduction

1.1 Introduction

Inland (freshwater) fisheries are typically characterised as complex socio-ecological systems (Barange and Perry, 2009). These fisheries are often informal, multi-gear, multi-species, dispersive and remote. This complexity has led to difficulty in monitoring and evaluating the systems (FAO, 2014; Bartley et al, 2015). Data concerning inland fisheries consumption, harvest and production are generally inadequate and incomplete, leading to neglect and an undervaluing of the importance of the sector within decision making processes (HLPE, 2014; Lynch et al, 2016). As a result, this sub-sector has been defined by Bartley et al (2015) as the most underreported and undervalued fisheries sector with concerns for its future management.

Inland capture fisheries are an important sector contributing towards global food security (HLPE, 2014). Emerging literature points to the important role of inland capture fisheries in providing a source of food, nutrition, employment and income for millions of people world-wide, particularly in developing countries (So-Jung et al, 2014; Béné et al, 2015; Lynch et al, 2016).

Global inland capture fisheries production has grown steadily to over 11.9 million tonnes in 2014, with the majority of the catches from developing countries (FAO, 2016). However, based on production information reported to the FAO, significant regional variations in production of inland capture fisheries exist and some countries are experiencing declines in production (FAO, 2016). The largest production of inland capture fisheries is from Africa and Asia; with East African countries such as Malawi experiencing some of the greatest variation in production and a decline in supply of fish per capita (FAO, 2016). The geographical distribution of inland capture fisheries production is also significant in the food and nutritional security discussion. Seventy-one Low-Income Food-Deficit Countries produce 80% of the reported global inland capture fisheries output and several countries are highly dependent upon inland fisheries as their main supply of fish, such as land-locked countries (FAO, 2012). In these regions inland fisheries can contribute an important source of animal protein intake and micronutrients, and provide employment that can help secure livelihoods (So-Jung et al, 2014; FAO, 2014). Consequently, inland fisheries contribute directly and indirectly to food and nutritional security and can have wealth generation benefits for much of the developing world (HLPE, 2014; So-Jung et al, 2014; Béné et al, 2015).

At the same time, inland fisheries are under significant threat by anthropogenic and non-anthropogenic stressors (Vörösmarty et al, 2010; Barange and Perry, 2009). Inland fish biodiversity is threatened by a diverse set of stressors rendering inland fishes one of the most endangered groups of species in the world (Dudgeon et al, 2006). Several reports have highlighted concern about the potential impact of climate variability and change on inland fisheries (Barange and Perry, 2009; Allison et al, 2006). Shallow lake systems are sensitive to climate variation and as a result inland fisheries in these systems experience fluctuation (Welcomme et al, 2010; Jul-Larsen et al, 2003). Unravelling the extent of climate impacts on inland ecosystems and livelihoods is very complex as livelihoods are often intertwined with other sectors (Allison et al, 2006; Welcomme et al, 2010; FAO, 2012). IFAD (2011) predicts that more people are likely to turn to fishing and extraction from other common pool resources in the future as a result of climate change impacts on agriculture. Allison et al (2009) reviewed countries with inland fisheries and listed twenty that were most vulnerable to climate change. Of those identified, over half were in Africa with one quarter located in East Southern Africa (Allison et al, 2009). A combination of high dependence on fish for protein in diets, limited alternative sources of food and employment and small weak economies increases the vulnerability of livelihoods in Africa to climate change (Allison et al, 2009; IFAD, 2011).

A large body of literature is emerging which argues for supporting capture fisheries as a vital part of the global debate on food and nutritional security. A compelling evidence-based case is made by HLPE, (2014) and Béné et al (2015) emphasising the contribution of fish to all four pillars of food security: availability, accessibility, sustainability and nutrition, via complex direct and indirect pathways. Yet significant gaps in knowledge exist in understanding the links between inland capture fisheries and food security. For example, Béné et al (2016) identified gaps in relation to understanding the role of capture fisheries to food security which included a lack of national and local level data, socio-economic analyses, research on the role to nutrition, and understanding local level impacts of change. The multiple pathways through which capture fisheries contribute to livelihoods, food and nutritional security are complex and remain unclear. Further, the majority of studies to date have been carried out in Asia and far less is known about the complex role of capture fisheries for livelihoods and food security in other developing regions such as Africa (Béné and Neiland, 2003; Kawarazuka, 2010). As outlined in **Chapters 4 to 7**, the thesis aims to address some of these gaps and provide an insight into the characteristics of fish-related livelihoods, impacts of climate variability, benefits obtained and the linkages to food security.

Greater recognition of the value of inland capture fisheries is required to improve management of the sector at the national and local decision making levels (Béné and Neiland, 2003; Bartley et al, 2015; Lynch et al, 2016). The complex socio-ecological nature of inland capture fisheries also presents methodological challenges in capturing the multidimensional nature of the role of inland fisheries to all four pillars of food security (Béné and Neiland, 2003). The productivity of unstable inland capture fisheries, such as shallow lake systems, warrants a deeper understanding of how climate change influences production, in relation to species harvested and seasonality. Further, for shallow lakes that are highly variable, the introduction of management measures such as closed seasons may result in negative social-economic impacts on local communities. Consequently, the role of inland capture fisheries in supporting livelihoods is complex (Béné and Neiland, 2003; Béné et al, 2009). Many important questions remain concerning the actual contribution of inland capture fisheries to all four pillars of food security and the extent to which complex site-specific socio-ecological factors influence both production and development outcomes from these systems (Béné et al, 2016; Lynch et al, 2016).

1.2 Research Rationale

Estimates by the FAO (2014) reveal that the need to meet the growing demand for fish is greatest in Africa. Currently Africa experiences some of the lowest levels of fish consumption (9.1kg per capital in 2009) in contrast to the global average of 19.2 kg in 2012 (FAO, 2014; Béné et al, 2015). Projections also reveal that the per capita fish consumption in sub-Saharan Africa (SSA) is expected to decline by 1% annually to 5.6kg in 2030 due to a rise in population growth and decline in wild fisheries (World Bank, 2013). In Africa, fish is known to provide a major and important high protein source, particularly in SSA where estimates reveal that fish can contribute more than 50% of total animal protein intake (FA0, 2006). As a result, the need to safeguard and improve the management of inland capture fisheries and the services they provide is increasingly recognised in the literature (So-Jung et al, 2014; Lynch et al, 2016). In light of the vital potential role of inland capture fisheries in supporting the livelihoods and nutrition of many of the rural poor across Africa, a significant need to address the sector's impact and actual contribution to livelihood and food security in the region has emerged (So-Jung et al, 2014; Béné et al, 2016).

Lake Chilwa in southern Malawi represents the second most important source of the supply of fish in the country (GoM, 2012). Lake Chilwa has been characterised as one of the most productive lake fisheries in East Africa, but also one of the most highly unpredictable lakes (Jul-Larsen et al, 2003). Due to the lake's shallow depths, it is highly sensitive to climate variability and has experienced extreme water level variability throughout its history (Njaya et al, 2011). Within the lake's catchment, 1.5 million people depend on its natural resources, including fisheries, for their livelihoods, food security and nutrition (Njaya et al, 2011). Studies have argued that communities are well adapted to the lake's high variability via adopting diverse 'fisher-farmer' livelihood strategies (Allison and Mvula, 2002; Jul-Larsen et al, 2003). Jul-Larsen et al (2003) argue that conventional fisheries management measures are not appropriate as Lake Chilwa fisheries are governed by the short-term changing environment rather than fishing effort. Lake Chilwa basin has been experiencing multiple stressors of increased population growth, increased demand on natural resources, and increased competition for water use for wetland cultivation (Njaya et al, 2011). These pressures raise questions about the resilience and adaptability of the lake system, and have implications for food security of communities around the lake. These conditions make Malawi and Lake Chilwa a particularly interesting case study to investigate the actual contribution of small-scale inland capture fisheries to livelihoods and food security.

This thesis aims to investigate the contribution of small-scale capture fisheries to food security, using the case study of Lake Chilwa, Malawi. Recognising, capturing and valuing the importance and contribution of inland capture fisheries to food security are fundamental to the sustainable development of the sector (Bartley et al, 2015; Lynch et al, 2016). The thesis investigates the production and social-ecological framing conditions of inland capture fisheries using the case study Lake Chilwa, Malawi. The thesis seeks to evaluate the contribution of inland capture fisheries to food security through the Sustainable Livelihoods Approach with a comprehensive focus on food security as a livelihood outcome. Given the heightened interest to put fish on the menu in the global debate on food security (Béné et al, 2015) and limited knowledge concerning the complex role of inland capture fisheries to food security, this thesis is a timely endeavour in addressing knowledge gaps in the literature, contributing to methodological approaches in the field as well as providing policy rich information to support the sustainable management of the sector within the region.

1.3 Research Aims and Questions

The overall aim of the thesis is to investigate the contribution of small-scale capture fisheries to food security, using the case study of Lake Chilwa, Malawi. Livelihoods underpin food security, and the thesis adopts a livelihood approach to investigate the characteristics of fish-related livelihoods, the benefits obtained and challenges in a small-scale fishery. In addition, the thesis investigates the temporal dynamics and availability of fish, which affect fish-related livelihoods, and the vulnerability context of livelihoods. A mixed methods approach has been adopted to generate new knowledge in data limited environments. The thesis aim will be investigated via four questions that incorporate both the social and ecological dimensions of the lake system. The research objectives are outlined in more detail within the indicated chapters.

- **Overall Research Aim:** Investigate the contribution of small-scale capture fisheries to food security, using the case study of Lake Chilwa, Malawi.
- **Research Question 1 (Chapter 4):** What effect do water dynamics have on fish supply?
- **Research Question 2 (Chapter 5):** What is the relationship between fishing livelihoods and food security?
- **Research Question 3 (Chapter 6):** How do fisherfolk experience seasonality, shocks and fisheries governance, and perceive the impacts of these on their livelihoods?
- **Research Question 4 (Chapter 7):** How do fisherfolk perceive the benefits and challenges of fisheries in their livelihoods?

1.4 Thesis Structure

The thesis consists of eight chapters. **Chapters 2 and 3** provide the research context and outline the methodological approaches. These are followed by four data chapters which investigate social and ecological aspects of fisheries and food security (**Chapters 4-7**). A final chapter then concludes by evaluating the thesis objectives, drawing out the high-level findings and considering the policy and practical implications of this research. An illustrative outline of the chapters is provided in **Figure 1.1**. A detailed overview of each chapter is provided below.

<u>Chapter 2 Literature Review</u>

The purpose of the literature review is to understand research on the biological, social and economic attributes of small-scale fisheries, livelihoods and food security. The review includes both marine and inland fisheries contexts and identifies research gaps.

Chapter 3 Research Methods

Chapter 3 sets out the research framework and methodological approach. The choice of study sites and sampling design are explained and the methods for achieving the research objectives are described. Details of research collaborators and ethical issues associated with this research are also provided.

Chapter 4 Fisheries and Water Dynamics

Chapter 4 sets out the changes in Lake Chilwa's fish yield trends, drought and flood events over time. The chapter aims to provide the temporal context of seasonality, shocks, vulnerability and change of the fishery. The chapter provides an analysis of the secondary data pertaining to fish yields, effort and hydrological fluctuations of a small-scale fishery. The chapter assesses the association between water dynamics and fish yields by testing the relative lake level fluctuation index.

Chapter 5 Fisheries and Food Security

Chapter 5 aims to understand the relationship between capture fisheries livelihoods and food security via analysis of quantitative household surveys comparing the livelihoods of fishers and non-fishers. The chapter draws upon the Sustainable Livelihood Framework to understand the livelihood platform of fishers and non-fishers, vulnerability and the livelihood outcome of food security.

Chapter 6 Fishing Patterns and Water Dynamics

Chapter 6 describes the dynamics of the fishery and environmental context from perceptions of fisherfolk. The chapter assesses perceptions of change and patterns of small-scale capture fisheries via analysis of primary qualitative data (focus group discussions) and quantitative data (household survey).

Chapter 7 Perceptions and Values of Fisheries

The overall aim of **Chapter 7** is to assess the value and role of small-scale capture fisheries for men and women fisherfolk in Lake Chilwa, Malawi. The chapter investigates perceptions of roles, benefits obtained and challenges experienced by fisherfolk. A qualitative participatory approach is used, via the photovoice method which encourages reflection and empowerment, to capture the perceptions of men and women fisherfolk on the nature of the fisheries and its importance.

Chapter 8 Discussion

Chapter 8 draws conclusions on the role of small-scale capture fisheries for food security. The methodological approaches and findings from **Chapters 4 to 7** are evaluated, and the policy and research implications considered.

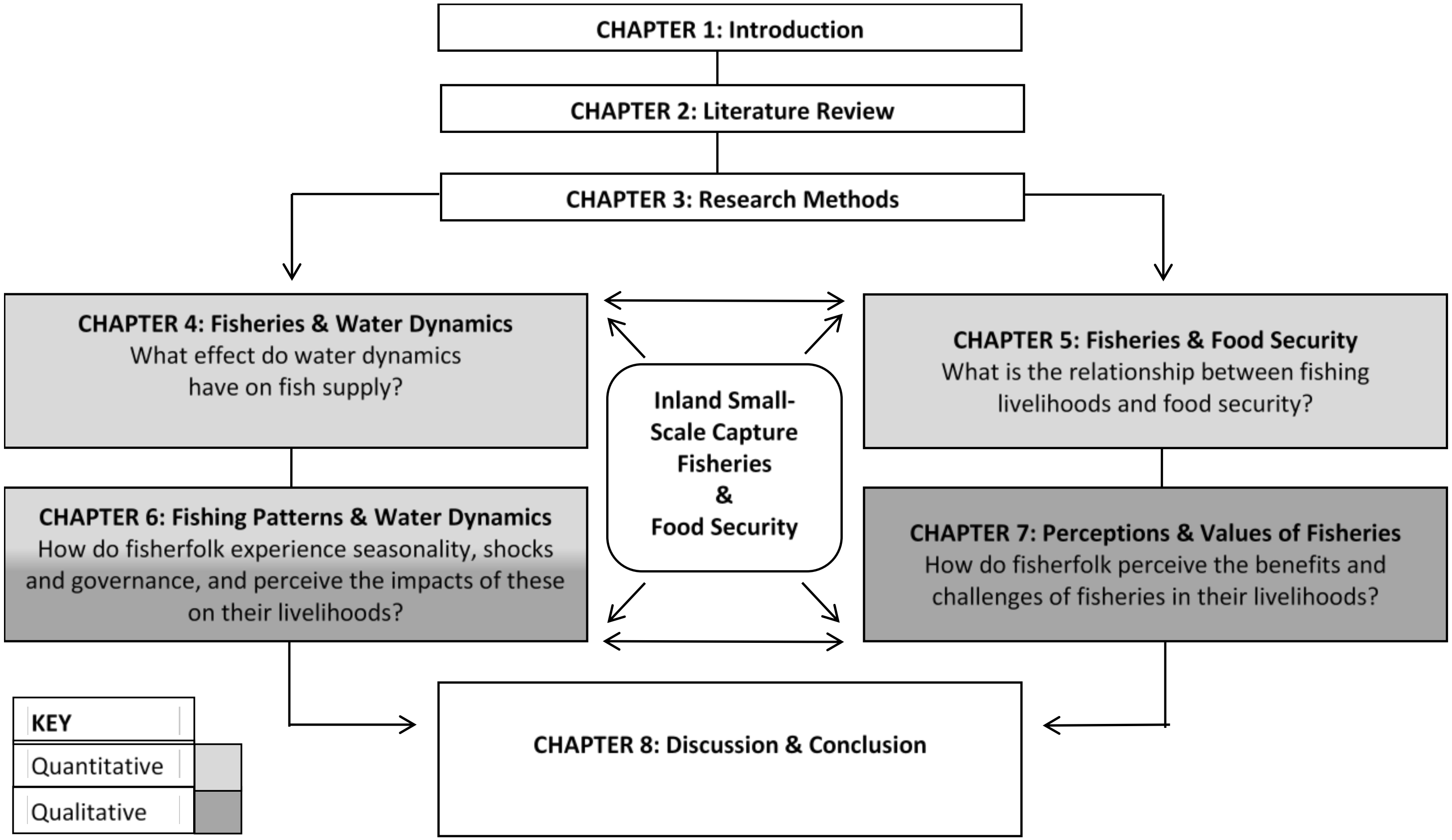

Figure 1-1 Thesis outline and structure

Chapter 2 Literature Review

2.1 Introduction

This chapter reviews the literature concerning small-scale inland fisheries: characteristics of the sector, availability of fish, fish-related livelihoods, socio-economic benefits and the role to food security. The review first provides an overview of the socio-ecological context of inland fisheries from a global, national and local perspective, with a focus on sub-Saharan Africa. The review then focusses on shallow inland capture fisheries, climate change, vulnerability and livelihoods. The review applies a socio-ecological lens detailing both ecological factors (e.g. biological production of inland fisheries - Section 2.2), and social factors (e.g. sustainable livelihoods approach, and access to and utilisation of fish - Section 2.3).

2.2 Inland Capture Fisheries

2.2.1 Defining Inland Capture Fisheries

Inland fish are defined as species that spend all or part of their life cycle in fresh water (FAO, 2014). Inland capture fisheries are defined as the harvesting of wild naturally occurring fish as opposed to farming of fish. Inland capture fisheries are distinct from marine fisheries in their nature and the range of drivers that influence them. They are found in diverse freshwater habitats: rivers, lakes and wetlands, with the majority in developing countries (IFAD, 2011). In terms of exploitation, capture fisheries are commonly defined by the fishing gear used, the level at which the fishery is governed and the species being exploited. The inland fisheries sector is a dynamic and evolving sector that is labour intensive, often led by individuals and households and thus driven by human effort and the overall number of people in the fishery (De Graaf, 2012; Welcomme, 2011). Activities are undertaken part-time, full-time or seasonally and the fish and fishery products are often sold to local or domestic markets, as well as for subsistence consumption (FAO, 2014). A wide range of fishing techniques is used as well as multiple scales of operations. Small-scale operators for example use hand-held bamboo fishing traps deployed from dugout canoes, whereas large-scale operators may use nylon purse seine nets deployed from planked boats (with or without engines) and assisted crew members (FAO, 2014). Small-scale inland capture fisheries are heterogeneous in nature and often are dispersive in area (De Graaf, 2012; Welcomme, 2011).

2.2.2 Production of Inland Capture Fisheries

The world's fish supply has increased by 8 times from 20 million tonnes in 1950 to 167 million tonnes in 2014 (FAO, 2016). The rate of increase has been largely attributed to the growth of aquaculture (FAO, 2016). Inland capture fisheries contribute below 10% to global fish supply with a reported 11.9 million tonnes produced in 2014 (FAO, 2016). Although inland capture fisheries represent a small share of the global fish supply, a sub-set of countries have a higher dependence on inland fisheries than the rest of the world (FAO, 2016). For many countries in the developing world and those that are land-locked, particularly in Africa and Asia, they constitute the major source of fish supply (FAO, 2016). These regions are often Low-Income-Food-Deficit countries with large rural populations and freshwater resources (FAO, 2016; Kolding et al, 2016). In Africa, capture fisheries play the major role in fish supply as opposed to aquaculture in Asia, and the majority of supply is from East Africa following the major African Great Lakes around the East African Rift and Africa's major rivers such as the Nile (FAO, 2016). However, there is large sub-regional variability and some countries such as Malawi have large variability in production (FAO, 2016).

2.2.3 Factors Impacting on Inland Capture Fisheries

2.2.3.1 Factors Affecting Fish Yields

Biological production can be defined as "the total biomass produced during a given period of time from a defined area", and the yield from a biological system can be defined as "the portion of production removed for use by humans over a given period of time" (Hortle, 2007, pg. 3). Yield is often measured in metric tonnes/hectares from a stated area, or, kg per capita per year (Hortle, 2007; Kolding and Zwieten, 2012). Yield is the biological component harvested by people, and has been described as "the best indicator of the size of the fishery, as biological production is impossible to measure in large systems" (Hortle, 2007, pg. 3). One study highlighted that the FAO often terms yield production, which is akin to economic terms rather than biological (Hortle, 2007). Yield is the term used for this study.

In order to understand the trends in fisheries, it is important to recognise factors that govern and shape the level of biological production of each inland fishery, as well as wider and extrinsic factors that affect biological production. Within the literature, there has been a general focus on lakes that have included lake ecology, lake dynamics, paleo-limnology and studies evaluating the linkages of lake fisheries with rivers and swamps in the wider wetland (Allison et al, 2006; Loverde-Oliveira, 2009; Wantzen et al, 2008a). The studies have drawn comparisons within temperate regions, and between temperate and tropical regions, in terms of lake ecological production and livelihood dynamics of people depending on their resources (Allison et al, 2006; Loverde-Oliveira, 2009; Wantzen et al, 2008a). Although a vast area of inland capture fisheries lies within tropical regions and developing countries which support millions of livelihoods, these have had less focus than temperate regions (Allison et al, 2006; Loverde-Oliveira, 2009; Wantzen et al, 2008a). This section provides a review of factors impacting fish biological production within inland waters with a focus on lake systems, and a focal point on tropical lake systems which is most applicable to inland capture fisheries in developing countries. Initially studies focused on morphological/edaphic factors influencing fish yields, but research has pointed to climate and socio-economic issues, hence this section is structured around these two main factors influencing fish yields in inland capture fisheries: morphological and edaphic ones, and climatic and socio-economic ones. These are now explored.

Morphological and Edaphic Factors

From the 1950s numerous studies have highlighted that specific characteristics of lakes can shape their biological production and carrying capacity. In the 1950s and 1960s studies drew mainly on static abiotic morphological and edaphic characteristics to classify lakes and understand factors governing biological production (Welcomme, 2011; Kolding and Zwieten, 2012). Rawson (1952), Hutchinson (1957) and Talling and Talling (1965) were some of the earliest studies which found that factors affecting a lake can be grouped as edaphic, morphometric and climatic. As biological biomass was difficult to measure, fish yield (amount harvested by people) was used as an indicator for the size of the fishery. Mean depth, a morphometric indicator, was shown to be one of the most significant factors governing fish yields due to its effect on temperature, stratification, circulation and nutrient level in a lake which drives primary production (Rawson, 1952). In the 1960s, a comparison of lakes in northern temperate regions demonstrated that fish yields were inversely related to mean depth and water chemistry determined by total dissolved solids (Ryder, 1965). A morpho-edaphic index (MEI), based on the combination of mean depth and water chemistry, was established and showed fishery yields to be higher in shallow lakes due to higher rates of nutrient recycling and a higher proportion of the lake in the euphotic zone (Rawson, 1952; Henderson and Welcomme, 1974; Ryder, 1974). Throughout the 1970s, 80s and 90s, further studies reviewed the MEI and its applicability to a wide range of lake and reservoir datasets. Reiger (1971) and Henderson and Welcomme (1974) were some of the first to apply the MEI to African lakes and confirmed the relationship between MEI and fish yields. The studies also confirmed that the applicability of the MEI index is not confined to lakes with homogeneous features, as the highly dynamic Lake Chilwa and Mweru-Wa-Ntipa were also included which experience unstable water dynamics. Several studies also investigated the food web dynamics within these systems and explored the relationship between primary production and fish yield (Melack, 1976; Oglesby, 1977). Henderson et al (1973) related primary production with MEI in African lakes, however primary production was not related to fish yields suggesting that higher trophic level production may be more limited by physiological requirement than primary production, and the complexity in measuring biological production (Ryder, 1974; Hortle, 2007).

Hydrological and Socio-economic Factors

In the 1980s and 1990s, studies began to explore in more depth the environmental, hydrological and socio-economic factors and their relationship with fish yields. The applicability and use of the MEI was scrutinised and some argued that it is limited to estimating the potential fish yield of a lake at one point in time, and is only useful at the onset of the development of a fishery (Henderson et al, 1973). Henderson and Welcomme (1974) also explored the relationship of fishing effort and MEI and argued that the relationship of catch and effort may be more useful in understanding fish yields than estimating the potential of the fishery via the MEI (Henderson and Welcomme, 1974). Bayley (1988) combined the analysis of MEI with fishing effort, in the form of number of fishermen per surface area, for understanding fish yields in 31 African lakes. Fishing effort was found to be the major determinant in fish yield, and fishing effort with MEI explained 80% of the variation in fish yields (Bayley, 1988).

Research also progressed from static morpho-edaphic factors to include dynamics aspects of the hydrological regime in understanding aquatic systems. McLachlan (1981) demonstrated how water level fluctuation is a natural characteristic in aquatic habitats that promotes the interaction between terrestrial and aquatic ecosystems, enhancing productivity. When a lake recedes grasses flourish and act as food for terrestrial animals, and when a lake floods, terrestrial plants decompose and release nutrients as well as providing nursery habitats for fish. Junk et al (1989) introduced one of the fundamental theories in understanding aquatic environments with the establishment of the flood pulse concept (FPC). It was argued that the FPC in river-floodplain systems affects the aquatic-terrestrial transition zone; enhancing nutrient recycling and increasing primary production. Fish yields were also strongly related to the extent of accessible floodplain (Junk et al, 1989). However, there was little exploration of the direct relationship between hydrological variables and fish yields in lake environments. The combined work of Talling (1992) and Dumont (1992) provided one of the most detailed studies looking at environmental regulation in African shallow lakes and wetlands, as well as hydrological dynamics. Water level fluctuation was demonstrated to influence shallow aquatic environments, such as Lakes George, Chilwa and Chad, where flood and dry cycles impacted on nutrient pathways and habitat availability (Talling, 1992). Dumont (1992) and Talling (1992) also suggested that lakes could be classified based on these environmental stresses, where the resilience of fish is based on the availability of refuges such as swamps and rivers.

Since the early 2000s, several papers have explored in more detail the socio-economic and dynamic hydrological variables governing fish yields. Jul-Larsen et al (2003) explored the relationship between environmental variation, fishing effort and fish catch on a water body scale for five medium-sized lakes in Africa. The report found that water level fluctuation was often more significant than fishing effort in explaining changes in fish yield. One of the key findings, supported by four of the case studies, was that artisanal fisheries in African inland waters are often characterised by unselective fishing patterns where the fishery is highly adaptive to changing environments. For one case study however, Lake Malombe in Malawi, fishing effort was the major factor governing its fishery as it represented a case of over-investment in a fishery via more efficient fishing gears, rather than Malthusian overfishing (Zwieten et al, 2003). Water dynamics have been shown to influence nutrient availability and recycling, and provide habitat availability through inundation of areas, enabling pathways of fish dispersal and pulses of food availability (Kolding et al, 2003). Several studies have shown the relationship between hydrological variables such as lake level change, and fish yields with 1-3 year lag periods, such as in Lake Chilwa, Lake Kariba, Lake Turkana and Lake Malawi (Fryer and Iles, 1972; Marshall, 1984; Tweddle and Magasa, 1989; Karenge and Kolding, 1995; Zwieten and Njaya, 2003; Kolding et al, 2003). The feedback between dry and wet cycles within lakes has also been shown to be a vital interaction. Mosepele et al (2009) demonstrated the importance of the combined flooding and dry cycles for fish production and the ecosystem in the Okavango Delta floodplain, and that the complexities of this feedback is poorly understood.

These studies have demonstrated that the length of time, nature of flow and magnitude are important aspects of the flood, and the relative rate of lake level change is a useful indicator to capture the influence of water dynamics of fish yield. However, these studies also show that factors influencing fish yield are not static and that their contribution and interaction can change over time and can be context specific. Weyl et al (2010) argue that Lake Malawi has experienced a transition in factors affecting its fishery; from water level fluctuation being a key determinant in the 1980s, to fishing effort post 1980s. In addition, the combined features of low water level and increased fishing pressure was argued to be a cause of a decline in catfish in the Lower Shire River in Malawi (Willoughby and Tweddle, 1978; Tweddle, 2010). During extended periods of low flood pulses and water level, it was suggested that vulnerability to fishing pressure would increase (Zwieten and Njaya, 2003).

The hydrological regime is not only important for the nutrient loading, nutrient recycling and productivity, but it also directly impacts on breeding and recruitment. Flooding is a major cue for breeding of fish in the tropics (King et al, 2003; Wantzen et al, 2008b). For lakes, an increase in water levels can open up new diverse habitats for spawning and provide new refuges (King et al, 2003; Wantzen et al, 2008b). It can also enhance survival by providing productive feeding grounds for juvenile fish. For fish recruitment, there may be a set period of flooding required for use of the floodplain areas for recruitment; dependent on the development time of fish species (King et al, 2003; Wantzen et al, 2008b). However, the use of the surrounding swamps and floodplain by lake fish is dependent on the nature of the fish species but also on the predictability of the flood pulse, the rate of the rise and fall in water levels, duration and area of inundation. This is particularly important in shallow lakes. Fernando and Halcik (1982) argue that the nature of the fish communities also plays a part in determining productivity based on their habitat preference, growth rates and resilience. Natural lakes are rare in the tropics except for the rift valley lakes in East Africa. Fernando and Halcik (1982) argue that large, stable lakes usually have more endemic species and that the fish in large tropical lakes in Africa are better adapted than those outside Africa to lacustrine environments. It was found that fish in reservoirs in Sri Lanka were better adapted to river environments as opposed to deep lake environments and thus when African cichlids were introduced the fishery productivity increased. Thus, the age of the lake and the nature of the fish communities are also factors in the productivity of fisheries, and are important to understand for deep or shallow tropical lakes.

In 2008, a collection of studies by Wantzen et al (2008a) provided a synopsis of the status of research on the ecological effects of water level fluctuations in lakes. Case studies from north temperate and tropical locations showed that water level change was related to fish yield, extreme water level change reduced species richness and that minimum water level thresholds could be established in order to maintain fish spawning (Keto et al, 2008; White et al, 2008; Wantzen et al, 2008a). In addition, Wantzen et al (2008b) outlined that water level fluctuation in lakes has received little attention compared with rivers and floodplains, and proposed that the Flood Pulse Concept be extended to lakes. Other authors also called for more research on lake systems and environmental change. Leira and Cantonati (2008) conducted one of the most detailed systematic reviews of the literature between 1992 to 2008 on water level fluctuation and lake ecosystems. They found that the majority of research has focused on Europe and North America; there is little research in developing countries; there are complex effects of high and low water dynamics; water dynamics play a key role in the interface between the littoral and ATTZ; greatest effects are in shallow lakes where small changes can inundate large areas; and, little attention has been given to water level fluctuation in lakes particularly in light of climate change (Leira and Cantonati, 2008). Lake Chad was used as an example of extreme water level fluctuation where the lake has experienced a significant decline in water level that has caused the loss of fish species (Wantzen et al, 2008b). These reports make the case for more research looking into water dynamics and ecosystems, the thresholds of change, resilience and the likely effect climate change will have on this (Wantzen et al, 2008a).

A new index was established by Kolding and Zwieten (2012) to build on the FPC and highlight its importance to lakes. The Relative Lake Level Fluctuation (RLLF) index was established which combines the mean depth indicator with the rate of water level fluctuation to determine fish productivity and environmental stability (Wantzen et al, 2008b; Kolding and Zwieten, 2012; Jul-Larsen, 2003). Kolding and Zwieten (2012) explored the relationship between RLLF with fish yield (annual fish yields per hectare), fishing effort density (annual number of fishermen per hectare), and fish species diversity in 41 tropical lakes and reservoirs in Africa and Asia, using data from the late 1980s to late 1990s. The study provides the most detailed comparison analysis of a large set of inland water bodies exploring the role of water dynamics in fish productivity. A system's productivity, measured by fish yield, was found to increase with increasing relative lake level fluctuation (RLLF) (Kolding and Zwieten, 2012). Fishing effort was also demonstrated to have a positive relationship with RLLF; suggesting that fishing effort is at least, also partly regulated by the productivity of the system. The study also classified inland water bodies based on the level of environmental (water level) change; as pulsed or stable, and provided an insight into the stability and resilience of a system to external disturbances in tropical lakes. With the support of ecological concepts, the study also found that pulsed systems are characterised by species with shorter life spans, higher intrinsic growth rate, lower biodiversity, and higher productivity and resilience (Kolding and Zwieten, 2012).

In light of the body of evidence within the literature, it can be argued that biological production of fish as measured through fisheries yields in tropical lakes is highest in shallow and unstable (high water level fluctuation) systems based on the following principles and characteristics:

- Productivity decreases with an increase in mean depth;
- Productivity follows a dome shaped function with nutrient concentration;
- Productivity follows an increasing (possibly dome shaped) relationship with the size and duration of the amplitude of water level changes; and,
- Productivity increases with low land gradients which represent a large ATTZ (efficient nutrient transfer).

It has been shown that inherent features of inland water bodies can shape their carrying capacity to support fisheries, such as morphology, edaphic, age, and climate and fish community characteristics; as depicted in **Figure 2.1**. However, these inherent characteristics are not static and can change over time. In addition, external pressures such as fishing effort have been demonstrated to be a major factor affecting fish yields and, together with hydrological characteristics, are highlighted to be the major factors affecting inland fisheries yields. These two factors are strongly inter-related and have made it difficult for studies to unravel the causality of fish yields.

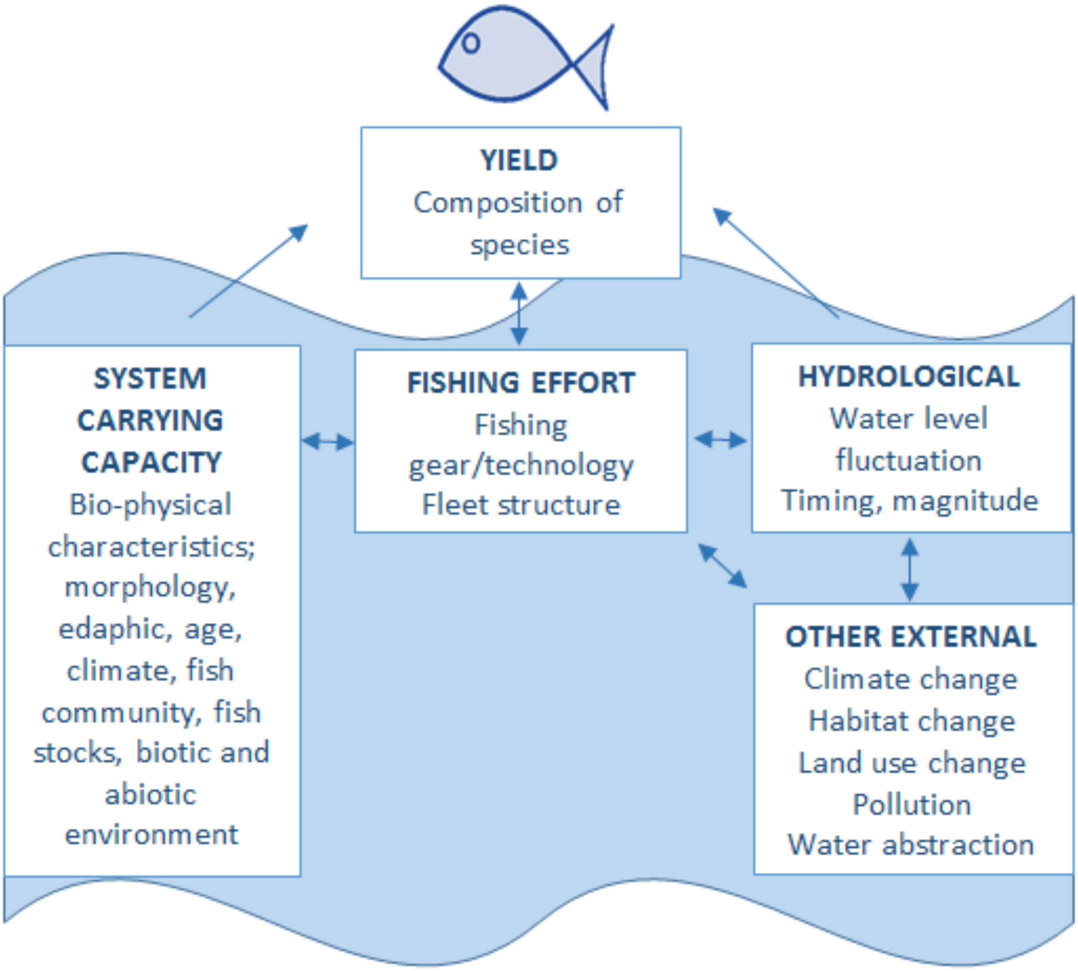

Figure 2-1 Factors affecting inland capture fishery fish yields

2.2.3.2 Threats to Inland Capture Fisheries and the Impacts of Climate Change

Inland capture fisheries are under increasing pressure from a range of environmental and human induced changes. These include climate change, habitat change, land use change, siltation, pollution and water abstraction. Lakes and wetlands are experiencing habitat loss through conversion of marshes to rice fields, draining of wetlands for development, declines in water level through increased water abstraction for irrigation and aquaculture, changes in hydrology regimes as a result of land use change, and pollution (IFAD, 2011). The pressure on inland fisheries water resources have the potential to reduce water level, reduce productivity and reduce the ability of fish to breed and take refuge in marsh areas (IFAD, 2011; Welcomme et al, 2010). For inland fisheries, reduced river discharge could cause a loss of biodiversity (HLPE, 2014).

The effects of climate change on aquatic ecosystems will have consequences for inland fisheries. Although small-scale fisheries have contributed little to anthropogenic climate change this sector is likely to be one of the first to feel its impacts (IFAD, 2011). Tropical fisheries are the most important to small-scale fishers in developing countries, yet the impacts of anthropogenic climate change on tropical inland fisheries have received little attention in comparison with temperate regions and marine fisheries (IFAD, 2011; Allison et al, 2006). Climate change can include changes in precipitation patterns, drought events, wind patterns, temperature and levels of irradiance, above the naturel levels that systems experience (IFAD, 2011; FAO, 2012). It can be argued that the most important climate changes impacting inland fisheries are likely to be changes to precipitation patterns (IFAD, 2011; Welcomme et al, 2010; FAO, 2012). In tropical regions such as East Africa, temperatures are predicted to increase, on average by 2 to 3 degrees by 2046 to 2065, with highest daily temperatures increasing by 4 to 6 degrees (IPCC, 2013). Yearly rainfall averages are also set to decrease across the region, with a general trend towards drier conditions (IPCC, 2013). However, climate models for the tropics and at regional scales may not be completely reliable and localised impacts of climate change are poorly understood (IFAD, 2011; IPCC, 2013). In addition, little is known on past ‘natural’ climate variability in the tropics in some areas, making it difficult to determine whether climate variability is natural or from anthropogenic climate change (IFAD, 2011; IPCC, 2013). The impacts however of climate change predictions on inland tropical fisheries are likely to include direct impacts on fish, and indirect impacts on the ecosystem they depend on (IFAD, 2011). The general trend towards drier conditions and increased temperature such as in East Africa will likely reduce rainfall and increase evaporation rates. This can have an impact on inland fisheries by affecting water levels and associated availability of habitats for spawning, feeding and nutrient exchange. This could impact on biological productivity, recruitment and increase the risk of predation during lower flows (IFAD, 2011). In addition, varying water levels will impact on water quality, salinity and dissolved oxygen levels. Although the RLLF shows that shallow unstable lakes are highly productive and resilient to large variations in fluctuation, little is known on the thresholds of tolerance in these systems and whether other stable systems, such as deep lakes, would tolerate or benefit from increased variation in water level. Changes in the timing and duration of rainfall will also impact on the seasonality of biological production, the spatial variation and may induce changes in species composition with implications for disease prevalence, toxic algae blooms and quality of the fish (IFAD, 2011; FAO, 2012). The effects of climate change will combine with other pressures such as over fishing and ecosystem degradation (HLPE, 2014). Already, some studies have indicated that lakes in East Africa are experiencing reductions in fish yields as a result of climate change, however others have contested this and outlined over fishing as the cause (IPCC, 2014; HLPE, 2014).

The studies have demonstrated that the length of time, nature of flow and magnitude are important aspects of the flood, and the relative rate of lake level change is a useful indicator to capture the influence of water dynamics of fish yield. However, these studies also show that factors influencing fish yield are not static and that their contribution and interaction can change over time and can be context specific. Just as the case with inland fisheries showing inter-related complexity between natural carrying capacity, shifting hydrological effects and fishing effort, the effects of climate change will need to be understood in the context of inter-related factors within the system.

Based on the RLLF index, it is argued that systems can fluctuate widely and be very resilient (Allison et al, 2006; Loverde-Oliveira, 2009; Wantzen et al, 2008b). Ecological resilience has been defined as “a characteristic of ecosystems to maintain themselves in the face of disturbance” (Adger, 2000, pg. 4). Unstable, pulsed-fluctuating environments, such as shallow lakes, are dominated by short-lived species, low biodiversity and shortened food chains, which arguably gives them the characteristics of being very resilient (Allison et al, 2006; Wantzen et al, 2008b). In comparison, it is suggested that stable systems such as deep lakes are highly diverse, less resilient and more vulnerable to exploitation (Allison et al, 2006; Wantzen et al, 2008a). Lake Chilwa in southern Malawi is a shallow lake which experiences seasonal fluctuating water levels, periodic complete droughts and is regarded as one of the most productive fisheries lakes in Africa at times. The ability of species to adapt to water level fluctuations is dependent on the nature of the species, predictability and rate of change of the water level, and the availability of refuge areas (Allison et al, 2006; Wantzen et al, 2008a).

The extent to which climate changes and other impacts will affect these shallow-unstable and deep-stable lake fishery systems is dependent on the resilience of organisms to such changes (Welcomme et al, 2010; FAO, 2012; Wantzen et al, 2008a). Changes in the flood pulse may have a meta-effect on biodiversity where in different years different groups of organisms may be successful. Lakes have a stronger residence time than rivers, and therefore multi-annual climate patterns will have a stronger influence on habitat structures and on the establishment or extinction of species in the ATTZ (Wantzen et al, 2008a). In addition, rapid rises and falls in water such as with extreme drought and flooding events may not enable species to adapt and migrate in time to safer refuges. A species' life span and traits, their phenological window of susceptibility and their ability to use flood borne resources at that time, are all important determinants of resilience and the likely effect that climatic changes and other impacts will have on fisheries (Welcomme et al, 2010; Wantzen et al, 2008a). In addition, there is limited information on the combined effects of climate change and other impacts on shallow-unstable and deep-stable lake fishery systems. Fisheries may become more vulnerable to exploitation and overfishing as a result of declining recruitment levels and declining refuge areas (FAO, 2012). Thus, utilisation of natural resources at levels once deemed sustainable may become destructive. However, the resilience of inland fishery ecosystems will depend on their unique socio-ecological character.

2.2.4 Methods to Understand Biophysical Aspects of Inland Capture Fisheries

Inland fisheries remain one of the sub-sectors for which it is most difficult to obtain reliable production statistics (Welcomme, 2011). Often, statistics have been over or underestimated and reported statistics should be used with caution (De Graaf et al, 2012). However, there are limited reports that analyse the status and trends of inland capture fisheries in Africa at a country and water body level (De Graaf et al, 2012). The nature of the fishery has led to difficulty in countries investing in monitoring (De Graaf, 2012; Welcomme, 2011). Where monitoring has been conducted, fish catch and effort data has been underreported given that catch is bartered locally or consumed by households, and that there are often no centralised landing ports or markets (De Graaf, 2012; Welcomme, 2011). In addition, several studies have highlighted that traditional methods to perform stock assessments are not adequate to be applied to inland fisheries given its complex characteristics (De Graaf, 2012; Welcomme, 2011).

On a national scale, countries evaluate their fisheries monitoring data and report fisheries catch and effort data to the United Nations Fisheries and Aquaculture Organisation (FAO). A 2003 study evaluated the status and trends of capture fisheries based on local case studies and extrapolated results to a global level. The report found that revised estimates of fish production were 50% higher than official reports, highlighting the current concern that inland capture fisheries are underreported (De Graaf, 2012; Welcomme, 2011). Trend analysis of inland capture fisheries data has also shown increases in catch at the same time as communities reporting decreasing catches (De Graaf, 2012; Welcomme, 2011). Several studies have argued that increasing trends can be a result of increasing recording which has led to misinterpretation of data (De Graaf, 2012; Welcomme, 2011). The traditional methods of landing surveys and frame surveys provide a good method for understanding the structure and characteristic of the fishery. These methods alone however cannot provide an overall assessment of the fishery. Census data or other social survey assessments are able to provide the additional information of the number of fishers in communities and livelihood information (De Graaf, 2012; Welcomme, 2011). Trends can be evaluated based on catch and effort monitoring from these surveys to provide an indication of the fisheries yield and importance to communities (De Graaf, 2012; Welcomme, 2011).

Regression models however have shown that relative lake level fluctuation or mean depth and water chemistry indexes have a strong log-linear relationship with fisheries yield (De Graaf, 2012; Welcomme, 2011). Most of the regression model investigations are currently applied to old research in the 20th century (De Graaf, 2012; Welcomme, 2011). There is a need to apply the regression models (area model, RLLF or MEI) to new fisheries data to a region, such as East Africa. Past models which used shorter time series could thus also be tested. Jul-Larson et al (2003) investigation using the RLLF model found that the average annual yield of fisheries across all African lakes is a constant 3 tonnes per fisher per year, irrespective of the size of the location (Jul-Larsen et al, 2003). This argument that there is a carrying capacity of each system to which fishing effort is partly governed by has important implications for understanding pressures on fisheries and management measures. Analysis of new data with longer time trends using regression models would thus be able to provide further evidence. Advanced regression models could be undertaken where data on external drivers of change to the system are included in analysis. Longer time trend data on change in lake area, depth, monthly water level change, fisheries catch and effort are more robust for the model input. In addition, secondary information on eutrophication levels and population density can fully encompass the environmental variables and test the traditional models. Kolding et al (2008) undertook a reassessment of the fishery stock of Lake Victoria in East Africa by applying the traditional single stock assessment methods for Nile perch that looked at the impacts of overexploitation, and factored in eutrophication data (Kolding et al, 2008). Eutrophication was found to be the main variable affecting fishing and called for a re-assessment of past fishery assumptions for that lake (Kolding et al, 2008).

New advanced techniques such as remote sensing may be able to provide the gaps in data and support regression models. This could be achieved by calculating the change in lake area and depth over time. GIS tools may also provide an effective way of understanding the spatial context of fisheries which could be applied to understanding spatial availability, spatial pressure and sensitive habitat areas and spatial access. In addition, in combination of secondary socio-economic and climate data, further spatial analysis could be undertaken (De Graaf, 2012).

2.3 Importance of Inland Capture Fisheries

This section explores the social and economic aspects by which fish and the fisheries sector contribute to livelihoods and food and nutritional security. The review is presented within the context of sustainable livelihoods and the four pillars of food security; availability, access, utilisation and stability, and also includes the effects of climate change and inclusion of men and women in the sector.

2.3.1 Food Security and Nutrition

Food insecurity is considered one of the most visible signs of poverty (Béné et al, 2003). Food security occurs “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit, 1996). A household is food secure when it has access to sufficient, safe and nutritious food for all its members. A healthy diet must be balanced and diverse comprising sufficient quantity of food to meet food energy requirements for physical activity, and a diversity of nutrient dense foods for macro and micro nutrient needs (Roos, 2016; HLPE, 2017).

Despite progress towards meeting international development goals over the past decade, the level of global food insecurity remains unacceptably high with over 800 million people globally with insufficient food energy (calories) and undernourishment (FAO, 2016). Social, economic, political and environmental factors affect food security including population growth, poor infrastructure, governance and conflict, climate change, environmental degradation, and lack of access to resources (Carletto et al, 2013). In 2016, the prevalence of undernourishment globally increased largely driven by climate related shocks and conflict, with the highest prevalence of undernourishment in sub-Saharan Africa, particularly East Africa (FAO, 2017). Nutritional outcomes are based on food security; consumption levels and nutritional quality of diets, but also on non-food factors that affect health status and the ability to absorb nutrients (HLPE, 2017). Non-food factors include sanitation, water quality, health care, and maternal and childcare, including access to nutritious food during in the early life of a child (Carletto et al, 2013; HLPE, 2017). Micronutrient deficiencies, particularly relating to iron, vitamin A, iodine and zinc, affect an estimated 2 billion people globally (FAO et al, 2003; HLPE, 2017). Food insecurity and malnutrition reduces individual and household economic productivity, causes delays in physical growth and cognitive development, increases the risk of morbidity and mortality, and reduces national development (HLPE, 2017).

In the 1970s, efforts to alleviate food insecurity and famine centred on increasing food supply and stabilising food prices (Cruz-Garcia et al, 2016). However, the agriculture Green Revolution and industrialisation over the past few decades demonstrated that improving physical food supply and availability alone does not secure adequate food needs (Cruz-Garcia et al, 2016). Amartya Sen highlighted the inequalities of food distribution particularly for vulnerable groups, and outlined physical and economic access to food as the root cause of food insecurity (Cruz-Garcia et al, 2016). Access encompassed household and individual level wellbeing relating to income, assets, purchasing power and food prices (Barrett, 2010). New studies on the temporal nature of food insecurity (chronic and transitory) and vulnerability to climate and economic shocks also highlighted the need to consider stability of food availability and access over time to ensure that people have access to sufficient food “at all times” throughout their life (World Food Summit, 1996). For example, in 2014/15 a significant rise in maize food prices caused acute severe malnutrition (HLPE, 2017). Developments also progressed on inclusion of the nutritional and safety quality of food; moving from evaluating food energy intake to micronutrient qualities and inclusion of socio-cultural preferences in securing food dietary needs. These developments lead to a new definition of food security based on multi-dimensions and the 'four pillars' of food security (Barrett, 2010):

- Physical availability of food – relating to global supply, national trade and production, local production and supply, and exchange (HLPE, 2017; Poppy et al, 2014);
- Economic and physical access to food – relating to capital assets, including financial and physical capital of income and wealth that increases the purchasing power for food; influenced by location, infrastructure and access to livelihoods and food (Carletto et al, 2013; Cruz-Garcia et al, 2016; HLPE, 2017);
- Utilization of food – individual uptake of food and nutrients determined by consumption and the diversity and nutritional quality of diets; cultural preferences; resources and skill to use food; and whether the nutritional value of food is delivered via food preparation, food safety, bioavailability and illness (Carletto et al, 2013; HLPE, 2017);
- Stability of availability, access and utilization – relating to access to sufficient food throughout the year irrespective of climatic, economic and political instability and conflict, and is underpinned by resilient and sustainable livelihoods (Carletto et al, 2013).

Food security is achieved when all four pillars are fulfilled (Beveridge et al, 2013; Cruz-Garcia et al, 2016). Food insecurity is underpinned by livelihoods; "they are the means by which people access resources and assets in their environment in order to meet household needs" (Béné et al, 2003; ACF, 2010). Livelihoods comprise of "the capabilities, assets (including both material and social resources) and activities for a means of living" (Scoones, 2009, pg. 6). Capital assets (social, human, financial, physical and natural) are the building blocks of livelihoods which are shaped by the vulnerability context (e.g. shocks and seasonality) and transforming structures and processes (e.g. governance and policies), which influence livelihood strategies and livelihood outcomes. The livelihood platform influences food security across its four pillars.

Social representation, power relations, gender and household dynamics also shape livelihood capabilities and mediate access to and utilization of food (Cruz-Garcia et al, 2016; HLPE, 2017). At the household level, single headed households have been found to be more vulnerable compared with dual headed households due to lower earnings and lack of protective social networks (Flato et al, 2017). However, within single headed households, those headed by females have generally been found to be most vulnerable (Abdullah et al, 2017; Flato et al, 2017). Women are often economically disadvantaged through gendered norms and power relations that limit mobility, material ownership and economic productivity, and have often been found to be more vulnerable to food insecurity and climate change (Sraboni et al, 2014; Kawarazuka et al, 2017). Differences have also been found in the motivations and spending priorities between men and women (Kawarazuka et al, 2017). Several studies have shown that women direct more of their earnings towards meeting their family food security needs and childcare compared to men (Sraboni et al, 2014; Kawarazuka et al, 2017). Increasing women's control over resources and empowerment in productive activities have shown to increase household expenditure on food and care for children with positive effects on child wellbeing, food security, health and education (Kawarazuka and Béné, 2010; Kawarazuka et al, 2017).

Data on all dimensions of food security are seldom available and difficult to report (Carletto et al, 2013). At the national level, undernourishment relating to food energy intake is estimated from net food availability, population and its food energy requirements, and often masks regional variation and intra-national distribution of food (Barrett, 2010; Carletto et al, 2013). At the household and individual level, surveys on food consumption, expenditure, vulnerability, welfare and health illuminate inter- and intra-household factors influencing food security and helps identify vulnerable groups, however surveys can be limited in understanding annual food security and temporal dynamics due to their frequency, and also limited in enabling a global comparison (Barrett, 2010; Carletto et al, 2013). The most widely used indicators to measure food security include dietary diversity; measuring food quantity and quality consumed, and coping strategies; measuring behavioural responses to food insecurity (Barrett, 2010; Carletto et al, 2013). They are often used together with poverty indicators to improve accuracy of measuring multiple dimensions of food security (Maxwell et al, 2013; Carletto et al, 2013). Some argue that a livelihood approach is fundamental to understanding food security, providing an understanding of local context, vulnerability, capabilities, and livelihood outcomes in a systems approach, which can also incorporate power relations and gender (Connolly-Boutin and Smit, 2016). There have been limited studies however adopting a sustainable livelihoods analysis together with food security indicators to provide a wider analysis of vulnerability, access and stability (Béné et al, 2003; Connolly-Boutin and Smit, 2016).

Future predictions of population growth and global food demand have pictured a 'perfect storm' across the food-energy-water nexus by 2030 and beyond and highlighted the need to feed more people with less water and land (Poppy et al, 2014; FAO, 2015). The Sustainable Development Goals agenda makes achieving food security and ending malnutrition a global priority by 2030 along with sustainable resource use and increasing resilience against climate change. However, it is argued that the 'major imperative' of food security is securing physical and economic access to food for vulnerable regions, particularly in sub-Saharan Africa (Cruz-Garcia et al, 2016). In addition, several studies have highlighted the gap in understanding the contribution of access to wild foods to food security and their role as a food source, income and safety net during lean agriculture periods (Poppy et al, 2014; Cruz-Garcia et al, 2016).

2.3.2 Fishery-based Livelihoods and the Pathways to Food Security

Global fish food demand is increasing, affecting the balance between sustainable use of fisheries resources and biodiversity conservation (Halpern et al, 2013; Jennings et al, 2014). A review by Rice et al (2011) highlights that many governance interventions to reduce pressures on the marine environment are incompatible with actions proposed to meet future food security needs. As a result, growing awareness of the need to consider conservation and food security demands as interrelated outcomes, particularly in developing countries, is emerging in the fisheries literature (Beard et al, 2011). Understanding food supply, factors influencing access and utilisation of fish are critical knowledge components of developing a holistic ecosystem approach to fisheries management for improved food security outcomes (Beard et al, 2011; Unsworth et al, 2014).

Fisheries can contribute to food security in a myriad of complex pathways (HLPE, 2014) which are underpinned by fish-related livelihoods. However, the linkages between fish-related livelihoods and food security are not straight forward as the sector's contribution to food security is dependent on a number of factors including: the productivity of the fishery and the degree of stress placed upon the system; the vulnerability of populations dependent on fish for income, revenue or nutrition; the nature of involvement in the fishery; as well as cultural norms and relations between men and women (Unsworth et al, 2014). Research into the contribution of the sector to food security has focused on the benefits of the sector for livelihoods, the nutritional value of fish, and a limited number of studies that have explored the direct linkages to food security.

2.3.2.1 Socio-Economic Value of Inland Fish-related Livelihoods

Fish-related livelihoods in inland capture fisheries

There is a growing literature on the role of fisheries as a livelihood activity and its contribution to livelihoods (Kawarazuka and Béné, 2010; Béné et al, 2016). Fisheries provide employment and act as an income-generating activity along their supply chain. The nature of the fishery is an important determinant for the number of people employed and income generated. Small-scale fisheries have been found to create employment several times higher than large-scale fisheries (IFAD, 2011; Welcomme, 2011; HLPE, 2014). Estimates on the global employment in the fisheries sector vary as a result of differences in scope; e.g. inclusion or not of part-time fishers, processors, traders and other activities along the fish value chain. In addition, the fisheries sector is characterised by high levels of informal employment which is often difficult to monitor and often under-reported (FAO, 2014). Inland capture fisheries have been estimated to employ over 19 million people in the primary sector (World Bank, 2012). It has also been estimated that potentially more than twice as many (39 million) are involved in post-harvest activities along the supply chain (World Bank, 2012). Men are predominantly involved in fishing whereas women largely participate in post-harvest activities (FAO, 2016; Bartley et al, 2015). In small-scale fisheries value chains, fish harvesting is often conducted with low to medium technology from hand-made fish traps to seine nets, and dugout canoes to planked boats. Processors process fish using low technology practices, such as sun drying or smoking, and sell to consumers or traders for transport to distant markets. Fish trade is often not captured due to the sector's informal, remote and dispersed characteristics, however increasing studies are illuminating the hidden supply and trade of fish (FAO, 2016). In Lake Chad, 80-90% of fish products have been found to be traded long distances, such as to southern Nigeria (Kolding et al, 2016). Thus, the nature of involvement in the fishery influences the benefits and contributions to food security. Increasing evidence also sheds light on the interconnectedness of the value chain where traders have provided resources to remote and marginalised fishers, for example, by providing microloans to fishers in Cambodia's Tonle Sap, and also providing equipment to fisherfolk (Kawarazuka et al, 2017).

The role of women in inland capture fisheries value chains

Women are predominantly engaged in secondary post-harvest activities in inland fisheries and are estimated to represent over half of the people engaged in the sector (FAO, 2016). However, the role of women in the fishery has largely been invisible (World Bank, 2012; HLPE, 2014; Bartley et al, 2015). Biases in sampling methods and research that fails to consider value chains, women, and wider fish-related activities such as near shore fishing, have often led to studies focusing on actors engaged in fish harvesting and fishermen (Harper et al, 2013). These biases have led to significant gaps in understanding fisheries value chains, particularly the involvement of women, their socioeconomic contributions and local ecological knowledge (Kleiber et al, 2014). Recent studies are making the role of women in inland fisheries more visible (Williams, 2008; FAO, 2015). Studies have shown that women engage in activities beyond post-harvest activities, such as acting as gear owners who employ fishermen, and actively partake in fish harvesting, such as fishing in shallow waters (Williams, 2001; FAO, 2015; Deb et al, 2015; Ngwenya et al, 2012; Harper et al, 2013). Their practices are often distinct from men's, they are often motivated to conduct activities that are close to home and can provide more food for the family (Weeratunge et al, 2010; Kawarazuka et al, 2017). For example, women have been widely reported to actively fish close to home in floodplain and upland fisheries in Zambia, Bangladesh, Tonle Sap and the Peruvian Amazon (Ngwenya et al, 2012; Rajaratnam et al, 2016; FAO, 2015; Murray, 2006). These practices also often catch smaller fish species for subsistence consumption and income (Harper et al, 2013). In the Okavango Delta in Botswana, East Africa, women comprise approximately 44% of fishers engaged in the small-scale inland fishery sector and hold local ecological knowledge on its pulsed dynamic system (Ngwenya et al, 2012). In this fishery women use baskets in shallow waters to harvest small fish species for subsistence consumption and income to supplement their primary livelihood activity of agriculture and enhance household income and food security (Ngwenya et al, 2012). As active fishers, a gender-neutral term of 'fisher' rather than fisherman is argued to be more appropriate for fisheries sectors (Harper et al, 2013; Branch and Kleiber, 2015).

The roles are shaped by gender norms, traditions and cultures which are highly context specific; fishing is often deemed to be too dangerous and physically demanding for women, or trading in distant markets too risky for young women to travel (Deb et al, 2015; Bene et al, 2016). In addition, intra-household dynamics and power relations shape and influence the role of women in the sector and their contribution to the household (Deb et al, 2015; FAO, 2015). In fishing communities in Cambodia, the Philippines and Solomon Islands, women had agency to negotiate gender norms and partake in fish-related productive livelihoods to assist the household in adapting to declining resources and improve income and food security (Kawarazuka et al, 2017). In the Mekong River floodplain, women have also been found to fish with their husbands by assisting with operating the boat and sorting fish catches in order to maximise the fishing season and returns to the household (FAO, 2015). In addition, women also support fishermen emotionally, such as in floodplains in Bangladesh where women practice worship and prayer for good fishing catches and safe return of fishermen (Deb et al, 2015). Despite the role of women in the sector they are often excluded from fisheries management and decision-making processes (Ngwenya et al, 2012; Kleiber et al, 2017).

Poverty in fishing communities

Although there are reported benefits of the sector for rural communities dependent on natural resources, fishing communities still face many challenges (Béné et al, 2016). Over the past century global fisheries, including small-scale fisheries, have provided a source of wealth for fisheries dependent populations (Eide et al, 2011; Sinan and Whitmarsh, 2010; FAO, 2016). However, small-scale fisheries are also described as being synonymous with poverty (Fisher et al, 2013). Poverty is multi-dimensional and in recent decades the definition has evolved beyond income, consumption and material wealth, to include basic human rights, wellbeing and people's own experiences, definitions, aspirations and feelings, that are shaped by political, social, economic and cultural factors (Allison and Horemans, 2006; Fisher et al, 2013). Vulnerability to natural, economic and health shocks also affects poverty (Hutton et al, 2011). Vulnerability has been defined as "a function of the risks to which people may be exposed, the sensitivity of their livelihood system to those risks, and their ability to adapt to, cope with, or recover from the impacts of an external 'shock' to their livelihood system" (Allison and Horemans, 2006, pg. 757).

Small-scale fishing communities often experience marginalisation, vulnerability and poverty because of dependency on natural resources, climate shocks, lack of access to basic services (e.g. education, health and markets), remote geographic location, unsecure rights, increased risk of water-borne diseases and poor sanitation (Allison and Mvula, 2002; Eide et al, 2011; Jentoft et al, 2018). Poverty is also influenced by power imbalances and access rights, which limit fisher's rights or means to access resources (Eide et al, 2011; Jentoft, 2013; Jentoft et al, 2018). Fishing communities can experience poverty but also influence it through unsustainable livelihood practices and resource use. Cinner (2011) has described a socio-ecological poverty trap in fishing communities where poverty, shocks and resource decline can lead to adoption of unsustainable practices and adaptations, such as illegal fishing, that accentuates resource decline and undermines livelihoods (Cinner, 2011). As summarised by Jentoft et al (2018), there are various perspectives to understanding poverty in small-scale fisheries which include viewing small-scale fisheries as a last resort relative to other occupations or as a safety net (Béné et al, 2003; Onyango, 2011). Despite small-scale fisheries communities typically being victim to these challenges and lack of capabilities, especially in least developed countries, it is increasingly reported that small-scale fisheries can contribute to improved incomes and sustainable livelihoods, as well as be a preferred way of life (Darling, 2014; Jentoft and Finstad, 2018; Allison et al, 2009; Weeratunge et al, 2014). The sector has also been found to contribute to wellbeing and creating a sense of personal identify and job satisfaction (Pollnac et al, 2001; De Silva et al, 2007; Weeratunge et al, 2014). In addition, the sector has been found to not be a livelihood option of last resort, providing a livelihood and career for all wealth groups in a rural community, and an all year round income (Béné et al, 2016). While we are attaining a better understanding of the social and ecological complexities of small-scale fisheries, further questions surround the nature and extent of poverty within the undervalued small-scale inland fisheries communities, and the role of the sector in alleviating poverty for marginalised rural communities. Given the multifaceted nature of poverty and the highly diverse nature of small-scale fisheries, context specific understandings in and solutions to poverty alleviation within fishing communities have been increasingly called for (George and Bennett, 2005; Darling, 2014; Béné et al, 2016; Jentoft et al, 2018).

Benefits from fish-related livelihoods

Fish-related livelihood activities have been found to be an important supply of primary or secondary income to all wealth groups in communities; providing a high income earning activity all year round for rural communities where little alternative employment exists (Kawarazuka and Béné, 2010; Béné et al, 2016). The past assumptions that fishermen are the “poorest of the poor” and that fishing is “an employment of last resort” have been tested by several studies and shown to not hold (Pollnac et al, 2001; Béné et al, 2003). Fishing as a livelihood activity has been found to play a central role in terms of income, food supply and labour to all wealth groups within communities and not just the poor, such as in Lake Chad (Béné et al, 2003). Several studies have compared the livelihoods of fishers to non-fishers in rural communities and a large number found that fishers had higher incomes (Pollnac et al, 2001; Kawarazuka and Béné; 2010). Dey et al (2005) discovered that fish farmers in communities in Malawi had one and a half times higher income than non-fish farmers. Several studies on inland capture fisheries in Africa (Lake Chilwa in Malawi, Lake Victoria in Kenya, Lake Kyoga in Uganda) also found similar results where fishers had higher income compared to non-fishers (Allison, 2004; Allison and Mvula, 2002; Ellis and Bahiigwa, 2003). Béné et al (2009) described the link between fisheries and livelihoods as a ‘bank in the water’ function where fisheries can act as a cash crop and an important primary and secondary source of income all year round; contributing to annual financial security. However, the benefits of the sector are highly context specific, and the links between income and livelihood outcomes are complex (HLPE, 2014). Cinner et al (2010) explored the capital assets and livelihood platform of fishers and non-fishers in coastal villages in Kenya, and found that although fishers had higher human and social capital assets, their financial capital was comparable to that of non-fishers and fishers had lower levels of asset wealth and physical capital. The study highlights the importance of looking at livelihoods holistically and understanding the complexity of local contexts, how income is utilised and translates into livelihood outcomes (Cinner et al, 2010). Fisheries have also been found to act as a safety net during agricultural lean periods or for the increasing landless poor, where fisheries can permit access to a livelihood and food source (HLPE, 2014). As many inland fisheries are located in rural areas in LIFD countries, the importance of the sector for employment and as a source of income can be amplified due to limited employment opportunities in rural communities (FAO, 2016; Kolding et al, 2016).

Inequalities in benefits across the value chain

Inequalities often exist between actors in the value chain in relation to access, economic returns and vulnerability to changing and declining resources (Bene and Merten, 2008; Porter, 2012). In some fisheries contexts, processing and trading activities are more profitable compared to fishing where fishers can earn less income and have higher vulnerability to changing resources (Hempel, 2010). In activities where women and men both partake, studies have shown that inequalities exist due to highly contextualised gender and power relations, beliefs and norms where women are often confined to the low value end of the value chain (Kawarazuka et al, 2017). Women are often limited in accessing the fishery in terms of time available and ability to travel to distant profitable markets due to household and childcare responsibilities (Porter, 2012). Within the value chain, men often have greater control over profitable fish-related activities, power in decision-making and better access to loans that enable them to occupy highly profitable fishery activities and expand their business (HLPE, 2014; Rajaratnam et al, 2016). As a result, women often have less access, bargaining power and profits in inland fisheries compared to men and can be more vulnerable to changing resources and competition (Bene and Merten, 2008; Porter, 2012). In addition, studies have shown that as certain fish species and activities become more profitable, women are often pushed out or become less advantaged (Geheb et al, 2008; Harper et al, 2013). For example, in Lake Victoria, men dominate the valuable Nile Perch export fishery whereas women are on the periphery of the fishery, accessing less valuable fish (Lwenya and Abila, 2001). Within inland fisheries, women have been reported to undertake 'fish-for-sex' activities in order to secure better access and prices of fish from fishermen, particularly within dispersed, competitive and highly fluctuating fisheries (Abbott et al, 2007; Bene and Merten, 2008; Kawarazuka et al, 2017). For example, in the Zambian Kafue River floodplain fisheries sector, female traders engaged in fish-for-sex transactions to secure access to fish to improve profit margins and livelihoods (Bene and Merten, 2008; Kawarazuka et al, 2017). Gender relations and inequalities in access to fishing resources, markets and loans also shape the capacity of individuals to innovate in the fishery value chain (Kawarazuka et al, 2017).

The value chain and role of actors within it are highly context specific, and there is a need for more gendered approaches to fisheries governance and a deeper understanding of actors' local ecological knowledge, socio-economic contribution and social relations (Ngwenya et al, 2012; Kleiber et al, 2017).

2.3.2.2 Nutritional Value of Fish as a Food Source

Increasing evidence points to the valuable role fish plays to human health. Fish provide a unique source of high quality protein, fatty acids, essential micronutrients (vitamins D, A, and B), and minerals (calcium, phosphorus, iodine, zinc, iron, and selenium) (Kawarazuka and Béné, 2011; HLPE, 2014; Thilsted et al, 2016). As a protein, fish has been found to be 5-15% more bioavailable than plant-based protein sources (HLPE, 2014). In many developing and LIFD countries with large rural populations, inland capture fisheries provide a major supply of fish and their contribution to nutritional security can be amplified due to limited alternative nutrient-dense food sources (HLPE, 2014; Thilsted et al, 2016).

It has been suggested that 90% of inland capture fish is used for direct human consumption and that for one third of the population it represents 20% of their average per capita animal protein intake (HLPE, 2014; Thilsted et al, 2016). The contribution of fish to animal protein intake can also exceed 50% in some countries such as Gambia, Sierra Leone and Ghana, and constitutes the major source of protein (Kawarazuka, 2010; FAO, 2016; HLPE, 2014). Small fish have also been shown to be particularly nutrient dense and an affordable food source for low-income consumers (Kawarazuka and Bene, 2011). For example, in Bangladesh and Cambodia, the small indigenous fish species Mola (*Amblypharyngodon mola*) provided a very important source of vitamin A due to the head and viscera of the fish being consumed (Roos, 2016). Fish can therefore add quality and diversity to diets and be beneficial in tackling micronutrient deficiencies, particularly in developing countries (Kawarazuka and Béné, 2011; HLPE, 2014). In regions in Africa where aquaculture has had little development, inland capture fisheries provide a major source of protein for millions of people (HLPE, 2014; FAO, 2016; Thilsted et al, 2016). Consumption of fish has been credited with a range of health benefits relating to brain function, learning ability, child development and reduction of human diseases such as cardiovascular disease (HLPE, 2014). Currently, due to poor data availability, the variation in nutritional value among different fish species and the importance of inland fisheries to nutritional security is not well understood (HLPE, 2014). In addition, there are limited studies investigating non-food factors such as health and disease and the impact on the uptake of nutrients from fish; fisherfolk are often exposed to water-borne diseases, which can undermine the nutrient uptake from fish (Kawarazuka, 2010; HLPE, 2014; Thilsted et al, 2016).

2.3.2.3 Links between Fishery-based Livelihoods and Food Security

Although there have been numerous studies investigating the role of fisheries for income, in comparison, there are fewer that have looked specifically at the outcome of food security (Béné et al, 2014). Research on the links between small-scale fisheries and food security have tended to focus on countries within Asia (Roos et al, 2007), the Pacific Islands (Cinner et al, 2010), and a few areas within Africa: Lake Victoria (Fiorella et al, 2014), coast of Kenya (Darling, 2014) and West Africa (Béné et al, 2014; Kawarazuka and Béné, 2010). In addition, the majority of studies have focused on aquaculture and capture fisheries in marine environments, which have tended to evaluate the effects of marine protected areas and environmental change on food security, as well as the direct pathways of fish consumption (Lowitt, 2014; Darling, 2014; Aswani and Furusawa, 2007; Roos et al, 2007; Dey et al, 2005). Less attention has been paid to understanding the links between inland fisheries and food security, despite the fact that some regulations; such as closed seasons, raise concern for the effects on food security (Béné et al, 2014; Kawarazuka and Béné 2010; HLPE, 2014). Studies on inland fisheries have tended to focus on the contribution to household income, asset wealth, fish consumption and food security measured largely through diet diversity and food coping strategies (Dey et al, 2005; Aiga et al, 2009; Allison and Mvula, 2002; Gomma and Rana, 2007; Geheb et al, 2007; Garaway, 2005). The link can often be context specific due to the multi-dimensions of understanding food security and diversified livelihoods (Béné et al, 2016).

Fisheries as a livelihood strategy have been found to contribute to food security directly where fish can be a source of nutritious food, and indirectly where income can increase the purchasing power of households to buy food (HLPE, 2014). Several authors have created conceptual diagrams to depict the relationship between nutritional status and fisheries, such as **Figure 2.2** below from Kawarazuka (2010). The main contributions identified are:

(1) through direct home consumption which contributes to food and nutrition intake,

(2) indirectly through sale of fish for cash which lowers market value of fish and increases purchasing power for other foods, and

(3) via employment in ancillary activities for women who are linked with spending more income on household food and nutrition (Kawarazuka and Béné, 2010).

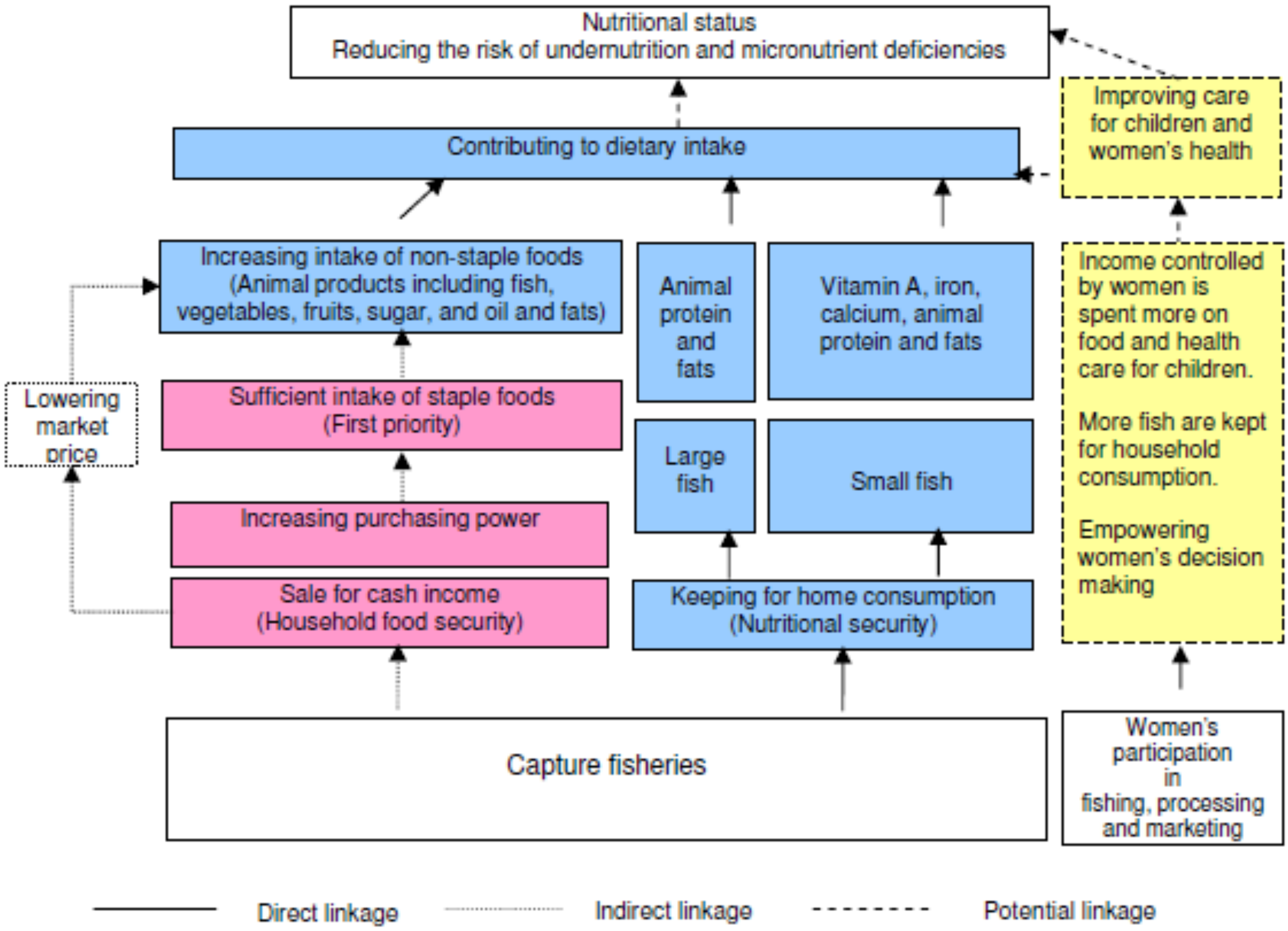

Figure 2-2 Pathways through which small-scale fisheries can contribute to nutritional status (taken from Kawarazuka, 2010). Direct pathways are shown in blue, indirect pathways in pink, and the contribution explicitly from women in the supply chain in orange.

These contributions of fish to household food and nutrition security are based on the pillars of food security; availability of fisheries providing a source of food and livelihood; fish-related livelihoods improving economic and physical access to food; fish utilised as a nutrient dense food source; and fisheries' safety net function and availability all year round helping to secure annual food security and stability of availability and access to food (Beveridge et al, 2013).

Although fisheries provide an income and employment in rural communities which can increase the livelihood platform and economic access to food (food purchasing power), the links between income and livelihood outcomes such as improved food security are not straight forward (HLPE, 2014). Further studies have shed light on the importance of understanding how fishers utilise their income. Geheb et al (2007) investigated increases in malnutrition around Lake Victoria and found that although the fishery provided a highly valuable income source, male fishers were not directing their income to household food security needs, while female fishers were more likely to prioritise household needs.

The prevailing narrative on fish consumption is that fish-producing livelihoods lead to more fish being consumed because fishers keep fish for home consumption (Gomma and Rana, 2007; Darling, 2014; Garaway, 2005). Gomma and Rana (2007) compared fish and meat consumption in fishing and non-fishing households within fishing communities in Nigeria. The study found meat consumption to be comparable between households, however fishing households consumed twice as much fish compared to non-fishing households. Income and location however have also been found to be important factors (Roos et al, 2007; Dey et al, 2005). Garaway (2005) showed inland fisheries to be an important economic activity all year round to all wealth groups in fishing communities in Lao PDR, and highlighted the importance of location where the role of small-scale fisheries in livelihoods and fish consumption differed greatly between villages even within the same district.

There have been limited studies looking into both direct (fish consumption) and indirect (e.g. income) pathways to food security, with only a few studies comparing food security between fishing and non-fishing households, and one known within the inland fisheries sector (Fiorella et al, 2014; Darling, 2014). Darling (2014) and Fiorella et al (2014) explored food security through multi-dimensions; investigating socio-economic factors at the household level, fish consumption and diet diversity between fishing and non-fishing households. The studies generally found that non-fishers and poorer groups in communities were most food insecure, testing the past assumptions that fishing is an occupation undertaken by the poor and is a livelihood of last resort. However, the two studies found interesting contradictions. Darling (2014) explored the status of food security in marine small-scale fisheries in Kenya and found that household food security was influenced by wealth and type of livelihood, with fishers being more food secure and consuming more fish than with non-fishing households. Fiorella et al (2014) on the other hand explored food security and fish consumption in fishing and non-fishing households within inland fishing communities of Lake Victoria in Kenya, and found no association with engagement with fishing. Food security and fish consumption was associated with income and the study challenges the assumption that food producing livelihoods lead to higher consumption of the food being produced (Béné et al, 2016). However, Fiorella et al (2014) focused on the valuable Nile Perch fishery which is largely dominated by men and due to complex political economic factors, fish is often sold for cash rather than kept for home consumption. In addition, wider studies in Lake Victoria have revealed differences between men and women in prioritising income for household needs and food security (Geheb et al, 2007).

The evidence highlights the highly context-specific nature of fisheries and food security due to the nature of the fishery and differences in how fishers utilise the benefits. Social representation, power relations, gender and household dynamics also shape livelihood capabilities and food security (Cruz-Garcia et al, 2016; HLPE, 2017). Single headed households and those headed by females have been found to be particularly vulnerable to food insecurity (Abdullah et al, 2017; Flato et al, 2017). Increasing women's control over resources and empowerment in productive activities have been shown to increase household expenditure on food and care for children with positive effects on child wellbeing, food security, health and education (Kawarazuka et al, 2017). The employment of women in the small-scale capture fisheries sector can therefore enhance the economic productivity of the households, reduce the vulnerability of single headed households, and through higher prioritisation of household food security needs, enhance household food security (HLPE, 2014; Kawarazuka and Béné, 2010).

Growing research also highlights the complex factors influencing food security including livelihood platform, capital assets (e.g. income and wealth), location, vulnerability and governance arrangements. Governance arrangements and decision making can affect food security via influencing access to livelihoods, the benefits obtained and the temporal stability of livelihood and food availability. Several studies have explored the impacts of fisheries governance on livelihoods, however the impacts on food security has received little attention. Darling (2014) found marine protected area to have no effect on food security in coastal communities in Kenya, whereas a more rigorous study looking at coastal food security and marine protected areas in the Solomon Islands found that, when effectively managed, they had a positive impact on food security (Aswani and Furusawa, 2007).

The review has highlighted critical gaps in the understanding of small-scale capture fisheries and their contribution to food security. Limited studies have explored livelihoods and vulnerability in-depth which underpin food security, and gaps remain in understanding the livelihoods of actors in small-scale capture fisheries, the constraints and benefits of livelihoods, household socio-economic and cultural factors, and the contribution of the sector to food security moving beyond availability and access, particularly in rural communities.

2.4 Conclusion

Hydrology has been clearly shown to be the driving force of natural resources in lakes (Junk et al, 1989; Wantzen et al, 2008a). This is particularly apparent for shallow lakes which experience extreme water level fluctuation such as Lake Chad and Lake Chilwa (Zwieten and Njaya, 2003; Kolding and Zwieten, 2012). In inland waters such as those presented above, the effects of fishing effort and the environment are often confounded, which complicates any effort to establish causation, and highlights the complexities of understanding the fishery system. The conventional approach to fisheries of surplus yield modelling and the maximum sustainable yield concept for ensuring sustainable fisheries has been argued to not be appropriate to inland waters due to their changing environments (Kolding, 1992; Kolding and Zwieten 2012). Of the simple empirical models applied to inland waters, hydrological variables (such as the relative lake level fluctuation), and fishing effort have been found to be important. Each inland fishery has been shown to have unique static morpho-edaphic factors which shape its biological carrying capacity. However, the transient hydrological (RLLF) and socio-economic (fishing effort) factors have been shown to be instrumental in influencing fish yield trends. The resilience of a system to change has been shown to be dependent on the level and rate of water level change, the life history traits of species and the availability of refuges in the environment (Wantzen et al, 2008b; Zwieten and Njaya, 2003; Kolding and Zwieten, 2012). In addition, the degree to which hydrological or fishing effort factors impact on fish yields is a constant dynamic relationship which can change over time, and in light of new pressures on social and ecological systems.

The review of fisheries and food security outlines pathways through which fish can contribute to livelihoods and food and nutrition security. There are limited studies, however, expanding the conceptual pathways to include differences amongst part-time, full-time, large-scale and small-scale fishers as well as for men and women (HLPE, 2014; Béné et al, 2016). There have been no considerations of the pathways of benefits in the wider socio-economic and livelihood frameworks to understand the contribution to overall livelihoods and food security (Béné et al, 2016). Small-scale fisheries generally make broader direct and indirect contributions to food security than larger scale fisheries, making affordable fish available and accessible to poor, which is key to sustaining livelihoods of marginalised and vulnerable populations (Welcomme, 2011). Yet, this has received little attention and gaps remain in understanding the nature of inland fisheries, livelihood platform and vulnerability of fishers along the value chain, and linkages to food and nutritional security (Béné et al, 2016). Studies exploring the link between fish and food security have looked at direct and indirect pathways, with few studies exploring sustainable livelihoods and food security holistically. There have been calls for more information on the benefits of fish-related livelihoods along the value chain, local level impacts of climate change on the sector, and local level evidence on the linkages between fisheries and food and nutritional security (Béné et al, 2016). Several studies have called for more weight to be given to local-level assessments, and more interdisciplinary approaches with mixed methodologies to look at fisheries, food security and governance (Garaway, 2005; Harper et al, 2013; Lowitt, 2014; Béné et al, 2016). The aim of the thesis as outlined in **Chapter 1** is to address some of these critical gaps in valuing small-scale capture fisheries and their role for food security, particularly in rural communities experiencing climate variability. The thesis aims to address gaps in understanding and valuing fish-related livelihoods along the value chain, locally specific and household factors, and linkages to food and nutrition security, adopting a holistic livelihood approach to understand food security and the role of fisheries across its four pillars. By inclusion of men and women fishers, the thesis contributes a first step in understanding the roles of men and women in the value chain, and their perceptions on challenges and benefits, in a sector where data has tended to be aggregated. A gender and intersectionality assessment was out of the scope of the thesis and requires more detailed future research.

Chapter 3 Research Methods and Processes

This section describes the research methodology and approach undertaken to achieve the objectives of the thesis stated in **Chapter 1**. The development of a conceptual framework, the choice of the study area, selection of research tools and the data collection process are explained.

3.1 Fisheries Research Methods Background

Although there is a growing body of evidence of the link between fisheries and livelihoods, as outlined in **Chapter 2**, the studies to date have lacked commonalities in definitions of sustainable livelihoods, food security and poverty, as well as in conceptual frameworks used. This has made it difficult to compare the social and economic complexities of the contribution of fisheries to livelihoods between studies.

The studies have shared similar methodological approaches, primarily adopting a mixed methods approach comprised of quantitative household surveys and secondary data, and qualitative key informant interviews and focus group discussions. Qualitative methods are considered more appropriate to address changing environments and governance issues, whilst quantitative methods are better for addressing socio-economic and vulnerability factors (Fiorella et al, 2014; Geheb et al, 2008; Darling, 2014; Allison and Mvula, 2002). One of the most recent studies investigating Lake Chilwa's fisherfolk in Malawi used a case study approach on two fishing villages and contributed to the global literature on the role of fishing to livelihoods (Allison and Mvula, 2002). It is also typical for studies of fisheries to draw upon a small case study to provide a more in-depth and deeper understanding of the complexities in fisheries and associated livelihoods (HLPE, 2014).

However, there has been no common conceptual framework or common indicators and few studies have taken into consideration the components of sustainable livelihoods and the food security pillars in more depth. In addition, the nature of fisheries and their benefits in the context of livelihood landscapes (mixed livelihood strategies such as fisher-farmers versus fishers) and shocks to the system (such as floods or drought) have received little attention. Investigating food security within the context of inland fisheries requires a method that develops our understanding of the availability of fish, access to this supply of fish, conditions leading to the utilisation of fish as well as the sustainability of that supply. Hence any approach needs to be interdisciplinary, drawing on multiple methods, ideally combining natural and social science methodologies (Beard et al, 2011; Poppy et al, 2014).Studies have shown that qualitative and participatory approaches are central to providing a deeper understanding of vulnerability and how livelihood benefits are utilised to achieve food security, combined with quantitative approaches such as household surveys to understand the five livelihoods assets (Macfadyen and Corcoran, 2002; DfID, 2004; ACF, 2010).

For the livelihood outcome of food security, the studies exploring the links between fisheries and food security tend to focus on several indicators: demographic, socio-economic and food consumption. Food security is often defined by levels of food consumption, coping strategies in response to shocks and changes in food availability, as well as through wealth indices such as the Material Style of Life index (Fiorella et al, 2014; Darling, 2014). Research varies in the extent to which it considers health, seasonality, environmental shocks, stability, vulnerability, resilience and governance, which are all important components of a sustainable livelihood and thus the outcome of food security. This indicates that researchers have tended to focus on the access dimension of food security, most commonly measured by income, expenditure, food consumption and food price, with less attention on the dimensions of utilisation (measured via the quantity and nutritional value of food, how food is consumed, and health such as stunting), stability (measured via shocks, political aspects, price fluctuations, etc.), household status and gender. In addition, it can be argued that studies have failed to acknowledge whether they are investigating chronic food security (i.e. food insecurity over a sustained period of time), or acute / transitory food security (i.e. food insecurity as a result of short term shocks including year to year change).

Participatory approaches have increasingly been used to explore socio-ecological issues of fisheries systems (Sarch, 1997) and have been identified as having great potential in advancing fisheries research. Fisherfolk along the value chain represent a wealth of untapped local ecological knowledge on the availability and temporal dynamics of inland fisheries, and can provide a deeper understanding of the hidden value of the sector (Moreno-Báez et al, 2010; Cinti et al, 2010; Daw et al, 2011b). Local knowledge of fishers is increasingly being used in research as a means to overcome data poor fisheries, enhance social and ecological understanding towards improved conservation of fisheries resources, empower and provide a voice for fishers, integrate the views of fishers in fisheries management and planning processes, and contribute to the design and management of protected areas (Lauer and Aswani, 2008; Heyman and Granados-Dieseldorff, 2012; Mellador et al, 2014). The use of local knowledge of fishers has been applied in an increasingly diverse array of fisheries research studies, including at local and regional scales, in combination with a range of natural and social methodologies (Cinti et al, 2010; Moreno-Báez et al, 2010; Barley et al, 2014). For example, Moreno-Báez et al (2010) used a range of participatory (interviews and mapping) and natural (GIS) methods to capture the local knowledge about fishing grounds and seasons of fishing communities in the Gulf of California, Mexico. The study concluded that the capturing of local knowledge was extremely valuable in deepening the understanding of highly diverse fishing activities at a regional scale. In addition, a more recent study by Mellador et al (2014) in a marine protected area in the Rocha lagoon, Uruguay, found that local knowledge of fishers can contribute to improved management of protected areas and deepen the understanding of spatial and temporal dynamics of fisheries, and conflicts. Although the need for local knowledge of fishers in research and management processes is increasingly being acknowledged, limited efforts have captured and incorporated the views of small-scale inland fishers, a sector which has been traditionally neglected and undervalued. Furthermore, a communication gap between fishers, researchers and policy, as well as an inability to integrate local knowledge adequately into management procedures, has limited the potential use of local knowledge of fishers. Such failures in integrating local ecological knowledge can lead to fisher conflicts or a decline in fisheries (Mellador et al, 2014; Drew, 2005). Increased attention to the importance of local ecological knowledge of fishers has been called for to enhance fishers' engagement and dialogue in management processes, improve fisheries management decisions and to overcome challenges arising from limited data (Lauer and Aswani, 2008; Cinti et al, 2010; Moreno-Báez, 2010).

3.2 Research Conceptual Framework

The aim of the research is to investigate the contribution of small-scale capture fisheries to food security, using the case study of Lake Chilwa, Malawi. To deliver this aim, the conceptual framework needs to be able to readily describe fishers' livelihoods through a focus on assets, seasonality and shocks, access to natural resources, markets and food, political institutions and social interactions (Allison and Ellis, 2001). **Chapter 2** outlined some of the critical issues in small-scale capture fisheries relating to vulnerability and shocks, governance, marginalisation, poverty and inequalities which are highly context specific. In addition, the nature of the fishery, household status and gender dynamics influence the benefits obtained from the sector and how they are utilised to improve food security at the household level.

Frameworks can be used to help understand the complexities within these systems and help guide research to best explore and address critical issues. Frameworks can be used for different purposes, from acting as a checklist that can support data collection, to those illustrating conceptual relationships that illuminate findings (Fisher et al, 2013). Ostrom (2009, pg. 420) states that "A framework is...useful in providing a common set of potentially relevant variables and their subcomponents to use in the design of data collection instruments, the conduct of field work, and the analysis of findings".

Although no single conceptual framework was used in the studies reviewed in **Chapter 2**, the sustainable livelihoods approach and its framework (SLF) was most commonly applied, particularly for livelihoods focused research (De Silva et al, 2007; Iwasaki et al, 2009). The sustainable livelihoods concept became central to rural development thinking in the 1990s. Sustainable livelihoods were defined as comprising "the capabilities, assets (including both material and social resources) and activities for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base" (Scoones, 2009, pg. 6). The sustainable livelihoods approach (SLF) promoted by DfID (1999) has been regarded as the most widely used framework for sustainable livelihoods (Allison and Horemans, 2006). The framework orders the complexity of rural development and poverty and acts as a checklist of important issues, influences and processes (**Figure 3.1**) (Allison and Horemans, 2006). Food security is one outcome of a livelihood strategy and it is important to understand the livelihood and socio-economic attributes which influence the pathways to food security. Livelihood assets have been defined as the building blocks of livelihoods and categorised as human (education, skill, health), natural resources, financial (cash income, credit, savings), social (institutions) and physical (shelter, infrastructure) assets (or capitals) (DfID, 1999). The vulnerability context, such as declining trends and seasonality of fish availability, health shocks or trends in fish prices, has direct impact on people's asset status, opportunities to improve livelihoods and ability to transform assets and strategies into positive livelihood outcomes (DfID, 1999). Allison and Horemans (2006, pg. 757) define vulnerability of a livelihood or person as "a function of the risks to which people may be exposed, the sensitivity of their livelihood system to those risks, and their ability to adapt to, cope with, or recover from the impacts of an external 'shock' to their livelihood system". Within the vulnerability context, people combine assets in innovative ways to achieve a desired livelihood outcome. Transforming structures and processes, such as policies and legislation in relation to fishing gears and seasons, determines access to livelihood building blocks (such as natural resources and markets), terms of exchange and returns to given livelihood strategies. The livelihood strategies people adopt are based on the vulnerability context and access to different levels and combinations of assets (DfID, 2004). This also impacts on the livelihood outcomes and thus the SLF is important for understanding the dynamics and interactions between components and livelihood outcomes (DfID, 1999). The framework therefore explains the complexity of rural livelihoods and helps to understand the livelihood platforms of households comprising capital assets and livelihood strategies, and the capabilities and transformations into positive livelihood outcomes such as improved food security (Allison and Horemans, 2006). The SLF has been highlighted to be a flexible tool that can help with data collection and to explain complexity, as well as allowing for linkages with other research that have adopted the approach (Béné et al, 2016). The framework is considered appropriate for describing fishers' livelihoods through its focus on assets, seasonality and shocks, access, political institutions and social interactions, and for understanding the contributions to food security (Macfadyen and Corcoran, 2002; DfID, 2004; Allison and Horemans, 2006; ACF, 2010). A review of the SLF applied in fisheries development research in 25 West African countries highlights the positive contributions of the sustainable livelihoods approach and its framework in capturing the multi-dimensional nature of poverty, vulnerability, heterogeneity of socio-economic status of households, diversity of livelihood strategies and influences of institutions on livelihoods and outcomes (Allison and Horemans, 2006). The review also found that the people-centred and local-level focus enabled development initiatives to build on existing strengths of livelihoods and local level issues to be recognised and linked with wider scale factors (Allison and Horemans, 2006). A review by Macfadyen and Corcoran (2002) of the use of SLF in fisheries research also highlights that the SLF provides one of the best approaches to understanding the complexities of livelihoods when combined with qualitative and quantitative tools. Although the SLF has been beneficial in better understanding local contexts of rural development and poverty, it can be argued that the framework does not consider wider influences at the regional, national and international levels such as for economic trade and environmental change (Scoones, 2009). The approach and its framework have limitations which include a lack of consideration of gender, temporal scales, intra-household dynamics, the role of markets and the role of cultural, political and institutional history (Macfadyen and Corcoran, 2002; Allison and Horemans, 2006). Due to its complexity, some have also argued that a holistic analysis cannot be achieved, and only a few studies have shown best monitoring and data collection approaches (Macfadyen and Corcoran, 2002). However, summarising the constraints and benefits across diverse socio-ecological frameworks, Fisher et al (2013) argue that the SLF acts as a key foundation framework to guide data collection and research efforts investigating livelihoods.

This thesis adopts the SLF as the research conceptual framework to investigate inland small-scale capture fisheries livelihoods. Livelihoods underpin food security, and the thesis focuses on the livelihood outcome of food security within the framework (**Figure 3.1**). The SLF was used as an analytical guide to identify variables for data collection and method design, and understand the complex factors, which shape livelihoods of rural communities. The SLF does not depict the dimensions of food security and therefore the pillars of food security were incorporated into the research conceptual framework to guide research and frame discussions of findings (**Figure 3.1**). Only two known authors have integrated the SLF with a focus on the food security lens across its pillars (ACF, 2010; Boutin and Smit, 2016). Boutin and Smit (2016) further adopted components of the SLF and expanded food security across its pillars to conceptualise linkages between climate change, livelihoods and food security in sub-Saharan Africa. Through the use of the SLF and with a focus on the livelihood outcome of food security across its pillars, this thesis investigates the local context of fish availability, shocks and vulnerability, as well as socio-economic complexities of fish-related livelihoods and food security. The research process incorporates data relating to different aspects of livelihoods and food security with an emphasis on fish, covering availability of fish and fish-related livelihoods; access to fish and food influenced by capital assets, livelihood strategies, governance and vulnerability; utilization of fish and food and nutrition intake; and stability through understanding perceptions of change. The thesis uses a mixed methodology approach to increase the validity of findings and to develop a more holistic view of the value of inland fisheries to food security in a local case study.

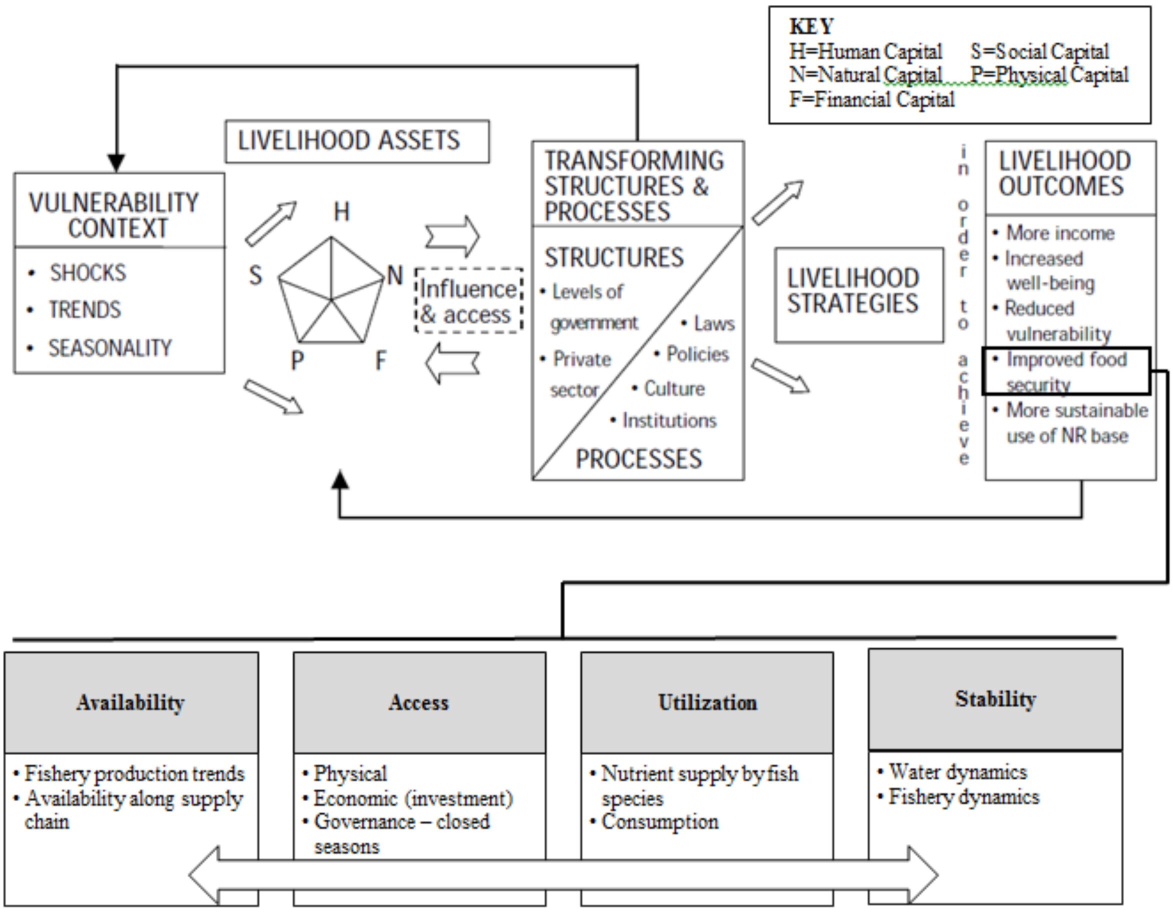

Figure 3-1 Research conceptual framework: the Sustainable Livelihoods Framework (DfID, 1999) with a focus on the livelihood outcome of food security, and its four pillars; availability, access, utilisation and stability.

3.3 Research Strategy

3.3.1 Research Paradigm, Ontological and Epistemological Position

A research paradigm consists of beliefs and practices that guide a research field (Creswell, 2003; Morgan, 2007; Scotland, 2012). It is underpinned by ontological stances on the nature of reality and epistemological positions on the theory and constituents of knowledge. Together, these inform research methodologies and methods. Three main research paradigms exist in natural and social sciences: post-positivism with quantitative methodologies, interpretism with qualitative methodologies and pragmatism with mixed methodologies (Creswell, 2003; Johnson et al, 2007; Morgan, 2007). Post-positivism holds an objective ontology where social phenomena are independent of actors, and knowledge is formed through deductive approaches, theory testing, and laws (Creswell, 2003; Tuli, 2010). Data is collected through quantitative methodologies, such as experiments and closed-question surveys, producing data that can be generalised and replicated (Tuli, 2010). Research however is not always transferrable to the social world and the research process is often fixed and inflexible to adjusting to emergent information as methods are pre-determined (Creswell, 2003; Scotland, 2012). Interpretism or constructivism believes that reality is socially constructed and a product of social processes that is subjective. The nature of inquiry is applied to real world situations and is interpretive using qualitative methodologies, such as in-depth interviews and focus groups, to build theory, interpret and describe social realities (Tuli, 2010). The researcher is connected to the research through collaboration with participants and interpretation. The research is flexible to change and produces rich, context specific data based on trustworthiness and credibility (Tuli, 2010). The transferability and generalizability of the research however can be limited and difficult to communicate to policy makers (Scotland, 2012). These two paradigms and methodologies of quantitative and qualitative approaches are embedded in natural and social sciences. However, some argue that research involves a middle ground working back and forth between inductive and deductive approaches and subjective and objective stances, and being contextual as well as transferrable (Morgan, 2007). An interdisciplinary and mixed method research paradigm, pragmatism is positioned between qualitative and quantitative approaches and incorporates many philosophical viewpoints to best address research problems (Johnson et al, 2007; Morgan, 2007). Pragmatism makes the research problem central and freely combines ideas and methods to best address the research question at the time (Creswell, 2003; Johnson et al, 2007). The integration of qualitative and quantitative methodologies is conducted simultaneously or sequentially to study the same phenomenon (Johnson et al, 2007). The triangulation of data from these integrated approaches can increase validity, generalizability and credibility (Creswell, 2003).

However, it also presents challenges in combining philosophies and tensions when contradictions arise in data from different source (Creswell, 2003). A mixed methodology approach therefore needs to address a particular research question and address the nature and principles of each method in interpretation (Johnson et al, 2007). An understanding in methods and ontological and epistemological differences across disciplines underpins rigour in pragmatism and mixed method approaches (Haider et al, 2017). Haider et al (2017) define this as a new ‘un-disciplinary science’ that is problem focused, reflexive and collaborative, and where a researcher is able to navigate epistemologies. Interdisciplinary research can therefore involve changing epistemological stances as the research develops and through the researcher’s journey of reflection and learning. Johnson et al (2007) outline that it is typical for interdisciplinary scientists to hold a blend of beliefs varying along a continuum of philosophical and methodological commitments (**Figure 3.2**). Through my experiences as an interdisciplinary researcher, my beliefs have developed from a post-positivist paradigm to a more pragmatic one supporting integration of mixed methodologies and coexistence of viewpoints from quantitative and qualitative stances (Johnson et al, 2007). My research outcomes have also highlighted the value of qualitative methodologies and interpretism stances as being critical to understanding people’s experiences of livelihood and food insecurity and adaptation, which is central to this thesis.

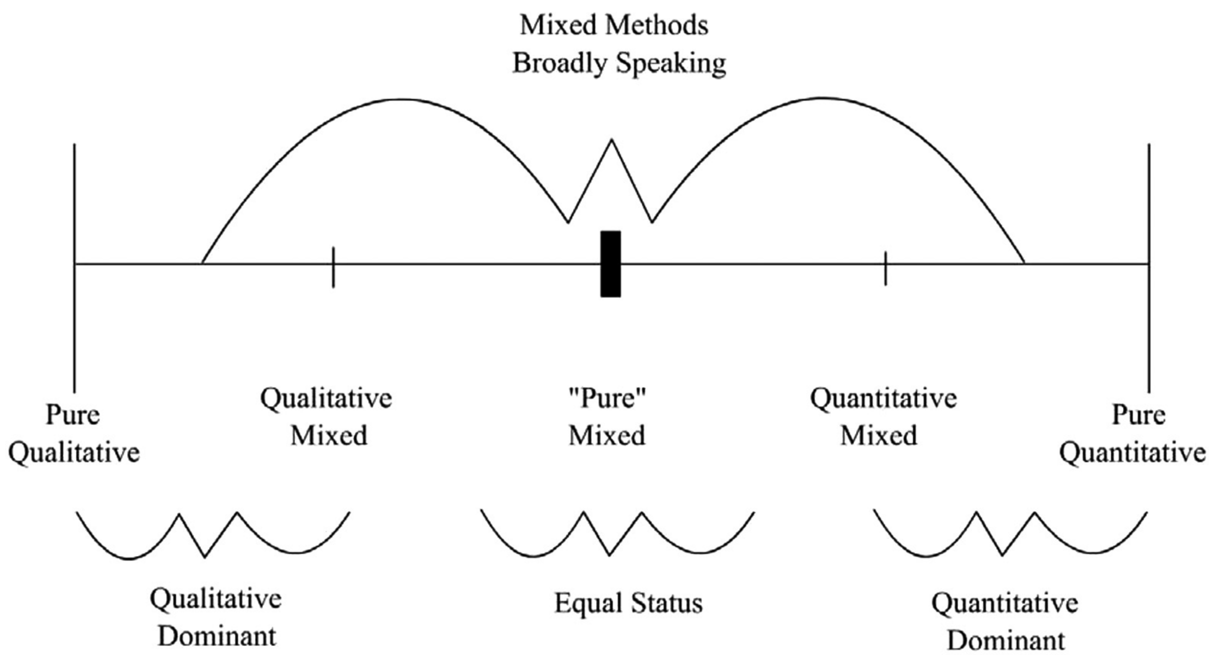

Figure 3-2 Three major research paradigms and sub-types (Source: Johnson et al, 2007).

3.3.2 A Case Study Approach

The inland small-scale capture fisheries sector presents methodological challenges in working in data limited environments and rural settings. As one of the most under-reported and under-valued fisheries' sectors, national statistics often mask the true value of the sector in terms of fish supply and consumption at the local level. In addition, inland capture fisheries are often dispersive and in remote settings, providing challenges in conducting research at the local level in relation to access, sample design, resources and costs. To address these challenges, this thesis adopts an interdisciplinary case study approach. Case studies have been extensively used in fisheries and natural resource management discourse as they enable an in-depth investigation into the complexities of socio-ecological systems (Lowitt, 2014; Allison and Mvula, 2002; Cleasby et al, 2014).

Numerous studies have shown a case study approach to be an effective method in advancing fisheries research and deepening our understanding of the complex pathways by which fisheries can contribute to improved food and nutritional security, particularly through small studies at local levels (HLPE, 2014; McVean et al, 2005). According to Gagnon (2010), a single case study makes it possible to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context. The value of the case study approach is well recognised across many disciplines as it can extend experience, add strength to previous research, support theoretical insights and provide detailed contextual analysis of specific relationships (Flyvbjerg, 2006). As described by Flyvbjerg (2006), the main benefit of conducting a case study is the rich understanding developed from a specific case which is often essential for understanding certain phenomena. Case studies can be qualitative or quantitative in nature and a mixed interdisciplinary methodology is often applied when investigating livelihoods and food security (Stake, 1995; Schreckenberg et al, 2010; Allison and Mvula, 2002; Poppy et al, 2014). A case study approach to research can provide a unique in-depth understanding into many important socio-ecological aspects of inland fisheries. A summary of the benefits, potential pitfalls and mitigation actions relating to case study research is presented in **Table 3.1**.

Table 3-1 Potential benefits, pitfalls and mitigating actions when undertaking case study research. Source: adapted from Stake (1995); Flyvbjerg (2006); Crowe et al (2011).

Potential Benefits	**Potential Pitfalls**	**Pitfalls- Mitigating action**
Exploration of complex issues or certain phenomena.	Selecting/conceptualising the wrong case(s) resulting in lack of theoretical generalisations	Developing in-depth knowledge of theoretical and empirical literature, justifying choices made
Can be qualitative or quantitative in nature.	Collecting large volumes of data that are not relevant to the case or too little to be of any value	Focus data collection in line with research questions, whilst being flexible and allowing different paths to be explored
Unique in-depth and multi-faceted investigation.	Defining/bounding the case	Focus on related components (either by time and/or space), be clear what is outside the scope of the case
Can use multiple sources of data.	Lack of rigour	Triangulation, respondent validation, the use of theoretical sampling, transparency throughout the research process
	Ethical issues	Anonymise appropriately as cases are often easily identifiable to insiders, informed consent of participants
	Integration with theoretical framework	Allow for unexpected issues to emerge and do not force fit, test out preliminary explanations, be clear about epistemological positions in advance

3.3.3 A Mixed Methods Approach

In order to develop a thorough understanding of a contemporary real-life issue, the case study approach typically comprises the collection of a diverse range of evidence, using quantitative and qualitative techniques. A mixed methods interdisciplinary approach is used in this thesis bringing together natural and social science methodologies. Both qualitative and quantitative data collection methods are used, including use of advanced methods (satellite derived water level data) and local ecological knowledge, to illuminate the hidden dynamics and socio-economic value of the sector in data limited environments.

A mixed methods approach in social and behavioural sciences originates from the 1980s (Tashakkori and Teddlie, 2003) and the benefits of such integration is increasingly being reported in the literature. Defined by Stange et al (2006; pg. 292), a mixed method involves "integrating quantitative and qualitative approaches to generate new knowledge and can involve either concurrent or sequential use of these two classes of methods to follow a line of inquiry." There is a growing acceptance for the integration of social methods and natural science methods in the broad literature, with increasing evidence revealing the benefits of this approach in conservation contexts (Schreckenberg et al, 2010). Qualitative and quantitative methods are increasingly considered as complementary to one another in livelihood analysis (Stirrat, 2003; Howe and McKay, 2005). The integration of these tools allows the assessor to take a broad and robust view of the complex pathways by which fish can contribute to livelihoods and food security. By integrating methodologies, a fuller assessment of the biological, social, economic and governing factors influencing livelihood outcomes derived from inland fisheries systems can be achieved.

Household surveys have been widely used to understand fish and food security where information on the frequency, source, purchased or self-provision, types of food and the ways of eating have been obtained quantitatively (Fiorella et al, 2014; Geheb et al, 2008; Darling, 2014; Allison and Mvula, 2002). Surveys based on structured, semi-structured and open questionnaires are widely used for data collection in social sciences (Bassey, 1999) and are increasingly being recognised as a valuable tool in fisheries research (Beard et al, 2011). Questionnaires can provide reliable information on livelihood strategies and outcomes and thus can serve as an effective tool in supplementing qualitative information gathered about the role of fish to local food security.

Information obtained from questionnaires can also provide an effective means to explore factors influencing the pathways to improved food security.

Participatory approaches and methods are being increasingly used in research and development process. As stated by Chambers (1994), Participatory Rural Appraisal (PRA) is a suite of methods used to enable research participants to share their experience of a particular issue. PRA was founded from participatory research and holds long traditions in the fields of anthropology and agriculture livelihood research (Gilbert et al, 1980; Shaner et al, 1982; Conway, 1987). Increasing consensus in the literature recognises that managing fisheries is as much a political issue as it is a technical biological one. Key considerations such as who obtains rights to fishing, who benefits from the fishery and how these benefits are distributed are often neglected questions in fisheries management (Daw et al, 2011a). A participatory approach to fisheries research can address these research needs in a non-threatening and gender-sensitive way.

There are a variety of PRA techniques which can be used either in extractive research or in participatory action research, the latter allowing the participant to have more control of the research process. As commonly reported in the literature, PRA tools are used in an interactive way, both as a starting point to obtain broad information about the local context as well as to obtain more rich information of specific issues as the research process progresses. Limitations of PRA include weaknesses in capturing differences of gender and power relations. Focus group discussion (FGD) is one of the most widely used participatory methods and can be used effectively to capture the views of often marginalised categories of people. Participatory methods such as FGDs have proven to be an effective tool for understanding diversity in the fisheries sector, capturing the views of often marginalised, illiterate fisherfolk as well as understanding the role of fishing in complex household survival strategies. Photovoice is a unique form of community-based participatory research founded on the principles of feminist theory, constructivism and documentary photography (Wang and Burris, 1997; Castleden et al, 2008; Bennett and Deardon, 2013). Photovoice as a research methodology provides participants with the opportunity to take photographs of a particular issue, to discuss the images as a group and identify common themes and create research outputs through shared understanding and ownership of the research process. The methodology has been widely used in the health sector with little application in natural resource management, however it has been shown to be a valuable method for gathering rich, unpredictable data within fishing communities (Bennett and Deardon 2013).

3.3.4 Case Study Selection

Malawi within East Southern Africa has experienced declines in fish supply per capita in the past decade with one of the lowest fish supplies globally (FAOSTAT, 2017). Lakes Malawi, Malombe, Chilwa and Chiuta comprise the major aquatic ecosystems. As a result of Malawi’s rich aquatic environment, fisheries resources have traditionally played a crucial role in contributing to livelihoods, employment, national economic development, the supply of low cost protein and more recently, the enhancement of nature-based tourism (GoM, 2012). Fisheries provide a significant source of employment and livelihoods, both directly and indirectly, to an estimated over 1.6million Malawians (GoM, 2012). According to recent government figures (GoM, 2012), the capture fishery sector employs over 60,000 people in the primary sector and a further 350,000 people in other stages of the value chain (e.g. fish processing, trading, transportation). This is synonymous with global employment estimates in the sector, revealing over twice as many workers engaged in secondary activities (World Bank, 2012). However, data regarding characteristics of employment (full-time, part-time, short-term seasonal) in Malawi’s capture fishery sector is limited. The capture fishery sector in Malawi is also of national cultural importance. Capture fisheries have long provided Malawians with the main source of fish protein (Russell et al, 2008). Rivers, small water bodies and the four major lakes of Malawi were actively fished by inland and lake-shore communities for centuries owing to a tradition of fishing practices, fish consumption and a strong sense of identity and social bonds to many rural communities (Hoole 1955; van Velsen, 1964). The fisheries sector in Malawi is divided into three groups: capture fishery, aquaculture and the aquarium trade. Malawi is dependent on capture fisheries for approximately 98% of its fish supply from two main sources: Lake Malawi followed by Lake Chilwa.

Lake Chilwa is a tropical lake at the southern end of the African Rift Valley, located within southern Malawi and on the border with Mozambique (**Figure 3.4**). The wetland was designated as a Ramsar site of international importance in 1996 for its water bird populations (Njaya et al, 2011; Rebello, 2011). It is the second largest fishery in Malawi and was chosen as a case study to address this thesis’s objectives. Lake Chilwa is a complex socio-ecological system representative of a typical shallow tropical inland fishery system, and is sensitive to changes in climate. Although the fishery has been reported to be one of the most productive inland small-scale fisheries at times (Njaya et al, 2011; Kolding and Zwieten, 2012), it is also one of the most variable as a result of climate-induced lake level changes. In peak years, average annual catch of over 20,000 tonnes has been recorded (Jul-Larsen et al, 2003; Rebello, 2011). The lake experiences periodic events of low water level and drought (Kalk et al, 1979; Njaya et al, 2011; Nagoli, 2016) (Jul-Larsen et al, 2003). Fluctuations in catch have been reported since 1845 and fisheries have been reported to cease completely during water level recessions and drought (Njaya et al, 2011; Rebello, 2011; Kafumbata et al, 2014). The fishery comprises three main fish species which are monitored by the Government of Malawi: *Clarius gariepinus* (local name: *Mlamba*), *Oreochromis Shiranus chilwae* (local name: *Chambo*) and *Barbus paludinosus* (local name: *Matemba*) (Njaya et al, 2011).

Within the lake's catchment, thousands of people depend on its natural resources, including fisheries, for their livelihoods, food security and nutrition (Njaya et al, 2011). The fishery has been classed as the 'engine of the basin's economy' (Njaya et al, 2011; Rebello, 2011; Kafumbata et al, 2014). Livelihood strategies around the lake vary spatially and include major livelihood activities of farming, fishing and livestock rearing combined to differing degrees by different people. Over recent decades, these activities have progressed from subsistence to commercial where agricultural products and fish are sold at markets for cash, and there have been reports of a reduction in livestock rearing (Kalk, 1979; State of the Environment, 1999). Studies have shown that in lakeshore village areas, engaging in fishing produces higher income earnings and assets through higher mobility and access to markets, however fishing livelihoods are vulnerable to declining fish catches and reduced ownership of land (Allison and Mvula, 2002).

The Lake Chilwa fishery is a typical small-scale inland fishery in developing countries and supports the livelihoods of approximately 10,000 fishermen at times, with potentially twice as many along its supply chain. The fishery is dominated by small-scale fisherfolk using traditional fishing gears such as hooks, fish traps and long lines, and processing techniques such as sun drying and smoking with small brick kilns. Larger scale operators also exist with fishermen using gill and seine nets, and processors using large pans to fry fish. Fish is often sold to local and regional markets for cash, however it is also used for subsistence consumption by fisherfolk. Women are involved in the fishery mainly as fish processors, and fishing is often dominated by men. Fishing in Lake Chilwa forms an important rural livelihood activity in the riparian catchment, and is often integrated with other natural resource activities, such as farming, for sustainable livelihoods and annual food security. However, socio-ecological systems are transitory and change over time depending on social, economic and ecological factors. This complex relationship demands more rigorous investigation in Lake Chilwa. Limited research has been conducted in the past decade on Lake Chilwa's fishery and gaps remain in understanding fish-related livelihoods along the value chain, vulnerability, perceptions of challenges and benefits obtained. A fisheries co-management regime operates on the lake to protect the fishery from over exploitation (Njaya, 2009). The regime implements restrictions including a closed fishing season each year from December to March and restrictions on destructive high technology gears, which are governed by Beach Village Committees (BVCs) (Njaya, 2009). However, the effects of the co-management regulations on the ecosystem and livelihoods remain poorly understood (Jul-larsen et al, 2003; Njaya et al, 2011). Lake Chilwa's inland fishery therefore presents a good case study for understanding the socio-economic importance and challenges of an inland capture fishery system. The role of Lake Chilwa's fishery for food security is poorly understood, and represents a good case study to explore vulnerability and livelihoods which underpin livelihood outcomes. Lake Chilwa was selected as a case study for the following reasons:

- Highly productive fishery;
- Experiences high environmental change (water level fluctuation);
- Availability of long-term biophysical data;
- Past social studies investigating livelihoods;
- Relatively closed system where complex relationships between multiple variables could be untangled;
- Governance intervention via introduction of a co-management regime in 1996 resulting in a closed season for part of the year;
- Catchment area undergone rapid population growth in past few decades;
- High dependency of local populations on fishery resources for livelihood support;
- Communities within the catchment are facing increasing pressures in producing and accessing food in light of economic and production shocks;
- Data poor regarding the value of Lake Chilwa's fishery for food and nutritional security; and,
- Accessibility of communities around the lake.

3.3.5 Case Study Village Selection

Lake Chilwa is encompassed by three administrative districts; Machinga, Zomba and Phalombe. Each district varies in size, accessibility, ecological characteristic and population density, representing differences in geography and socio-economics. The District of Zomba encompasses the central and largest portion of the lake (Ambali and Kabwazi, 1999). There are four fish landing sites around the lake located to the North, South, North West, and West (Ambali and Kabwazi, 1999). The major fish-landing site is Kachulu in the West within the District of Zomba. There are approximately 40 fishing villages along the lakeshore of Lake Chilwa, each with a Beach Village Committee (BVC) set up for fisherfolk as part of co-management of the fishery between the Government and communities. Some fishing villages and their BVCs are located next to landing sites and some are further away. Lakeshore communities typically engage in farming and fishing to various degrees which is shaped by spatial access (Allison and Mvula, 2002). A literature review on fishery and livelihood studies around Lake Chilwa and a scoping exercise was conducted in 2014 to assess lakeshore villages and fishing characteristics. Villages around two districts of Lake Chilwa; Machinga and Zomba, were visited and assessed in terms of fishery characteristics, livelihoods and access through observations and key informant expert advice from local partners. Key informant interviews and discussions with local officials and partners identified key districts and village sites for the study that were representative of fishery and livelihood characteristics in the basin.

The district of Zomba and its main landing site of Kachulu was selected purposively for this study. The district represents a larger proportion of Lake Chilwa and the main fish-landing site is located there. Two fishing villages located within Zomba and around Lake Chilwa were purposively selected to provide in-depth knowledge on key characteristics of fisherfolk and the relationship between fish resources, livelihoods and food security. Selection was based on technical criteria as well as field budget, accessibility and time constraints.

Landing sites are epicentres of a variety of fisherfolk and are gateways to markets (Nagoli and Mwanza, 2010). One village was selected next to a landing site in-order to capture the variety of fisherfolk, and to understand how accessibility to market can determine the role of fishing for their livelihood. Fishing villages are also found with further distance away from landing sites, and also comprise fisherfolk along the supply chain; fishermen, women processors and traders (Nagoli and Mwanza, 2010). The second village was selected based on further distance away from the landing site, infrastructure and markets. The two villages were selected in the same geographical region and within the same district (Zomba) so that experiences are homogenous in relation to environmental change. They both represent heterogeneity in fisher activities (small and large-scale operators), heterogeneity of dependency (fishers and fisher-farmers), diversity in roles and gender (women and men processors, traders and fishers), and represent diversity in access to markets (epicentre and remote). Small-scale fishers are characterised by use of handmade fishing equipment and dugout canoes with catch often consumed at the household, while large-scale fishers are characterised by advanced equipment such as seine nets and plank boats, with fish often sold at market. Fishers are defined as any adult individual male or female partaking in the fishing industry along the supply chain, including primary and secondary activities such as fishing, processing and trading. Non-fishers are defined as any adult individual male or female not partaking in primary and secondary fishing activities. This representation enables the study to evaluate what 'mix' of fisher patterns, social and economic factors are needed for fisheries to contribute to food security and poverty alleviation. There were no active aquaculture operations at the two case study villages and thus fisheries-related activities were solely related to inland small-scale capture fisheries.

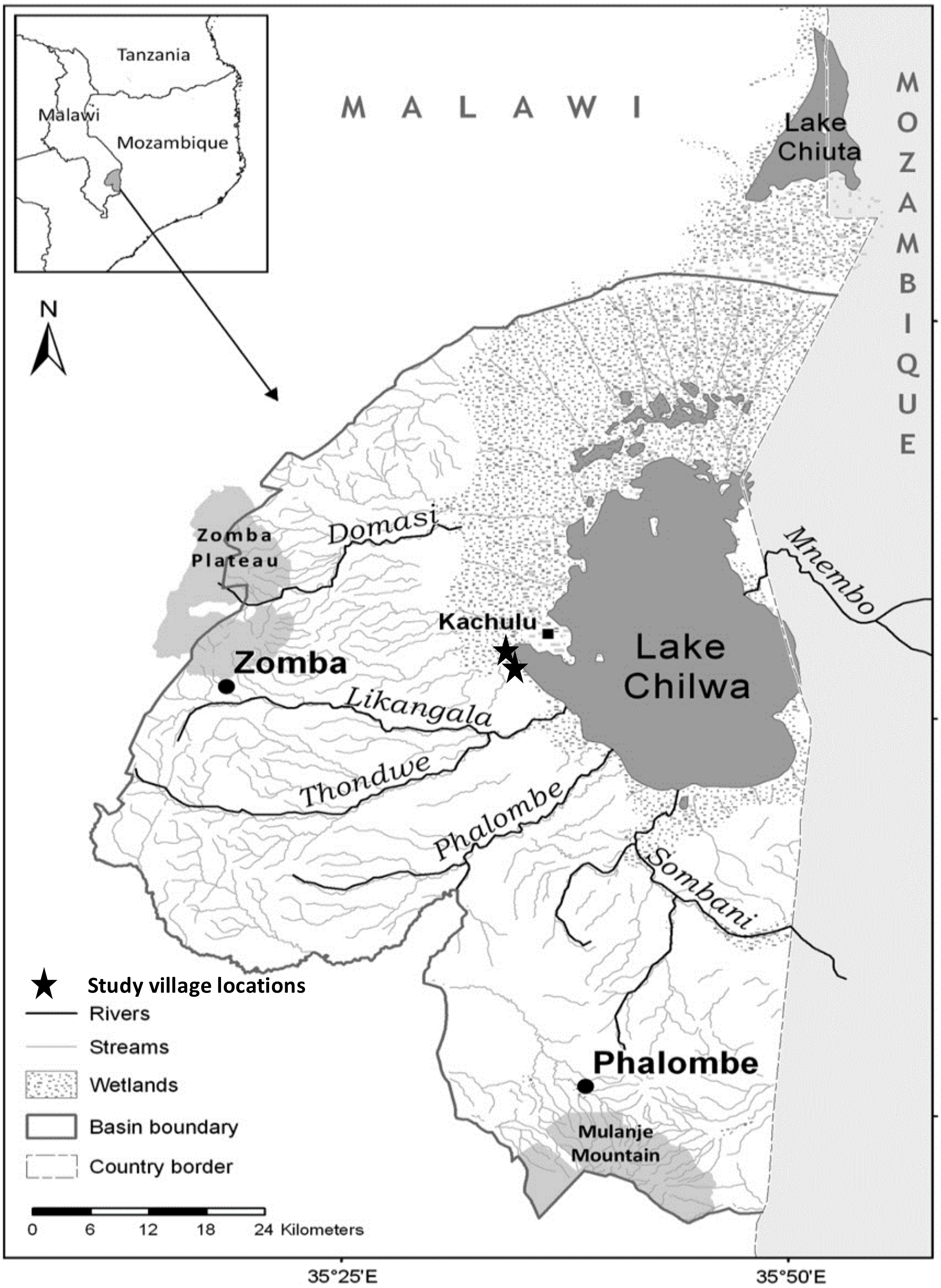

Figure 3-3 Map of Lake Chilwa in Malawi with study villages (indicated with a star). Likapa village is closest to the fishing port of Kachulu, and Sauka Phimbi further away.

The two villages, Likapa (next to Kachulu) and Sauka Phimbi (further away from Kachulu), are both located within the Traditional Authority (TA) of Mwambo and within the District of Zomba. The locations of the study villages are illustrated in **Figure 3.3**. Permission was sought from the Group Village Headman in Mwambo TA and from the Village Headman of both villages to conduct research in the study sites.

The study area had a history of past livelihood and fishery research that could help inform research design and enable an understanding of changes over time (Kalk, 1979; Allison and Mvula, 2002; Chiwaula et al, 2012). However, due to the remote location of Lake Chilwa, studies were limited, particularly in extremely remote locations in Phalombe and Machinga. Thus, although attempts were made to ensure the selected location and case study villages were representative of diversity in livelihoods and fishery activities in the basin, limitations exist in the extent to which findings are generalizable to all lakeshore communities, particularly those in extremely remote locations where fish-related activities may play an even more critical role in livelihood and food security given limited alternative sources of employment and nutrient dense food. The nature and characteristics of the study site and fishery are depicted in **Figure 3.4**.

Figure 3-4 Photographs of field observations in Lake Chilwa.

3.4 Method and Sampling Design

A range of methods and tools were used to explore the role of fish for food security in Lake Chilwa. An outline of the combined qualitative and quantitative approaches applied to the Lake Chilwa case study is provided below, and a summary provided in **Table 3.2**. Methods include both quantitative and qualitative approaches: quantitative household surveys (HHS) and fisher surveys, and, qualitative participatory rural appraisal exercises that included Focus Group Discussions (FGDs) and the Photovoice methodology. The strength of this approach is that it enables 'triangulation' of results where the weaknesses of one method are supported by the strengths of another. Data was collected at different scales; biophysical data collected at the water body level, and social data collected at the individual, household and community level with fisherfolk involved in diverse activities along the value chain, which included both men and women fishers. By inclusion of diverse fisherfolk activities and men and women, the thesis goes beyond traditional studies that only investigate male fishermen, and provides a more representative investigation of the livelihoods and perceptions of inland fisherfolk. By inclusion of men and women fishers, the thesis contributes to understanding the roles of men and women in the value chain, and their perceptions on challenges and benefits, in a sector where data has tended to be aggregated. A gender analysis was out of the scope of the thesis and gender relations and power dynamics between fisherfolk, and within households was not explored.

Field work to collect primary and secondary data was undertaken for one month in July 2014, and four months between May and August in 2015. Primary data collection started with qualitative work before proceeding with the quantitative household surveys that included more sensitive aspects of governance perspectives. Recognising the challenges of building confidence and trust between external researchers and local respondents, a total of 6 weeks was spent in each village during data collection. I was introduced to the villages by locally-trusted actors (extension officers and World Fish) which helped smooth the way for me to work with the communities.

Table 3-2 Research methods and tools.

Research Method	Scale	Temporal Scale	Research Tool	Variables of Interest
Quantitative	Water-level	1980-2010	Secondary Data Time Series Analysis.	Fish Yields Fishing Effort Relative Lake Level Change
	Household	June-August 2015 (including past 12 months recall, and past events recall).	Structured Household Survey.	Demographics Socio-economic Food Security Perceptions change and governance
Qualitative	Individual	2014	KIIs - Semi-structured Interview.	Value, drivers of change and knowledge gaps
	Community	June-August 2015 (including past 12 months recall, and past events recall).	FGDs – interview guide and PRA tools (seasonal calendar and matrix)	Perspectives on how seasons and shocks affect fish supply by species, fishing patterns; and, fish consumption and preference
	Community and Individual	June-August 2015	Photovoice	Perceptions of fisherfolks role, benefits received from their role, and the challenges they experience.

3.4.1 Quantitative Approaches

Secondary Data Time Series Analysis - Fish Availability and Stability of Supply

Secondary data was used to investigate **Research Question 1** of the thesis: What effect do water dynamics have on fish supply? The approach informs **Chapter 4**: Fisheries and Water Dynamics, of this thesis. See **Chapter 1** for further details on thesis aims and objectives, and structure, as well as **Chapter 4** for its application. Trends in fish catches by species were explored over time in Lake Chilwa, and the effects of climate variability on fish catches investigated in order to understand the availability and stability of fish which underpins fishing livelihoods, vulnerability and its contribution to food security. Secondary bio-physical data on fish catches by species, rainfall and lake level from 1980 to 2010 was used to explore the relationship between fish catch and water dynamics. The investigation by species enables an evaluation of species resilience and understanding of the supply for each species. In addition, annual fishing effort (number of crewmembers and gear owners) is included in the analysis. The variables selected build on the theories presented in **Chapter 2**. Data was requested and provided by the Government of Malawi in 2014 and 2015. The time period was selected because it is representative of an extreme dry period (in 1995/96) and higher water level (1997/8), and based on availability and quality of data. Remote sensing satellite radar altimetry was also used to obtain relative lake level change for the period of 2003-2010, and is integrated with biophysical secondary data for earlier periods.

Household Surveys

Household surveys were undertaken in order to investigate **Research Question 2** of the thesis: What is the relationship between fishing livelihoods and food security? and **Research Question 3**: How do fisherfolk experience seasonality, shocks and governance, and perceive the impacts of these on their livelihoods? The results inform **Chapter 5**: Fisheries and Food Security and part of **Chapter 6**: Fishing Patterns and Water Dynamics, of this thesis. See **Chapter 1** for further details on thesis aims, objectives and structure, as well as **Chapter 5 and 6** for its application. A household survey, divided into three parts and in the form of closed questions that include ranking and multi-choice options, was designed and carried out in the study villages. See **Appendix B** for household surveys Part1-3. The survey was designed based on the SLF and the four pillars of food security. The aim of the household surveys was to collect quantitative information at the household scale on socio-economic status, demography and household structure, food security with emphasis on fish, livelihood activities, seasonality, fish preference, shocks and coping strategies, change in fisheries and governance. A breakdown of each part of the survey and the information collected is provided below:

- PART 1: assets, livelihood activities and ranking by income, livelihood seasonality, fishing activities, expenditure, livelihood shocks and coping strategies, food consumption frequency, fish consumption, fish preference and seasonality patterns, food security shocks and coping strategies, social networks;
- PART 2: fisher activity characteristics, seasonality of activity, use of fisher activities income, start up, shocks, fisheries change and perceptions, value of activity, constraints and perceptions on governance; and,

- PART 3: fisher and processor details on role, start up, distribution, technique and fish species.

In May 2015, household listings were undertaken to record the number of households in each village, and to record the livelihood activity of the household in regards to their involvement in the fishing industry. Typical villages in the districts are between 20 – 200 households. A short filter questionnaire with a key village informant identified households involved in the fishing industry and those not. Households were then selected via stratified random sampling by involvement in the fishing industry (yes or no). Within each village, 40 fishing households and 20 non-fishing households were selected at random for interview. The head of the household was interviewed for each household. A sample size of approximately 60 households for administering the quantitative surveys in each village was determined based on minimum requirements for statistical analysis of stratified groups, as well as due to field budget and timing constraints. The case study and sample size is common in local level assessments using a mixed methodology approach to gain a deeper understanding of complexities in livelihoods (Allison and Mvula, 2002; De Silva et al, 2007; Iwasaki et al, 2009; Darling, 2014).

Field testing of the questionnaire was carried out prior to the survey with a small group of participants from a fishing village (near to sample villages), with local partners in Malawi in order to validate and finalise questions. The questionnaire was translated into Chichewa and back-translated into English to ensure consistency of meaning. A local experienced and qualified enumerator was used to administer the survey and was trained in the survey. A map of selected households was produced in each village before surveys commenced, which included additional households for contingency in circumstances where the household member was not present. Part 1 of the survey was administered to all 120 households across the two villages. Part 2 and 3 of the survey was administered to only fishing households which was 80 in total across both villages. Part 1 to 3 of the survey was administered to participants within approximately 1 hour and 30 minutes.

3.4.2 Qualitative Approaches

Qualitative approaches were used in order to investigate **Research Question 3**: How do fisherfolk experience seasonality, shocks and governance, and perceive the impacts of these on their livelihoods? and **Research Question 4**: How do fisherfolk perceive the benefits and challenges of fisheries in their livelihoods? These methods inform part of **Chapter 6**: Fishing Patterns and Water Dynamics, and **Chapter 7**: Perceptions and Values of Fisheries, of this thesis. See **Chapter 1** for further details on thesis aims and objectives, and structure, as well as **Chapter 6 and 7** for its application.

A range of qualitative tools drawn from Participatory Rural Appraisal (PRA) methods were used to assess the patterns of use of the fishery resource, seasonality of fish consumption and fisher activities, fish preference, the effects of water dynamic shocks on availability, and the perceptions of value, benefits, change and challenges. Within each of the two fishing villages around Lake Chilwa, the following PRA methods were undertaken: Key Informant Interviews (KIIs), Focus Group Discussions (FGD) with Ranking Exercises and Seasonal Calendars, and Photovoice exercise. A summary of the approaches and key issues addressed by each is outlined below.

Key Information Interviews (KIIs)

A key informant is anyone who has special knowledge of a particular topic. The approach was applied to the first exploratory phase of data collection in order to understand key issues concerning fisheries in Lake Chilwa. During the first phase of data collection (July, 2014), semi-structured interviews were carried out with key informants who were likely to have specialized knowledge concerning Lake Chilwa's fishery. Key informants were purposively selected and identified with assistance from experts from the WorldFish office, Malawi. A semi-structured questionnaire, comprised of open-ended questions, was developed with the aim to explore the value, drivers of change and knowledge gaps regarding the socio-ecological context of Lake Chilwa. The second aim of carrying out the KII was to obtain secondary data from key experts. This exploratory phase was crucial to building rapport with key stakeholders actively involved in the capture fisheries sector in order to aid future research design. Interviews ranged between 45 minutes to 1.5 hours and were carried out in the offices or homes of the participants. Information gathered was used to help identify priority areas and issues in Lake Chilwa. A summary of the KII questionnaire can be found in **Appendix C**.

Focus Group Discussions (FGDs)

FGDs were conducted in the two study villages between June and August 2015. Livelihoods are affected by trends, shocks and seasonality, and in order to understand the availability of fish, fish consumption and its role to food security, temporal considerations of resource use are required (DfID, 1999). The use of FGDs and PRA tools provide an effective means to capture local people's knowledge regarding relationships and patterns of resource use over time. Six FGDs were conducted in each village, with three being conducted with women and three with men. On average FGDs involved seven people, and a total of 84 people took part in FGDs across the two villages. The FGD exercises covered three main topics: 1. Fish availability, seasonality, shocks, and change, 2. Fish consumption, seasonality, shocks and preference, and 3. Technique, seasonality and preference of fish species. A discussion guide (**Appendix D**) was used to provide consistency across groups as well as to provide flexibility to probe for local knowledge, values and experiences by the participations. PRA tools such as seasonal calendars and matrixes were also used to aid discussions and help facilitate a deeper and more inclusive discussion. Findings from FGDs and discussions around seasonal calendars were used to identify the months or periods that are associated with highest vulnerability in terms of food security.

Participants were recruited via a purposive and snowball approach with the assistance of a local key informant within each village. Participants were recruited based on the following criteria: adult fisherfolk actively engaged in fish-related activities in the past 12 months, five or more years of experience, mixed scales of fishing operation, mixed ages, and representing diversity of fisher roles in village. All FGDs were recorded and transcriptions of recordings were undertaken by local translators.

Photovoice

Photovoice methodology was used as a final qualitative tool to capture the characteristics of fish-related activities and perceptions of women and men fishers regarding benefits and challenges experienced. The method was administered during June to August 2015 in both study villages to between seven and eight participants in each village. Participants were recruited via a purposive and snowball approach with the assistance of a local key informant within each village. Participants were recruited based on the following criteria: adult fishers who are actively involved in Lake Chilwa's fishery in the past 12 months, mixed scales of fishing operation, mixed ages and representing diversity of fisher roles in village. The methodology involved providing participants with disposable cameras to explore their role, benefits and challenges. One-to-one interviews were then conducted with each participant and narratives formed based on photographs taken (see the manual in **Appendix E**). The method involved several steps and the full process is discussed in Simmance et al (2016), appended as **Appendix F**. All interviews were recorded and transcriptions of recordings were undertaken by local translators.

3.4.3 Triangulation of Methods and Tools

Triangulation of data from multiple sources can increase validity, generalizability and credibility of research findings (Creswell, 2003). However, it also presents challenges when contradictions arise in data from different source (Creswell, 2003). By adopting a mixed method approach, the research overcomes the weakness of using one method alone, and reduces the impact of bias. Different methods were used to collect data on the same topic in order to obtain rich perspectives, increase in-depth understanding and allow for cross verification of findings. **Chapter 8** presents a discussion of research findings from **Chapters 4 to 7**, and triangulates data across qualitative and quantitative methods. **Chapters 4 and 6** allow for triangulation of quantitative secondary data with rich qualitative information on the perceptions of fisherfolk regarding the temporal dynamics of Lake Chilwa's fishery, effects of climate variability and changes in availability. **Chapters 6 and 7** allow for cross verification of the perceptions of fisherfolk regarding challenges and benefits of the sector, which together allow for triangulation with quantitative findings in **Chapter 5** on the household livelihood and food security status of fishers. The use of multiple sources of data (data triangulation) increased the validity of the research and helped develop a more holistic view of the value of inland fisheries to food security in a local case study.

3.5 Research Phases

At the initial stage, a comprehensive literature review was developed (see **Chapter 2**) to draw upon the current knowledge of inland fisheries and identify research gaps. Outcomes of the literature review were used as a useful resource to guide the development of research objectives and questions presented in **Chapter 1** of this thesis. The research objectives and conceptual framework were cross checked with key local stakeholders to help validate the research design. Based on this the case study area, the Lake Chilwa catchment, was purposively chosen to pursue the objectives of the research. A research conceptual framework, approach and design were developed in accordance with research objectives, time, budget, field work logistics and ethical considerations bounding this PhD. Both qualitative and quantitative data, collected from a wide range of data sources, were used in the study in an interactive way. Secondary and primary data were collected in a two staged process. The first phase of data collection involved the collection of biophysical and socio-economic secondary data from a diverse range of sources, collection of primary qualitative data via interviews with key informants and a scoping exercise to assess lakeshore villages and fishing characteristics. This exploratory phase of data collection was carried out in July 2014 and strategy and management considerations of the research were reviewed to effectively plan for the second and final phase of data collection. Quantitative household surveys and qualitative FGDs and photovoice exercises were undertaken between May and August 2015 as part of the final data collection and fieldwork stage. Outcomes of the information gathered from different sources were presented and cross-checked with key local stakeholders. Internal validation was developed through triangulation of methods, and the study found approaching certain issues from different techniques developed a clearer picture of the role of capture fisheries to food security. See **Chapters 4 to 7** for further details.

3.6 Research Collaborators

The research study was conducted with the support of three collaborators, two located in Malawi, and one international. The WorldFish Centre is one of the institutions under the Consultative Group on International Agricultural Research (CGIAR). It is an international, non-profit research organization dedicated to reducing poverty and hunger by improving fisheries and aquaculture. Dr. Joseph Nagoli is the lead fisheries social scientist in WorldFish Malawi office and kindly provided logistical and technical support throughout and acted as an in-field supervisor.

Leadership for Environment and Development, Southern and Eastern Africa (LEAD SEA) is an affiliate programme of LEAD International, a non-profit organization based in the UK. LEAD SEA's mission is to create, strengthen and support networks of leaders and institutions promoting change towards sustainable development through capacity development and strategic, outcome-oriented activities consisting of policy, research, communications, and training. Professor Sosten Chiotha is the director of LEAD SEA, and together with Dr. Dalitso Kafumbata who is affiliated with LEAD SEA and from the University of Malawi, Chancellor College, they provided logistical and technical support. Dr. Charon Birkett is an Associate Research Scientist with the Earth System Science Interdisciplinary Centre at the University of Maryland-College Park. Dr Birkett is part of the USDA PECAD project which uses remote satellite near-real time altimetric-monitoring to monitor lake and reservoir height variations around the world. Dr Birkett kindly offered to extend their programme to include Lake Chilwa specifically for this thesis research (see **Chapter 4** Water Dynamics and Fisheries for further details).

The research study was also affiliated with the 'Attaining Sustainable Services from Ecosystems through Trade-off Scenarios' (ASSETS) project that conducted research in Malawi. Where possible, the thesis research used similar indicators and methods to the ASSETS project and its affiliated researchers in order to allow for future wider comparison across sites. Alison Simmance is an ASSETS-affiliated PhD researcher investigating aquaculture in Malawi. The study collaborated with Alison in the development of the Photovoice Manual (**Appendix E**) and the Household Survey Part 1 (**Appendix B**), with differences relating to the separate fisheries sectors (inland capture and aquaculture) studied by the two researchers.

Finally, the researcher collaborated with the Food and Agriculture Organization of the United Nations (FAO) and contributed to the inland fisheries report: 'Review of the state of world fishery resources: inland fisheries' (Funge-Smith, 2018).

3.7 Ethics

Prior to the onset of field work, ethical clearance was obtained from the University of Southampton Faculty of Social and Human Sciences Ethics Committee (reference: 14728) (**Appendix H**). This is in line with the University of Southampton guidelines and research ethics of the UK Research Councils. In addition, ethical clearance was also obtained in Malawi from the National Commission for Science and Technology.

Data collection and recruitment of participants followed ethical procedures and protocols in social science research; please see research methods detailed within **Chapters 5 to 7** and **Appendix H**. Steps included verbally discussing the purpose of the research with participants and providing information sheets in local language prior to obtaining consent for participation in the study. Consent was obtained in written form or recorded verbally according to the preferences and literacy of the participant. It was communicated to participants that they could withdraw from the research at any stage and contact details were provided post-research if they had any further queries. The researcher maintained participant anonymity and confidentiality in collecting, analysing and writing up of data via use of pseudonyms for all individuals and quotes referred to, so that the views of individuals could not be identified. Audio recordings, transcripts and other documents were stored electronically and password protected. Interviewers participating in the study also signed a confidentiality agreement and were fully briefed prior to and following interviews on the ethical procedures and confidentiality requirements of the study.

Participatory research presents many ethical concerns and challenges regarding the participation of individuals and groups. Challenges include trust, social conflict with recruitment of participants, distribution of costs and benefits from participation, time burden, and power dynamics in groups. Participation is often biased towards those more educated, in power, wealthier and those with more time. The photovoice methodology also presented additional concerns around use of a camera which included: intrusiveness and consent of pictures of community members and sensitive subjects, theft, conflict and stigma with participation and ownership of a camera (Wang and Burris, 1997). In addition, the method required longer time from participants (one week) which could have caused a burden on household duties.

The ethical concerns and challenges of participatory research were overcome by several steps. Time was spent over the field work periods to engage with district and village level leadership and communities to build relationships, introduce the research project and data collection methods, its expected outcomes, and gain permission for research. I was also introduced to the villages by locally-trusted actors (extension officers and World Fish) which helped smooth the way for me to work with the communities. Data collection started with community participatory methods to build rapport, build relations and get to know community members prior to household level data collection. Group exercises were conducted separately with male and female groups and a male and female research assistant was used for each to minimise the influence of power and gender dynamics. Attempts were made to recruit participants from a range of wealth, fish-activity scales, age and gender for FGDs and photovoice process.

A detailed 8-stage process was implemented on photovoice which aims to address some of the challenges that may arise with the method (see **Appendix E**). Training was undertaken with participants on the use of the camera and regular checks were made to ensure that they were happy with the process, time demand and did not experience any community conflict with the use of cameras (Wang and Burris, 1997; Bennett and Deardon, 2013; Simmance et al, 2016). The method also used inexpensive one-time use cameras to avoid theft and conflict, and the researcher worked with the village chiefs and communities to communicate the nature of the method and aims (Bennett and Deardon, 2013; Simmance et al, 2016). It was explained to participants that they had to seek permission to take photographs of community members, and a final stage of validation of photos and reaffirming permission on use of photographs and narratives was conducted (Simmance et al, 2016). However, the study still had limitations in the time spent with communities in conducting participatory research methods, and further time would have allowed more in-depth discussion on livelihood and food security challenges at the community level, and on deeper reflection of the photovoice methodology (Bennett and Deardon, 2013). Some challenges did arise with photovoice relating to some of the quality of photographs where a few photographs were poor, however this did not affect the overall research outcomes. In addition, there was a challenge with the time required for photovoice. One participant in the photovoice process explained challenges of time commitments due to unexpected household events and the study adapted to the needs of participant via forming a narrative on some themes without the use of pictures.

The study also went beyond research ethics committee requirements and applied ethics principles to unpredictable in-field situations. Vermeylen and Clark (2016) provides a deeper perspective for what ethics means, based on responsibilities and sensibilities where the researcher ensures the safety of the participant and responds to unpredictable circumstances that arise in the field sensibly, based on principles and respect for local conditions. Microethic concerns can also arise in the field, based on vulnerabilities and sensitivity of the research (Chenhall, Senior, and Belton, 2011; Pollock, 2012). Unexpected challenges arose in the field for this study. At the onset of data collection in the dry season, access to Sauka Phimbi village was prohibited by vehicle due to the level of water in the wetland. Therefore research commenced first in Likapa to allow time for water levels to be reduced to access Sauka Phimbi. The study investigated fisheries governance, which can be a sensitive issue in regards to illegal fishing and conflict, and presents challenges in conservation surrounding ethics and safeguarding participants (St John et al, 2016). As a result, the study did not investigate the topic by group exercises, researched the issues around fisheries governance one to one with heads of households during the household surveys. Steps were also taken to safeguard participants' identity to ensure that comments on sensitive or possibly illegal issues were made confidential and that the study maintained participant anonymity (St John et al, 2016). The study also found that interviews on food insecurity was sensitive for a few households, particularly non-fishing households who were experiencing hardship. Efforts were also made to reduce the length and time of the household interviews, to undertake interviews at times convenient for participants, and at the participant's house to aid comfort.

3.8 Rigour in Qualitative Research: Validity, Reliability and Positionality

Special attention was paid to the effects of researcher positionality as a means to improve the rigour of this study. Central to developing high quality qualitative research is the ability to understand the influence of the self in the production of knowledge, a term known as researcher positionality (Day, 2012). A researcher's positioning includes personal characteristics such as personal experiences, theoretical view point, gender, race, beliefs, emotional responses to participant, age and has traditionally been defined in terms of insiderness and outsiderness (Day, 2012; Fletcher, 2010). Increasingly and particularly in qualitative research methodologies, researchers need to understand the multiple components of positionality and its influence on the production of knowledge throughout a research process. As described by Berger (2013), positionality may influence a research process in three ways: 1. Affect access to the recruitment of participants in the field via influencing willingness of participants to partake in a study; 2. Influence the relationship between researcher-researched, particularly gender dynamics, and openness of participants to share information; 3. Personal characteristics of the researcher may influence the research process and outcomes produced (Kacen and Chaitin, 2006; De Tona, 2006). As a result, researchers increasingly need to carry out a self-appraisal in research, carefully monitoring the impact of personal characteristics and the situatedness of the research in order to enhance rigour and trustworthiness of the research process and outcomes (Bradbury-Jones, 2007; Gemignani, 2011; Pillow, 2003).

Within this study, a commonly used quality control tool known as reflexivity was adopted to address the effects of the researcher's own situation within the research process. Reflexivity has been defined by (Horsburgh, 2003, pg. 309) as the "active acknowledgement by the researcher that her/his own actions and decisions will inevitably impact upon the meaning and context of the experience under investigation". As such, active acknowledgement and explicit recognition of the effect of one's position was carefully monitored during all phases of the research. As part of this process, I paid special attention to addressing two important aspects relating to the research context and process: 1) inherent dilemmas in fisher-research relationships as described by Jacobsen et al (2011); and 2) fluidity of the research process and positionality. Within this context, it was acknowledged that the affinity to either insider/outsider status would be multi-layered and challenging to monitor given the different methods applied and spaces occupied throughout the research process, as experienced by Suffla et al (2015).

To address the possible influence of my positionality on the research process and improve the rigour of the study, I adopted the following techniques throughout the phases of the research. First, peer review and scrutiny of the research design was carried out by supervisors and local experts to help overcome potential biases in research design and ensure the design of the materials reflected the reality of the field. During field data collection, a comprehensive process of recruiting, training and monitoring of translators was followed to enhance rigour in research procedures. In addition, specific time and attention was given to a) carefully translating research materials into the local language through several iterations; and b) planning an effective training session with research assistants; in order to ensure the methods were implemented efficiently and in a sensitive way to allow for trust building with participants. During data collection, I took a number of steps to overcome gender and other biases, ideological stances and other positionality influences. I reviewed data collected daily and reflected with research assistants on participant responses and influence of positionality. Research assistants also actively noted reflections after interviews. A female research assistant was selected to assist with photovoice in order to allow particularly vulnerable female participants to feel more comfortable and to speak more freely about their issues. A training course was held which included role plays in order to anticipate responses, understand sensitive areas and ensure that language translations were correct. Specific protocols of ethical considerations were reviewed to ensure that participants could be as comfortable as possible, e.g. meeting at a convenient time and location for participants, specifically avoiding lunch-time hours and repeatedly being transparent about research aims and position as a researcher/student). In addition, efforts were made to speak a few phrases in the local language and to wear the local clothing to facilitate development of trust with the participants. Finally, during data analysis the adoption of explicit self-reflection allowed me to become aware of 'unconscious editing' and to remove any self-biases, emotions, thoughts from the identification of themes and interpretation of data.

Lastly on reflection of the research as presented by others (Pasgaard et al, 2017), investigating small-scale inland capture fisheries presented many challenges in collecting secondary data, working in remote locations and generalizability. At the start of the project it was hoped that secondary data would permit a wider ecosystem analyses to explore more comprehensively factors affecting the fishery in a socio-ecological system at larger scales. However, during the scoping exercise and key information interviews data challenges emerged and it was evident that data was not available. A mixed method and local case study approach was therefore adopted with use of remote sensing and local ecological knowledge which provided rich insights into how the fishery has changed over time. The local case study also provided rich context specific information on the complexities of food security and challenges in the sector that is often masked at wider scales.

Chapter 4 Fisheries and Water Dynamics

4.1 Introduction

4.1.1 Characteristics of Inland Capture Fisheries

Inland capture fisheries are found in diverse freshwater habitats: rivers, lakes, and wetlands, with the majority of fisheries in developing countries (IFAD, 2011). The sector is characterised as small-scale, multi-species, multi-gear and dispersive and is generally labour intensive; often led by individuals and households and thus are driven by human effort and the overall number of people in the fishery (De Graaf et al, 2012; Welcomme, 2011; Kolding and Zwieten, 2006). While the sector represents a small share of global fish supply, for many countries in the developing world it constitutes the major source of supply (Kolding and Zwieten, 2006; Dugan et al, 2007; Mills et al, 2011; FAO, 2014; Youn et al, 2014; HLPE, 2014). This is particularly evident in the continent of Africa where in many regions aquaculture has not fully developed (FAO, 2014). Within Africa, inland capture fisheries have been reported to have increased linearly with around 3.7% in production from 1950 to 2009 however, some countries within East Africa, such as Malawi, experience large variability in production with a reported stagnant to declining trend in production (FAO, 2014).

The growth in fish production globally has been faster than the growth in world population and thus it has been reported that the availability of fish per capita has increased from 1950 to 2012 (FAO, 2014). However, trends in fish supply per capita in some regions have remained static or decreased, such as in East Africa and Malawi (HLPE, 2014; FAO, 2014). The future of fish supply per capita is predicted to decrease as a whole for the continent of Africa as its population is predicted to outgrow supply (HLPE, 2014; FAO, 2014).

4.1.2 Role of Fish for Food and Nutritional Security

Inland capture fisheries are an important source of food, nutrition, and income for millions of people globally, particularly in developing countries (HLPE, 2014; Youn et al, 2014; IFAD, 2011; Kawarazuka, 2010; FAO, 2014). The contributions of fish to improved food and nutritional security have been documented through several pathways (HLPE, 2014; Kawarazuka, 2010). Fish can act as a cash crop generating income, which can increase the purchasing power for other food items (HLPE, 2014; Kawarazuka, 2010). In addition, fish directly consumed can improve food and nutritional security (HLPE, 2014; Kawarazuka, 2010). The role of fish, both directly and indirectly, to household food and nutritional security is only achieved when all four pillars of food security: availability, access, utilisation (preferences), and future sustainability are met (Beveridge et al, 2013; HLPE, 2014; Kawarazuka, 2010).

The fisheries sector is an important supplier of food and income locally to communities and in aggregate can be considered a large supplier of food, labour and income on a regional, national and global scale (De Graaf et al, 2012; Welcomme, 2011). In addition, the common pool nature of capture fisheries also enables the sector to be an important safety net for food security during agriculture lean months or for the increasing landless poor (FAO, 2014; Welcomme, 2011; HLPE, 2014; Kawarazuka, and Béné, 2011; Kolding and Zwieten, 2011).

4.1.3 Monitoring of Inland Capture Fisheries

Inland fisheries remain one of the most difficult sub-sectors for which to obtain reliable production statistics (Youn et al, 2014; Welcomme, 2011; Welcomme et al, 2010; De Graaf et al, 2012, Welcomme and Lymer, 2012). The less commercial nature and dispersed characteristics of the fishery has led to difficulties in countries investing in and undertaking effective monitoring. Where monitoring has been conducted, catch and effort data have been underreported or unreliable given that catch is bartered locally or consumed by households, that there are often no centralised landing ports or markets, and financial resources for monitoring are limited (De Graaf et al, 2012; Welcomme, 2011).

A thorough review of conventional monitoring approaches by De Graaf et al (2012) illustrates that simpler alternative approaches are required to monitor, analyse and evaluate the status of inland capture fisheries. New methods of participatory fisheries monitoring are promising and in some cases can be more representative spatially and temporally in monitoring fisheries dynamics (De Graaf et al, 2012; Welcomme, 2011, Mbewe, 2014). However, information can still be drawn from conventional fisheries monitoring that have acquired long time series data (De Graaf et al, 2012; Welcomme, 2011; Kolding and Zwieten, 2012). As monitoring has been consistent over time in some cases, trends can be detected which can aid in understanding the status and drivers of fisheries (Jul-Larsen et al, 2003; Welcomme, 2011; Kolding and Zwieten, 2012).

Environmental and socio-economic parameters have also been monitored in many countries and together enable an ecosystem-based approach to understanding fisheries (Jul-Larsen et al, 2003; Welcomme, 2011; Kolding and Zwieten, 2012). The effectiveness of monitoring these parameters in and around inland waters also shares similar difficulties with fisheries monitoring (Jul-Larsen et al, 2003; Welcomme, 2011).

4.1.4 Models Applied to Understanding Inland Capture Fisheries

Due to the complex nature of inland fisheries, conventional fishery methods are rarely adequate to evaluate the status and assess stocks (Jul-Larsen et al, 2003; De Graaf et al, 2012; Welcomme, 2011; Kolding and Zwieten, 2006; Kolding and Zwieten, 2012). In addition, limited data for many water bodies presents difficulties in evaluating the system (De Graaf et al, 2012; Welcomme, 2011; Kolding and Zwieten, 2006).

Simple empirical regression-model approaches have been developed since the 1950s to predict potential yields and productivity (Welcomme, 2011; Kolding and Zwieten, 2012). These models have used conventional catch and sometimes effort data along with several environmental parameters in order to understand factors governing fish yields within inland waters, as well as to predict the potential yield of inland waters when the fishery was not well developed or where data was limited (Welcomme, 2011; Kolding and Zwieten, 2012).

1950s to 1960s

In the 1950s and 1960s, authors drew mainly on static abiotic morphological and edaphic characteristics to classify lakes and understand factors governing fish production (Welcomme, 2011; Kolding and Zwieten, 2012). Rawson (1952), Hutchinson (1957) and Talling and Talling (1965) were some of the earliest studies which found that factors affecting lake productivity can be grouped as edaphic, morphometric and climatic. Mean depth, a morphometric indicator, was shown to be one of the most significant factors governing fish yields due to its effect on temperature, stratification, circulation and nutrient level in a lake (Rawson, 1952). Further studies describe the influence of climate and edaphic features (Northcote and Larkin, 1956).

Ryder (1965) established a morpho-edaphic index (MEI) as a method for estimating the potential production of fish. The MEI is an approach that relates nutrient concentration, determined by total dissolved solids and influenced by mean depth, with biological production at a higher trophic level (Ryder, 1965; Henderson and Welcomme, 1974). The index is at the ecosystem level, focusing on edaphic rather than climatic features, and is derived by undertaking a comparison analysis of lakes (Ryder, 1974). Initially applied to north temperate lakes, the MEI showed fishery production to be higher in shallow lakes due to higher rates of nutrient recycling and a higher proportion of the lake in the euphotic zone (Rawson, 1952; Henderson and Welcomme, 1974; Ryder, 1974). The MEI was also argued to be an index of stress, environmental change and the nutrient capacity of a system (Ryder, 1974). This is because of total dissolved solids and mean depth also being representable of several variables of complex inter-relations in an ecosystem, such as total alkalinity and conductivity, and euphotic zone and mixing depth, respectively (Kemp, 1971; Ryder, 1974).

1970s to 1990s

Throughout the 1970s, 80s and 90s, further studies were conducted on more morphological static indicators such as lake area, but also on primary production (Welcomme, 2011; Kolding and Zwieten, 2012). These models were applied to lakes in Africa and also to rivers. Several authors reviewed the MEI and its applicability to a wide range of lake and reservoir datasets up until the 1990s. Regier (1971) and Henderson and Welcomme (1974) were some of the first to apply the MEI to African lakes and confirmed the relationship between MEI and fish yields. The studies also confirmed that the MEI applicability is not confined to lakes of homogeneity features, as the highly dynamic Lake Chilwa and Mweru-Wa-Ntipa were also included. Several studies investigated the relationship between fish yield and primary production (Melack, 1976; Oglesby, 1977). Henderson et al (1973) related primary production with MEI in African lakes, however primary production was not related to fish yields suggesting that higher trophic level production may be more limited by physiological requirement than primary production (Ryder, 1974).

The applicability and use of the MEI however was scrutinised. Some argued that it is limited to estimating the potential fish yield of a lake at one point in time, and is only useful at the onset of the development of a fishery (Henderson et al, 1973). It was also argued that it is not relevant to reservoirs as it expresses the trophic system of lentic environments; where primary production is the euphotic zone, rather than that of lotic environments; where energy is derived from detritus carried into the system (Jenkins, 1967; Henderson et al, 1973).

The consideration of fishing effort as a factor influencing fish yields had little attention. In the 1980s and 1990s, studies began to explore in more depth the environmental, hydrological and socio-economic factors and their relationship with fish yields. Carlander (1955) explored the relationship between fish yields and fishing effort, and found that small lakes are better exploited than large lakes when have proportional effort. Henderson and Welcomme (1974) also explored the relationship of fishing effort and MEI and argued that the relationship of catch and effort may be more useful in understanding fish yields than estimating the potential of a fishery via the MEI (Henderson and Welcomme, 1974).

Fishing effort, technology and the demand on fish supply was also brought to light by Ryder (1974) to be important in understanding fish yields; however, no detailed analysis was undertaken. Bayley (1988) combined the analysis of MEI with fishing effort, in the form of number of fishermen per surface area, for understanding fish yields in 31 African lakes. Fishing effort was found to be the major determinant in fish yield, and fishing effort with MEI explained 80% of the variation in fish yields (Bayley, 1988). The relationship between fish yields and lake surface area or volume was also explored and found to be a crucial indicator for also explaining the variance in fish landings (Rempel, 1991; Crul, 1992; Lae, 1999).

Previous research on hydrological influences on fish production were limited. Ryder (1974) suggested that hydrological variables may influence nutrient dynamics; however, its influence tended to be considered only for reservoirs (Henderson et al, 1973). In 1981, McLachlan demonstrated that water level fluctuation is a natural characteristic in aquatic habitats that promotes the interaction between terrestrial and aquatic ecosystems, enhancing productivity. When a lake recedes grasses flourish and act as food for terrestrial animals, and when a lake floods, terrestrial plants decompose and release nutrients as well as providing nursery habitats for fish. Junk et al (1989) introduced one of the fundamental theories in understanding fluctuating aquatic environments with the establishment of the flood pulse concept (FPC). The FPC shows the importance of the flood and water dynamics in river-floodplain systems. Fish yields and production were strongly related to the extent of accessible floodplain. The characteristic of the flood pulse was found to affect the aquatic-terrestrial transition zone and enhance nutrient recycling and thereby increasing productivity. The combined work of Talling (1992) and Dumont (1992) provided one of the most detailed studies looking at environmental regulation in African shallow lakes and wetlands. The studies highlighted again the distinct properties between deep and shallow lakes where the latter has a wider coverage by a littoral zone with continuous interactions between abiotic and biotic variables (Dumont, 1992). Water level fluctuation was demonstrated to influence these shallow aquatic environments, such as Lake George, Chilwa, Chad and Pongolo floodplain, where flood and dry cycles affected nutrient pathways and habitat availability (Talling, 1992). Dumont (1992) and Talling (1992) also suggested that lakes could be classified based on these environmental stresses, where the resilience of fish is based on the availability of refuges such as swamps and rivers. Wider studies on lake bodies in Africa also found relationships between water level fluctuation and fish catch at different time lags, such as in Lake Turkana where lake levels effected fish catches 1 year later (Kolding, 1989).

2000s

Since 2000, several studies have demonstrated the importance of considering hydrological and socio-economic variables in understanding factors governing fish yields. A pioneering fisheries technical paper by Jul-Larsen et al (2003) explored for the first time the relationship between environmental variation, fishing effort and fish catch on a water body scale for five medium sized lakes in Africa. The report found that water level fluctuation was often more significant than fishing effort in explaining changes in fish yield. One of the key findings, which four of the case studies supported, was that artisanal fisheries in African inland waters are often characterised by unselective fishing patterns where the fishery is highly adaptive to changing environments. For one case study: Lake Malombe in Malawi, fishing effort was the major factor governing its fishery as it represented a case of over-investment in a fishery via more efficient fishing gears, rather than Malthusian overfishing (Zwieten et al, 2003). Several studies on a water body scale since the 1970s also supported these findings regarding the influence of water dynamics (Furse et al, 1979; Kalk et al, 1979; Marshall, 1984; Karenge and Kolding, 1995; Chifamba, 2000; Kolding et al, 2003).

In 2008, a collection of studies by Wantzen et al (2008a) provided a synopsis of the status of research on the ecological effects of water level fluctuations in lakes. Many authors outlined that water level fluctuations are natural patterns in aquatic habitats, which are necessary for the survival of many species and influence productivity and biodiversity of ecosystems (Wantzen et al, 2008a). Some argued that only extreme or untimely floods or drought have deleterious effects on the ecosystem (Wantzen et al, 2008a). Case studies were drawn from northern temperate and tropical locations and found that water level change was related to fish production, extreme change reduced species richness and that minimum water level thresholds could be established in order to maintain fish spawning (Keto et al, 2008; White et al, 2008; Wantzen et al, 2008b).

A pioneering study by Wantzen et al (2008b) outlined that water level fluctuation in lakes has had little attention compared with rivers and floodplains, and proposed that the Flood Pulse Concept be extended to lakes. The study drew upon four case studies from temperate and tropical locations, representing shallow and deep lakes; Lake Ferto and Lake Constance, Lake Chad and Lake Titicaca respectively. The contribution of the littoral zone to productivity was found to be disproportionately high compared with the central part of a lake (Wantzen et al, 2008b). Water level fluctuation was shown to enhance the interaction at the ATTZ and cause 'biochemical hot moments' resulting in higher production, particularly in shallow lakes which are more sensitive to fluctuation. Wantzen et al (2008b) recommended that managers should preserve flood pulses and the ATTZ in lake environments as pulsed systems are more productive than stable systems. Leira and Cantonati (2008) conducted one of the most detailed systematic reviews of the literature between 1992 to 2008 on water level fluctuation and lake ecosystems. Some of the key findings of the review was the following:

- the majority of research has focused on Europe and North America; there is little research in developing countries;
- there are complex effects of high and low water dynamics;
- water dynamics plays a key role in the interface between the littoral and ATTZ;
- the greatest effects are in shallow lakes where small changes can inundate large areas; and,
- little attention has been given to water level fluctuation in lakes particularly in light of climate change.

These reports make the case for more research looking into water dynamics and ecosystems, the thresholds of change, resilience and the likely effect climate change will have on this (Wantzen et al, 2008a). The early static empirical models, as well as the more dynamic 'flood pulse concept' (Junk et al, 1989; Wantzen et al, 2008b), led to the development of a new indicator: the relative lake level fluctuation index (RLLF) (Kolding and Zwieten, 2012). This indicator expands on the flood pulse concept; focusing on its importance for lakes and reservoirs, and combines mean depth with the dynamic indicator of water level fluctuation (Jul-Larsen, 2003; Welcomme, 2011; Kolding and Zwieten, 2012).

Kolding and Zwieten (2012) explored the relationship between RLLF; derived from average monthly lake level recordings, with fish yield (annual fish yields per hectare), fishing effort density (annual number of fishermen per hectare), and fish species diversity in 41 tropical lakes and reservoirs in Africa and Asia using data from the late 1980s to late 1990s. The study provides the most detailed comparison analysis of a large set of inland water bodies exploring the role of water dynamics in fish productivity. The study classified inland water bodies based on the level of water fluctuation; as pulsed or stable. The study found that pulsed systems are characterised by species with shorter life spans, higher intrinsic growth rate, lower biodiversity, and thus higher productivity and resilience (Kolding and Zwieten, 2012). A systems productivity, measured by fish yield, was found to increase with increasing relative lake level fluctuation (RLLF) (Kolding and Zwieten, 2012). Fishing effort density was also demonstrated to have a positive relationship with water fluctuation; suggesting that fishing effort is at least, also partly regulated by the productivity of the system.

4.2 The Influence of Water Dynamics on Fish Yields at the Water Body Scale

In Lake Chilwa, a highly fluctuating lake in Southern Malawi, a correlation was found between fish catch and the previous year's relative lake level change (Zwieten and Njaya, 2003). The influence of water dynamics on habitat availability (areas of inundation), pathways of fish dispersal and pulses of food availability have also been linked with the fishery of the Bangweulu Swamp (Kolding et al, 2003). The production of Mweru-Luapula fishery, consisting of Lake Mweru, Luapula River, floodplains swamps and lagoons, has been demonstrated to be dependent upon water dynamics via nutrient pulses brought in with the floods (Kolding et al, 2003; Zwieten et al, 2003). In these systems, it is argued that susceptibility to fishing pressure is low, recovery high and fish yield high but variable (Kolding et al, 2003).

Man-made Lake Kariba also experiences changing hydro-dynamics with lake level fluctuations ranging between 1 to 1.5 metres. Several studies have investigated factors affecting the fishery and its fish catch has been correlated with the previous year's hydrological regime; river inflow and relative water level fluctuation (Marshall, 1984; Kolding et al, 2003; Karenge and Kolding, 1995; Chifamba, 2000). These studies have outlined that flooding and inundations appears to be a vital source of nutrients and have a beneficial effect on productivity in this reservoir, with low water levels reducing production (Karenge and Kolding, 1995; Chifamba, 2000; Kolding et al, 2003).

In large deep lakes such as Lake Turkana and Lake Malawi, fish species have also been found to respond to environmental changes in the hydrological regime (Fryer and Iles, 1972; Tweddle and Magasa, 1989; Kolding, 1992; Weyl et al, 2010). In Lake Turkana in Kenya, a correlation was also found between average lake levels and catch rates one year later; revealing the role of water carrying nutrients into the system (Kolding, 1992). In addition, Gownaris et al (2018) found a strong association between seasonal lake oscillations and the previous year's lake level with fisheries catch in Lake Turkana from 1993-2014. In Lake Malawi, changing lake levels was found to influence a cichlid multispecies fishery three years later, where higher lake levels improved fish recruitment and survival of young (Fryer and Iles, 1972; Tweddle and Magasa, 1989). Weyl et al (2010) argues that Lake Malawi has experienced a transition in factors affecting its fishery; from water level fluctuation being a key determinant in the 1980s, to fishing effort post 1980s.

The feedback between dry and wet cycles have been outlined to be a vital interaction. Mosepele et al (2009) demonstrated the importance of the combined flooding and dry cycles for fish production and the ecosystem in the Okavango Delta floodplain, and that the complexities of this feedback is poorly understood. Although low water level can increase catches of fish initially due to increased catchability, and then cause low catches for a few years after, there are some important benefits from the cycle (Willoughby and Tweddle, 1978; Karenge and Kolding, 1995; Zwieten and Njaya, 2003). Dry periods allow nutrients to accumulate that will be released when flooding returns and ultimately increase fish production. Wet periods increase nutrients and provide habitats for fish to spawn, and provide nursery grounds and food resources.

The combined features of low water level and increased fishing pressure was argued to be a cause of a decline in catfish in the Lower Shire River in Malawi (Willoughby and Tweddle, 1978; Tweddle, 2010). During extended periods of low flood pulses and water level, it was suggested that vulnerability to fishing pressure would increase (Zwieten and Njaya, 2003).

These studies reveal the significant role of water dynamics in governing fish production via the flood pulse concept and enhanced ATTZ interaction for lakes, reservoirs and floodplain fisheries. The studies have demonstrated that the length of time, nature of flow and magnitude are important aspects of the flood, and the relative rate of lake level change is a useful indicator to capture the influence of water dynamics of fish yield. However, these studies also show that factors influencing fish yield are not static and that their contribution and interaction can change over time and can be context specific.

4.3 Research Aims and Study Site

4.3.1 Research Aims

Hydrology has been clearly shown to be the driving force of natural resources in lakes (Leveque and Quensiere, 1988; Lemoalle et al, 2012). This is particularly apparent for shallow lakes, which experience extreme water level fluctuation such as Lake Chad and Lake Chilwa (Leveque and Quensiere, 1988; Lemoalle et al, 2012; Zwieten and Njaya, 2003). In inland waters such as those presented above, the effects of fishing effort and the environment are often confounded, which complicates any effort to establish causation, and highlights the complexities of understanding the fishery system. The conventional approach to fisheries of surplus yield modelling and the maximum sustainable yield concept for ensuring sustainable fisheries has been argued to not be appropriate to inland waters due to their changing environments (Kolding, 1992; Kolding and Zwieten, 2012; Nyikahadzoi and Raakjær, 2014). Of the simple empirical models applied to inland waters, hydrological variables; such as the lake level fluctuation have been found to be important (Kolding and Zwieten, 2012).

In floodplain environments, the evidence of environmental driven fish production is growing. A systems resilience has been shown to be dependent on the level and rate of water level change, the life history traits of species and the availability of refuges in the environment. Little attention has been paid to the quality of the data and the limitations of analysis. Models have also mainly been applied to data in the 1970s to 1990s, and have focused on comparison studies of lakes. There has been little research on a water body scale considering local context conditions, and new long term time series data (Crul, 1992; Welcomme, 2011). Investigating the effects of water level fluctuations on inland fisheries at the local scale is critical to understanding the local impacts of climate change and the availability and stability of fish for livelihood and food security.

This chapter investigates the relationship between water fluctuations and fish catches in a shallow and climate-sensitive small-scale fishery: Lake Chilwa in Malawi, and addresses research question 1 of the thesis. For the first time, the study uses satellite derived lake level data in combination with traditional climate data to understand how Lake Chilwa's fishery has changed over time: from 1980 to

2010, and the effects of climate variability. Only one other study is known to date which investigates water dynamics and inland fisheries on a water body in Africa using satellite and gauge data (Gownaris et al, 2018). Due to data limitations in researching an under-reported sector, the study conducts an exploratory investigation into the effects of climate variability on Lake Chilwa's fishery, building on previous research (Kalk et al, 1979; Zwieten and Njaya, 2003; Kolding et al, 2012). By exploring the stability of Lake Chilwa's fishery, the study will help understand the availability of fish which influences fish-related livelihoods and the subsequent benefits to food security, and the vulnerability context of fish-related livelihoods.

4.3.2 Study Site

See **Chapter 3** for a full description of the study site: Lake Chilwa and its small-scale inland capture fishery.

4.4 Data Collection

Data was obtained on total annual fish catches, rainfall and lake level from 1980 to 2012, and on the number of fishermen from 1983 to 2010, from the Government of Malawi and the United State's Department of Agriculture Global Lakes and Reservoirs Database (**Table 4.1**). Rainfall data was obtained from the nearest rainfall station to Lake Chilwa: Chancellor College, in the District of Zomba. Lake level data was obtained from two sources: lake gauge recording at Kachulu harbour on the lakeshore from 1980 to 2002 (estimated 622.25 m.a.s.l.), and from satellite-derived lake level data from 2003 to 2010 (estimated datum level 625.27 m.a.s.l., stdev 0.06m). Several studies on African lakes have found good comparability between gauge data and satellite data (Gownaris et al, 2018). Data quality varied amongst variables with fishing effort (number of fishermen) being limited in the number of years of available data which limited its use.

Satellite based surface water-level variations

Satellite radar altimetry is a technique that can be successfully applied to the monitoring of surface water levels of lakes, reservoirs, river channels, floodplains, and inundated wetland regions (Ballatore et al, 2014; Birkett, 1995; Birkett, 2000; Cretaux et al, 2011). With some limitations on the extent of water, and both temporal and spatial resolution, there is the potential for observing level-variations over historical time periods (across the last 2 decades) and within near real time results (1-3 days after satellite overpass) (Birkett, 1995; Birkett, 2000). Considering continuity coverage, the instruments fall into two groups, those with a 35-day temporal resolution, and those with a 10-day resolution (Birkett, 1995; Birkett, 2000). The ESA ENVISAT mission operated during 2002-2010 in a single fixed orbit, with ground tracks that repeated every approximate 35days. With continuous operation, the instrument recorded data along each ground track, across a variety of land, water and ice-covered surfaces.

ENVISAT performed one ascending (rev571/pass285) and one descending (rev184/pass092) pass over Lake Chilwa. Both passes however did not cross the permanent waters (as depicted on Google Earth optical imagery **Figure 4.1**) but over the outer, seasonally inundated marsh regions. Nevertheless, water variations were recorded well along each. The seasonal and inter-annual variations as observed along an approximately 17km stretch of ground track on pass092 is represented in **Figure 4.2**. Here, the time series is formulated via repeat track techniques where an average elevation (with respect to a satellite-based reference ellipsoid) is determined along the 17km stretch for each repeat overpass or cycle (Birkett, 1995). Taking one overpass as a reference datum (0m) and comparing all other overpasses to it enables a relative time series of water level variations to be computed. **Figure 4.2** shows results for 2002-2010, based on ENVISAT cycles 010 to 093 and the use of model-based atmospheric altimetry range corrections, and the sea-ice radar echo re-tracker algorithm. Clearly observed are an approximate 1m seasonal variation, characterised by a rapid rise in the beginning of each year followed by a more prolonged desiccation, and an approximate 1m recovery from a general decline at the end of 2007.

The findings of the satellite radar altimetry are consistent with the average approximate 1m annual variation reported by several authors (Kalk et al, 1979; Jul-Larsen et al, 2003; Kolding and Zwieten, 2006). The lake level data from Kachulu gauge recording on Lake Chilwa’s lakeshore also indicates an approximate 1m variation in lake level (**Figure 4.3**).

Table 4-1 Summary of data variables.

Variable	**Description**	**Code**	**Year**	**Data Source**
Fish Catch	Annual total fish catch (tons) Annual total fish catch by species (tons): 1. *C. gariepinus* 2. *O. shiranus chilwae* 3. *B. paludinosus* 4. *Other sp.*	Total Fish *C. gariepinus; O. shiranus chilwae; B. paludinosus; Other*	1980-2012 1980-2010	The Government of Malawi 2014 and 2015.
Rainfall	Total rainfall (mm) from January to December. Delta total rainfall (mm): inter-annual change in total rainfall. Amplitude of rainfall: change within a year (total monthly max – total monthly min) from November to October.	Total Rain Delta Rain Amplitude Rain	1982-2012	The Government of Malawi 2015: Chancellor College rainfall gauge in the District of Zomba. Total rainfall for year 1998 obtained from the GoM (2012). For amplitude of rainfall years 1998 and 1999 missing.
Lake Level	Annual average lake height (m.a.s.l) from January to December. Delta lake height): Inter-annual change in lake height. Amplitude lake height: change within a year (max –min) from January to December.	Lake Height Delta Lake Height Amplitude Lake Height	1980-2010	Data 1980 to 2002 obtained from the Government of Malawi in 2015: Kachulu lake level gauge (estimated 622.25 m.a.s.l) recording in Lake Chilwa. Data 2003 to 2010 obtained from the United Stated Department of Agriculture Global Lakes and Reservoirs Database: satellite-derived lake level data (estimated datum level 625.27 m.a.s.l, stdev 0.06m).
Fishing Effort	Number of fishers: crewmembers and gear owners.	No. Fishers	1983-2010	The Government of Malawi 2015. Seven years missing.

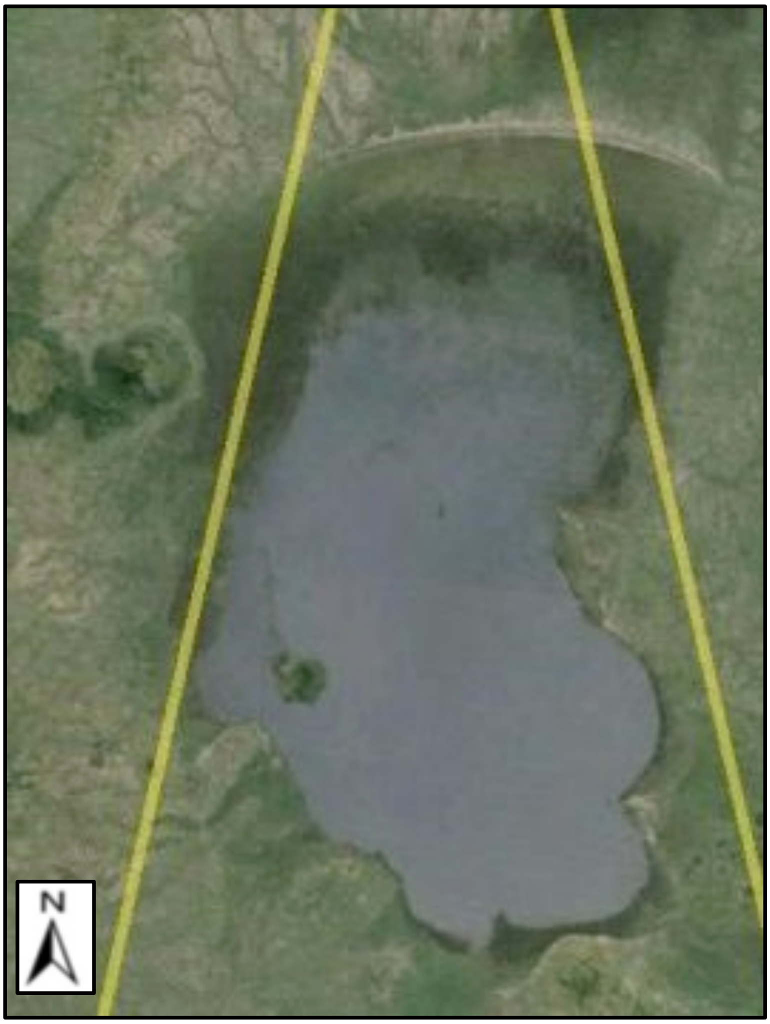

Figure 4-1 Google Earth optical imagery of the ENVISAT ascending (rev571/pass285) and descending (rev184/pass092) pass over Lake Chilwa, depicted in yellow.

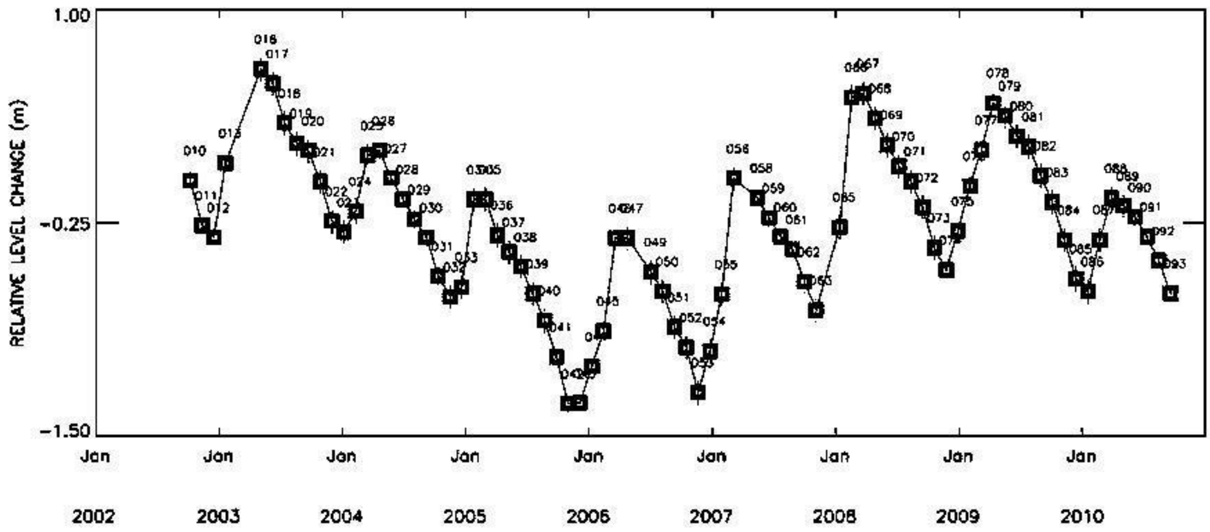

Figure 4-2 Relative lake level change derived from a satellite radar altimeter during the period 2002 to 2010. (0079.Chilwa Pass092 ENVISAT – Try1 SeaIcetracker USO – corrected).

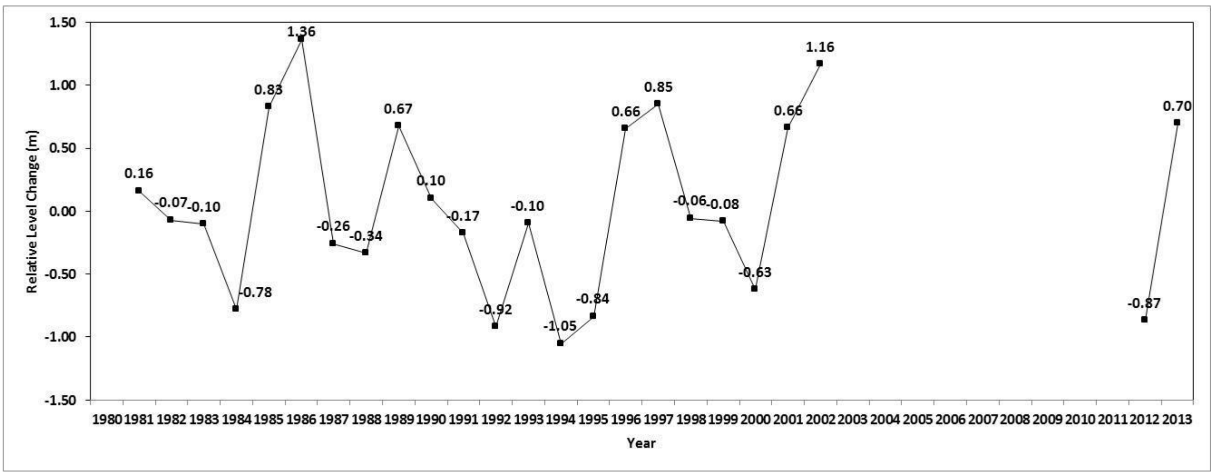

Figure 4-3 Relative annual lake level change derived from Kachulu lake water gauge (located on the western shore of Lake Chilwa) during the period 1980 to 2013.

4.5 Analyses Approach for Investigating the Relationship between Water Dynamics and Fisheries

Data was expressed in raw form and data quality was tested using standard techniques and approaches in climate and fisheries data (Longobardi and Villani, 2010). Basic descriptive statistics were explored and inspected for outliers and missing values. All variables were tested for normality via the Shapiro–Wilk test (Shapiro and Wilk, 1965) (**Appendix A**).

Variables were selected through a process based on a mixture of theory and statistics. Independent water dynamic variables were selected based on previous studies and theory on the association between water fluctuation proxies and fisheries catch. This includes research on fish catch and lake levels, relative lake level change, seasonal lake level oscillations and river inflows in Lake Turkana (Kolding, 1992; Gownaris et al, 2018), Lake Chilwa (Zwieten and Njaya, 2003), Lake Kariba (Kolding et al, 2003; Karenge and Kolding, 1995; Chifamba, 2000), and Lake Malawi (Tweddle and Magasa, 1989) with water dynamics influencing fish catch one to three years later. Kolding et al (2012) found that relative lake level fluctuation increased a systems productivity, and highlighted relative change indicators to be important in understanding the system. The study had data on multiple indicators of water fluctuation (rainfall, lake level, relative lake level change) with each variable having limitations in data quality and the number of years of data available due to collection methods and resources. In addition, each variable had different strengths as a proxy for water dynamics in inland fisheries. The aim of the study was to investigate the association between water dynamics and fisheries catch. Therefore, each independent water dynamic variable was tested independently against the dependent variable of fish catch.

Analyses of Trends in Water Dynamics and Fish Catches

An exploratory first step was taken to investigate trends in variables over time; average annual lake height, total annual rainfall, annual number of fishers, annual total fish catch and fish catch by species. An exploratory approach was undertaken and model specification was data driven where parametric and non-parametric standard approaches (simple linear regression and Mann-Kendall test) were used based on the nature of variables to understand how lake level, rainfall, fishing effort and fish catches have changed over time; decreasing, increasing or no trend detected. Simple linear regression of the dependent variable on time was performed to test for a linear trend. The regression tests whether a linear monotonic trend exists over time. The Mann-Kendall test is a non-parametric form of a trend analysis commonly applied to climatic data and was also performed for all variables for cross verification.

Data was further explored through techniques to identify years of extreme variation in trends. A further sequential T-Test analysis for regime shifts (STARS) was performed to identify statistically significant change points in each data series (Rodionov, 2004). The approach is common in bio-physical research and has been used to detect change points in fisheries and climatological data that can help provide further information for investigating causes of change (Rodionov and Overland, 2005; Hossain et al, 2016). A t-test is conducted sequentially over the time series with a cut off length at 10 years. A test is performed on each additional data point to detect whether there is a significant deviation from the mean of the current regime. The test produces a Regime Shift Index value for each time point representing the cumulative sum of normalised deviations. The year where a significant deviation has occurred is a change point. STARS was performed on total annual fish catch, fish catch by species, mean lake level height and total annual rainfall with cut off length at 10 years and significance level of 0.05. The exploratory technique was not applied to fishing effort due to data gaps in a number of years. A cut off length of 5 years was also performed and revealed similar results thus where otherwise stated results for 10 year cut off points are presented (Rodionov, 2004). The technique was also applied to inspect changes in variance of each series.

Rainfall variability was investigated to identify occurrences of extreme wet and dry years and changes in monthly rainfall over time. Total annual rainfall (Jan-Dec) (mm) was standardised into a variability index (RVI) representing deviations of total annual rainfall from the long-term mean:

$$RVI_t = \frac{X_t - \bar{X}}{\sigma_x}$$

Where RVI_t is the rainfall variability index in a specified time year, X_t is total annual rainfall for a given time year, $\bar{X}$ is the long-term mean of annual total rainfall series, and σ_x is the long-term standard deviation. The RVI scores were categorised into an extreme wet and dry scale according to the widely used Standardised Precipitation Index (SPI) scale for drought assessment (Ndebele-Murisa et al, 2017;

McKeee al, 1993). Total monthly rainfall was also standardised into z scores and large deviations explored for changes over time.

Analyses of Relationships between Water Dynamics and Fish Catch

The relationships between the dependent variable: total fish catch, and independent water dynamics variables: rainfall and lake level dynamics, were investigated through cross-correlation analyses and standard linear regression. The relationship was initially explored through the cross-correlation function which allows for correlations between variables to be explored across time lags. Previous studies have shown the effects of water dynamics on fish catches one to three years later, and have used similar approaches (Gownaris et al, 2018; Zwieten and Njaya, 2003; Karenge and Kolding, 1995; Chifamba, 2000; Tweddle and Magasa, 1989). Independent variables that were strongly correlated with total fish catch were selected for linear regression with the associated time lag. A Box-Cox test was performed to determine whether transformation of the dependent variable was required for linear regression. The Box Cox test estimated a lambda (λ) value of 0.5 and total fish catch dependent variable was transformed via the square root function to improve normality of the test residuals. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity, which was confirmed post-analyses via inspection of the normal P-P plot and scatterplot of standardised residuals. Due to strong correlations amongst independent variables, standard linear regression analyses was undertaken between total fish catch and each of the independent variables separately. Statistical analyses were conducted using IBM SPSS Statistics 24.

Limitations of Investigating Water Dynamics and Fish Catch

Given the under-reported nature of the sector and challenges in data limited environments, limitations existed in data analyses. The lack of time series data and data quality issues limited analyses and the approach of the study. As a result, the study adopted an exploratory approach that was data driven to understand correlations and relationships between variables. Model selection was therefore limited due to the number of years of available data. Although the analyses approach was based on theory and statistics, and built upon previous research, limitations still remained in model selection and the confidence in significance of results which was also experienced by other studies (Tweddle and Magasa, 1989; Karenge and Kolding, 1995; Chifamba, 2000; Kolding et al, 2003; Zwieten and Njaya, 2003; Whittingham et al, 2006). In the absence of large time series data, wider environmental variables, and more advanced models, such as an information theoretic approach which compares model fit across a number of models (Whittingham et al, 2006), caution therefore needs to be applied in inference of the strength of the association between water dynamics and fish catches at the local water body scale (Zwieten and Njaya, 2003; Kolding et al, 2012; Gownaris et al, 2018).

However, the study provides the first exploratory and baseline assessment on Lake Chilwa's fishery since the 1990s using best available data, and building on previous evidence on the impacts of water dynamics on fish catches (Zwieten and Njaya, 2003; Kolding et al, 2012). The study provides a timely contribution to Taylor et al (2016) 'Call to action – the Rome declaration: ten steps to responsible inland fisheries' to understand the trends and challenges in inland fisheries and improve the assessments of the fishery for science-based management. The study also contributes to the wider calls for local level assessments on the impact of climate change on the sector, new assessments of trends in fish catches and the influence of water dynamics using best available data, and use of innovative technologies such as remote sensing for data collection and monitoring (De Graaf et al, 2012; Welcomme, 2011; Béné et al, 2016). The study also provides a background on the availability and stability of fisheries in Lake Chilwa which is the first step in understanding the contribution of the sector to livelihoods and food security (HLPE, 2014). Further research with larger data sets on wider environmental factors would permit more advanced analyses, such as time series and an information theoretic approach, and would enable a more comprehensive assessment of the status and trends of inland capture fisheries. Integration with participatory research approaches and local ecological knowledge can also provide an untapped wealth of information on ecosystem change in data limited environments (De Graaf et al, 2012; Welcomme, 2011; Daw et al, 2011b; Mbewe, 2014). Triangulation of data with local ecological knowledge on perceptions of change is presented in **Chapter 6** and discussed in **Chapter 8**.

4.6 Results

4.6.1 Trends in Water Dynamics and Fish Catches

Trend results are presented in **Appendix A** (**see also Figure 4.4 and 4.5**). All water variables exhibited stable trends over time with large fluctuations around the mean. Fisheries variables all displayed decreasing trends over time except for catches of *C. gariepinus*. Catches of *O. shiranus chilwae* and other fish species experienced the most significant declines.

The reported total fish catches of Lake Chilwa showed a decreasing trend from 1980 to 2012 (*linear* $r^2 = 0.13$, $p = 0.03$, *Mann-Kendall* $p<0.05$). Fish catches exhibited fluctuations around the multi-annual mean with high increases in catches in 1980, 1990, 1999, 2000 and 2011, and a large reduction in catches in 1996 to 1997. These patterns appear to coincide with above average rainfall and lake height from 1985 to 1990 and in 1997, and with below average levels from 1990 to 1995. A regime shift was detected in the year 1995 with a significant change in mean total fish catches ($p \leq 0.05$). This coincides with the regime shift in lake height in 1994 and drying in 1995. From 1980 to 1994, fish catches averaged 12,035 tons. After 1995, catches significantly reduced to an average of 6,329 tons between 1995 and 2010. A statistically significant decline in the variance of total fish catches was also detected from 2001.

Fish catch in Lake Chilwa is dominated by three species; *C. gariepinus*, *O. shiranus chilwae* and *B. paludinosus*, with other fish species reported as 'other'. The composition of fish species changed over time from 1980 to 2012 with periods of change coinciding with the drying of the lake in 1995. Average catches varied by species: *B. paludinosus* ~4000 tons, *O. shiranus chilwae* ~2,300 tons, *C. gariepinus* ~1,721 tons and other fish species ~1,000 tons. Catches of *O. shiranus chilwae* and other fish species displayed significant decreasing catches over time with regime shifts in the mean of catches identified in 1993 and 1995, coinciding with the drying of the lake. The drying phase also appears to have affected *B. paludinosus* in 1995 and lastly *C. gariepinus* in 1996 with below average catches reported. However, catches of *C. gariepinus* displayed no significant trends from 1980 to 2010 (**Appendix A**).

Rainfall and lake height had similar patterns of above average levels from ~1985-1990, followed by below average rainfall from 1990-1995 and a below average lake level from 1992-1996. A significant regime shift in average lake height occurred in 1994 with a drying phase in 1995. An above average rainfall year occurred in 1997 and rainfall variance declined from 1998 to 2012. Lake level increased in 1997, with the subsequent period of 1994 to 2010 showing a reduced mean lake level height compared with 1980 to 1994. From 2000 to 2010, rainfall fell below average in 2005 and lake level experienced a decline in variance from 2005. Lake levels also experienced above average levels in 2003, 2008 and 2009. The rainfall variability index showed a number of moderate and two extreme rainfall events occurred from 1982 to 2012. Moderate to extreme wet years occurred in mid-late 1980s and late 1990s. An extremely (RSI ≥2.0) wet year occurred in 1985 with moderately wet years occurring in 1986, 1989, 1996 and 1997. Moderate to extreme dry years occurred in early 1990s and in 2005. A severely dry year occurred in 1990, followed by moderately dry years in 1992 and 1994, and an extreme dry year in 1995.

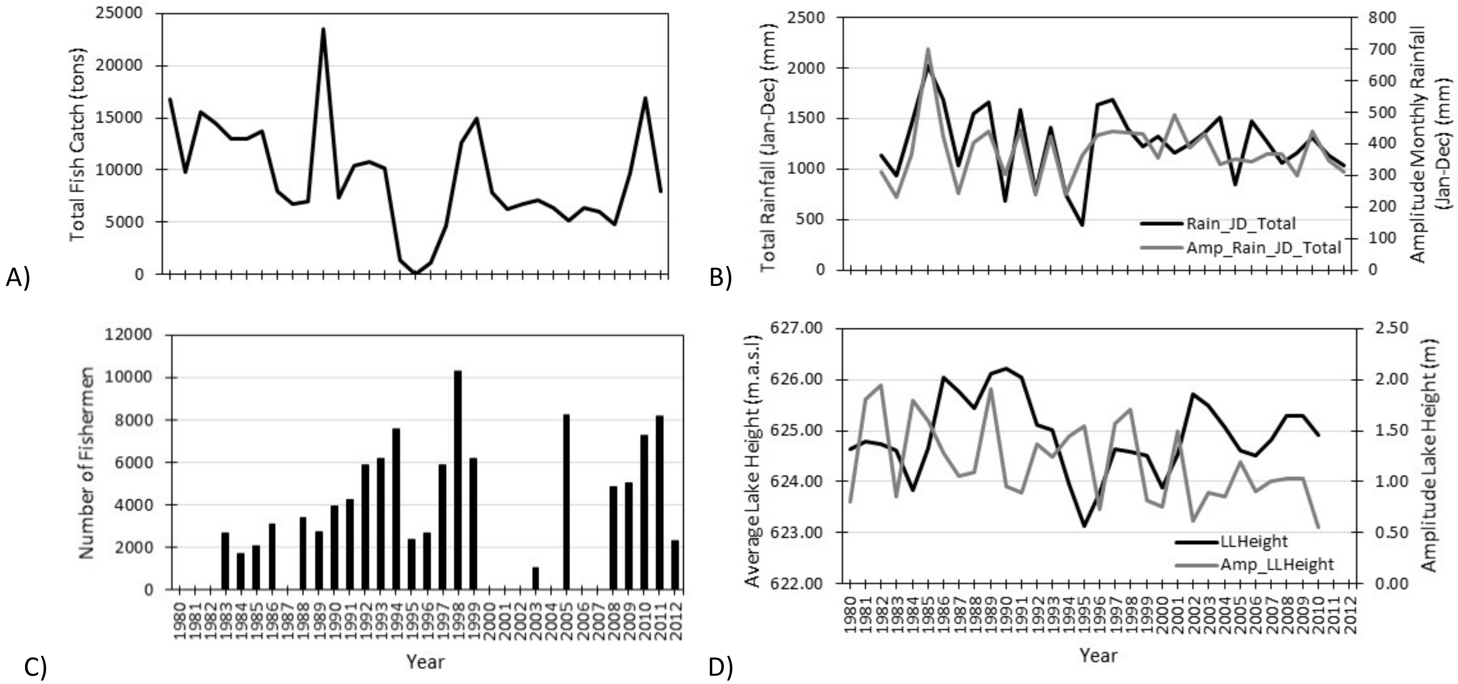

Figure 4-4 Fisheries and water dynamics of Lake Chilwa. A) Total annual fish catch (tons) from Lake Chilwa between 1980 and 2012, B) Total annual rainfall (mm) from January to December and seasonal amplitude (mm) at Chanco rainfall gauge from 1982 to 2010, C) Fishing effort represented by the number of fishers (crewmembers and gear owners) in Lake Chilwa between 1983 and 2012, D) Annual average lake level height (m.a.s.l) and seasonal amplitude (m) for Lake Chilwa from 1980 to 2010.

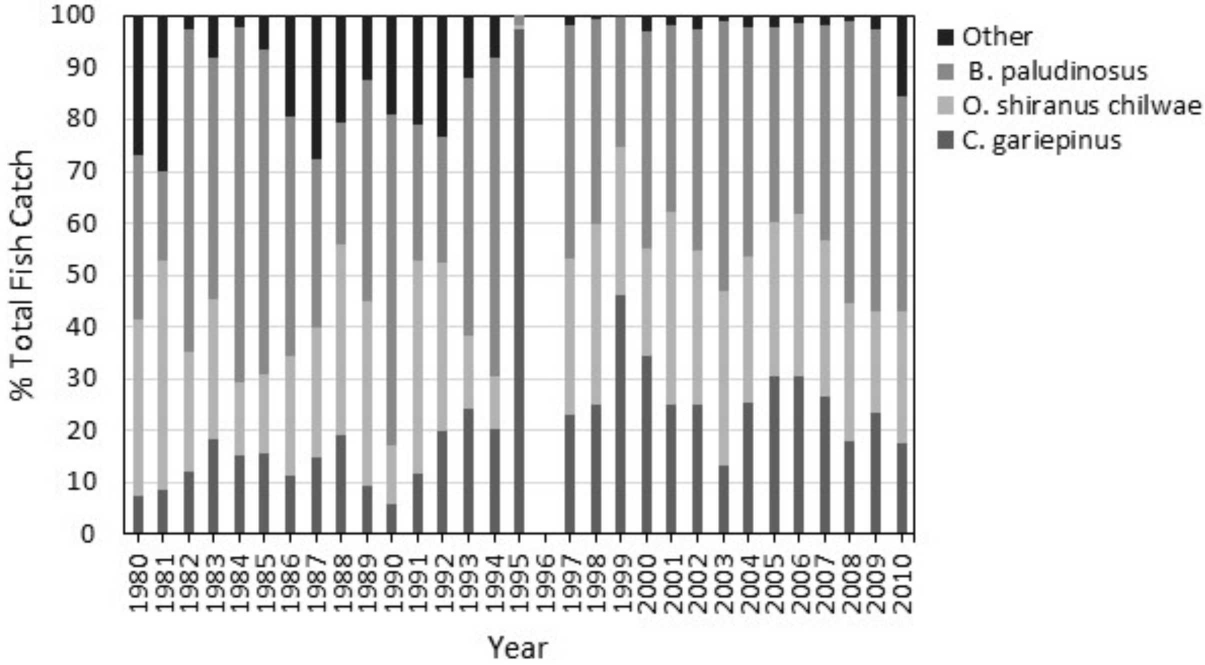

Figure 4-5 Species composition of Lake Chilwa's fishery from 1980 to 2010.

4.6.2 Relationships between Water Dynamics and Fish Catch

Cross correlation analyses revealed an influence of rainfall and lake levels on fish catches for up to 3 years after (**Table 4.2**). Linear regression analyses also revealed the association between total fish catch and water dynamic variables (**Table 4.3**). No association between total fish catches and number of fishers was found ($p>0.05$) however caution needs to be applied in the findings as data limitations existed in fishing effort and therefore the relationship could not be assessed comprehensively. Total annual rainfall, amplitude of rainfall within a year, and annual lake height were identified to be particularly important in explaining total fish catches in the following year. Inter-annual change in total rainfall was also found to influence fish catches in the same year. The overall fit of the models were significant at explaining ~14-27% of total fish catch levels. However, although the findings support wider studies on the relationship between water dynamics and fish catches for up to three years (Tweddle and Magasa, 1989; Zwieten and Njaya, 2003; Gownaris et al, 2018), and builds on earlier work by Zwieten and Njaya (2003) which found that Lake Chilwa was largely influenced by the environment, data and analyses limitations warrants caution to be applied in inference of the strength of the association and confidence in significance of results (Whittingham et al, 2006). The most important factor explaining total fish catches was found to be lake height ($p<0.02$).

Table 4-2 Cross correlation of water dynamic variables with total fish catch (tons) within the same year and up to five years after.

Time Lag (years)	**Total Rain (mm)**	**Delta Rain (mm)**	**Amplitude Rain (mm)**	**Lake Height (masl)**	**Delta Lake Height (m)**	**Amplitude Lake Height (m)**
0	-.162	-.371	.169	.238	-.105	.395
+1	.330	.176	.471	.329	.120	.428
+2	.211	.215	.149	.238	.030	.299
+3	.097	-.143	-.176	.218	.252	.227
+4	.152	-.145	.047	.019	.402	.078
+5	.135	.260	.346	-.301	.079	-.133

Table 4-3 Standard linear regression statistics of water dynamic variables related to total fish catches (tons) (Sqrt(Y)).

Variable	**B**	**B SE**	**β**	***t***	***p***	**R^2**	**S**	**F (df)**	**F Sig.**
Model 1					0.032*	0.153	28.31	5.07 (1, 28)	0.032
(Constant)	48.99	19.66		2.49					
Lag-1Total Rain	0.034	0.01	0.39	2.25					
Model 2					0.043*	0.139	28.55	4.51 (1,28)	0.043
(Constant)	91.63	5.21		17.57					
Delta Total Rain	-0.022	0.01	-0.37	-2.12					
Model 3					0.025*	0.185	27.84	5.66 (1, 25)	0.025
(Constant)	46.75	19.63		2.38					
Lag-1 Amplitude Total Rain	0.12	0.05	0.43	2.38					
Model 4					0.019*	0.176	27.90	6.20 (1,29)	0.019
(Constant)	-10592.42	4288.89		-2.47					
Lag-1 Lake Height	17.09	6.86	0.42	2.49					
Model 5						0.277	26.79	4.41 (2,23)	0.024
(Constant)	-8072.75	4723.79		-1.70	0.101				
Lag-1 Amplitude Total Rain	0.09	0.05	0.33	1.79	0.086				
Lag-1 Lake Height	13.00	7.56	0.31	1.71	0.099				

NB: dependent variable Sqrt(Y) Total Fish Catch (tons). *p < 0.05

4.7 Discussion and Conclusion

There are limited studies investigating in-depth the current status of small-scale inland capture fisheries in terms of yield and trends, their role for food security and poverty alleviation, and understanding how climate change will impact upon them (Youn et al, 2014; HLPE, 2014). This is due to data limitations and the complex characteristics of small-scale inland capture fisheries: informal, multi-gear, multi-species, dispersive, and remote (Welcomme, 2011). As a result, the sector has often been underreported, undervalued and mal-managed (Youn et al, 2014; Welcomme, 2011; Jul-Larsen, 2003).

Water level fluctuations have been widely reported to influence the stability, productivity and resilience of inland fisheries. However, there has been limited research applied at the water body scale over longer periods, and the effects of climate change on inland fisheries is still not fully known, particularly at the local scale. Taylor et al (2016) 'Call to action – the Rome declaration: ten steps to responsible inland fisheries' has called for more research into understanding the trends and challenges in inland fisheries. In addition, wider studies have called for more local level assessments of the impacts of climate change on the sector, and a need for new assessments using best available data at the water body scale with innovative techniques (De Graaf et al, 2012; Welcomme, 2011; Béné et al, 2016). This study aimed to fill this void and investigated the relationship between water level fluctuations and fish catches in a shallow-climate sensitive fishery: Lake Chilwa. To overcome data limitations, satellite derived lake level data was used for the first time on Lake Chilwa in combination with traditional climate data. The study is one of a few studies to utilise satellite derived lake level data for understanding water dynamics and fisheries (Gownaris et al, 2018).

The study finds evidence that Lake Chilwa's fishery is influenced by the environment. Rainfall amplitude within a year and annual lake level height were found to be significantly associated with total fish catch in the following year. Seasonal oscillation of rainfall is important for fisheries production; it acts as a cue for breeding, enhances lake levels which inundates surrounding floodplains creating new habitat for fish to breed and enhancing nutrient recycling. Therefore, the findings give an insight into the important relationship between rainfall, lake level and fishery production. In Lake Turkana, Gownaris et al (2018) also found evidence of seasonal oscillations and the previous year lake level influencing fisheries catch from 1993 to 2014. The findings support wider studies revealing that fish production is strongly driven by fluctuations in rainfall, as reflected in lake level variations (Kolding, 1992; Gownaris et al, 2018; Zwieten and Njaya, 2003; Kolding et al, 2003; Karenge and Kolding, 1995; Chifamba, 2000; Tweddle and Magasa, 1989). However, although the findings build on and are supported by previous studies on Lake Chilwa (Kalk et al, 1979; Jul-Larsen et al, 2003; Kolding and Zwieten, 2006), the study had limitations in data quality and analyses approaches due to the data-limited environment and therefore caution needs to be applied in interpreting the strength of the association.

The study provides a new exploratory assessment on Lake Chilwa's fishery and a timely update over the past decade using best available data and innovative technology (Zwieten and Njaya, 2003; Kolding et al, 2012). Water level fluctuations are natural patterns in aquatic habitats, which are necessary for the survival of many species and influence productivity and biodiversity of ecosystems (Wantzen et al, 2008a). However, as our findings and wider studies show, extreme or untimely floods or drought have deleterious effects on the ecosystem, with consecutive low water levels for two to three years affecting inland fisheries catches (Wantzen et al, 2008a). In data limited environments, satellite radar altimetry therefore has the potential to provide real time data on water dynamics that can be used by governments, fisheries and water resource managers to help preserve water flows and identify minimum water level thresholds and vulnerability of inland fisheries (Wantzen et al, 2008b). Effective water resource management in light of uncertain impacts of climate change will be important to maintain the function of inland fishery ecosystems. The findings also help in the understanding the availability and stability of fish supply to vulnerable populations dependent upon them for livelihood and food security; providing the first step in understanding the contribution of the sector to food security (HLPE, 2014).

Chapter 5 Fisheries and Food Security

5.1 Introduction

The Sustainable Development Goals agenda makes achieving food security and ending malnutrition a global priority. Food security occurs "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). Despite progress towards meeting international development goals over the past decade, the status of global food insecurity remains unacceptably high with over 800 million people globally with insufficient food energy (calories) (FAO, 2014). In terms of nutrition, micronutrient deficiencies, notably in vitamin A, iron and iodine, affect more than 2 billion people primarily in developing countries (FAO, 2012). Over 25% of all children under the age of five are stunted and approximately 30% suffer from vitamin A deficiency (FAO, 2013; Roos, 2016).

Fish is one of the most valuable wild foods, providing an accessible and affordable nutrient dense food source and a source of income and employment. Increasing evidence points to the role fish plays to human health and the sector has been recognised as playing an essential role in tackling food and nutrition security worldwide (HLPE, 2014; Béné et al, 2016). Compared with other food sources, fish has been found to be a particularly important source of vital micronutrients (vitamins D, A, and B), minerals (calcium, phosphorus, iodine, zinc, iron, and selenium) and unique fatty acids (HLPE, 2014; Roos, 2016). The health benefits of fish for child development, brain function, and reduction of diseases (such as Alzheimer's and cardiovascular diseases) have been widely reported (He et al, 2004; Kaunda et al, 2008; HLPE, 2014). Protein in fish has also been found to be 5-15% more bioavailable than plant-based protein sources (HLPE, 2014). Micronutrients are concentrated in the bones, heads and viscera of fish species and therefore the part of the fish consumed plays a key role in determining the intake of these nutrients. Small fish species that are often consumed whole are particularly nutrient dense and an affordable food source for low-income consumers (Kawarazuka and Béné, 2011; Allison, 2013; HLPE, 2014). Intake of these nutrients is often determined by cultural perceptions and individual preferences. Nutrient composition can also vary by fish species, however the nutritional profiles of fish species, particularly inland capture fisheries, are not fully known (Bogard et al, 2015). Fish can therefore add diversity to diets and be beneficial in tackling micronutrient deficiencies, particularly in developing countries (Kawarazuka and Béné, 2011; HLPE, 2014).

Inland capture fisheries contribute a small amount to the global food fish supply; however, for many countries they can contribute an important source of fish and income for millions of people. The bulk of inland capture fisheries production occurs in developing countries that have substantial freshwater resources and large rural populations, with many classified as Low-Income-Food-Deficit. Over 200 million of Africa's 1 billion people regularly consume fish (Heck et al, 2007), and nearly half of the officially recorded supply of fish comes from inland fisheries (Neiland, 2005). The sector is also largely small-scale creating employment several times higher than large-scale fisheries. The contribution of inland small-scale fisheries (SSF) to livelihoods and food security is therefore amplified when considering that the fisheries are often in rural remote locations where communities have a lack of nutritious food sources and livelihood options.

Fisheries can contribute to food security in a myriad of complex pathways (HLPE, 2014). These are dependent on a number of factors including the productivity of the fishery and the degree of stress placed upon the system; the vulnerability of populations dependent on fish for income, revenue or nutrition; the nature of involvement in the fishery; as well as cultural norms and relations between men and women (Unsworth et al, 2014). The main contributions are illustrated in **Figure 5.1** and are identified as:

(1) Directly through direct home consumption which contributes to food and nutrition intake;

(2) Indirectly through sale of fish for cash which lowers market value of fish and increases purchasing power for other foods, and;

(3) Via employment in ancillary activities for women who are linked with spending more income on household food and nutrition (Kawarazuka and Béné, 2010).

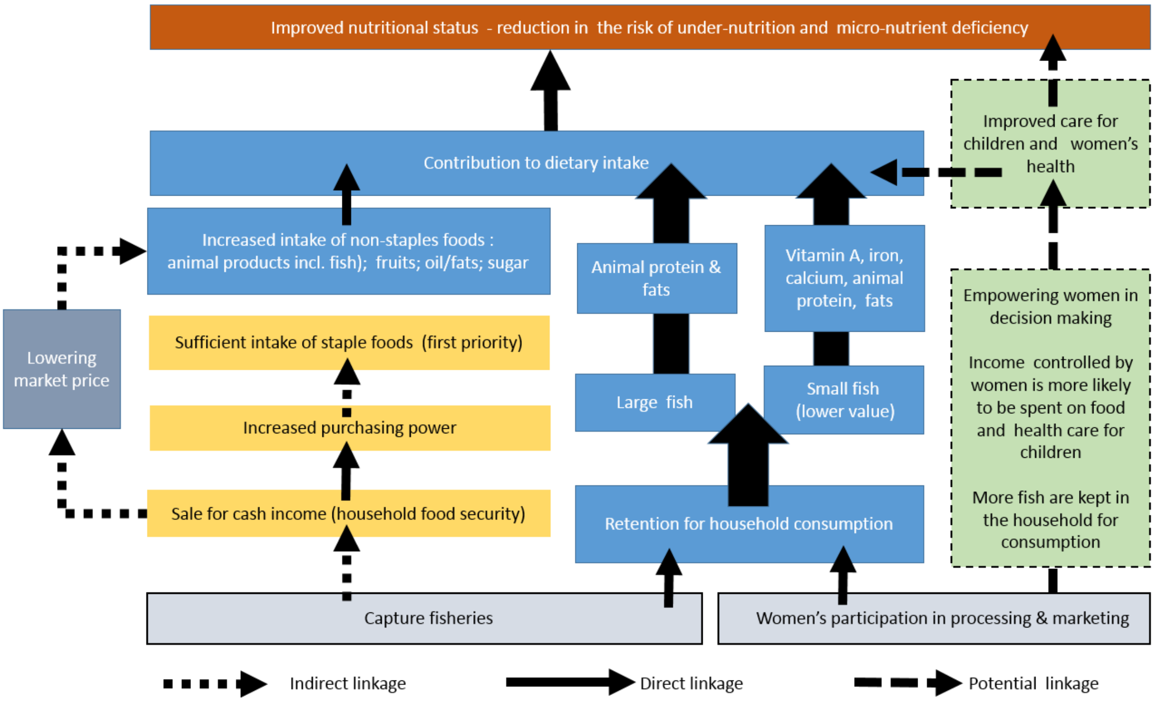

Figure 5-1 Pathways through which small-scale fisheries can contribute to nutritional status. (Source: adapted from Kawarazuka, 2010). The figure portrays the direct pathways in blue, indirect pathways in orange, and the contribution explicitly from women in the supply chain in green.

In rural economies, compared to other natural resource-based livelihood strategies, fishery related livelihood activities have been found to have a higher income earning potential; contributing to annual income security and sustainable livelihoods (Heck et al, 2007; Béné et al, 2016). These studies test the past assumptions that all fishermen are the poorest of the poor (Pollnac et al, 2001; Béné et al, 2003). In addition, fish-related activities can act as a safety net during climate induced agricultural lean months or for the increasing numbers of landless poor (HLPE, 2014; Kawarazuka and Béné, 2011). Several studies on inland capture fisheries in Africa; Lake Chilwa in Malawi, Lake Victoria in Kenya, Lake Kyoga in Uganda, found that fishers had higher income compared to non-fishers (Allison, 2004, Allison and Mvula 2002, Ellis and Bahiigwa 2003). Béné et al (2009) described the link between fisheries and livelihoods as a bank in the water function where fisheries can act as a cash crop and an important primary and secondary source of income.

Due to poor data availability, the importance of inland small-scale capture fisheries (SSF) to food and nutritional security is not well understood (Miao et al, 2010; Youn et al, 2014). Inland SSF present unique challenges in monitoring and evaluation due to their dispersive, remote and informal characteristics: where fish-related activities are sometimes undertaken part-time or seasonally, and fish trade is difficult to monitor (Welcomme and Lymer, 2012). As a result, the sector is often omitted from national socio-economic surveys and fish catches are under-reported. National consumption surveys have been shown to provide more accurate information on the level of fish consumption, which can be used as a proxy for fish yields and supply, as well as in understanding nutritional contributions of fish to diet. As an example, in Malawi whose fish supply is predominantly from inland SSF, the national 2010/11 Third Integrated Household Survey showed fish consumption to be 11.6 kg/capita/year for the average Malawian diet (Verduzco-Gallo, 2014), which is at least double the level of official records of apparent supply for the same period (FAOSTAT, 2017). In addition, the contribution of fish protein in the overall diet in Malawi was three times larger than official records (Funge-Smith, 2018). One reason for the under-reporting could be the tendency to under-estimate inland SSF due to the challenges in monitoring. Case studies can also shed light on the 'hidden' SSF supply and value to food security. Lymer et al (2016) calculated the contribution of inland fish catches in the Lower Mekong River to annual nutritional requirements, and highlighted fish as a conserving and efficient source of nutrients compared with the replacement by terrestrial animal sources. There are limited studies that explore in-depth the pathways between SSF and food security. In marine SSF, Darling (2014) found that engaging in the marine fishery sector and wealth strongly influenced household food security in terms of consumption levels, protein intake and food coping strategies. Studies in inland capture fisheries around Lake Victoria have shown food security to be driven by higher income and asset wealth, as well as gender where male fisherfolk directed income away from the household compared with women who prioritised household food security (Fiorella et al, 2014; Geheb et al, 2008). Little is known however on the vulnerability context and the food security of households involved in different types of fish-related activities and livelihood typologies.

This chapter contributes to the growing field investigating SSF and their contribution to food and nutritional security. The chapter explores the levels of food security between fishing and non-fishing households in two lakeshore villages in Malawi. The chapter addresses research question 2 of the thesis and the objectives are:

a) to assess whether fishing households have higher fish consumption than non-fishing households; and,
b) to assess whether fishing households have higher food security than non-fishing households.

The study will be the first to investigate food security in SSF communities in the context of vulnerability and inclusion of actors along the value chain. In addition, as an inland protected area, the study will shed light on the impacts of fisheries management on livelihoods and food security. The sustainable livelihood framework is adopted to understand the building blocks of livelihoods (capital assets), vulnerability context, and pathways to achieving the livelihood outcome of food security.

5.2 Materials and Methods

5.2.1 Study Site

See **Chapter 3** for a description of the study site: Lake Chilwa, its small-scale fishery and villages selected for surveying.

5.2.2 Research Framework

Livelihoods underpin food security and its pillars of availability, access, utilisation and stability of food supply (**see Chapter 3**). The sustainable livelihoods framework (SLF) promoted by DfID (1999) has been regarded as the most widely used framework for understanding and assessing sustainable livelihoods (Schreckenberg et al, 2010). The framework orders the complexity of rural development and poverty and can readily describe fisher's livelihoods through its focus on assets, seasonality and shocks, access, political institutions and social interactions (Allison and Ellis, 2001). A livelihood comprises of social, natural, physical, human and financial capital assets that act as building blocks of livelihoods. Social relations, structures and processes: such as culture, laws and policies, shape access to these capital assets, which shape the livelihood strategies adopted. External vulnerability factors: such as shocks, trends and seasonality directly affect people's asset status, opportunities to improve livelihood and ability to transform assets and strategies into positive livelihood outcomes (DfID, 1999). Within the vulnerability context, people combine assets in innovative ways and adopt a portfolio of activities to achieve a desired livelihood outcome (DfID, 2004). The SLF enables a wider understanding of food security through focusing on the assets, strategies and vulnerability context through which food security is achieved (ACF, 2010). This research focuses on the role of fishing as a livelihood strategy and its contributions to the outcome of improved food security. Household surveys were designed based on the SLF and collected information on capital assets, shocks, livelihood strategies, and food security adapted to the context of small-scale capture fisheries (**Table 5.1**).

Table 5-1 Summary of study variables for analysing the role of fisheries to food security in rural livelihoods, using the Sustainable Livelihoods Framework and pillars of food security (modified from Allison and Ellis, 2001).

Sustainable Livelihood Component	**Variable**	**Food Security Pillar**
Livelihood Platform: Capital Assets		The livelihood platform influences access to and utilisation of food
Human Capital	Gender of head of household Marital status of head of household Age of head of household Household size Education level of head of household Household members read and write Household morbidity in past 4 weeks	
Natural Capital	Land ownership Land size (acres) Protected drinking water source	
Physical Capital	Asset Index (wealth) Access to electricity	
Financial Capital	Household has savings Expenditure over 7 days and over 4 months	
Social Capital	Membership of organisations Kinships and cash/food exchanges	
Location	Study village site 1 and 2	
Vulnerability Context: Shocks	Livelihood shocks experienced Impacts of livelihood shocks on income, assets and food	Shocks affect the availability and stability of food supply, as well as access
Livelihood strategies	Fishing household or non-fishing household Type of fishing household: fisher, processor, trader, mixed Number of livelihood occupations Top ranked livelihood activity	Livelihood strategies influence access to food, and can affect the availability of food

Livelihood Outcome: Food Security		Livelihood outcome of food security is based on all pillars: availability and stability (seasonality and vulnerability), access (food acquired) and utilisation (diet diversity, nutritional quality, preferences)
Acute	Food consumption levels over 7 days (FCS) Food nutritional quality over 7 days (FCS-N) Fish consumption over 7 days by fish species (No. days consumed fish) Fish consumption habits and preferences by species Perception of food security over 7 days (households had enough food) Food insecurity coping strategies over 7 days (rCSI)	
Long-term	Seasonality of food insecurity over 12 months Causes of food insecurity over 12 months Food insecurity coping strategies over 12 months	

5.2.3 Characterisation of Variables

Livelihood component variables

Household type was defined as fishing or non-fishing and was characterised by whether the head of the household reported any member of the household engaging in fish-related activities over the past 12 months. A fishing household was categorised as engaging in either the primary (fishing) or secondary sector (fish processing and trading), or both.

A range of household socio-economic characteristics were recorded (see **Table 5.1**). This included capital assets: human capital (e.g. education, age and gender of the head of the household), natural capital (e.g. land ownership and quality of drinking water sources), physical capital (e.g. presence of material assets as a proxy for wealth), financial capital (e.g. expenditure and savings) and social capital (e.g. relatives and membership of organisations). A proxy indicator of household level wealth was created from the presence of material assets: durable goods (radio, bicycle, TV etc.), household characteristics (types of flooring, roofing etc.), utilities and infrastructure (protected water source, electricity) (Vyas and Kumaranayake, 2006; Fiorella et al, 2014). The asset items were factor analysed using the principal component analysis (PCA) method (see **Appendix G**). Variables with low factor loadings were removed from the analysis and Catell's (1966) scree test was used to determine the final number of factors to extract from the analysis. The first PCA axis was used as the Asset Index and explained 35.2% of the variation in asset wealth amongst households which is typical in studies (Darling, 2014; Cinner et al, 2010). The index described poorer households as having dirt floors, thatched roofs, and lack of modern household equipment, whilst wealthier households had cement flooring, iron sheet roofing, a TV and modern furniture. Livelihood strategies were measured by the type and number of livelihood activities that households engaged in. Respondents were also asked to rank the top livelihood activities by household income. Vulnerability was measured by recording the stressors and shocks that people had experienced in the previous year. Respondents ranked shocks by severity.

Food Security

Livelihood outcomes focused on food security. Acute-short-term food security was investigated by measuring a range of universal indicators over a 7-day recall period: food consumption levels, food nutritional quality, fish consumption, perceptions of food insecurity and coping behaviours to food insecurity (see **Appendix G** for more details). Diet diversity and food frequency obtained from food consumption recall surveys have been shown to be effective indicators for understanding food intake and food security (WFP, 2008). Household food consumption levels were measured by recording the frequency of food items consumed over a 7-day recall period. Food items represented major food groups and food found in Malawi (**Table 5.2**). A Food Consumption Score (FCS) composite index was calculated for households based on the diversity of food groups and items consumed, the frequency of consumption over the 7-day recall period, and the relative nutritional importance (WFP, 2008) (**Table 5.2**).

Household FCS scores were categorised to create FCS-Groups according to WFP (2008) universal classification of food consumption levels: poor (<21), borderline (21-35) and acceptable (>35). The WFP's (2015) Food Consumption Score Nutrition Quality (FCS-N) index provides a measure of nutrition. The index focuses on protein, which is important for preventing wasting and stunting, and micronutrients of vitamin A and iron, which are essential for functioning of the immune system, growth and development. Foods that were consumed over the 7-day period and that were rich in protein, hem iron and vitamin A were grouped and a FCS-N score was calculated for each household based on the number of days that nutrient rich foods were consumed (**Table**

5.2). Freshwater fish can be a rich source of micronutrients, such as zinc and vitamin A, especially in small fish species that are eaten whole (HLPE, 2014). However, the nutritional value of fish is often under-valued and fish is omitted from vitamin A calculations in the FCS-N. Consumption of different fish species was therefore also measured independently by frequency of consumption over the 7-day period and perceptions of food preferences recorded.

Perception of food security was measured by asking respondents whether they worried about their household not having enough food over a 7-day recall period (Maxwell and Caldwell, 2008). Coping strategies were investigated to understand the level of food insecurity and adaptation. Households were asked the number of days over the 7-day recall period that they adopted coping strategies based on a universal reduced set of behavioural responses (Maxwell and Caldwell, 2008). Coping strategies included eating less preferred food, limiting portion sizes, borrowing food or money to buy food, limiting adult intake, reducing the number of meals and going without food for whole days (Maxwell and Caldwell, 2008). The more coping behaviours a household exercises, the more food insecure they are. Coping strategies can vary in severity where limiting adult food intake is more severe than eating less preferred food. Weights were assigned to each coping strategy based on their universal standardised severity score (**Appendix G**) (Maxwell and Caldwell, 2008). Household's perceived the severity of each coping strategy similarly; being worried to very worried about undertaking the coping strategy (**Appendix G**) (Maxwell and Caldwell, 2008). A single household score was calculated from the frequency and severity of each coping strategy to form the Reduced Coping Strategy Index (rCSI). A higher score indicates a higher level of food insecurity. Longer-term food insecurity was investigated by measuring perceptions of food insecurity occurrences, causes and responses over the 12-month period prior to the survey as well as the frequency of occurrence over the past 10 years.

Table 5-2 Food groups and their Food Consumption Score weights and nutritional components.

Food Items	**Food Groups**	**FCS Weight (WFP, 2008)**	**FCS-N Components (WFP, 2015)**
Cereals: maize, rice, etc. Root and tubers: sweet potato, carrots, pumpkin, cocoyam, other etc.	Main staples	2	Vitamin A: carrots, pumpkin
Beans, pigeon pea, nuts etc.	Pulses	3	Protein
Green leafy vegetables: cabbage, nkhwani, rape, other	Vegetables	1	Vitamin A: green leafy vegetables.

Other vegetables: onion, tomato etc.			
Mango, papaya, other	Fruit	1	Vitamin A
Chicken, beef, goat, other red meat (e.g. guinea fowl), pork, fish (by type of species), eggs	Meat and fish	4	Protein Vitamin A: eggs Hem Iron: meat and fish (excl. eggs)
Milk and milk products	Milk	4	Protein Vitamin A
Sugar / honey	Sugar	0.5	
Oil/fats	Oil	0.5	

5.2.4 Data Collection

Household surveys were conducted in two lakeshore villages around Lake Chilwa during the dry season between June and August 2015. Villages were selected with local informants to be representable of SSF characteristics in Lake Chilwa. One village; Likapa, was located next to a main fishing port and road, and Sauka Phimbi village located more remotely from Likapa with no main road connections (**see Chapter 3**). A total of 120 interviews were conducted with heads of households, with a total of 588 household individuals. In each village, households engaged in fish-related activities were surveyed (n= 80) and households that did not engage in fish-related activities; non-fishing households, were surveyed (n=40). Households were selected by stratified random sampling of households to ensure that households both engaged in and not engaged in fishing were included. Households were defined as a group of people living together and eating the same meals. Male and female head of households were interviewed, and if no head of household was present, the adult spouse was interviewed. Field-testing of the questionnaire was carried out via a pilot study: conducted in one fishing village with a small group of participants, and with local partners in Malawi, in order to validate and finalise questions. Amendments were made to the questionnaire: such as making terminology clearer and extending responses to closed questions. The questionnaire was translated into Chichewa and back-translated into English to ensure consistency of meaning. A local experienced and qualified enumerator was used to administer the survey and was trained in the study survey by the researcher. Ethical approval was obtained from University of Southampton Faculty of Social and Human Sciences Ethics Committee (reference: 14728) and from the National Commission for Science and Technology in Malawi prior to commencement of research. Permission was sought from the Group Village Headman and from the

Village Headman of both villages to conduct research in the study sites. Prior to interview consent was also obtained from each household in line with survey ethics.

5.2.5 Statistical Analyses

Continuous variables: such as age, household size, literacy, asset index, expenditure, occupations and food security, were examined for normality and many displayed non-normal distributions. Variables were compared between fishing and non-fishing households using Chi-square test for independence, Mann-Whitney U test and Kruskal-Wallis test. Validation tests were performed on all proxy indexes (Wealth Index, FCS, FCS-N, rCSI) by non-parametric Spearman rho correlation with other indicators.

The relationship between socio-economic and food security variables were investigated using Pearson product-moment correlation coefficient and standard multiple linear regression. The influence of socio-economic variables: fishing household, village, gender, education secondary level, asset wealth, household size and number of occupations, on food consumption levels (FCS) and reduced food insecurity coping strategies (rCSI) was assessed. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity, which was confirmed post-analyses via inspection of the normal P-P plot and scatterplot of standardised residuals. Significant correlations existed between independent variables and dependent variables. Tolerance and variance inflation factor values (<2) indicated no collinearity amongst independent variables. Independent variables were selected based on previous studies and theory on the association between capital assets and livelihood and food security. Retention of variables in the model was based on correlation and retention of significant terms to improve model fit. This led to some variables being removed in the food coping strategy model. Statistical analyses were conducted using IBM SPSS Statistics 24.

Table 5-3 Summary of key variables and comparisons between fishing and non-fishing households.

Variable	Range	Fishing households (80 households) n (%) or median (range)	Non-fishing households (40 households) n (%) or median (range)	Test p-value
Human Capital:				
Female-headed households (%)	1-male, 2-female	13 (16.3%)	15 (37.5%) *	**0.01**
Head of household married (%)	0-unmarried, 1-married	70 (87.5%) **	22 (55.0%)	**<0.01**
Age of head of household	20 to 82	34 (20-82)	41 (20-73)*	**0.01**
Household size	1 to 13	5 (1-13) *	4 (1-8)	**0.01**
Education level of head of household (%)	1-Pre-school 2-Primary 3-Secondary 4-Never been to school	2 (2.5%) 62 (77.5%) 10 (12.5%) 6 (7.5%)	1 (2.5%) 26 (65.0%) 7 (17.5%) 6 (15.0%)	0.48
No. household members read and write	0 to 10	2 (0-10) **	1 (0-4)	**<0.01**
Household morbidity in past 4 weeks (%)	0-never ill, 1- ill	51 (63.8%)	27 (67.5%)	0.83
Natural Capital:				
Land ownership (%)	1=yes, 2=no	64 (80%)	35 (87.5%)	0.44
Land size (acres)	0.5 to 8	1.75 (0.5-8)	2 (0.5-7)	0.94
Protected drinking water source (%)	1=yes, 2=no	78 (97.5%)	36 (90%)	0.08
Physical Capital:				
Asset Index	0 to 99.96	14.22 (0-99.96)	13.83 (0-51.24)	0.18
Electricity (%)	1=yes, 2=no	5 (6.3%) *	0 (0%)	**0.04**
Financial Capital:				
Savings (%)	1=yes, 2=no	30 (38%) *	7 (17.5%)	**0.03**
Expenditure 7 days	MWK 50 - 9,500 (USD$ 0.08 - 16.8)	1,400 (50-9,500) *	950 (60-4,000)	**0.05**
Expenditure 4 months	MWK 50 - 745,650 (USD$ 0.08 - 1319.19)	20,842 (50- 745,650) *	10,305 (800-97,840)	**0.01**
Social Capital:				

Variable	Range	Fishing households (80 households) n (%) or median (range)	Non-fishing households (40 households) n (%) or median (range)	Test p-value
Membership of organisations	1=yes, 2=no	33 (41.3%)	10 (25%)	0.12
Household has relatives	1=yes, 2=no	78 (97.5%)	38 (95%)	0.85
Give and/or receive cash from relatives	1=yes, 2=no	57 (73%)	21 (55.2%)	0.29
Give and/or receive food from relatives	1=yes, 2=no	67 (85.8%)	30 (78.9%)	0.52
Livelihood Strategies				
Top (1st) ranked livelihood activities	Farming	27 (33.8%)	31 (77.5%) **	**<0.01**
	Fishing	27 (33.8%)	0 (0%)	
	Fish processing	11 (13.8%)	0 (0%)	
	Fish trading	9 (11.3%)	0 (0%)	
	Other fish business	1 (1.3%)	0 (0%)	
	Agriculture wage	2 (2.5%)	5 (12.5%)	
	Petty business	0 (0%)	3 (7.5%)	
	Business	3 (3.8%)	0 (0%)	
Number of occupations	1 to 10	3 (1 to 10) **	2 (1 to 5)	**<0.01**
Shocks:				
Livelihood shocks over past 12 months ranked most severe	Drought	9 (11.3%)	3 (7.7%)	0.28
	Flood	29 (36.3%	17 (43.6%)	
	Livestock disease	1 (1.3%)	0 (0%)	
	Low fish availability	8 (10%)	0 (0%)	
	Low price agriculture output	2 (2.5%)	1 (2.6%)	
	Low price fish output	1 (1.3%)	1 (2.6%)	
	High costs input agriculture	1 (1.3%)	0 (0%)	
	High costs input fish	2 (2.5%)	0 (0%)	
	High price food	8 (10%)	6 (15.4%)	
	Reduction in earnings	1 (1.3%)	0 (0%)	
	Serious illness/accident	9 (11.3%)	7 (17.9%)	
	Death	5 (6.3%)	3 (7.7%)	
	Theft	3 (2.5%)	0 (0%)	

Variable	**Range**	**Fishing households (80 households) n (%) or median (range)**	**Non-fishing households (40 households) n (%) or median (range)**	**Test p-value**
Impact of livelihood shocks (decrease)	Income	79 (98.8%) *****	34 (89.5%)	**0.02**
	Assets	77 (96.3%)	33 (86.8%)	0.06
	Food production	78 (98.7%)	36 (94.7%)	0.22
	Food stocks	79 (100%) *****	35 (94.6%)	**0.03**
	Food purchases	51 (63.8%)	19 (50%)	0.36
Food Security:				
Food Consumption Score (FCS) over 7 days	15 to 112	63 (15-112) ******	49 (17-104)	**<0.01**
Nutrition (FCS-N) over 7 days:				
Vitamin A rich foods	1-25	5 (1-25)	6 (1-21)	0.98
Protein rich foods	1-31	12 (2-31) ******	7 (1-28)	**<0.01**
Hem iron rich foods	1-22	7 (1-22) ******	4.5 (1-11)	**<0.01**
Fish consumption no. days over 7 days	0 to 7	6 (0-7) ******	3.5 (0-7)	**<0.01**
Reduced Coping Strategy Index (rCSI) over 7 days	0 to 46	2.5 (0-46)	8 (0-43)	0.18

Note: *<0.05, **<0.01

5.3 Results

Descriptive statistics are presented in **Table 5.3** showing comparisons of variables between fishing and non-fishing households.

5.3.1 Characteristics and Capital Assets

Respondents in fishing and non-fishing households showed levels of similarities and differences in many socio-economic characteristics that compose capital assets (**Figure 5.2)**. The majority of households held religious beliefs of Christianity (84%) followed by Islam (9.2%) and Catholicism (3.4%). Households were largely from two ethnic groups: Lomwe (43.3%) and Nyanja (26.7%). Within fishing households interviewed, fishing activities covered both primary and secondary activities. Nearly half of fishing households were engaged in the primary sector as fishers, 30% were in the secondary sector as processors and traders, and 20% were involved in both sectors. Location influenced the type of fish-related activities in the household ($p<0.05$) with a higher percentage of fishing households engaged in mixed sectors in Sauka Phimbi compared with Likapa. Approximately one third of fishing households who undertook fishing activities were characterised as large-scale: operating a seine net or a boat. Females were largely involved in processing and trading ($p<0.05$).

Fishing households generally had a higher level of human capital compared with non-fishing households. Fishing households had a higher level of households headed by males who were predominantly married compared with non-fishing households who had higher levels of female and unmarried headed households ($p<0.05$). Fishing households on average also had younger household heads, larger families, and a higher number of people in the household able to read and write ($p<0.05$). Level of education attainment and rates of morbidity were similar amongst all households ($p>0.05$).

Natural capital relating to land ownership characteristics were similar across fishing and non-fishing households (*$p>0.05$*). The majority of respondents owned land (82.5%), primarily used for agriculture farming (98.9%). The area of land owned ranged from 0.5 to 8 acres with a median of 2 acres (IQR: 1, 3). The majority of households derived their drinking water from protected water sources of boreholes and protected wells (*p=>0.05*). Protected water sources were also primarily used as domestic and washing water sources. Additional sources of water for washing included rivers, which non-fishing households (5.1%) used, and Lake Chilwa, which fishing (12.5%) and non-fishing (5.1%) households used.

Physical capital, measured by the ownership of household assets, were generally comparable between fishing and non-fishing households ($p>0.05$) however fishing households had higher levels of electricity and ownership of a radio ($p<0.05$). As expected, a significantly higher percentage of fishing households owned a boat (35%, $p<0.01$) and fishing seine nets (34%, $p<0.01$) compared to non-fishing households. Ownership of livestock on the other hand was similar between fishing and non-fishing households ($p>0.05$). The Asset Index revealed that the majority of households had low levels of material well-being (Md: 14.22, IQR: 6.99, 20.43). Wealth groups created from the index (percentiles 20, 40, 60 and 80) revealed that all wealth groups, not just poorer households, undertook fishing. Non-fishing households had a slightly lower median Asset Index score (Md=13.83) compared to fishing households (Md=14.22), and a higher percentage of non-fishing households were classified as very poor (32.5% in percentile 20 compared with 15%), however differences were not significant between groups ($p>0.05$).

Financial capital was higher in fishing households with a higher percentage of households with savings and on average higher expenditure costs ($p<0.05$). Across households, food was the first priority area of expenditure, followed by clothes and personal beauty ($p>0.05$). The fourth priority area of expenditure varied ($p<0.05$) with non-fishing households additionally prioritising firewood and business, and fishing households prioritising business with a few also reporting milling fees, farm input, cigarettes and beer.

Social capital was strong amongst households with the majority having relatives and engaging in mutual exchange of food and cash. The mutual exchange of food was higher than cash, and approximately 10% of all households only received food or cash. Over one-third (36%) of survey respondents were affiliated to local groups and organisations which were comparable between household type (p=>0.05). Organisations that households were members of included community committees (16.7%), governance committees (13.3%), NGO supported groups (5.8%), as well as political parties which only fishing households were members. Households received some benefits from their memberships with organisations except from political parties, which were similar across all households (p=>0.05). Community committees provided satisfaction in helping others and economic benefits, as well as recognition for fishing households and help in times of problems particularly for non-fishing households. From governance committees, fishing households received satisfaction in helping others, security and economic benefits. Non-fishing households on the other hand received help in times of problems and a higher percentage reported economic benefits. NGO supported groups also provided households with satisfaction in helping others and economic benefits.

Generally fishing households had higher capital assets and a higher livelihood platform compared with non-fishing households (**Figure 5.2**). Capital assets are attained within and affected by the vulnerability context: natural, economic and health shocks experienced by households.

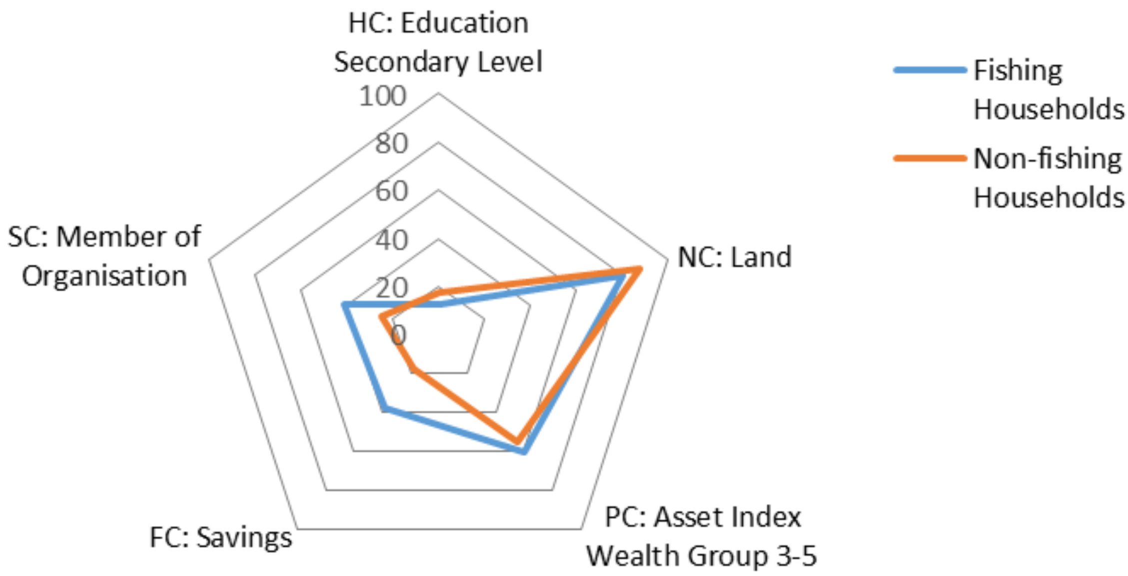

Figure 5-2 Capital asset pentagon showing percentage of total fishing and non-fishing households attaining selected variables that represent human (HC), natural (NC), physical (PC), financial (FC) and social capital (SC).

5.3.2 Livelihood Shocks

Households experienced a number of livelihood shocks from multiple sources that included natural, economic, human health, ecological and social shocks (**Figure 5.3**). The majority of households experienced flooding (99%) and high prices of food (90%), as well as low fish availability (77%), serious illness (63%) and drought (58%). Low fish availability and fish price shocks were primarily experienced by fishing households ($p<0.05$). A higher percentage of fishing households also experienced shocks of theft compared with non-fishing households ($p<0.05$). Village location was also important in determining the type of livelihood shocks households experienced. Drought, crop and livestock disease, and death of a household member was a significantly larger shock to households in Sauka Phimbi compared with Likapa village (p=<0.01). Reduction in earnings on the other hand was more experienced by households in Likapa compared to Sauka Phimbi village (p=<0.05).

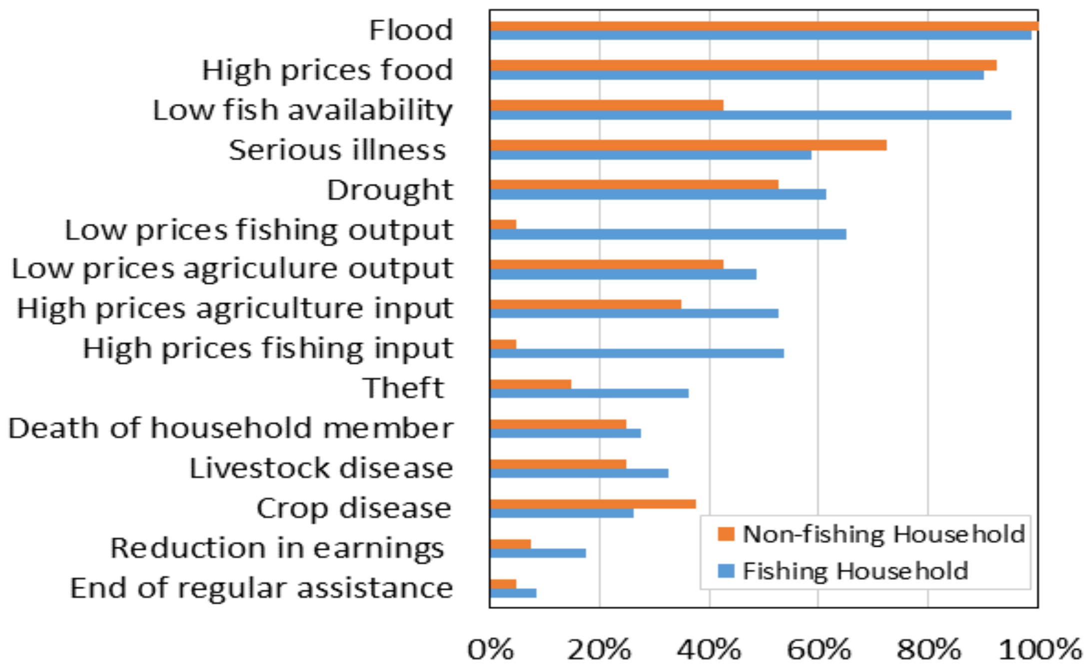

Figure 5-3 Shocks experienced by fishing and non-fishing households. Bars represent total % of households of each group that experienced the shock in previous 12 months.

Households ranked livelihood shocks by order of importance. The first and second most severe shocks primarily related to natural, economic and human health shocks. Flooding was the main shock ranked first and second most severe by households (39% and 23% respectively). Serious illness, high food prices and drought were also highly ranked as the first and second most severe shock. Differences were found in the second ranked shock (p=<0.05): fishing households additionally ranked low fish availability and non-fishing households additionally ranked high costs of agriculture input amongst the second most severe shocks. Differences also emerged between villages in ranking the first and second most severe shocks (p=<0.01). Flooding and high food prices was ranked more highly in Likapa, and drought, crop disease and death of a family member was ranked more highly in Sauka Phimbi.

Approximately all households reported that shocks had a negative impact on their household income (96%), assets (93%), food production (97%) and food stocks (98%) by causing a reduction. Fishing households had higher levels of reductions in income (p=<0.05) and food stocks (p=<0.03) compared with non-fishing households. Shocks also affected food purchases with fishing households having a slight higher decrease in purchases compared with non-fishing households who had slightly higher increases in purchases, although the different was not significant (p=>0.05).

The majority of household's experienced natural shocks of floods and drought, economic shocks of fluctuations in food prices, health related shocks, and sector specific (fishing / non-fishing) shocks. Shocks negatively impacted upon a household's wealth and food security, particularly for fishing households. This vulnerability context affects the livelihood strategies adopted and the ability to transform them into positive outcomes.

5.3.3 Livelihood Strategies

Nearly all households engaged in a diverse portfolio of livelihoods activities (95%). Fishing households had higher livelihood diversification (Md=3) compared to non-fishing households (Md=2) and engaged in up to 10 livelihood activities (p<0.01). The type of non fish-related livelihood activities that households diversified into were comparable between fishing and non-fishing households (p>0.05) (**Figure 5.4**).

Households ranked up to four livelihood activities by importance in relation to contribution to household income. Fishing households on average depended on fish-related activities for 30% of total household income. The most important livelihood activity differed between fishing and non-fishing households (p<0.01) (**Figure 5.5**). In fishing households fish-related activities (60%) and farming (34%) were ranked most important to livelihood income, as well as business and agricultural wage. The majority of non-fishing households however ranked farming as most important (78%) as well as petty business and agricultural wage labour.

Location was also a factor for type of livelihood diversification. In Sauka Phimbi, nearly half of households surveyed participated in petty business (46.7%) and livestock rearing (48.3%), compared with Likapa (15% and 13.3% respectively). The portfolio of activities and diverse strategies adopted by households resulted in a range of livelihood outcomes: influencing income, well-being, vulnerability, food security and sustainable use of resources.

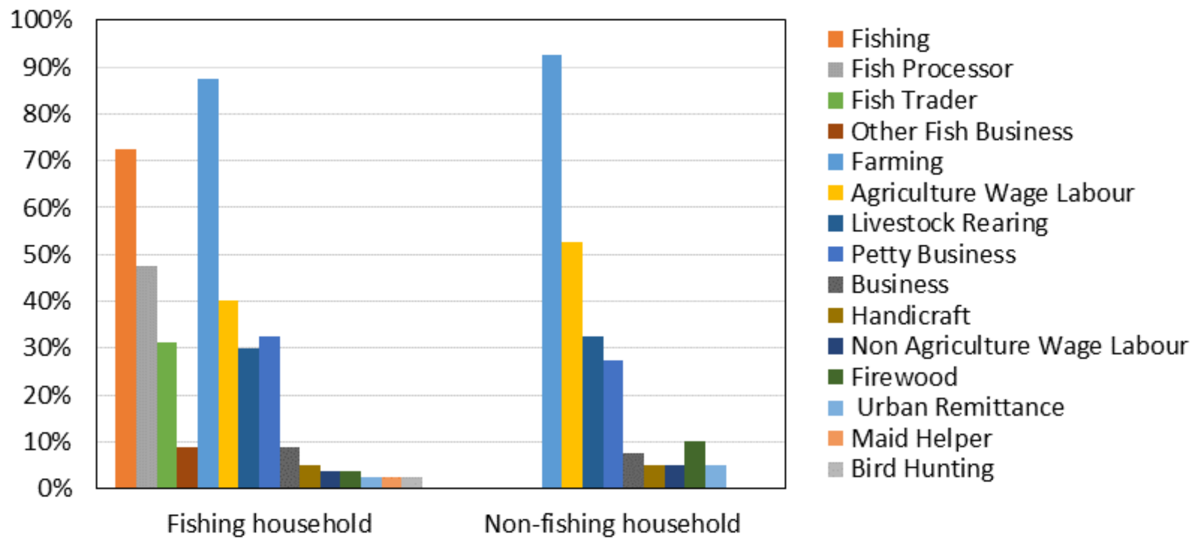

Figure 5-4 Reported livelihood activities that households engaged in over a 12 month period.

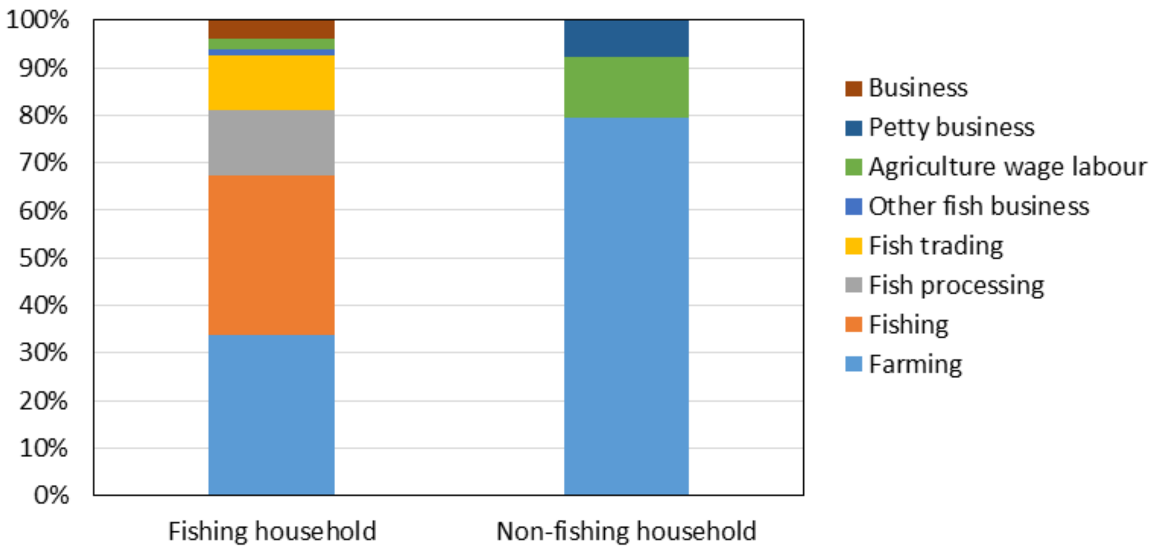

Figure 5-5 Top ranked livelihood activity by household type.

5.3.4 Food Security

5.3.4.1 Food Consumption Levels and Nutritional Quality

Food consumption scores (FCS) ranged from 15 to 112 with a median value of 61.5 (IQR: 47.2, 68.5). A higher FCS score was representable of a more diverse diet with key nutritional food groups (**Figure 5.6**). A Mann-Whitney U Test revealed a highly significant difference in the FCS of fishing (*Md*= 63, n =80) and non-fishing households (*Md* = 49, n = 40) (U = 1012, z = –3.27, p = .001, r = .29) with fishing households showing higher levels of food security. FCS Groups (FCS-G) showed that 88% of households had acceptable FCS and 12% had poor and borderline FCS which is similar to reports in local districts in 2011 (WFP, 2011). A significantly higher percentage of non-fishing households (25%) were classified as having 'poor' and 'borderline' food consumption levels compared to fishing households (5%) (p=<0.01) (**Figure 5.7**).

Foods rich in vitamin A, protein and hem iron were consumed by all households however the frequency of consumption varied (**Figure 5.8**). The FCS-N showed that households with 'acceptable' levels of food consumption (FCS) had higher nutritional security. Fishing households consumed foods rich in protein and hem iron significantly more frequently compared to non-fishing households (p=<0.01). Consumption of vitamin A rich foods were comparable (p=>0.05) across households with 43.5% of all households consuming vitamin A rich foods over the whole 7 days. However, the FCS-N does not include fish as a source of vitamin A, and fishing households (*Md*=6, n=80) consumed fish significantly more frequently compared to non-fishing households (*Md*=3.5, n=40) (U = 900, z = –4.00, p = .01, r = .36).

5.3.4.2 Perceived Food Security and Coping Strategies

The majority of respondents (74%) reported worrying about food insecurity over the 7-day period. Both fishing households (70%) and non-fishing households (82.5%) perceived experiencing food insecurity (p=>0.05). The number of negative coping strategies adopted in response to perceived food insecurity were comparable between households (**Figure 5.9**). The most common coping strategies were reducing the number of meals in a day and limiting portion sizes. Non-fishing households more frequently undertook coping strategies, including one quarter reporting going without food for whole days. The coping strategy index score (rCSI) ranged from 0 to 46 for all households with a median value of 5.0 (IQR: 0, 14). Fishing households had a slightly lower median rCSI score compared with non-fishing households indicating higher food security, however a Mann-Whitney U Test revealed no significant difference (*fishing households Md=2.5, n=80: non-fishing households Md=8, n=39: U=1333.5, z=-1.31, p=0.18, r=0.12*).

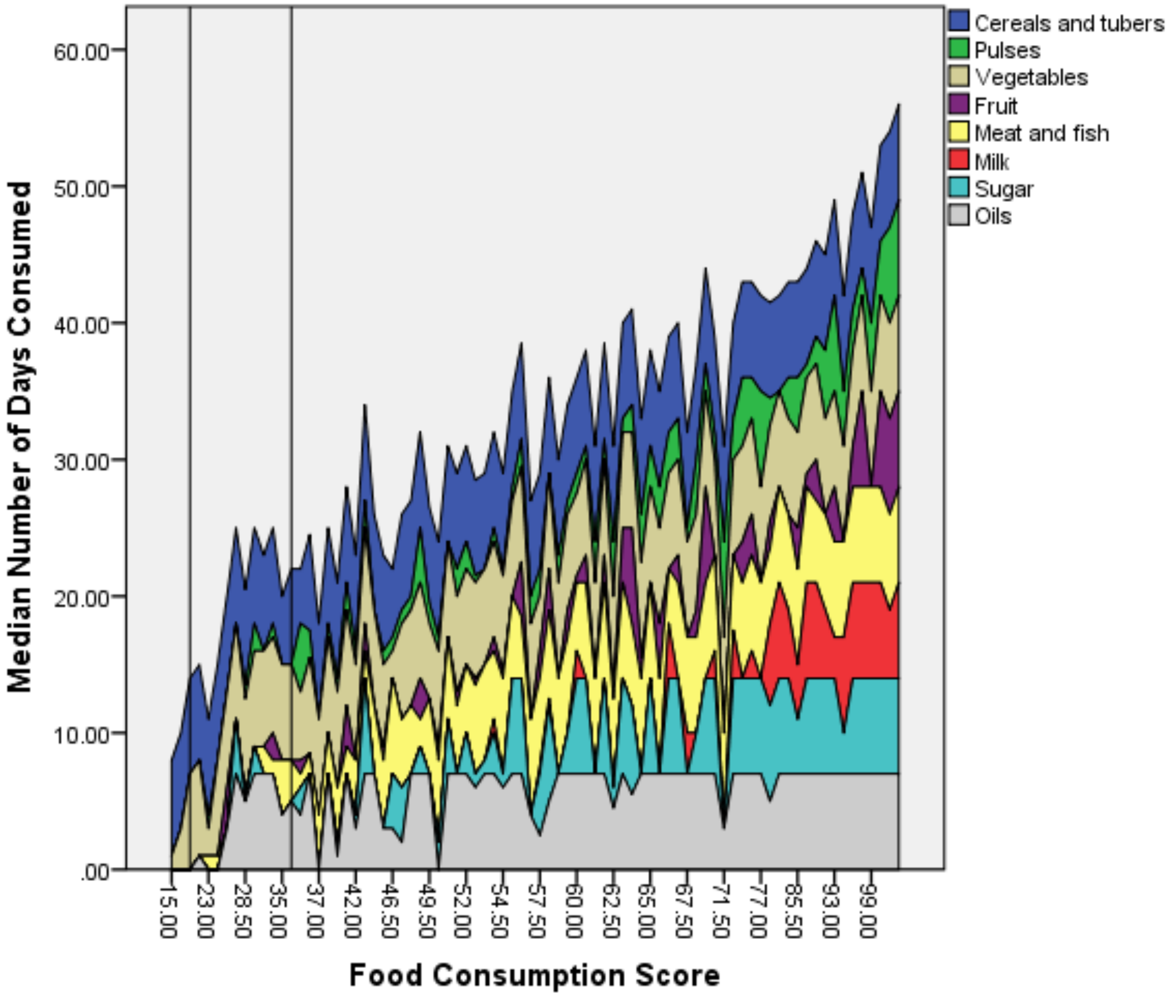

Figure 5-6 Food Consumption Score (FCS) and food groups. Lines represent the cut-off points for poor (<21) and borderline (>35).

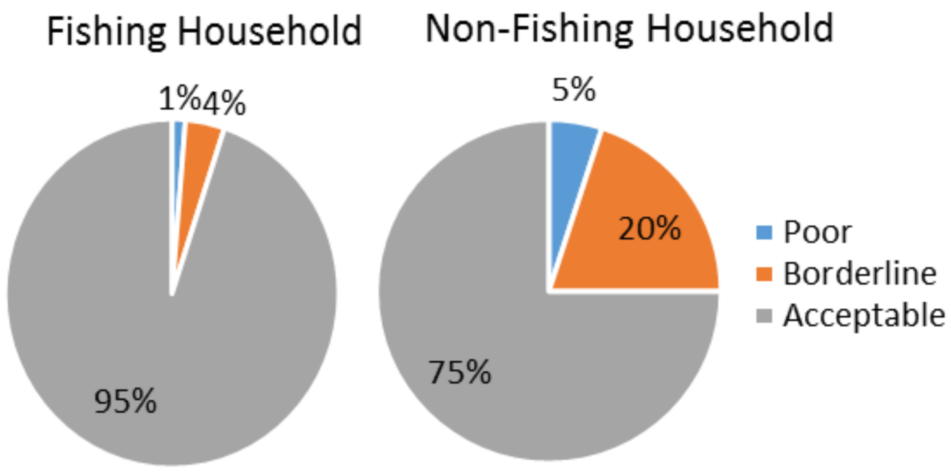

Figure 5-7 Food Consumption Score (FCS) Group by household type: fishing household and non-fishing household.

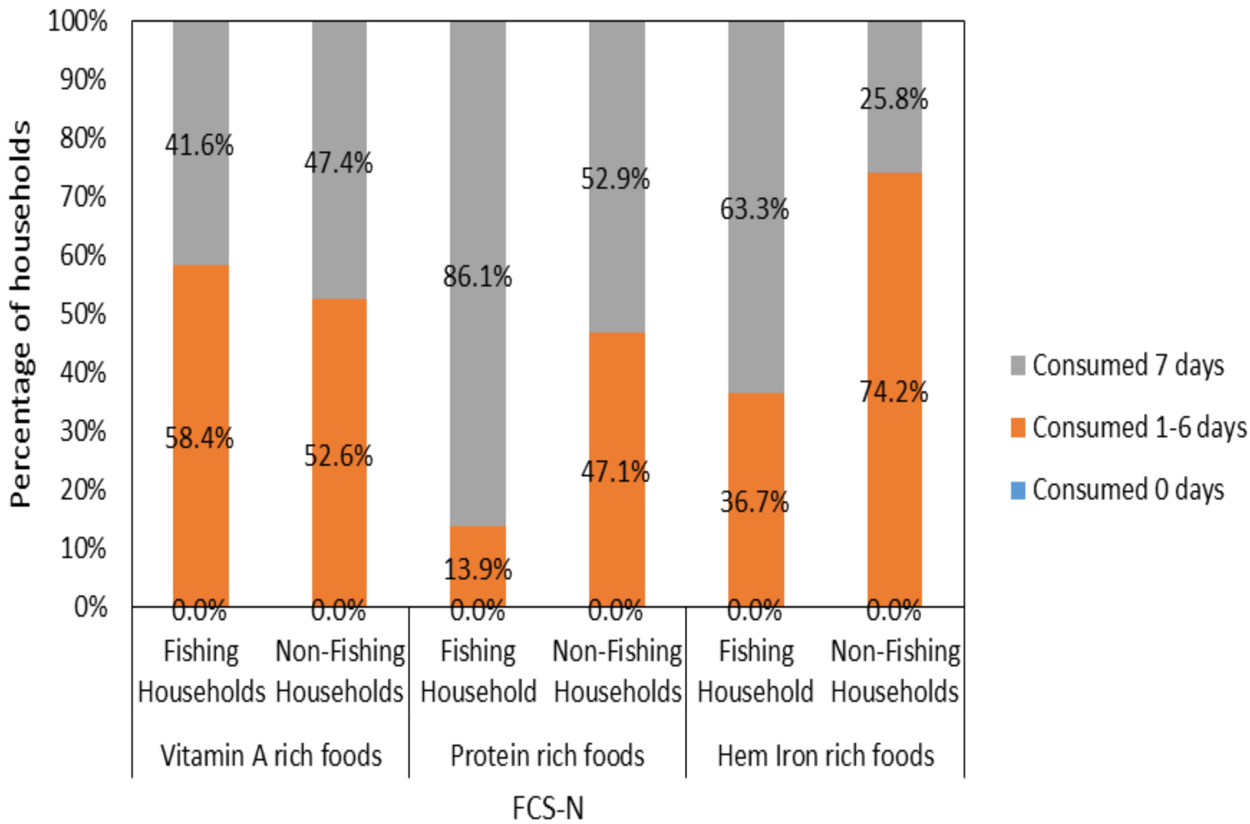

Figure 5-8 Frequency of consumption of nutrient rich foods (FCS-N) by household type.

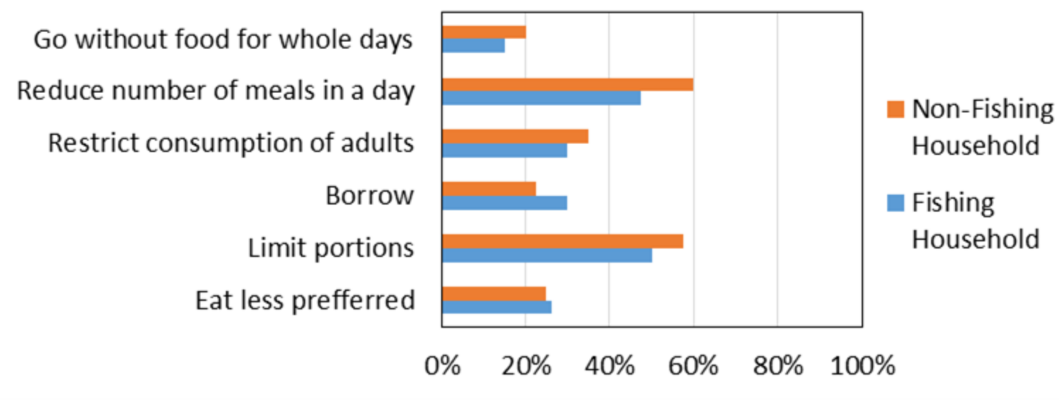

Figure 5-9 Food insecurity coping strategies. Bars represent percentage of total respondents.

5.3.4.3 Fish Consumption Characteristics and Preferences

More than ten fish species were consumed over the 7 days preceding the survey with the majority consuming the three main species from Lake Chilwa: *Clarius gariepinus* (74%) (local name: *Mlamba*), *Oreochromis Shiranus chilwae* (76%) (local name: *Chambo*) and *Barbus paludinosus* (43%) (local name: *Matemba*) (**Figure 5.10 and Table 5.4**). The type of fish species consumed varied by households: *chambo* and *mlamba* were consumed more frequently in fishing households, and ncheni more frequently consumed in non-fishing households ($p=<0.05$). In addition, fishing households consumed a higher number of fish species (*Md*= 2, n =80) compared with non-fishing households (*Md* = 1, n = 40) (U = 1046.5, z = –3.192, p = .001, r = .29). Fish species consumed originated from Lake Chilwa and/or Lake Malawi (**Table 5.4**). Fish from Lake Chilwa were largely fresh and smoked, with the smaller sized species such as *Matemba* also being sundried. Lake Malawi fish were dried or smoked to enable long-distance transport and trade.

Fish consumed were obtained from purchasing with income, own production or as a gift. On average, non-fishing households derived 92% of their fish consumed from income purchases (92%) compared with fishing households who obtained lower levels of fish through income purchases (60%) and higher levels through own production (37%) ($p<0.01$). Consumption of fish through own production also differed by fishery user, with those involved in the primary sector consuming higher levels of fish from own production ($p<0.01$). Households also reported what part of the fish was eaten by members of the household. The majority of all fish species were reported to be eaten whole by both adults and children in the households except for *mlamba*, *chambo* and *matemba*. For *mlamba* and *chambo* species, separate parts of the fish were eaten; such as the head, fillets and tails, and a higher percentage of adults (70%) consumed a whole fish compared with children (53%). The middle / fillet part of *matemba* was also reported being eaten by children. Households reported that their preferred fish to eat was *chambo* (72%) followed by *mlamba* (22%) because of good taste (57%) and that the fish species was more nutritious (12%). As an animal protein food source, only 9.2% of all households preferred fish, with chicken (47%) and goat (29%) being more favourable due largely to taste and perceived nutrition value. The majority of households (77%) experienced constraints with accessing fish for consumption in the last 12 months. Fishing households largely reported constraints to be the result of low fish catches whereas non-fishing households reported constraints due to high costs at market and lack of fish at market.

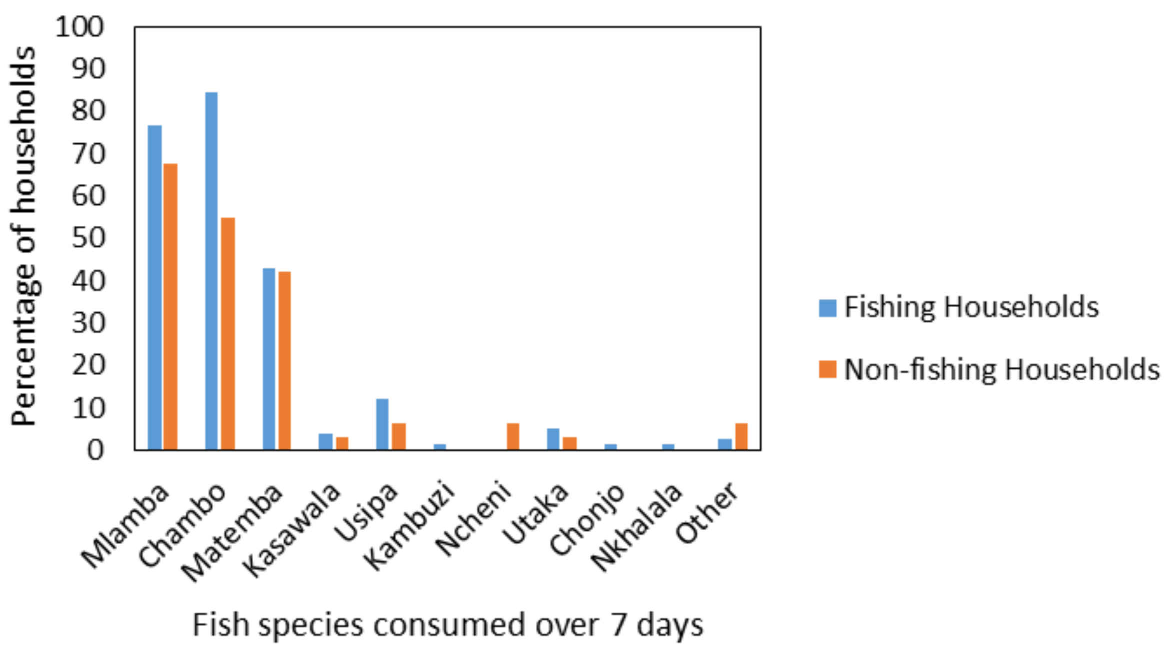

Figure 5-10 Fish species consumed over 7 days by household type.

Table 5-4 Fish species consumed and their characteristics.

Fish Species (local name)	**Fish Species (scientific name)**	**Reported Source of Fish**	**Reported Processed Technique of Fish**
Mlamba	*Clarius gariepinus*	Lake Chilwa	Fresh, smoked
Chambo	*Oreochromis Shiranus chilwae*	Lake Chilwa	Fresh, smoked
Matemba	*Barbus paludinosus*	Lake Chilwa and Lake Malawi	Fresh, dried, smoked
Kasawala (*juvenile chambo*)	*Oreochromis Shiranus chilwae*	Lake Chilwa	Fresh, dried, smoked
Usipa	*Engraulicypris sardella*	Lake Malawi	Dried
Kambuzi	*Lethrinops spp.*	Lake Malawi	Smoked
Ncheni	*Rhamphochromis spp.*	Lake Malawi	Dried
Utaka	*Copadichromis spp.*	Lake Malawi	Dried, smoked
Chonjo	unknown	Lake Chilwa	Fresh
Nkhalala	*Brycinus imberi*	Lake Chilwa	Fresh

5.3.4.4 Food Security Over 12 Months

Over the 12 months prior to the survey, respondents reported the months that they perceived experiencing food insecurity. Over one third of households experienced food insecurity during October to April, which is primarily in the wet season (see **Figure 5.11**). The highest food insecure months were January and February where over two thirds of households experienced food insecurity (70% and 81% respectively). Differences emerged between the months of food insecurity between fishing and non-fishing households (p=<0.05). Non-fishing households mainly experienced food insecurity in the months of September to July (non-fishing households >30%). Fishing households mainly experienced food insecurity in the months of December to March (fishing households >30%). Households in both villages experienced food insecurity during the 12-month period (p=>0.05).

Over half of households reported that food insecurity was caused by flooding (82%), high food prices (70%), drought (65%) and reduction in incomes (53%) which was similar to reported livelihood shocks. Similarities were found between fishing and non-fishing households (p=>0.05). However, approximately one third of fishing households reported food insecurity caused by closed fishing seasons (p=<0.05) occurring from December to March. Over the past 10 years, households mainly reported that they frequently experience household food insecurity every year (54.5% of total households). A few households also experienced food insecurity only in the year 2015 (21%).

Additional coping strategies over the 12 months involved longer-term behaviour changes. These included consuming seed stock (58% of households), purchasing food on credit (53% of households), intensifying fishing activities (43%), intensify non-fishing and non-agricultural activities (32%), gathering wild food (18%) and begging (8%). Over one third of fishing households also fished during the closed season (31%) and a few used illegal fishing gears in order to fish and cope with food insecurity (17%).

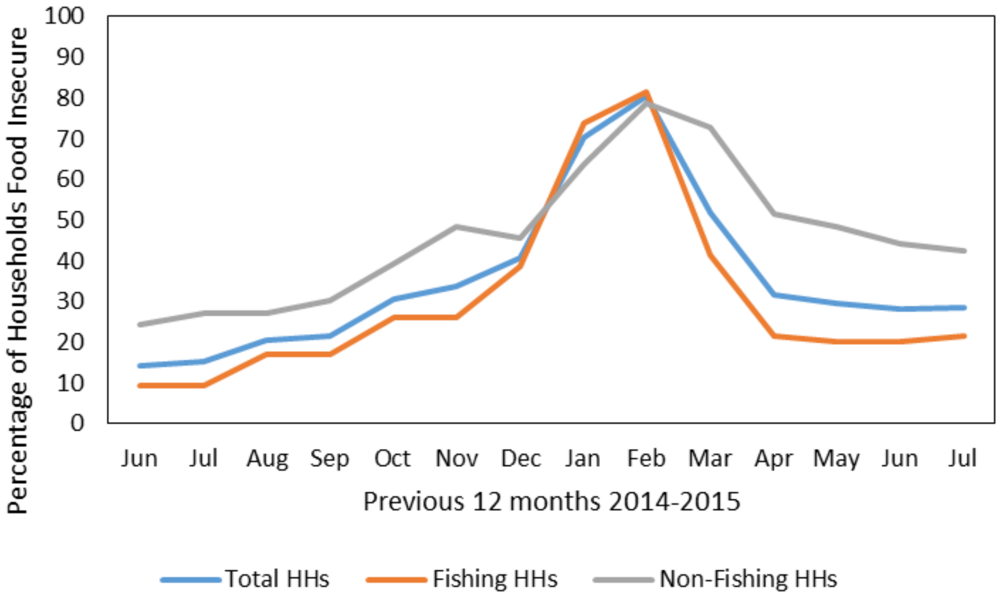

Figure 5-11 Perceived seasonality of food insecurity over 12 months prior to the survey.

5.3.5 Fishing Household Characteristics

The level of livelihood diversification was comparable between fishing households, however the type of diversification differed ($p<0.05$) with primary and mixed sector fishing households having higher levels of engagement in agricultural wage labour. All fishing households ranked fish-related activities as most important to household income (>50%). Mixed sector fishing households had a higher dependency (Md=66.5%) on fish-related activities for household income compared with households engaged in only the primary sector (Md=40%) (secondary sector households Md=50%). Capital assets, livelihood shocks experienced and food security were largely comparable within fishing households. Food consumption levels were lower and food insecurity coping strategies higher in households engaged in the primary sector compared with secondary and mixed sectors, however there was no significant differences ($p>0.05$). A higher dependency on fish-related activities for household income was positively correlated with food consumption levels (FCS) (rho=0.29, n=116, p=<0.01).

5.3.6 Factors Influencing Food Security

Correlation analyses revealed that food security indicators; FCS and rCSI, were strongly correlated with each other and the Asset Index, with increasing wealth associated with increasing food consumption and decreasing food insecurity coping strategies (FCS r=0.189 and rCSI r=-0.184, $p<0.05$) (**Table 5.5**). Food consumption was also strongly positively associated with a household's number of livelihood occupations (r=0.201, $p<0.05$) and level of dependency on fish activities (r=0.269, $p<0.05$). Mann-Whitney U tests also revealed an association between food security with gender of head of household and location. Food consumption levels and wealth differed by gender of head of household, with male-headed households having higher assets ($p<0.01$) and slightly higher food consumption (p=0.06) compared to female-headed households. Female-headed non-fishing households were the most food insecure households compared with male-headed non-fishing households and both male and female-headed fishing households ($p<0.05$).

Food security also differed by location with Likapa having lower food consumption (p=0.01) and slightly higher levels of food insecurity coping strategies (p=0.07) compared with Sauka Phimbi (median FCS: Likapa 57.7 and Sauka Phimbi 63.5, median rCSI: Likapa 7.5 and Sauka Phimbi 3.0). Within both locations, fishing households had higher food consumption (fishing households median FCS: Likapa=61, Sauka Phimbi=65) than non-fishing households (non-fishing households median FCS: Likapa=48, Sauka Phimbi=56). Wealth was similar between villages ($p<0.05$) and food insecurity coping strategies weakly differed (p=0.07) with Likapa having higher levels of coping strategies.

Table 5-5 Pearson correlation coefficients (r) between socio-economic and food security variables. (The significance level was 0.05 in the cases marked with * and 0.01 with cases marked **).

	FCS	rCSI	Asset Index	Household Size	No. of Livelihood Occupations	Dependency on Fish Activities
rCSI	-.291**					
Asset Index	.189*	-.184*				
Household Size	0.118	0.024	.267**			
No. of Livelihood Occupations	.201*	-0.028	0.067	0.126		
Dependency on fish activities	.269**	-0.092	-0.007	0.151	-0.009	
Age of Head of Household	-0.175	-0.042	-0.038	-0.051	-0.062	-.331**

Linear multiple regression analyses revealed the association between food security and socio-economic variables. Location, fishing household and asset wealth were identified to be particularly important in explaining food security. However different socio-economic factors were associated with food consumption levels and food insecurity coping strategies. For food consumption levels, the overall model fit was significant at explaining 20.7% of food consumption levels (r2=0.207, F (8, 106) =4.61, p<0.01) (**Table 5.6**). Whilst controlling for the variation explained by all other variables, indicators which made the largest and significant unique contributions to explaining food consumption levels were village (beta=-0.257, p<0.01) followed by fisher household which was borderline significant (beta=0.192, p=0.05). Gender of head of household (beta=-0.147, p=0.12) and asset index (beta=0.145, p=0.11) also provided larger contributions to food consumption levels however they were not uniquely significant. For food insecurity coping strategies, the overall model fit was significant at explaining 10% of food insecurity coping strategies (r^2=0.097, F (5, 105) =2.31, p<0.05) (**Table 5.7**). Whilst controlling for the variation explained by all other variables, indicators which made the largest and significant unique contributions to explaining levels of food insecurity coping strategies were asset wealth (beta=-0.223, p<0.05) and village (beta=0.214, p<0.05).

However, limitations exists in the analyses due to small sample size and model selection and therefore caution needs to be applied in inferring the strength of the association. However, the case study approach and findings provide insights into complex factors that shape livelihoods and food security and the relationships with engagement in fishing.

Table 5-6 Standard multiple regression statistics of socio-economic variables related to food consumption levels (FCS).

Variable	B	B SE	β	*t*	*p*
(Constant)	61.204	9.361	-	6.538	.000
Fisher Household	8.234	4.221	.192*	1.951	.054
Village	-10.369	3.694	-.257**	-2.807	.006
Gender of Head of Household	-7.011	4.494	-.147	-1.560	.122
Asset Index	2.948	1.865	.145	1.580	.117
No. of Occupations	1.061	1.402	.070	.757	.451
Household Size	.255	.944	.025	.270	.788
Age of Head of Household	-.122	.133	-.085	-.914	.363
Education Secondary Level	3.268	5.513	.056	.593	.555
$\mathbf{R^2}$ = 0.207	**F** (8, 106) = 3.45		**S**= 18.74	**p**<0.01	

*p < 0.05, ** p < 0.01

Table 5-7 Standard multiple regression statistics of socio-economic variables related to food insecurity coping strategies.

Variable	B	B SE	β	*t*	*p*
(Constant)	7.377	4.058		1.818	.072
Fisher Household	-2.343	2.101	-.109	-1.115	.267
Village	4.348	1.875	.214*	2.319	.022
Asset Index	-2.278	.977	-.223*	-2.330	.022
Household Size	.548	.491	.109	1.118	.266
Age of Head of Household	-.062	.068	-.086	-.911	.364
$\mathbf{R^2}$ = 0.097	**F** (5, 105) = 2.31		**S**= 9.91	**p**=0.04	

*p < 0.05

5.4 Discussion

The bulk of inland capture fisheries production is in developing and Low-Income-Food-Deficit (LIFD) countries with large rural populations. The sector provides an important source of fish and income for millions of people who often have a lack of nutrient food sources and livelihood options. However, the importance of inland small-scale fisheries (SSF) to food and nutritional security is not well understood (Miao et al, 2010; Youn et al, 2014). This study explored the levels of food security between fishing and non-fishing households in two rural lakeshore villages in Lake Chilwa, Malawi: a region experiencing high climate variability. The study finds evidence that engagement in the fishery sector increases household food security.

Engagement in the fishery sector influenced the livelihood platform, capabilities and transformations of positive livelihood outcomes. Fishing households generally had higher levels of capital assets compared with non-fishing households (**Table 5.8**). Households engaged in the fishery sector had increased physical and financial capital: asset wealth, expenditure and savings, especially for households engaged in secondary and mixed fishery sectors. The finding supports wider evidence that shows in rural economies, compared to other natural resource-based livelihood strategies, inland fishery related livelihood activities can have a higher income earning potential (Heck et al, 2007; Béné et al, 2016). Human capital was higher in fishing households having younger headed households with a higher proportion married with larger families. Natural capital in terms of land ownership was comparable across households where fishing households also engaged in agricultural farming. Households also had similar levels of social capital: with mutual exchange of food and cash common and social relations providing an important safety net during food insecure times.

Livelihood platforms result in and are influenced by livelihood strategies. Fishing households undertook a higher number of livelihood activities, with varying levels of dependency on fish-related activities for total household income; ranging from 40-66%. Fishing households predominantly ranked their fish-related income as most important for their household. Fishing households engaged in the secondary or both primary and secondary sectors had higher dependency compared with those engaged only in the primary sector.

Livelihood strategies are developed within and are affected by the vulnerability context. Fishing and non-fishing households both experienced multiple natural, economic and health related shocks: floods, drought, high food prices and illness. These reported shocks experienced during the 12 months prior to the survey were comparable with the concurrent floods and drought that Malawi experienced from 2014 to 2015 due to El Niño patterns. Similar shocks were experienced by fishing and non-fishing households, however impacts varied with fishing households experiencing higher levels of reduction in income and food stocks.

Table 5-8 Synthesis of livelihood and food security analysis between fishing and non-fishing households. (Note: + indicates higher, - lower, and = equal, in relation to overall levels of variables).

Variable Group	**Fishing Households**	**Non-Fishing Households**
Human Capital	+	-
Natural Capital	=	=
Physical Capital	+	-
Financial Capital	+	-
Social Capital	=	=
No. Livelihood Occupations	+	-
Shocks and impacts	+	-
Food Security	+	-
Nutritional Security	+	-

The most common reasons for household food insecurity reported by fishing and non-fishing households were floods, drought, high food prices and reduction in earnings. Universal classification of food consumption levels based on diet diversity, consumption frequency and nutrient quality identified the majority of households as having adequate food consumption levels. However, a larger proportion, up to one quarter, of non-fishing households compared with fishing households were classified as having poor or borderline food consumption levels, and experienced food insecurity for more months throughout the year. Fishing households, compared with non-fishing households, had higher levels of food security in terms of consumption and diversity of food, and also had higher levels of nutritional security through a higher consumption of protein and hem iron rich foods. Frequency of vitamin A rich foods were comparable between fishing and non-fishing households. However, fishing households compared with non-fishing households ate more diverse and higher amounts of fish obtained through own production and income purchases which are a rich source of vitamin A and wider micronutrients such as zinc. Fish was also often eaten whole and therefore provides a greater potential intake of essential minerals and vitamins to the diet (Roos; 2001; Roos et al, 2003). Engagement in fish-related activities was thus associated with higher food consumption, diet diversity and nutrition. All households were vulnerable to shocks and reported to carry out a number of food coping strategies, such as reducing the number of meals in a day and limiting portion sizes, in order to cope with food insecurity. Non-fishing households adopted more severe coping strategies with one quarter reporting going without food for whole days indicating higher food insecurity. Within fishing households, those engaged only in the primary sector had less dependency on fishing for household income, lower expenditure, and lower food security compared with those engaged in the secondary or mixed sectors.

Food security as measured by the Food Consumption Score (FCS) Index was strongly associated with household type and location, and weakly associated with wealth and gender of head of household. Food insecurity coping strategies were associated with location and wealth. The findings support the study by Darling (2014) revealing that wealthier and fishing households were more food secure in in the context of SSF. The finding also contradicts the study by Fiorella et al (2014) which found no association between fishing and food security or fish consumption amongst fishers in Lake Victoria, and highlights the importance of understanding context specific factors when investigating diverse SSF and their role to food security. Likapa village, located next to a road and market, had lower food security levels particularly in non-fishing households. In addition, shocks experienced differed between village locations; households in Likapa ranked flooding and higher food prices more highly which may have influenced economic access to purchasing food. Non-fishing households also reported high food prices as a cause of food insecurity. Further research would benefit from an investigation into the effect of location on household food security, including the effects of the proximity to market, level of function of the market, and nature capital assets in influencing access to improved food security.

Findings from this thesis also reveal that the gender of the head of household influenced food security. For example, ale-headed households had higher material asset wealth, were more likely to be married and had slightly higher food consumption levels compared to female-headed households. These findings are comparable with an emerging body of evidence that reveals that single and female-headed households have less material ownership and economic productivity, and are more vulnerable to poverty and food insecurity (Sraboni et al, 2014; Kawarazuka et al, 2017; Abdullah et al, 2017; Flato et al, 2017). These findings demonstrate the importance of understanding household status (dual or single headship) in assessing the complex dimensions of livelihoods and food security as it can affect household economic productivity and capabilities, as well as influence livelihood outcomes and vulnerability. In addition, when considering household type, female-headed households were the most food insecure non-fishing households, but were the most food secure fishing households. These findings both support and build upon a growing body of evidence that reveal that inland capture fisheries can provide a valuable livelihood strategy for women, and deepens our understanding on the effect of factors such as female-headed households and type of livelihood on food security (Kawarazuka and Béné, 2010; Kleiber et al, 2017). Furthermore, growing evidence demonstrates that women direct more of their earnings towards meeting household food security needs (Kawarazuka and Béné, 2010; Porter 2012; Sraboni et al, 2014; Kleiber et al, 2017). For example, in Lake Victoria, studies found that female fishers prioritised using their benefits for meeting their family food security needs compared with male fishers (Geheb et al, 2008; Fiorella et al, 2014). In addition, a growing body of evidence reveals that intra-household relations between men and women can affect household food security through power dynamics and divisions in financial decision responsibilities (Kleiber et al, 2017). Whilst this study illuminated the under-reported role and perceptions of different gender groups in SSF and the influence on food security outcomes, a more in-depth investigation into intra-household gender relations and power dynamics was outside the scope of this thesis. Further research would benefit from deepening our understanding of the history of household headship and livelihood strategies, intra-household gender relations and unpackaging its influence on household food security needs, decisions and outcomes within the context of inland SSF.

Limitations

The multidimensional concepts of livelihoods and food security render the assessment of the role of inland SSF to food security complex and difficult to measure Firstly, I was restricted in scope to providing a static analysis of the role of inland SSF to household food security over the short term. Whilst this study provides a valuable and important in-depth understanding of the underreported and complex role of inland SSF to local food security, further research would benefit from a longer time frame analysis in order to support improved monitoring and effective decision making for both improved fisheries management and the alleviation of food insecurity in Malawi. The study was also limited in its ability to make causal inferences on the directional processes between engagement in the fishery sector and livelihood and food security, such as on whether households with higher asset wealth and food security engaged in the fishery sector, or whether engaging in the fishery sector increased wealth and food security. However, qualitative methods can be used to provide rich information on the linkages between the sector and food security as discussed in **Chapter 8**.

Secondly, as experienced in other studies (Darling, 2014; Fiorella et al, 2014) and highlighted by Whittingham et al (2006), “no one model should be relied upon for inference” and the analyses was limited in scope in its inferences and selection of variables. Thirdly, the small sample size also limits generalisability and detection of differences within fishing households. However, the study adopted a case study approach and did not aim to achieve predictive power, but rather provide insights into complex factors that shape livelihoods and food security and the relationships with engagement in fishing that can inform future larger scale research. Future research with larger scale data would benefit from using analyses approaches such as an information theoretical approach, that compares model fit across a number of models which can provide stronger evidence on associations ween livelihood variables and food security (Whittingham et al, 2006). In addition, through a mixed method approach and triangulation of qualitative and quantitative data, validation of findings can be increased as outlined in **Chapter 8**.

5.5 Conclusion

Small-scale inland capture fisheries are one of the most under-reported and under-valued fisheries sector worldwide. Understanding the value of inland small-scale fisheries to livelihoods and food security is an important question for poverty alleviation, sustainable resource management and development, particularly for low-income-food-deficit countries experiencing food insecurity and climate variability. This study is one of the first to investigate food security in an inland small-scale fishery in the context of vulnerability and inclusion of actors along the value chain. In rural lakeshore communities experiencing drought and floods, food security was found to be associated with the type of livelihood activity adopted. Fishing households consumed more fish through own production and purchases, and had more diverse and nutritious diets compared with non-fishing households. In addition, fishing households experienced less severe food insecurity with lower levels of food insecure coping strategies, such as going without food for whole days. Food security is underpinned by livelihoods, and fishing households had higher capital assets (physical, financial and human), that can increase the ability of households to cope with natural shocks.

The study builds on growing evidence regarding the role of fish-related activities in providing a high income earning activity and a nutrient dense food source for rural communities. The findings presented within this chapter support wider studies that demonstrate that inland SSF can contribute positively to household livelihood and food security (Kawarazuka and Béné, 2010; Fiorella et al, 2014; Darling, 2014). Food security was also found to be associated with location and asset wealth, and weakly associated with gender, supporting wider studies highlighting the importance of wealth, local contexts and intra-household gender relations in determining food security (Kawarazuka and Béné, 2010; Kleiber et al, 2017; Fiorella et al, 2014; Darling, 2014). This study was restricted in scope to the in-depth, albeit static, investigation of the role of inland SSF to local food security in two case study communities. Further research is needed into the sequential development of livelihoods and flows between benefits and food security to provide a deeper understanding on the linkages between fisheries and food security. Inland capture fisheries thus have the capacity to support the achievement of the Sustainable Development Goals: contributing to Goal 2 - End hunger, achieve food security and improved nutrition. The findings are important for promoting effective fisheries management, climate adaptation and poverty alleviation development.

Chapter 6 Fishing Patterns and Water Dynamics

6.1 Introduction

The inland capture fisheries sector has contributed little to anthropogenic climate change but it is argued to be one of the first sectors to feel its impacts (IFAD, 2011). Climate change will likely impact fish directly and indirectly via effecting the freshwater ecosystems to which they depend on (IFAD, 2011). Projected changes in wind patterns, extreme rainfall and increasing temperatures will likely alter river flows, lake stratification, nutrient cycling, lake levels, water quality, fish habitat availability, primary production and subsequently fish yields (IFAD, 2011; FAO, 2012). Changes in the timing of precipitation and availability of water may also affect fish spawning and feeding. The majority of reported inland capture fisheries catches are in tropical developing countries with many inland bodies located in drylands (FAO, 2016; Kolding et al, 2016). The major impact of climate change on inland fisheries will likely be changing precipitation and subsequent freshwater flows (IPCC, 2014). Freshwater environments are already one of the most threatened environments globally experiencing the most rapid deterioration over the last few decades (Millennium Ecosystem Assessment, 2005). Inland fisheries and their freshwater environments are under increasing pressure from multiple stressors such as habitat change, water abstraction, land use change, pollution, dam construction and fishing effort. Lakes and wetlands are experiencing habitat loss through cultivation of marshes to rice fields, draining of wetlands for development, declines in water level through increased water abstraction for irrigation, changes in hydrology regimes because of land use change, and pollution (IFAD, 2011). Climate change will likely exacerbate these stressors, and unravelling the extent of climate change impacts on inland fisheries at the local scale will be complex.

It is argued that many inland water ecosystems are well-adapted to change (Kolding and Zwieten, 2012; FAO, 2016). Aquatic ecosystems are largely driven by water dynamics where water level fluctuation is a natural characteristic that promotes nutrient cycling, primary production, and subsequently fish yields (Junk et al, 1989; Talling, 1992). The Flood Pulse Concept (FPC) proposed by Junk et al (1989) showed how for many inland floodplain fisheries, flood pulses were important in driving the production of fisheries via injecting nutrients into the system, inundating areas and opening up new habitat, and regulating fish spawning and recruitment. In the Okavango Delta floodplain in Botswana, Mosepele et al (2009) found that flood pulses and feedbacks between wet and dry cycles enhanced primary production and drove fish dynamics, which was also influenced by the timing, duration and nature of freshwater flows (Mosepele, 2014). Water level dynamics drive inland fisheries within lakes. In East Africa's Rift Valley, lake levels in the large deep lakes of Lake Malawi and Lake Turkana influence fish catch rates one to three years later (Kolding, 1992; Fryer and Iles, 1972; Tweddle and Magasa, 1989). Many inland lake fisheries in the tropics also experience large water level fluctuations seasonally and inter-annually which increase fish yields (Kolding and Zwieten, 2012). Shallow lakes and man-made reservoirs have the highest rates of lake level fluctuation and subsequent highest fish yield per unit areas, compared to deep stable lakes (Kolding and Zwieten, 2012). For example, in the shallow endorheic (closed) Lake Chilwa in Malawi, the fishery has been reported to be one of the most productive fisheries at times where fish catches following a 'boom' and 'bust' cycle with periodic large water level fluctuations (Jul-Larsen et al, 2003; Njaya et al, 2011). These pulsed lake systems are resilient to even extreme changes in lake levels, such as drying up, and were characterised by fish species with short life spans, higher intrinsic growth, lower biodiversity and higher productivity (Kolding and Zwieten, 2012). The ability of these fisheries to respond quickly to drought still remains unclear, however maintaining ecological connectivity and refuges such as lagoons and swamps, are important.

Although many tropical inland fisheries are adapted to water fluctuations, there is still uncertainty about the effects of climate change on biological processes and inland fisheries, particularly at the local scale (Allison et al, 2006; Wantzen et al, 2008a). Evidence suggests that climate change has already affected inland capture fisheries. Surface water temperatures have increased over the past few decades in many of East Africa's rift valley lakes (IPCC, 2014). In Lake Tanganyika, increases in lake surface water temperature and reduced wind speeds have reduced fish yields by 30% (Allison et al, 2007; Ogutu-Ohwayo et al, 2016). Many shallow lakes have experienced increasing lake level fluctuations (Kolding and Zwieten, 2012; Ogutu-Ohwayo et al, 2016).

There has been a call for more local level assessments of the impacts of climate change on fisheries and the subsequent effects on social and ecological systems (Béné et al, 2016). This has been a result of the difficulty in monitoring small-scale fisheries and predicting climate change at the regional level (Welcomme, 2011; Béné et al, 2016). Understanding the impacts of climate change on the sector is critical for the millions of people in low-income-food-deficit countries that depend on the resource for livelihood and food security. A study by Allison et al (2009) found that inland fishery countries in Africa are some of the most vulnerable to climate change as a result of the dependence on fish proteins in the diet, the limited alternative sources of food and employment and small weak economies (Allison et al, 2006; IFAD, 2011).

The sustainable livelihoods framework (SLF) is regarded as the most widely used framework for understanding sustainable livelihoods in rural contexts (Schreckenberg et al, 2010), and can readily describe fisher's livelihoods and the pathways to achieving food security (**Table 6.1**) (Allison and Horemans, 2006; ACF, 2010; Boutin and Smit, 2016). External vulnerability factors: such as climate shocks, trends and seasonality in fisheries can directly affect people's livelihood platform of capital assets, portfolio of livelihood activities adopted, and the transformation of these into positive livelihood outcomes: such as improved food security (DfID, 1999). In addition, access to capital assets and livelihood activities are shaped by laws and policies such as fisheries governance regulations of closed fishing seasons.

Local ecological knowledge can provide an untapped wealth of information on the status of a fishery and environmental change, particularly in data limited environments (Moreno-Báez et al, 2010; Cinti et al, 2010; Daw et al, 2011b). Daw et al (2011b, pg. 75) highlighted "the importance of multiple information sources to understand dynamics of fisheries" and the value in incorporating fishers' knowledge in data limited environments. A study on farmers' perceptions of rainfall in Malawi also found that local knowledge can complement climate change analysis on a different scale (Simelton et al, 2013). Adaptation and responses to change are shaped by perceptions and experiences which can be influenced by age, experience, attitudes and interests (Simelton et al, 2013; Andrachuk and Armitage, 2015). Different fishery users can perceive change differently, which affects how individuals anticipate change, respond and adapt (Gelchi et al, 2009; Simelton et al, 2013; Andrachuk and Armitage, 2015). Perceptions of attitudes and effectiveness of governance are important in evaluating the positive and negative social and ecological consequences of fisheries management. Gelchi et al (2009) found that perceptions of governance can differ amongst fishery users based on level of experience, wealth and dependency. Governance can be beneficial to some but also have unintentional negative social consequences for others: such as loss of livelihoods and increases in poverty (Andrachuk and Armitage 2015; Bennett et al, 2017). Over recent decades, it has become widely accepted that successful conservation is underpinned by social sustainability (Barclay et al, 2017). Participatory research has been highlighted as an effective approach to capture the complexity of context specific factors, to integrate the views and realities of fishers, and to achieve effective fisheries management (Schreckenberg et al, 2010; Bennett, 2016; Barclay et al, 2017).

Table 6-1 An adapted Sustainable Livelihoods Framework for rural livelihood analysis and understanding the role of fisheries to food security (modified from Allison and Ellis, 2001).

Livelihood platform	Access modified by	In context of	Resulting in	With effects on
Capital Assets Natural: fisheries stocks, land etc Physical: infrastructure, assets etc Human: education, literacy etc Financial: savings, expenditure etc Social: kinships, memberships	**Social relations** Gender, age, ethnicity **Structures and processes** Institutions, culture, policies and laws (e.g. closed fishing seasons)	**Shocks** Natural (e.g. floods and drought), human health, economic etc **Trends** Resources (e.g. fisheries), population, governance, economic etc **Seasonality** Prices, resources (e.g. fisheries) etc	**Livelihood strategies** Diverse natural resource and non-natural resource occupations Fishing or non-fishing	**Livelihood outcomes** Income Food and nutrition Vulnerability **Environment sustainability** Fish stocks, water, forests etc **Livelihood platform**

Understanding the vulnerability and governance context of fisheries resources and the effects on fisher livelihoods is critical for understanding the role of the sector to food security, and for achieving effective ecosystem management and poverty alleviation (DfID, 1999; Cinti et al, 2010). This study responds to the call for more local level assessments of the impacts of climate change on inland SSF (Béné et al, 2016). The study investigates local ecological knowledge, perceptions of change and attitudes of governance at the group and individual level amongst fisherfolk in two lakeshore villages in Lake Chilwa, Malawi. The objective of the chapter is to address research question 3 of the thesis which aims to: a) understand how fisherfolk experience and perceive seasonality, shocks and governance, and b) evaluate their perceptions of impacts of these on their livelihoods and food security. The study will provide a unique insight into the perceptions of different fishery users along the value chain, including women and men fisherfolk, in an inland SSF experiencing change and co-management regulations. In addition, it will provide further context to the governance, vulnerability and temporal nature of fisher livelihoods and how they can influence food security.

6.2 Materials and Methods

6.2.1 Study Site

See **Chapter 3** for a description of the study site: Lake Chilwa, its small-scale fishery and villages selected for surveying.

6.2.2 Data Collection

Focus group discussions (FGD) and surveys were conducted with adult fisherfolk to investigate the characteristics of fish-related activities; perceptions of seasonality and trends in fish availability, consumption and activities; and perceptions of governance. Research was undertaken in two lakeshore villages around Lake Chilwa during the dry season between June and August 2015. Villages were selected with local informants to be representable of SSF characteristics in Lake Chilwa. One village; Likapa, was located next to a main fishing port and road, and Sauka Phimbi village located more remotely from Likapa with no main road connections.

A total of 80 survey interviews: 40 in each village, were undertaken with fisherfolk. Participants were recruited for surveys via random sampling and included women and male fishers actively engaged in fishing, processing and trading. The survey collected information on: characteristics of fish-related activities, start up, benefits, fish availability, seasonality, shocks, perceptions of change in the fishery, and perceptions on governance. Field-testing of the questionnaire was carried out via a pilot study: conducted in one fishing village with a small group of participants, and with local partners in Malawi, in order to validate and finalise questions. Amendments were made to the questionnaire: such as making terminology clearer and extending responses to closed questions. The questionnaire was translated into Chichewa and back-translated into English to ensure consistency of meaning. A local experienced and qualified enumerator was used to administer the survey and was trained in the study survey by the researcher. Basic descriptive analyses was performed on survey data using IBM SPSS Statistics 24.

A total of six FGDs were conducted in each village based on three exercises which were undertaken separately with women and male fisherfolk. Participants were recruited via a purposive and snowball approach with the assistance of a local key informant within each village. Participants were recruited based on the following criteria; adult fishers who are actively involved in Lake Chilwa's fishery in the past 12 months, more than five years' experience, mixed fishing scales of operation, mixed ages, and represent diversity of fisher roles in village. Each FGD had seven participants and a total of 84 participants were involved in FGDs across the two villages. The FGD exercises were based on 1. Fish availability, seasonality, shocks, and change, 2. Fish consumption, seasonality, shocks and preference, and 3. Technique, seasonality and preference of fish species. A discussion guide was used to provide consistency across groups as well as to provide flexibility to probe for local knowledge, values and experiences by the participations; see **Appendix D**. PRA tools such as seasonal calendars and matrixes were also used to aid discussions and help facilitate a deeper and more inclusive discussion. All interviews were recorded and transcribed by local translators. Transcripts, FGD notes and PRA tools were then analysed via codifying and exploring, formulating, and interpreting themes.

Data collected from the survey and FGDs were triangulated with bio-physical data and between each other to increase the validity of research on perceptions and local ecological knowledge. Ethical approval was obtained from University of Southampton Faculty of Social and Human Sciences Ethics Committee (reference: 14728) and from the National Commission for Science and Technology in Malawi prior to commencement of research. Permission was sought from the Group Village Headman and from the Village Headman of both villages to conduct research in the study sites. Prior to interview and FGDs, consent was also obtained from each participant in line with survey ethics.

6.3 Results

6.3.1 Characteristics and Benefits of the Sector

Over half of fisherfolk interviewed were involved in fishing (55%) of which two thirds were crew members, one third were gear owners, and a tenth were gear owners and crew members. The remaining fisherfolk were involved in fish processing and trading. The majority of fishers were male whereas the majority of processors and traders were female. A minority of fisherfolk engaged in fishing as well as processing or trading. The number of years of experience ranged from 1-5 years, to more than 20 years, with 55% of fisherfolk having 1-10 years of experience and 45% 11 or more years. Crew members had longer experience where 59% had over 11 years of experience. Nearly all participants (93%) stated that they became involved in the fisheries sector for income, as well as food (64%) with a few stating due to tradition (8%) and community project (3%). Fisherfolk largely became involved in the sector by gaining information from family and other fishers, with a few gaining information from community groups, literature and radio. The majority of respondents considered their fishing activities profitable, felt that their life had improved since partaking in the fishing industry, and would recommend the sector to others. However, differences emerged amongst fishery users with processors and traders having more positive perceptions ($p<0.05$) and crewmembers having more mixed views. Fishing activities enabled fisherfolk to have increased income (33%), take care of their family's finances (24%), no longer worry about food insecurity (19%), employ people (16%), and take care of their family's health (15%), with a few reporting increased personal health (6%). In addition, the majority of fisherfolk ranked the importance of their fish-related activities to household income and food security highly; scoring 4 or 5 representing important and extremely important (**Figure 6.1**).

General day-to-day constraints in the fishing industry included low prices to sell fish, high prices to buy fish, variability in availability of fish, bad weather conditions, limited access to markets, as well as theft, conflict and predation. Over half of participants (57.5%) outlined that they had stopped their activities for a year or more at least once. However, nearly all (87.5%) outlined that they would remain in the sector indefinitely.

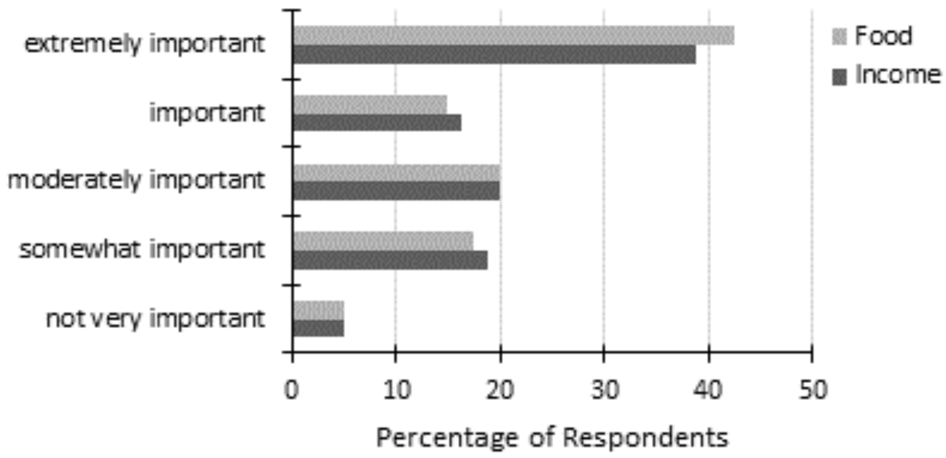

Figure 6-1 Ranked importance of the fishery sector to household food security and income.

6.3.2 Perceptions of Fish Availability, Seasonality and Shocks

6.3.2.1 Availability and Seasonality of Fish in Lake Chilwa

High and low seasons were identified for fish-related activities. Fisherfolk mainly engaged in their activities full time during the high season and part-time during the low season. The majority of respondents reported high season months of September to April, particularly October, November, December and March (>50% of respondents). Low season months were from May to July (>50% of respondents) with the majority also reporting August. This was comparable with focus group participants who also described seasonality of fish availability, activities and consumption. Reported income was greater during the high season with an average of approximately 36,000 MKW earned per week compared with 10,000MWK in the low season. Traders and processors had slightly higher incomes compared with other fishery users however there were no significant differences with reported income ($p>0.05$).

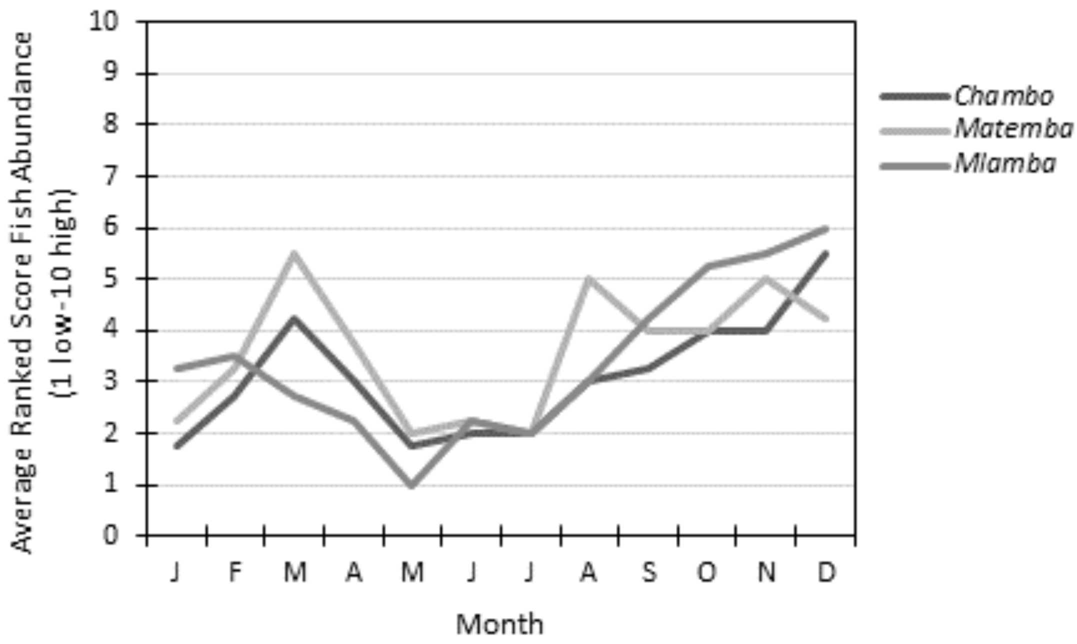

Figure 6-2 Seasonality of fish availability reported by group participants.

All group participants outlined *Clarius gariepinus* (local name: *Mlamba*), *Oreochromis Shiranus chilwae* (local name: *Chambo*) and *Barbus paludinosus* (local name: *Matemba*) as the main species available to catch from Lake Chilwa all year round (**Figure 6.2**). Other fish species were also reported; *nkhalala, ntchentcheta* and *chonjo* but rarely caught, with *mphuta* species also being reported in Sauka Phimbi village.

Chambo was found all year round with peak and low months depending on the climate. Some group participants in Sauka Phimbi outlined that *chambo* were not caught between December and February due to breeding and closed seasons. Peak months of availability were from November to April during the rainy season and breeding season, with particularly good catches either during or after the closed season as fish had multiplied, younger fish were less wise and easier to catch, and not disturbed. *Chambo* was outlined to move to the shallow reeds and lakeshore areas to breed and a species which carries their young in their mouths. Low availability was during the cold and dry months of May to September as *chambo* move from the reeds and lakeshore to the deeper centre of the lake where it becomes more difficult to catch and is more mature.

Matemba was described as a smaller species which acts differently from *mlamba* and *chambo*; found more all year round and breeds a lot, with some stating breeding months of December to March. Only male group participants in Sauka Phimbi mentioned that they were not caught during the closed season from December to February. Peak and low months varied across group participants and study sites. Peak months included months of breeding preparation in August, September and October, as well as March when the lake was open. Low months varied widely with predominantly low catches during the cold months of June and July. *Matemba* is mostly found in the reeds along the lakeshore where it breeds and feeds. Participants described how *matemba* moves to the central lake in the dry season for cooler water and moves to rivers in the rainy season for clearer water and less wind.

Mlamba was a species found all year round with group participants predominantly stating high season during the rainy and hot months of October to February, and low season during the colder months of May to July. Some differences occurred between specific months across study sites; such as Sauka Phimbi stating January and February as peak months compared with Likapa stating low months. Peak months for *mlamba* coincided with the breeding season where *mlamba* migrated from the open lake to reeds and rivers to breed, are found nearer the lake surface, produce many young and migrate back to the open lake. During the low season, *mlamba* was outlined to disappear in the reeds to escape from the cold waters.

Availability of other fish species from Lake Chilwa; *nkhalala, ntchentcheta, chonjo* and *mphuta* were rare. These species were stated as riverine fish species and were often caught from August to October during the warmer months when lake levels are low with some stating other months throughout the year.

6.3.2.2 Seasonality of Fish-related Activities in Lake Chilwa's Fishery

Fish-related activities were undertaken all year round however some group participants, particularly female processors, also stated no activity during the closed fishing season from December to February.

Fish processing techniques included sun drying, smoking, frying and salting (termed locally *bakayawo*). *Chambo* and *matemba* were the main species sun dried and salted as they were outlined to be smaller species and of better quality compared with m*lamba* who was perceived by group participants to be too large and of poor quality for sun drying: being infested by worms and requiring a higher level of processing. All fish species however could be smoked and fried. Sun drying is the cheapest technique which uses bamboo racks and gauze wire, followed by smoking where firewood is cheaper than oil used in frying. Salting and frying are relatively new techniques introduced since 2010 with salting usually performed when fish cannot be sold or for longer preservation. Selection of fish to process was based on price to buy and sell as well as demand; with *chambo* being in high demand and *mlamba* or *matemba* being better priced depending on location.

Fishing techniques included the *nkhoka* and *ukonde* nets, *mbedza* line and hooks, and the *mono* fish traps. The nets are able to catch the three main fish species in Lake Chilwa and are predominantly used in the open lake as well as the lakeshore and reeds. Nkhoka was stated to be banned during the closed season due to their small mesh sizes. The hook and line targets *mlamba* species due to their larger size which is used in all locations in the lake with baited worms. Fish traps are designed specifically for different fish species with bamboo baskets targeting *matemba* in reeds, and bamboo fences targeting *mlamba* and *chambo* in the mouth of rivers and reeds. The gears were used all year round across both sites except for the *nkhoka* net that was not used during the fishing closed season from December to February. Each gear had peak and low seasons depending on the fish targeted, fish behaviour and level of the lake. General high months were from September to April and low from May to July which were comparable with fish availability and seasonality. Fishers also stated that high months of fishing did occur in May to August but only for target fishing of *mlamba* with hook and lines (*mbedza*) and *matemba* with nets (*ukonde*) and fish traps (*mono*), which was also comparable with the seasonality of these species. Mosquito nets were also used all year round only in Sauka Phimbi and were outlined to be illegal due to their small mesh sizes. Species caught was based on availability.

6.3.2.3 Fish Consumption around Lake Chilwa

Consumption patterns of fish species were comparable with perceptions on availability and seasonality, with main species consumed being *chambo*, *matemba* and *mlamba*. Other fish species from Lake Chilwa were consumed only in Sauka Phimbi, with group participants in Likapa reporting that some of these species were no longer available due to the drought in 1994. Fish species from

Lake Malawi were also consumed particularly at times when there was low availability of fish in Lake Chilwa: *usipa*, *utaka*, *mcheni*, *bombe* and *kambezu*. Consumption of these species were reported to have started from 2012 as a result of a drought and less availability of fish in Lake Chilwa. Cultural preferences for consumption of different fish species varied between groups. All fisherfolk ranked taste as a top factor for fish consumption preference, followed by price. Quality of the fish, size and beliefs were also important factors by several fisherfolk, with women from Sauka Phimbi also stating availability, smell, ease of preparation and soft flesh. Fisherfolk stated *chambo* had the best taste, quality, nutrition and ease of preparation but was also most expensive. Quality was found to be important in terms of fish having more flesh that is nutritious. *Mlamba* and *matemba* had the best price as well as *usipa*, *ntchetetha*, *chonjo*, *kambezu* and *utaka*. The biggest sized fish were *mlamba* and *chambo* that were also rated most available. Beliefs were an important factor for consumption preferences, particularly for the male group in Likapa. Beliefs were highly associated with consumption of *mlamba*, as well as *mphuta* and *bombe* which were stated to be similar to *mlamba*. It was reported that people in the community believe consumption of *mlamba* causes illnesses such as headaches, fits and loss of hair in children. In addition, it was reported that the Seventh-day Adventist Church prohibits consumption of *mlamba* because they do not have scales and eat anything. As a result, only *chambo* and *matemba* are eaten at festivities and religious events; such as weddings and appointment of a new chief. Generally, fisherfolk outlined the top species for consumption as *chambo*, *matemba*, *mlamba* and *usipa*. However, during low lake levels and drought, *mlamba*, *chambo*, *matemba* and *usipa* are consumed more.

6.3.2.4 Perceived Shocks Affecting the Fishery

Fisherfolk reported several shocks affecting their fishing activities. Over half of respondents experienced drought, floods and low price of their outputs. Respondents from all activities ranked floods and drought as the most severe shocks. Processors and traders also ranked low price of outputs as a significant shock compared with fishing gear owns and crew members ($p<0.05$). Perceptions of occurrence of shocks were similar amongst fishery users and number of years of experience ($p>0.05$). Flood events were reported to mainly occur once (71%) with some stating occurring 2-3 times (16%) or every 1-5 years (13%). Drought was also stated to mainly occur once (46%), 2-3 times (34%), and or every 1-5 years (20%). Occurrence of other shocks were also reported such as fish disease occurring once in 2014-2015 (**Figure 6.3**).

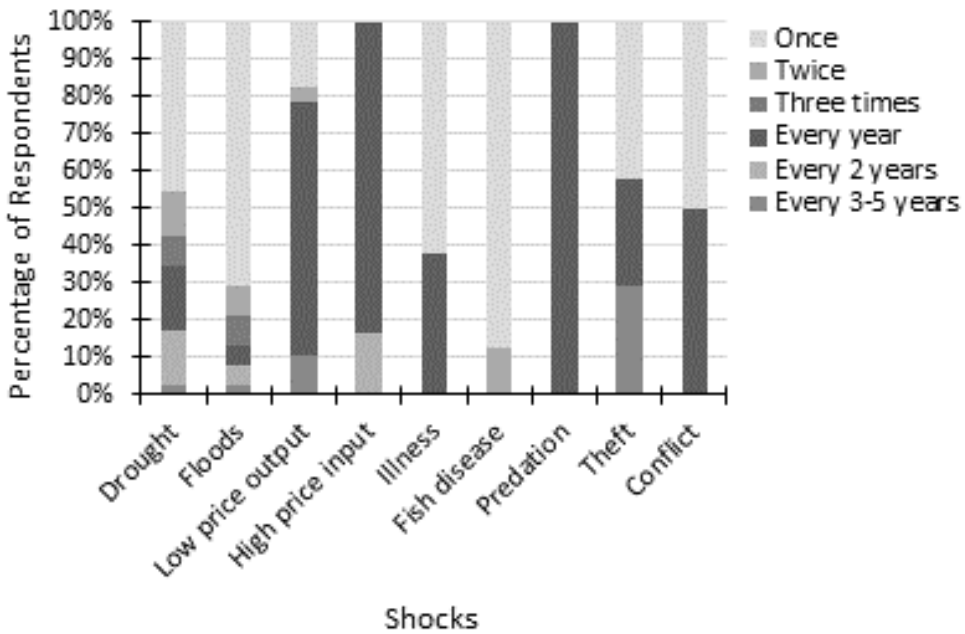

Figure 6-3 Occurrence of shocks reported by respondents. Percentage represents percentage of respondents who reported each shock's occurrence.

Nearly all participants outlined that the shocks caused a decrease in the amount of fish available, fish consumption, fish-related income, assets and food purchases. The flood earlier in the year in 2015 caused a decline in the availability of *matemba* (81%) and *chambo* (68%), and an increase in *mlamba* (74%). Fisherfolk involved in processing and trading largely perceived a negative impact of the flood on fish availability compared with crewmembers and gear owners ($p<0.05$). Nearly all participants (>85%) reported however that catches of all three fish species would increase next year and in the future. This was comparable with group participants who explained that floods had mixed impacts immediately but that once a certain level of high water was reached; increased catches were expected in the following years for all species. Group participants also explained the impacts of drought and low lake levels on fish species availability. *Mlamba* was stated to be the most resilient species to environmental change: being the only species found during a drought and most available. Catches of *chambo* and *matemba* however were reported to be significantly reduced by drought, which disrupts breeding and causes death due to low oxygen and high temperatures. *Matemba* and *chambo* was stated to be less resilient species taking two to three years to recover after a drought. Other climatological factors were also reported to affect fish availability; high winds (54%), low temperatures (40%), high temperatures (14%), direction of wind (6%) and low winds (3%).

6.3.2.5 Perceptions of Change in the Fishery Over Time

The perceived changes in availability and size of fish species in Lake Chilwa over the past 10 years were reported with similar perceptions amongst fishery users ($p>0.05$). Nearly all participants (>90%) reported that the amount of *chambo* and *matemba* available in the lake had decreased. However, changes in *mlamba* fish species differed with over two thirds reporting a perceived increase in availability and one-third reporting a decline. The majority reported a reduction in the size of *chambo* (65%) and *mlamba* (68%); however, perceptions on the changes in the size of the small fish species: *matemba*, varied. Fishing effort over the past 10 years in terms of number of fishermen was reported to have increased by two thirds of fisherfolk, whilst some stated a decline. This was comparable with group participants who explained that since the 1994-1996 drought, all species have decreased in abundance. Good fishing years were described when lake levels were high, such as in 1990-1992, 2000, 2005 and 2009, with bad fishing years when lake levels were low, such as in 1994-1996, 2012-2013. Fisherfolk stated "the good years are decreasing and the bad years increasing" with more bad years since 2000. The main reasons for the change in the fishery were drying of the lake, increased fishing effort, use of illegal gears, change in wind patterns and rainfall, cutting of reeds and deforestation. Group participants described how the timing and strength of northern and southern winds are changing effecting safety of fishing and fish availability. In addition, fishers perceived deforestation to be associated with stronger winds and changing rainfall. A summary of fisher's perceptions of fish availability, seasonality and shocks are presented in **Table 6.2**. Lake Chilwa's fishery is within a high vulnerability context which impacts upon the availability, access and stability of fish and its pathways to food security. Governance and regulations in these systems are often challenged (Jul-Larsen et al, 2003) and perceptions of governance and its effectiveness is important to understand for ecosystem management and poverty alleviation.

Table 6-2 Summary of fishers' perceptions of availability, processing techniques, fishing gears and consumption preferences of Lake Chilwa's main fish species.

Fish Species (local name)	Fishing Gear	Processed Technique	Availability and Seasonality	Impacts of Floods and Drought	Consumption Preferences
Mlamba	Nets, hook and line, and	Smoked and fried.	Most abundant fish found all year round	The most available fish species in Lake Chilwa during	Least preferred: best price, largest and most available, but

	bamboo fence traps.		particularly during October to February.	low lake levels caused by drought. Increases with high water levels.	poor quality, cause illness and banned by some religions.
Chambo	Nets and bamboo fence traps.	Salted, sun dried, smoked and fried.	Can be found all year round particularly during peak months of November to April.	Low lake levels caused by drought reduces availability and taking 2 years to recover. Increases with high water levels.	Most preferred: best taste, quality, nutrition eaten at festivities but most expensive.
Matemba	Nets and bamboo basket traps.	Salted, sun dried, smoked and fried.	Can be found all year round with highly variable peak months that include August to March.	Low lake levels caused by drought reduces availability and taking 3 years to recover. Increases with high water levels.	Best price and eaten at festivities, however smallest fish species.

6.3.3 Perceptions of Governance

6.3.3.1 Awareness and Attitudes

Nearly all participants (n=66, 82%) were aware of laws and regulations governing Lake Chilwa's fishery. Approximately two thirds (63%) stated that these laws were government led, with some fisherfolk also stating co-management (26%) and traditional local level management were in place (11%). Fisherfolk with 5 or less years of experience were less aware of the regulations in place ($p<0.05$). Fisherfolk were aware of restrictions on which months to fish and on types of fishing practices. The majority reported a closed fishing season on the lake during the months of December to February (49%), with some also stating December to March (13%), in order to allow the fish to breed and grow. Only three respondents outlined restrictions on fishing in rivers at various times of the year. Several fishing gears were reported to be banned at certain times of the years as they caught too many young fish and to allow the fish to breed. The nkhoka was reported to be banned mainly from December to February, and the mosquito net and gauze wire banned mainly all year round which also corresponded with group participant perceptions. Ukonde and dande fishing nets and cutting of reeds were also reported to be banned at various times of the year or all year round.

Respondents perceived the compliance rate of fishery regulations to be low with an average score of 2 out of a scale from 0 to 5; with 2 representing fisherfolk sometime complying and 5 always complying. Only one fifth of respondents reported that fishferfolk often or always complied with the fishery regulations. Nearly all respondents (70%) outlined that fisherfolk do not fully comply with regulations because they need to meet household income and food needs. The level of enforcement of the fishery regulations and laws was outlined to be high with an average score of 4 out of a scale from 0 to 5; with 4 representing very often and 5 full enforcement (**Figure 6.4**).

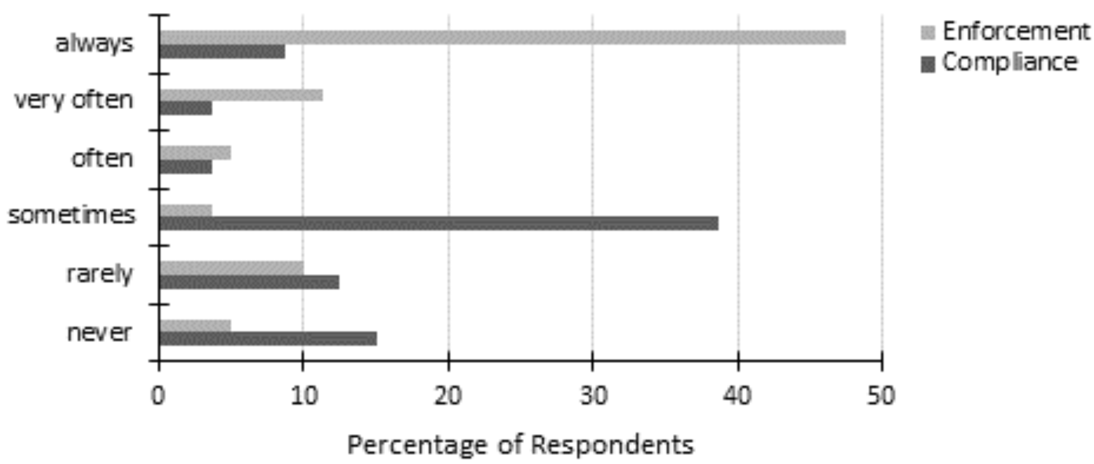

Figure 6-4 Perceived compliance and enforcement of fisheries regulations by respondents (n=66).

6.3.3.2 Impacts and Effectiveness of Fisheries Governance

Approximately half of fisherfolk reported perceptions on the impacts of the regulations on their benefits, household food security and income (**Figure 6.5**). Fisherfolk predominantly held neutral or negative perceptions which differed amongst users ($p<0.05$) with crewmembers particularly stating a decline in food security (62% of respondents) and income (63% of respondents) as a result of the regulations. A slightly higher proportion of fisherfolk with 1-5 years of experience also held negative views on the impacts on household food security and income ($p<0.05$).

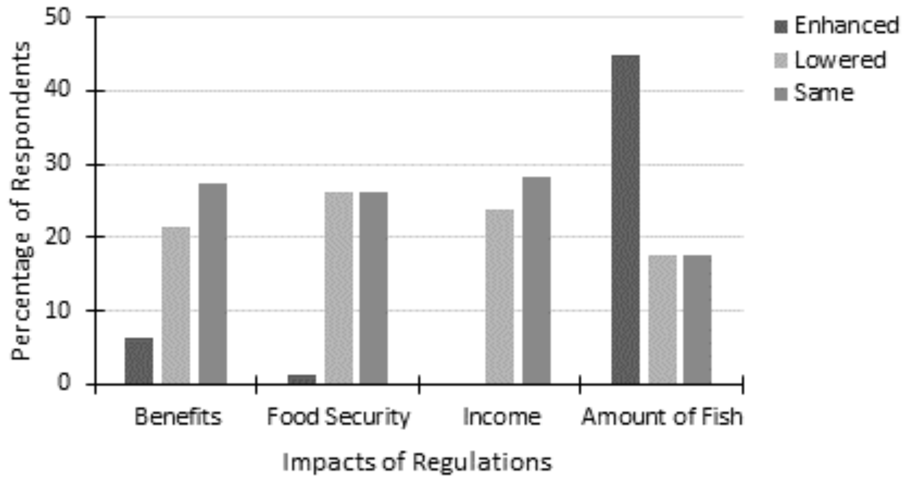

Figure 6-5 Perceptions of the impacts and effectiveness of regulations.

Respondents (80%) also reported their perceptions on whether the amount of fish in Lake Chilwa had changed since the regulations have been in place. Several fisherfolk (45%) reported that fish had increased, whilst a few stated a decline (17.5%) or no change (17.5%). Perceptions were similar amongst users ($p>0.05$) but differed depending on the number of years of experience; only fisherfolk with more than 5 years of experience stated a decrease in the amount of fish since the regulations have been in place ($p<0.05$).

6.3.3.3 Access to Support Services

Access to government and local organisations providing support to fisherfolk was limited. Only one third of respondents reported access to government extension services, which provided technical advice with 1 to 6 visits per month. Access differed amongst fishery users and depending on the number of years of experience. A larger percentage of fisherfolk engaged in fishing (crewmember/gear owners) (41%) reported access to services compared with those in processing and trading (18%) ($p<0.05$). In addition, respondents with 5 or less years of experience had the lowest reported access to services (5%) ($p<0.05$). Fisherfolk were generally satisfied or somewhat satisfied with the support from government services (88%). Only one respondent reported receiving support from non-government organisations, and no support from research institutes or other organisations were stated.

6.4 Discussion

Understanding the vulnerability and governance context of fisheries resources and the effects on fisher livelihoods is critical for understanding the role of the sector for food security: in terms of the availability of fish, access to the fishery and the stability of supply (DfID, 1999; Cinti et al, 2010). This study investigated local knowledge, perceptions of change and attitudes of governance at the group and individual level amongst fisherfolk along the value chain in two lakeshore villages in Lake Chilwa, Malawi. Fish-related activities were very important for household food security and income. The majority of fishers held positive views of the sector as being profitable, improving livelihoods through increased income and food, and would recommend engaging in the sector to others. However, perceptions of the sector differed by fishery user with crewmembers having mixed views on the benefits obtained. Fishers experienced many constraints in their fish-related activities, such as low fish availability and price fluctuations, however the majority held a positive view of remaining in the sector.

6.4.1 Perceptions of Fish Availability and Seasonality, and Comparison with Biophysical Data

Fisherfolk showed immense ecological knowledge on the availability and behaviour of fish species in Lake Chilwa. The study finds evidence that trends and seasonality in fish availability in Lake Chilwa are in rhythm with water levels, which contributes to wider studies on the relationship between water dynamics and fisheries (Jul-Larsen et al, 2003). Clear seasonal patterns are evident in the fishery with fish species having distinct breeding and migrating periods that are affected by rainfall and lake levels altering habitats and feeding grounds. This was found to have influenced access to fish species between locations showing the importance to consider geographical variation. Fishers engaged in their fish-related activities full-time in the high season between September and April, and often part-time during the low season from May to August. This seasonality supports wider studies on inland fisheries often being part of a diversified livelihood strategy (Béné et al, 2016).

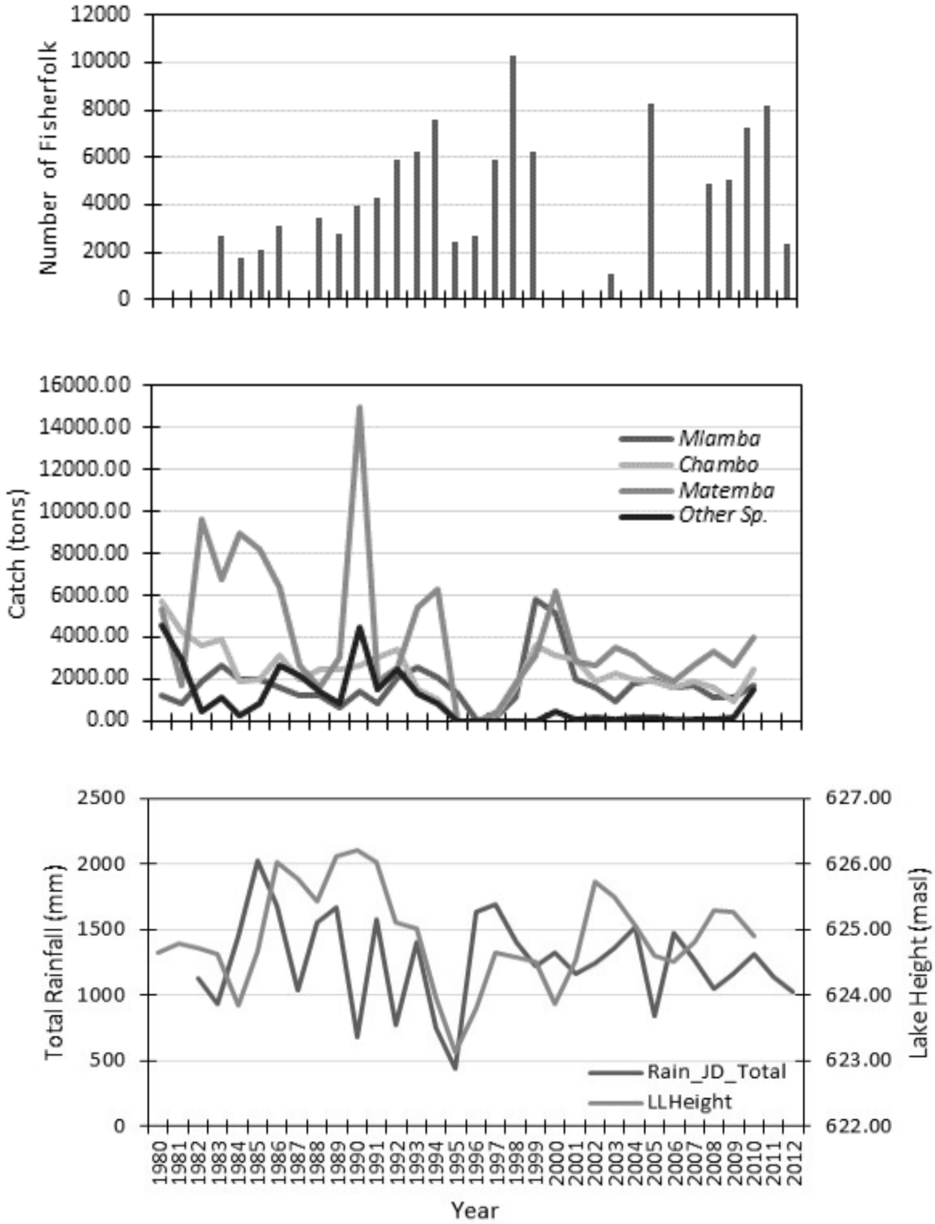

Figure 6-6 Fishery and lake level trends for Lake Chilwa from 1980 to 2012. Number of fisherfolk represents number of gear owners and crewmembers.

Fish consumption patterns followed seasonality of fish availability, with fish also being sourced from Lake Malawi from 2012 as a result of drought. This finding contributes to the 'hidden' trade of fish in remote settings that is often not captured in statistics (Welcomme and Lymer, 2012). The study found unique evidence in an inland fishery of the importance of cultural preferences in fish consumption. Consumption of *chambo* was most favoured based on taste and quality. However, the fish species perceived to be most available, *mlamba*, was also least preferred and perceived by some to cause negative health impacts and consumption was reported to be forbidden by some religious groups. The beliefs associated with *mlamba* are comparable with studies showing catfish can be heavily infected with parasites which when undercooked can cause human health concerns (Barson, 2004).

Fishers predominantly described changes in the fishery because of climate related water levels. Fishers' perceptions were generally comparable with trends in official fisheries and climate records (**Figures 6.6 and 6.7**) and earlier studies documenting fish biology, behaviour and drought in Lake Chilwa (Kalk et al, 1979; Njaya et al, 2011). Flooding was perceived to increase catches over the following years. However, drought was perceived to cause significantly declines in catches of *chambo* and *matemba* for 2-3 years, with *mlamba* being most resilient, which is reflected in official records during the 1995/96 drought (**Figure 6.6**). Overall, fisher's perceived fish catches to be declining over time, particularly *chambo* and *matemba*, with other fish species rarely found after the 1995/96 drought which is also reflected in official records (**Figures 6.6 and 6.7**). Drought was perceived by fishers to cause a decline in household income, asset base and food security. Good and bad fishing years were described in rhythm with the water levels, with good years when lake levels were high and bad years when lake levels were low. Group perceptions of good fishing years with high lake levels in 1985, 1989, 1990-92, 2000, 2005, 2009 were generally similar with reported high lake levels and fish catches in similar years except for 2005 and 2009. The perceived drought from 2012 was also identifiable in rainfall and fish catch monitoring. Other perceived reasons for changes in the fishery were increased fishing effort, use of illegal gears, cutting of reeds and deforestation which supports wider studies in the catchment (Njaya et al, 2011). Comparability however with perceptions of increasing number of fishers and official reported data is less clear due to limited quantitative data on the number of fishers. In addition, fishers perceived changes in wind patterns to be significant in affecting fish catches and safety of fishing, a topic which merits further research.

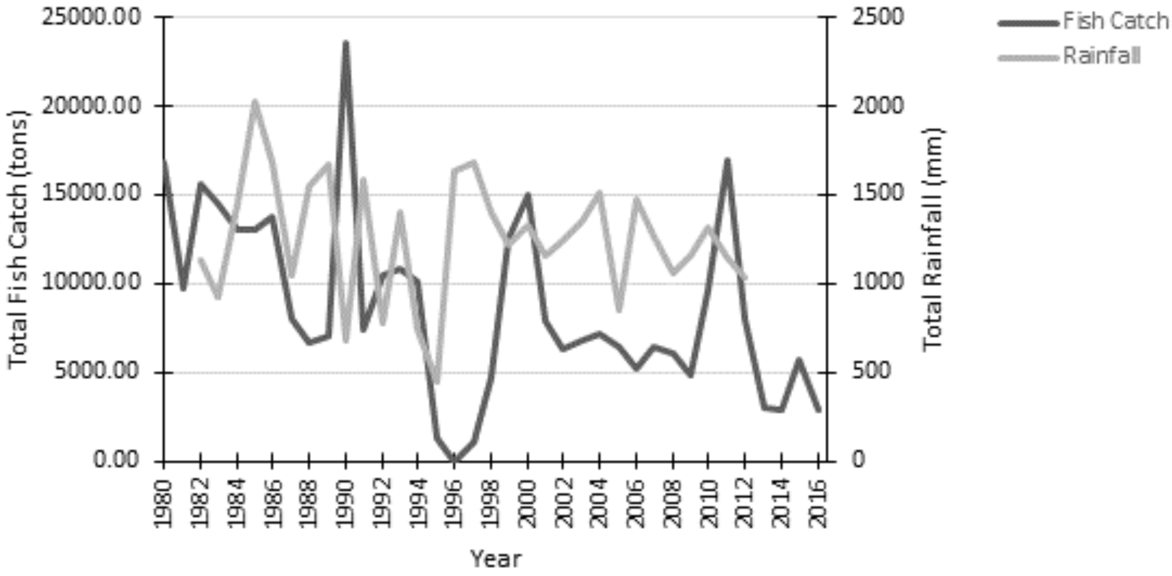

Figure 6-7 Fish catch and rainfall in Lake Chilwa from 1980 to 2016 (data sourced from Government of Malawi, 2015 and 2017).

6.4.2 Perceptions of Fisheries Governance: Awareness, Attitudes and Effectiveness

Effective management is dependent upon the awareness and understanding of regulations, and the perceptions of legitimacy, acceptance, and its effectiveness. Several fisherfolk were aware of rules and regulations governing Lake Chilwa's fishery however, those new to the sector were less informed. Fishers reported the following regulations: a closed fishing season in the Lake from January to February or March including a ban on nkhoka seine nets during this time. Other gears such as mosquito nets and gauze wire were prohibited all year round. This is comparable with reported regulations and a closed season from December to March however not all fishers were aware on the correct timing of the closed season (Njaya et al, 2011). Fishers perceived the closed season to be in place in order to allow fish to breed and grow. Access to government and local organisations providing support to fisherfolk was limited, particularly for those new to the sector and those engaged in processing and trading.

Fishers perceived compliance to be low and enforcement high, with non-compliance due to fishers needing to meet household food and income needs. There were also mixed attitudes on the effectiveness and impacts of the regulations which differed amongst fishery users. The majority held neutral and negative perceptions on the impacts of regulations on their benefits obtained, household income and food security. Crewmembers and less experienced fishers perceived the regulations as having more of a negative impact on their livelihoods. This supports findings by Gelchi et al (2009) on the importance of type of fishery user and experience in shaping perceptions of governance. The effectiveness of the regulations at protecting fish species had positive and negative perceptions. Nearly half of fisherfolk perceived the regulations as effective in increasing the amount of fish. Some fishers also perceived peak fish catches during or after the closed season because fish had multiplied and were less disturbed. However, half of fishers had mixed opinions, with more experienced fishers perceiving a decline in fish availability since the regulations are in place. Thus, crewmembers required more support from fisheries managers during closed seasons, and fishers new to the sector require education on regulations.

6.5 Conclusion

Understanding the vulnerability and governance context of fisheries resources and the effects on fisher livelihoods is critical for understanding the role of the sector to food security (DfID, 1999; Cinti et al, 2010). This is particularly important for inland capture fisheries which support the livelihoods of millions of rural communities in LIFDCs but are one of the most under-reported fisheries sectors. In addition, the effects of climate change on the sector is still uncertain, particularly at the local scale (Wantzen et al, 2008a; Béné et al, 2016).

The study investigated local ecological knowledge, perceptions of change and attitudes of governance amongst fisherfolk in two lakeshore villages in Lake Chilwa, Malawi. Fisherfolk were found to have immense local knowledge on fisheries and climate change that compliments official monitoring analyses and provides a unique contribution to observed and perceived change at the local scale (Simelton et al, 2013; Andrachuk and Armitage, 2015). Fisherfolk's rich local ecological knowledge revealed that trends and seasonality in fish availability in Lake Chilwa are largely in rhythm with water levels and affected by extreme events of floods and drought, which contributes to wider studies on the relationship between water dynamics and fisheries (Jul-Larsen et al, 2003). Fisherfolk were aware of rules and regulations governing the fishery however, attitudes towards the regulations and its impacts on livelihoods and effectiveness differed by fishery users and level of experience. The study also provided an insight into the role of the sector in food security. Fish-related activities were largely perceived to be very important for fisherfolk's household food security and income, and were positively viewed as improving their livelihoods through increased income and food. However, primary sector fisherfolk held less positive views on the benefits of the sector and were also found to be more negatively impacted by governance.

The study provides a rich insight into the perceptions of fisherfolk and local knowledge on the impacts of climate shocks and co-management regulations on inland fisheries and fisher livelihoods and builds on wider studies on the value of fishers' knowledge in data limited environments (Daw et al, 2011b). The vulnerability and governance contexts can influence availability, access and stability of fish and subsequently the benefits that fisherfolk obtain of fish-related income and food security. The findings are important for achieving effective ecosystem and fisheries management and poverty alleviation.

Chapter 7 Perceptions and Values of Fisheries

7.1 Introduction

Inland capture fisheries are an important source of food, nutrition, employment and income for millions of people globally, but primarily in developing countries (HLPE, 2014; Kawarazuka, 2010). The production of inland capture fisheries has been reported to be growing slowly in some regions of the world (FAO, 2014). However, in the continent of Africa, where inland fisheries constitute in some countries the major supply of fish, there have been regional variations in production (FAO, 2014). East Africa has reported some of the highest production levels of fish however some countries, such as Malawi, experience the largest variations, and the lowest availability of fish per capita (FAO STAT, 2015). Fisheries can act as an important contributor to improved food and nutritional security in many developing countries (HLPE, 2014; Kawarazuka, 2010). Fish can act like a cash crop generating employment along its supply chain, and income which can increase the purchasing power for other food items (HLPE, 2014; Kawarazuka, 2010). Fish can also be a direct source of nutrient-dense food which is directly consumed and can improve food and nutritional security (HLPE, 2014; Kawarazuka, 2010). In addition, during periods of environmental shocks such as drought, it has been argued that capture fisheries can act as an important safety net for food security during agriculture lean months or for the increasing landless poor (Kawarazuka and Béné, 2011). These myriad of complex pathways through which fisheries can contribute to food security are dependent on a number of factors including: the productivity of the fishery and the degree of stress placed upon the system; the vulnerability of populations dependent on fish for income, revenue or nutrition; the nature of involvement in the fishery; as well as cultural norms and gender relations (Unsworth et al, 2014).

Small-scale inland capture fisheries are complex socio-ecological systems. Their characteristics as informal, multi-gear, multi-species, dispersive and remote fisheries, has led to the sector being the most difficult subsector for which to obtain reliable capture production statistics (FAO, 2014). The fishery is often in remote areas and dispersive making access to villages for monitoring difficult and expensive (De Graaf et al, 2012). In addition, the informality of the sector where fish is often bartered locally or consumed within households, creates further challenges in designing reliable monitoring (De Graaf et al, 2012). It has been argued that this complexity has made it difficult for undertaking assessments of stocks and for valuing the sector via traditional economic assessments (Welcomme, 2011). The sector has therefore been highlighted as under-estimated and under-represented (FAO, 2014).

There have been few in-depth studies exploring the role of fisheries to livelihoods and food security, particularly for the under-reported and under-valued inland capture fisheries sector (Béné et al, 2016). For inland capture fisheries, studies around Lake Victoria have shown that participating in fishing as a livelihood was not associated with household fish consumption or food security, and rather associated with higher incomes and assets (Fiorella et al, 2014; Geheb et al, 2008). In addition, gender dynamics have been highlighted as an important factor affecting the pathways of fish to food security (HLPE, 2014). In Lake Victoria, men have been shown to spend most of their fishing livelihood income on alcohol and non-household food security items, compared with women (Fiorella et al, 2014; Geheb et al, 2008). The role of women in prioritizing food for household members has also been highlighted by other studies (Quisumbing et al, 1995; Porter, 2012) and women have been identified as providing an untapped potential source of valuable local ecological knowledge (LEK) for improved fisheries management (Kleiber et al, 2014). A gap in understanding men and women fisherfolk activities, and how income is utilised from their activities in supporting their livelihoods continues to be widely reported in the literature (Neis et al, 2005; FAO, 2009; FAO, 2014; Béné et al, 2016). More specifically, a dearth of gender-disaggregated data in the fisheries sectors exists which limits the accurate understanding of how these sectors function (Geheb et al, 2008; Harper et al, 2013). A review by Kleiber et al (2014) highlights that biases in sampling methods and research have led to significant gaps in understanding the involvement of both men and women along the supply chain in small-scale fisheries. A landmark paper by Béné et al (2016) evaluates the global evidence in the scientific literature of the contribution fisheries plays to food security and concluded that more research was required on several areas, including; gender relations, distributional aspects of benefits, local impacts on capture fisheries and food security, and methods that capture complex relational interplay. The study also highlighted the benefits of local case studies in capturing complex and multi-dimensional nature of the pathways by which fish contribute to livelihood and food security.

The sustainable livelihood approach and its framework (SLF) can act as a useful tool to identify factors sustaining livelihoods and assist in explaining complexities in relationships. Food security is one outcome from a livelihood strategy that is shaped by assets, vulnerability, rights of access, social interactions and the influence of shocks and trends. Within the small-scale fishery sector, the SLF has the potential to readily understand fisher livelihoods. Quantitative methods can be used to understand the scale of livelihood and food insecurity, whereas qualitative methods can be used to understand how and why livelihood strategies or benefits are selected and prioritised.

As part of a wider study using the SLF to investigate the role of fisheries to food security along the SLF components, this chapter aims to evaluate the perceptions and values of fisherfolk regarding their role, benefits obtained and challenges experienced. This is investigated through the following objectives:

1. To document the activities of men and women fisherfolk, including the techniques and processes used, and scales of operation;
2. To assess the types of benefits received and their perceived value by men and women fisherfolk; and,
3. To assess the relative importance of different types of challenges, and perceptions of coping strategies by men and women fisherfolk.

By using a qualitative participatory method which encourages reflection; photovoice, the study contributes to a better understanding of the vulnerability, livelihood and income context, as well as the pathways from fisheries to food security through direct and indirect pathways.

7.2 Methodology

7.2.1 Method Approach

Characterisation of socio-ecological aspects for both men and women fisherfolk within fisheries research presents special methodological challenges. Although a range of qualitative and quantitative methods have been applied in fisheries and aquaculture research, flexible and creative tools have been called for to a) capture the complexity of context specific factors (Harper et al, 2013; Kleiber et al, 2014); b) produce policy relevant results (Wiber et al, 2004); and c) to integrate the views and realities of fishers within the management process. Participatory research is described as having considerable, yet often unrealised, potential in advancing fisheries research globally (Wiber et al, 2009). In addition, studies have shown that participation of participants through qualitative approaches are central to a deeper understanding of vulnerability in the context of livelihoods and the Sustainable Livelihoods Approach (SLF) (DfID, 2004).

One innovative community-based participatory research method that has been increasingly reported in the literature as having the potential to offer considerable promise for use with marginalised, often neglected, illiterate populations is the photovoice process (hereafter referred to as photovoice). Photovoice is a unique form of community-based participatory research founded on the principles of feminist theory, constructivism, and documentary photography. The originators, Wang and Burris (1997; pg. 369) describe photovoice as a process by which ‘‘people can identify, represent and enhance their community through a specific photographic technique.’’ The photovoice process involves providing participants with the opportunity to take photographs of a particular community issue that are then used to facilitate participant’s critical reflection. Throughout the process, participants have control over what they document, what conclusions to report, and how to catalyse change in their communities (Wang and Burris, 1997). The photovoice process typically comprises several stages, including: recruitment and training, photography assignment, group or individual selection and discussion of photographs, coding of themes from the photographs and a final phase to create research outputs (Wang and Burris, 1997; Castleden et al, 2008). The theoretical principles underpinning photovoice are: “(1) to enable people to record and reflect their community’s strengths and concerns; (2) to promote critical discussion and knowledge about important community issues through large and small group discussions of photographs; and (3) to reach policymakers” (Wang and Burris, 1997). Photovoice seeks to make community needs more visible and to empower illiterate participants to advocate for changes at the individual, community and policy level (Wang and Burris, 1997). Critiques of the photovoice method relate to: i) people’s ability to capture important information, especially about challenges, when they are working with both hands and may not have time to take pictures; ii) the quality of the evidence gained if people are not familiar with composing photographic pictures; and iii) representativeness – the extent to which the pictures document the full spectrum of issues.

An evaluation of the photovoice methods and studies by Simmance et al (2016) reveals growing recognition that photovoice provides a powerful tool in addressing complex social-ecological issues and in capturing unique perspectives of marginalised populations in diverse settings (Berbes-

Blazquez, 2012; Bennett and Deardon, 2013; Kong et al, 2015). In addition, a few studies highlighted that photovoice generated more enriched data and opportunities for mutual learning between researcher and participant over and above traditional research methods such as semi-structured interviews, and is a valuable tool for triangulation of mixed methods (Bennett and Deardon, 2013; Kong et al, 2015; Baldwin and Chandler, 2010). The participatory method has proven to be successful in capturing complex context specific issues as well as producing high quality, richer and policy relevant research (Bennett and Deardon, 2013; Kong et al, 2015). The use of photovoice in fisheries and aquaculture research has, only been applied to a small number of studies, with no reported studies within the context of small-scale or inland fisheries known to date (Bennett and Deardon, 2013).

For the purposes of this study, the modified eight step photovoice methodology designed for the context of small-scale fisheries was used. More details are provided in Simmance et al (2016) (see **Appendix F**). By using a qualitative participatory method which encourages reflection and empowerment; photovoice, the study contributes to understanding the SLF components of vulnerability, livelihood strategies and income, which can help lead to food security through direct and indirect pathways.

7.2.2 Study Site

See **Chapter 3** for a description of the study site: Lake Chilwa, its small-scale fishery and villages selected for surveying.

7.2.3 Photovoice Process and Sampling

The research study collaborated with World Fish and LEAD, who work in the fishing communities around Lake Chilwa. Field work was undertaken over three months from June to August 2015. Participants were recruited via purposive and snowballing sampling techniques. A key informant was used in each village to recruit participants based on the following criteria; represent diversity of fisher roles and scales in village, male and female, active fisher in the past 12 months. The photovoice process was conducted with seven individuals from Likapa, and eight individuals form Sauka Phimbi. Males and females were recruited along the value chain in order to understand both roles in the fishery. Informed consent was obtained from participants once training had been provided on the study and method. Participants were asked to take up to 9 photographs on a disposable camera over one week on each of the three topics below:

1) What activities do you carry out in relation to capture fisheries?
2) What benefits do you receive from capture fisheries?
3) What challenges do you experience in capture fisheries?

One to one interviews (of between 30 minutes and 3 hours) on the photographs were then undertaken with each participant within one week of collecting the cameras. This period was chosen to ensure that participants did not forget the reasons behind capturing each photograph. Participants were asked to then select up to five photographs from each topic that best represent that topic and to which would be discussed. The same line of questioning was asked and repeated for each photograph (please also see **Appendix E; Photovoice Manual**):

1) What's in the picture?
2) Why did you take the picture for that topic?
3) Why did you select this picture over the others?
4) What would you like to tell to others with this picture?
5) Why would it be important to give this message to others?
6) Is there any other information you were unable to capture during the exercise that you would like to share in relation to this topic?

Participants were also asked to select one photo overall to best represent the topic. This enabled an understanding of prioritisation of themes within each topic. At the end of discussing all three topics, the prioritisation step was repeated, where participants were asked to select one photo from the whole exercise that they felt best captured their views. Audio recordings were transcribed and analysed in a similar way to other qualitative data; via codifying, exploring, formulating and interpreting themes. A final voluntary group discussion was undertaken in each village with all participants in order to share their priority photos from each topic and to validate with participants the emerging main themes. The aims of the final group session were to: a) share narratives and verify key messages; b) discuss dissemination activities; and c) capture group perspective on the photovoice experience.

Ethical approval was obtained from University of Southampton Faculty of Social and Human Sciences Ethics Committee (reference: 14728) and from the National Commission for Science and Technology in Malawi prior to commencement of research. Permission was sought from the Group Village Headman and from the Village Headman of both villages to conduct research in the study sites.

7.2.4 Participant Demographics

In Likapa, 4 female and 3 male fisherfolk were selected to participate, and in Sauka Phimbi, 4 female and 4 male participants were selected to participate (**Table 7.1**). The participants' roles in the fishing industry were diverse and consisted of the primary and secondary sectors of the supply chain; fishers (including gear owners and crew members actively fishing), fish processors and fish traders. Participant's age ranged from 30 to 46 in Likapa, and 28 to 61 in Sauka Phimbi, with men generally being older than women in both sites. The number of years of experience participants had in their fisherfolk role varied from 4 to 29, with an average of approximately 10 years at both sites.

7.2.5 Analysis

All interview and group discussions were audio recorded and translated into English by Malawian speakers. Translations were coded deductively by the primary author, with initial categories and themes drawn from interview guiding questions and photograph topics (see results below). Detailed and clear code definitions were developed and adhered to. The translations were then coded inductively to identify new themes that emerged. Iterative coding resulted in a list of categories, themes and multiple sub-themes. Both the themes and sub-themes were continuously examined and refined. Themes in each category were then explored for commonality, differences and relationships.

Table 7-1 Characteristics of participants.

Participant	Age	Gender	Role	Years' Experience	Participant Code
Likapa:					
1	30	F	Fisher	7	A1_F_F
2	32	F	Processor	6	A2_F_P
3	32	F	Processor	6	A3_F_P
4	30	F	Trader	5	A4_F_T
5	40	M	Processor	15	A5_M_P
6	40	M	Trader	4	A6_M_T
7	46	M	Fisher	29	A7_M_F
Sauka Phimbi:					
1	36	M	Fisher	7	B1_M_F
2	34	M	Fisher	12	B2_M_F
3	35	M	Processor	5	B3_M_P
4	61	M	Fisher	4	B4_M_F
5	28	F	Processor	7	B5_F_P
6	32	F	Processor	20	B6_F_P
7	52	F	Fisher	10	B7_F_F
8	35	F	Processor	14	B8_F_P

7.3 Results

7.3.1 Summary of Photographs Taken

Of the photographs taken, approximately 65% were relevant for the photovoice process (**Table 7.2**). This was as a result of a few photographs being taken of family members for personal keep, and as a result of some photographs being of poor quality. The latter may have been due to the participants inexperience of using a camera as well as limitations with using a disposable camera. Of the photographs discussed during the semi-structured interviews, nearly half of all photographs represented the topic of activities, with one third depicting benefits and approximately one fith showing challenges. This reflects the general note by most pariticpants that not all challenges could be captured using a camera.

Table 7-2 Number of photographs taken and discussed.

Study Site	Total Taken	Relevant Taken*	Discussed
A	164	113	72
B	129	79	66
Total	293	192	138

*Excluding photographs of family taken personally, or those of poor quality

7.3.2 Research Themes Developed from Photovoice

The photographs and semi-structured interviews produced 29 themes in Likapa and Sauka Phimbi (**Table 7.3**). The themes were grouped into three broad topics/categories; activities, benefits and challenges. Based on coding coverage, the category discussed the most was activities. Several themes were discussed by the majority of participants across the four categories, such as fish availability as a challenge, and food as a direct benefit. Several sub-themes also emerged which revealed further complex differences in perceptions between men and women fisherfolk such as on the benefits obtained from their activities. The following section explores the results of the photovoice process for each of the four categories in depth.

Table 7-3 Research Theme Definition.

Category	Theme / Sub-theme	Coding Definition
Activities	Gender and activities	Description or reflection on roles, or specific gender related differences.
	Process	Activity processes, tasks, characteristics.
	Activity Asset	Ownership of equipment and hiring of employees.
Benefits	Asset	Material goods: house, land, farm animals, electronics etc.
	Needs	Household food, income, education, finance etc.
	Diversifying Livelihoods	Other livelihood strategies: crops, livestock, petty business etc.
Challenges	Fish Availability: Seasonality, shocks, scarcity	Descriptions of fish availability issues, climatological and other.
	Governance	Discussion on rules and regulations of the fishery.
	Market / finance	Access to markets, infrastructure, economic, transport etc.
	Equipment	Cost of equipment, servicing, availability, ownership.
	Preservation	Discussion on fish quality, preservation concerns.
	Theft	Equipment being stolen.
	Predation	Problems of animals predating on fish caught within fish traps, such as otters.
	Health	Individual health concerns from activity or other.
	Work / supply chain	Discussions on supply chain and labour issues.

7.3.2.1 Fish-related Livelihood Activities

Participants used photos to portray three main roles in the fishery supply chain: fishers, fish processors, fish traders. Linked to these roles, participants discussed four sets of issues (**Table 7.4)**. There were several similarities between men and women fisherfolk across both sites on themes identified.

Table 7-4 Activities portrayed during the photovoice process.

Activities	No. of Participants	Female	Male	Likapa	Sauka Phimbi
Gender and activities	5	4	1	3	2
Activity Asset	12	7	5	5	7
Process	12	7	5	6	6

Gender and Fish-related Livelihood Activities

The predominant roles amongst both men and women participants were fishers and fish processors. The majority of fishers were male participants, whereas the majority of fish processors were female participants. However, there were a few men who processed fish, and a few women who were fishing gear owners but who did not actively fish on the lake. One female fisher discussed how women can partake in fishing despite traditionally not being allowed to fish on the lake:

"For women who would like to start fishing I would tell them that they don't have to be discouraged with the fact that women don't do the actual fishing, they only need the men to help them" (Participant A1_F_F. ***Figure 7.1,*** *Picture F).*

The majority of participants also expressed individual pride in their activities, self-actualisation, independence, strong identity and job satisfaction. Both male and female participants expressed these attributes, however females provided more frequent and in-depth views on these non-material benefits:

"A woman should not take herself as a failure. It is possible for a woman to go to the lake, buy fish, process it and from then be able to sustain herself….I am advising as well as encouraging women to not just think of asking money from men and everything else. They should also think of going to the lake, buy fish and sell it and earn money which they can use to buy their needs and therefore sustain themselves" (Participant B8_F_P).

Activity Assets and Process

The scale of activities varied amongst participants. A number of both female and male fishers were characterised as large-scale where they fished using the nkhoka fishing net and employed employees. Only one male fisher from Sauka Phimbi was characterised as small-scale where hand-made baskets called mono fishing traps were used for fishing and there were no employees. Several fisher participants expressed that they owned their fishing equipment such as gears, and owned their own boats. Only a few female fishers and one male small-scale fisher from Sauka Phimbi outlined that they rented a fishing boat. The latter participant detailed the disadvantages of renting equipment such as a fishing boat (**Figure 7.1 Picture B**):

"I greatly wish that I had my own fishing boat, so that I could be effective and at the same time there will be flexibility, such as I would choose to relax one day and one day I would go fishing……Because despite having the rest of the things like the fish traps and fish hooks, still more, the key resource to have is the fishing boat." (Participant B2_M_F)

Several fishers detailed how they sell fish to processors or direct to traders which was via auction or by setting a price. For processing of fish, the majority of participants across gender and sites discussed the fish processing technique of drying and smoking in combination. One processor summarised the process in **Figure 7.1 Picture C**:

"Once one has bought fresh fish, they have to make sure they dry the fish before they start smoking it" (Participant A5_M_P).

Men and women processors also stated frying as a processing technique, however this was solely by participants in Likapa. The techniques of solely drying and selling of fresh fish was also outlined by women processors and fresh fish was primarily a technique in Likapa. Salting of fish was mentioned by a few processors which was targeted for customers from Mozambique. Both male and female fish processors stated that they either owned or rented some of the processing equipment: smoking oven, drying rack, drying nets and pans. There were a larger number of participants who stated that they rented equipment in Sauka Phimbi compared to Likapa. The majority of participants processed fish themselves. However, one female processor from Likapa, who owned all of her processing equipment and who fried fish, outlined that she employs one person to assist in cleaning the fish (**Figure 7.1 Picture D**):

"Fish processing involves one to clean the fish, dry it and then fry it in a pan… Not only me to do the work. There are some people employed". (Participant A3_F_P)

Several fish processors explained that they buy fish directly from fishermen, with one case within Likapa where fish was bought from middle men called 'Cheu'. Both fishers and processors stated that a key task in their activity is servicing equipment such as fishing nets, baskets and fish processing drying nets. The species caught by fishers and processed by processors was also stated by participants and comprised of mainly two species from Lake Chilwa. *Clarius gariepinus* (local name: *Mlamba*) was the most frequently mentioned fish species followed by endemic *Oreochromis Shiranus chilwae* (local name: *Chambo*). Very few participants discussed *Barbus paludinosus* (local name: *Matemba*) which can also be found from Lake Chilwa. Only one trader discussed trading fish species sourced from outside of Lake Chilwa.

Priority of Fish-related Livelihood Activities

The importance of the process task of servicing equipment was highlighted as a priority theme for activities by the majority of participants, particularly from Likapa. A few participants from Sauka Phimbi also mentioned quality of fish and ownership of equipment as priority themes.

Figure 7-1 Pictures portraying activities taken by photovoice participants. Moving clockwise from top left corner. A) Large-scale fishing activities with plank boat, net, employees and material; B) Small-scale fisherman portraying renting of a dugout canoe boat; C) Fish processor drying mlamba fish before smoking D) Fish processor employee cleaning mlamba fish before drying and frying E) Fish trader selling fish at a stall, F) Female fisher showing ownership of nkhoka net and male employee.

7.3.3 Benefits from Fish-related Livelihood Activities

In relation to the benefits obtained from fishing livelihoods, three themes emerged from the photovoice process: acquiring assets, meeting basic needs of the household, and diversifying livelihoods (**Table 7.5**). Some of the sub-themes revealed clear differences between men and women, and between sites, on specific attributes revealing the complexity of how benefits from fisher activities are utilised (**Figure 7.2)**.

Table 7-5 Benefits portrayed during the photovoice process.

Benefits	No. of Participants	Female	Male	Likapa	Sauka Phimbi
Assets:	**13**	7	6	6	7
Livestock	6	2	4	3	3
Land	2	1	1	1	1
House	5	3	2	4	1
Bicycle	5	3	2	1	4
Electronics	2	2	0	0	2
Small shop	3	1	2	3	0
Clothes	5	4	1	2	3
Household goods	7	5	2	4	3
Needs:	**12**	7	5	6	6
Education	4	1	3	2	2
Food	11	6	5	5	6
Income	5	2	3	2	3
Supporting family	3	2	1	2	1
Financial; relatives and HH	4	2	2	2	2
Development of children	4	2	2	2	2
Livelihood:	**12**	6	6	6	6
Livestock rearing	6	2	4	3	3
Farming crops	4	2	2	2	2
Petty business	4	3	1	1	3
Business	3	1	2	3	0
Dependency	3	2	1	1	2

Acquiring Assets by Utilising Fish-related Income

Most participants explained that their fishing activity enabled them to acquire assets which were very important for sustaining their household needs and for coping with challenges. Assets mentioned included household goods, livestock, house, clothes, bicycle, small shop, electronics and land, however differences emerged between men and women fisherfolk and across sites on their acquisition. Several male and female participants explained the benefit of being able to construct their own house and acquiring a small shop, however these were primarily from Likapa. As an example, several participants noted:

"To build a house it is a very big thing that's why I took a picture because it is the very first thing that came from the first profits we made from fishing" (Participant A1_F_F).

Some male and female participants also mentioned being able to purchase a bicycle out of their fishing activities, however this was primarily in Sauka Phimbi which was the more remote village. One participant explained:

"When I started processing and selling fish, one of the very first things that I bought was the bicycle and the rest of the things I bought later….as I noticed that it was difficult for me to transport and walk from where I am to smoke and to the market so I wanted my own mode of transport….the bicycle enabled me to earn more and more money" (Participant B3_M_P).

Differences between men and women fisherfolk emerged on the benefits relating to diversifying livelihood via acquiring livestock and benefits of assets for the household. Livestock was noted as a benefit primarily by male fisherfolk and household goods and clothes were more frequently discussed by female fisherfolk.

Meeting Household Needs from Fish-related Income and Fish as Food

Under the theme of meeting household needs, most male and female fisherfolk across both sites noted the benefits of food and income attributable to their fisher role, with some expressing the benefits of being able to provide financial assistance to family. As an example one participant stated:

"Without fishing I would not have been able to buy clothes for my family and food to support them". (Participant A1_F_F).

Several participants discussed the benefits of child development with regards to education, however this was primarily discussed by male fisherfolk:

"With my fishing business I have been able to provide all the needs for my children's education" (Participant A6_M_T).

Diversifying Livelihoods with Fish-related Income

Diversifying livelihoods was a consistent emerging theme on the benefits that female and male participants discussed as a result of their fishing activities. A number of participants noted livestock rearing, farming crops, petty business and business as additional livelihood strategies that they were able to engage in as a result of their fishing activity. A few male and female fisherfolk discussed farming of crops across both sites, and businesses such as a saloon or shop, however the latter was primarily discussed from participants from Likapa. Livestock rearing as an additional livelihood strategy was primarily mentioned by male fisherfolk across both sites. One participant outlined the benefits of livestock rearing:

"When I earned some money at the very beginning of my fishing career, I decided to buy some chickens……It is very important to have farm animals and chickens there, because at certain points in time one cannot catch fish at the lake, because maybe of too much wind, or other factors, so in such cases then one can rely on the farm animals like chicken for relish or for sale and use the money to buy whatever they don't have at the household" (Participant B2_M_F).

Several women fisherfolk from Sauka Phimbi discussed the additional livelihood of petty businesses. One female participant stated:

"Having two businesses is good because at times it may happen that there is no fish to buy at the port because it was windy on that day, so I use the money which I earn from the samosa selling business" (Participant B6_F_P).

The dynamics between male and female fisherfolk were also identified and inter-dependence on fishing and non-fishing activities was found. A few male participants expressed pride and gratitude to their wives who started businesses to support their fishing careers, encouraged other male fishers to encourage their wives, and expressed reliance on their partners. A small-scale male fisher noted:

"My wife's business there is very good, it is assisting me, sometimes when I go to the lake and I do not come back successfully, but then because she is doing the tomato selling business, sometimes she uses the money to buy whatever we are lacking at the house without waiting for me to come back…. I am very grateful to my wife since she thought of starting that business, and this is very good indeed because we are assisting each other, the husband can bring some things home the same way the wife can" (Participant B2_M_F).

Priority of Benefits Obtained from Fish-related Livelihood Activities

The importance of owning a house as an asset out of benefits from fishing activities was highlighted as a top priority benefit by several male and female participants primarily from Likapa. Household goods and clothes was also selected as a priority benefit by women fisherfolk, and several male participants also prioritised diversifying livelihoods who primarily were from Sauka Phimbi. Some participants provided advice on how to obtain good benefits. Several participants re-iterated the positive contributions of diversifying your livelihood and highlighted the value of working hard to realise benefits such as one female processor stated:

"You too should work hard to realise the benefits like the ones I have been able to realise" (Participant A2_F_P).

In addition, a few participants also acknowledged:

"*In fishing we have challenges but the benefits surpass the challenges*" *(Participant A1_F_F)*.

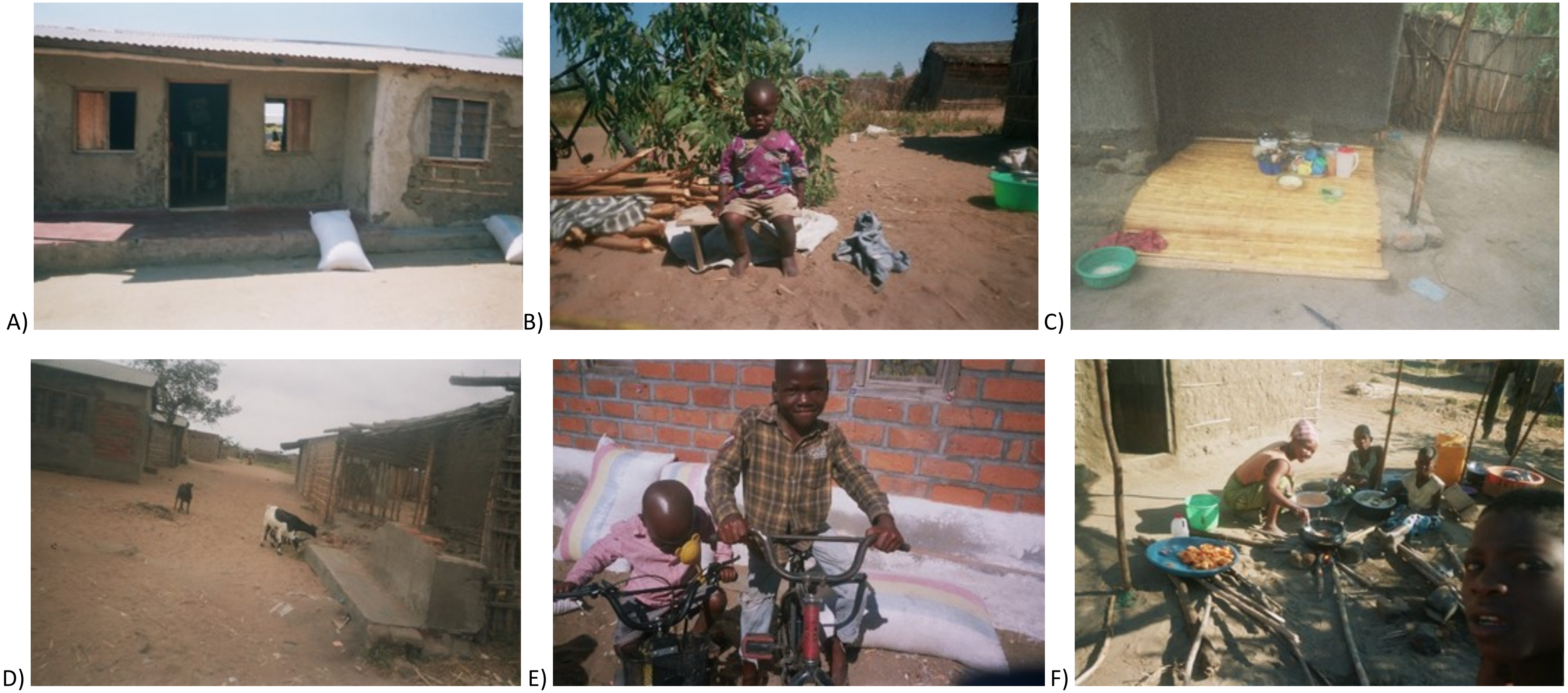

Figure 7-2 Pictures portraying benefits arising from fishing activities taken by photovoice participants. Moving clockwise from top left corner. A) House; B) Clothes for children; C) Household kitchen utensils and land D) Livestock goats E) Supporting family with rice for food and bicycles, F) Diversifying livelihood with petty business of samosa selling.

7.3.4 Challenges Experienced in Fish-related Livelihood Activities

Photographs taken by participants to represent challenges that they experience in their fisher roles showed a total of thirteen themes related to environmental, social and economic challenges (**Figure 7.3, Table 7.6**). Further sub-themes emerged under the challenge of fish availability where seasonality, shocks and scarcity of fish were noted. There were a number of similarities between men and women as well as between sites on the challenges expressed, with generally little dissimilarities. Photographs and narratives of males and females at both sites focused primarily on three thematic challenges: 1. Fish availability; 2. Market / financial and equipment constraints, and; 3. Governance issues.

Table 7-6 Challenges portrayed during the photovoice process.

Challenges	No. of Participants	Female	Male	Likapa	Sauka Phimbi
Fish Availability;					
Seasonality	13	7	6	6	7
Shocks	5	2	3	3	2
Scarcity	5	2	3	2	3
Market / finance	10	5	5	5	5
Governance	6	3	3	3	3
Equipment	8	3	5	2	6
Preservation	4	2	2	4	0
Theft	2	1	1	2	0
Predation	1	0	1	0	1
Health	2	1	1	1	1
Work / supply chain	2	0	2	1	1

Environmental Challenges – Seasonality and Shocks

Fish availability was the most frequently noted challenge by men and women fisherfolk across both sites where participants attributed scarcity of fish to two main causes; seasonality and shocks in climate. Most of the participants discussed the effect of seasonal wind patterns; known locally as 'Mwera' winds, on the availability of fish each year during the months of May to July. Participants described how the winds affected the catchability of fish and the safety of fishermen where some fishers have lost their lives. One participant noted:

"When it is very windy the water becomes muddy and the fish do not swim anymore they just hide somewhere, so when it is windy it is always hard to catch any fish" (Participant B2_M_F).

A few fish processor participants also described fish scarcity during the same months of June and July being the result of cold temperatures. A number of participants described longer term trends of scarcity of fish, with specific fish species of *Barbus paludinosus* (local name: *Matemba*) primarily being impacted followed by the endemic *Oreochromis Shiranus chilwae* (local name: *Chambo*). There were no discussions on fish scarcity of *Clarius gariepinus* (local name: *Mlamba*). One participant noted:

"Lake Chilwa nowadays is no longer able to give us a considerable large amount of fish, particularly matemba, when compared to the past. Because in the past, it was the case that fishermen could just throw away matemba because there was too many, but these days one cannot do that, only able to get very few amounts of matemba on the lake, so it is now a challenge, with the amount of fish we are able to get from the lake decreasing compared to the past" (Participant A2_F_P).

Several men and women participants attributed the longer term change in fish availability to drought which they have been experiencing for several years. One participant highlighted the effect of this recent drought on *matemba* species and outlined that the drought has led to seasonality to become a greater problem:

"In a year, it is especially June and July when fish is scarce, but, recently this has been a problem due to water levels coming down, the lake has been drying…….Matemba has become completely scarce now. At least mlamba and chambo can catch in little amounts….Started from 2009……In 2013 noticed matemba has become scarce completely" (Participant A2_F_P).

The dynamics of water level in light of the most recent flooding period in January and February 2015 was also discussed in connection with the drought and fish availability. One participant felt positive about fish availability in the future due to a rise in lake levels from flooding in January and February 2015 and associated increased in fish:

"In the future the amount of fish will be increasing, also especially chambo and matemba will start multiplying in large numbers again, because, now water levels are rising again." (Participant A2_F_P).

However, one participant stated that concern on fish availability and drought remained and outlined that the most recent rainfall event was not sufficient. A deeper perspective on the effect of fish availability on fisherfolk's livelihoods was outlined by some participants. One female fisher outlined the immediate effect of wind induced low fish availability on day to day household food:

"When it is windy, fishermen are not able to catch a lot of fish, now this becomes a problem even at household level, because people are not able to have relish for the day" *(Participant B7_F_F)*.

The effect of drought was also discussed by a few participants who highlighted that the drought caused a reduction in personal assets. A number of participants also provided some advice on how to cope with fish availability challenges by providing links between number and type of livelihood strategies and challenges. A few outlined the risks involved in the fishing industry of experiencing good and bad months, and re-iterated diversifying livelihoods:

"A word of advice to my colleagues, sometimes relying on Lake Chilwa for business is risky, as sometimes it becomes hard, sometimes you cannot find *matemba* or the fish species we were expecting, but they should think of having a variety of selling items for them to be safe*" (Participant A2_F_P).*

A small number of participants from Sauka Phimbi provided further suggestions as potential future coping strategies such as fish farms.

Economic Challenges – Equipment, Market and Financial

Many participants, men and women across both sites, described market and financial challenges which included lack of profits, fluctuations in prices, upfront money for maintenance and continuing business, difficulty in buying and selling fish, and lack of loans and credit unions. Many outlined the difficulty in taking pictures of these challenge and therefore resorted to expressing the challenges during discussions. Transport was also outlined to be a problem by one trader who discussed the problems of packaging of fish and damages. Fisherfolk most frequently discussed lack of profits as a constraint, where the challenge was expressed mostly by processors or small-scale fishers from Sauka Phimbi. Several participants linked lack of profits with challenges of fluctuations in prices of buying and selling fish where high fish supply creates low profits, or low fish supply creates losses. One participant described the challenge of low supply: *"When there is drought fish is scarce and it is expensive and in such cases we make losses when we sell it" (B8_F_P)*. Several participants also discussed the challenge of having upfront money for maintenance of equipment and running their business:

"Mlamba is only available during the cold months, now that we are changing to the hot season, mostly It happens we don't have enough money for buying the fish traps to start catching chambo, now we start borrowing money from the traders so we use the money for preparing the fish traps" (Participant B2_M_F).

A few male and female participants from Likapa also mentioned the challenge of having no financial loan institutions to enable them to grow their businesses:

"In the past 12 years, water levels in the lake have been dropping down, so village lending institutions have stopped coming, but before these years, there were a number of lending institutions which gave money to people in the fishery business sector. Right now we are failing to grow our business, be able to make it grow, as no lending institutions for money" (Participant A2_F_P).

Challenges associated with equipment in relation to access, servicing and price was discussed by fisherfolk, with several from Sauka Phimbi where the remote site often led fisherfolk to discuss their challenges in acquiring equipment. One participant noted the reliance on traders in bringing in equipment from further afield: *"Hooks and rod have to be replaced every year…. I appreciate very much what the traders do for me….the buying of materials" (Participant B2_M_F)*.

Social-related Challenges – Fisheries Governance

Governance issues was also expressed by a few participants, both men and women from both sites. Participants discussed disagreement with the co-management rules of closed seasons, compliance issues and how the closed season effected their livelihoods. Participants from both sites stated tension with fisheries managers, however Sauka Phimbi participants outlined distrust and the impact of the closed season on livelihoods. One participant stated:

"There is no agreement, no oneness between the two groups, BVC and fishermen………Both the BVC and the fishermen are both from within the very same village…..the BVC members instead of simply advising the fishermen never to use the nkhoka net during the closed season, they instead hide and wait for them to go and do their fishing then arrest them and ask them to pay the fine, which they do merely just to get the money which the fishermen pay as a fine, to get the money for themselves" (Participant B1_M_F).

Another participant explained the impact of fisheries regulations on their fisher livelihood:

"When the lake is closed we use all the money and when it is being opened we have no money so we struggle…….I do not feel good about the fisheries department closing the lake because during the time the lake is closed, I am not able to run this business anymore, though at the same time I know it is also good for me because at that time the fish will breed and grow and I will be able to run the business" (Participant B6_F_P).

Governance rules in addition to closed fishing seasons also includes a ban on certain fishing equipment. One participant outlined the challenge of high equipment prices combined with the fishing regulations where it was financially difficult to comply with the rules:

"Sometimes what happens is that when I am repairing the fishing net, I do not have enough pieces for repairing the fishing net, so I am forced to use a piece of a gauze wire, and use it where the net is torn. Then when the fishing net is taken to the lake for fishing, the BVC take that part away…they tear it off from the net as it is not the right material to use…I do that out of being desperate, because it happens at times I do not have any money, so I use the gauze wire hoping that when I have money I can purchase the right material." (Participant B7_F_F).

Priority Photos on Challenges Experienced in Fish-related Livelihood Activities

The importance of fish availability as a challenge was noted by the majority of male and female participants who selected fish scarcity as the top priority challenge. One participant noted:

"Even though the water levels are low and the BVC and fishermen don't agree, if we were able to catch still a lot of fish we would not be worried, so I will choose this picture because it represents

a major challenge to us, because what matters to us is being able to catch a lot of fish but we are not able to because they are becoming scarce" (Participant B1_M_F).

A) 

B) 

C) 

D) 

E) 

F) 

Figure 7-3 Pictures portraying environmental and social challenges in Lake Chilwa's fisheries taken by photovoice participants. Moving clockwise from top left corner - A) Scarcity of fish with small amounts of chambo and mlamba, and no matemba species, as a result of water levels declining; B) Wind on the lake in June 2015 effecting fish catches; C) Low lake levels showing fishermen in waist high level of lake water in July 2015 effecting fish catches; D) Governance disagreement and a divide between fisheries managers (in red attire) and fishermen; E) Equipment challenges of availability and renting; and, F) Transport issues of overcrowding of packages of fish that causes damages and fish losses at market.

7.4 Discussion

This paper presented the results of a participatory photovoice study conducted in fishing villages on the shores of Lake Chilwa, Malawi. The aim of the study was to explore the perceptions of both male and female fisherfolk on their roles in the fishery, the relative benefits obtained, and challenges experienced in order to understand the complex pathways by which fisher livelihoods contribute to food security. This section discusses the results in relation to the study objectives and provides a concluding section on the main findings and prospects of the photovoice method for future research in fisheries and conservation.

First, photovoice was a useful tool for documenting the pathways through which fisher livelihoods contribute to food security. Diverse benefits were derived from fisher activities with the major benefits perceived by all fisherfolk participants being meeting their household food and income needs. This finding supports a wealth of evidence highlighting the benefits of fish-related activities for income and food security in rural communities (HLPE, 2014; Béné et al, 2016). Fisherfolk also stated that their benefits derived from fisher activities enabled them to acquire assets; such as constructing their own house, and diversify their livelihoods through starting other businesses; such as livestock rearing. Acquiring assets can increase a fisher's wealth and alleviate fishers from poverty, which many participants stated. Several fisherfolk had high levels of material asset wealth, characterised by owning several assets such as a house and land, which reaffirms the findings of recent studies disputing past assumptions that fishers are the poorest of the poor and that fishing is an employment of last resort (Pollnac et al, 2001; Béné et al, 2003). The benefit of diversifying livelihoods can improve a fisher's adaptive capacity to cope with seasonality and shocks such as drought, which numerous participants stated was important around Lake Chilwa. This finding reaffirms a study by Allison and Mvula (2002) which showed that fishers around Lake Chilwa had mixed livelihood strategies. However, the study does reveal that not all fisherfolk portrayed the same level of asset wealth and level of diversification from their fish-related activities. Wider studies have found scale, gender and location to be important factors determining benefits from the sector and how they are utilised, and therefore further research would shed light into differences between fishery users (Dey et al, 2005; Geheb et al, 2007; Darling, 2014; Kleiber et al, 2017). Although both male and females portrayed similar benefits from their activities, differences emerged between men and women on specific attributes showing social complexity. Male fisherfolk tended to focus more on diversifying livelihoods and obtaining education as benefits from their activities; representing the importance of indirect pathways to securing food via income and increasing adaptive capacity. However, livelihood diversification also included livestock, which can contribute directly to food security by providing a food source. Women fisherfolk on the other hand utilised their benefits for family needs, clothes and household goods, and particularly emphasised the role of fish-related income in enabling them to meet household food security needs. The finding reaffirms the evidence by Geheb et al (2007) on women playing a dominant role in taking care of household needs and the value of inland fisheries in providing employment to women. However, the study was limited in exploring gendered priorities in detail, and a gender analyses investigating power relations and norms would provide a more in-depth understanding.

Second, the photovoice process provided a new insight into challenges experienced by fisherfolk and revealed richer, more unexpected information. There were few differences in perceptions of challenges between men and women fisherfolk, with environmental, social and economic challenges being expressed. Evidence on Lake Chilwa extensively displays the fishery as unstable and highly fluctuating as a result of lake level change inter-annually due to drought (Jul-Larsen et al, 2003; Njaya et al, 2011). The photovoice process revealed similar findings where climate affecting fish availability, particularly *matemba* and *chambo* species, was highlighted as a challenge by a number of participants. Photovoice could therefore, potentially, be used as a method for triangulation with other qualitative and quantitative approaches. In addition, photovoice can also be used for biological assessments through capturing local ecological knowledge on species change. Interestingly, not all participants highlighted the challenge of drought; change in wind direction was also discussed causing seasonality. This is an important finding as other studies have shown difficulty in using secondary catch data to understand seasonality trends in fish availability (Jul-Larsen et al, 2003). In addition, evidence on seasonality of livelihoods around Lake Chilwa have not assessed the relative importance of wind (Allison and Mvula, 2002). These findings are particularly interesting when participants provided in-depth discussions in their coping strategies and diversity of livelihoods from benefits. Although drought was less frequently discussed, drought related stress has more of an impact in reducing one's assets and livelihood platform. Some participants mentioned that they struggle during the windy months to provide for their family needs. A few participants however explained that the effects of seasonality on fish availability and on their livelihood have become worse due to the fact that drought in recent years since 2012 has further reduced fish production and decreased their assets. The economic challenges of market and financial issues were also highlighted with similarities between men and women fisherfolk. These issues re-affirmed what we know about the importance of location on influencing access to credit facilities, markets, equipment and stability of prices (Darling, 2014; Béné et al, 2016). Differences between location, rather than gender, on perceptions of social challenges such as governance was also highlighted, where the more remote study Sauka Phimbi revealed the negative effect of co-management on their livelihoods, compared with the accessible study Likapa reflecting on issues on compliance. This is an important finding as the effect of seasonality, shocks, and governance inter-twined can impact on livelihood and food security, and together have rarely been evaluated (Béné et al, 2016).

Thirdly, aside from material benefits, fisherfolk also revealed rich information on subjective well-being such as individual pride, self-actualisation, identity, independence, job satisfaction and self-reliance. Several male and female participants expressed pride in their roles and benefits obtained, appreciation of the supply chain and strong identity linked with hard working, business focused and risk-taking characteristics. Female fishers however expressed more in-depth self-actualisation, independence, self-reliance and empowerment, where females were proud that they were able to do male dominated roles. These revealed that the majority of fisherfolk, perceived their fisher activities as not merely a livelihood activity, but a career and way of life that enabled them to improve their standard of living. This reaffirms findings by Weeratunge et al (2014), and adds a deeper understanding on the perceptions and role of women in the sector. This perception however was not shared by the most vulnerable fishers such as the small-scale fishers in the remote Sauka Phimbi.

Finally, in review of photovoice as a method, several participants at the end of the interviews spoke of how beneficial the process was in discussing topics through their own photographs where they felt that the research was in their hands. A number of participants also expressed that the process was very positive in enabling them to reflect on their achievements and values. One participant noted:

"*Just by looking at this picture one cannot make out what is happening there, you have been able to know what is happening there because I have explained it to you, just like a symbolic representation of my ideas*" *(Participant B1_M_F).*

The requirement of the photovoice process for participants to take time and contemplate, plan and reflect on the photography assignment task for one week, led to the formation of rich, varied, and in-depth information on their daily activities and challenges. It can be argued that other traditional methods such as focus group discussions and interviews, would not as readily provide reflection and in-depth information on aspects of daily livelihoods (Kong et al, 2015). The method however does have limitations; the method captures perceptions at one point in time that can omit important issues that are not occurring in the timeframe of the analysis, and it can lead to omission of wider community issues (Bennett and Deardon, 2013; Simmance et al, 2016). In addition, the sampling approach produces data that is illustrative and not representative of the larger population. This provides a depth and richness, but is not necessarily transferable. Some challenges also arose with the quality of photographs and the time required. One participant in the photovoice process explained challenges of time commitments due to unexpected household events and the study adapted to the needs of participant via forming a narrative on some themes without the use of pictures. The study was also limited in the extent of time spent with communities, and as a powerful tool for empowerment and policy development, further research and development initiatives should establish a longer term relationship with communities to catalyse the power of the method and to share development outcomes with communities. By capturing rich information on the views and realities of fishers, and the complexity of context specific factors, it provides a tangible window into the perceptions of fisherfolk and the benefits and challenges of inland capture fisheries.

7.5 Conclusion

In conclusion, the study suggests that photovoice can reveal more detail and depth of understanding than other qualitative data methods, although its limitations cannot be ignored. The method provided rich qualitative, contextualised and varied information on the benefits and challenges of the sector. The study revealed how important it is to understand the type and amount of benefits obtained, how benefits are used, and the relative challenges experienced by fisherfolk.

Fisherfolk provided rich and deep insights into the link between fish activities and food security. Many fisherfolk stated that through their fish-related activities they were able to acquire assets; such as a house, diversify their livelihoods, and meet their household's food, income and clothes needs. Through evaluation of the benefits that fisherfolk derived from their activities, the study found that fisher livelihoods contributed to food security via three pathways: 1. directly via meeting household's food needs; 2. indirectly via meeting household income needs; and, 3. indirectly via improving resilience (increased asset wealth and livelihood diversification). In addition, the study highlighted the relative importance of seasonality of fish availability and drought, which were the biggest challenges experienced by fisherfolk. The study highlights the value of a case study and qualitative approach in providing a deeper understanding of the complexities of socio-ecological systems and food security, and the local impacts of climate change as argued by Béné et al (2016). More research is needed on fisheries and pathways to food security that incorporate both men and women, scale, location and adaptive capacity into assessments, particularly for contexts experiencing climate change such as Lake Chilwa. This is particularly needed for inland capture fisheries that are one the most under-valued fisheries sector where the contribution to food security is not fully understood, and the impacts of protected areas and climate change not fully known.

Chapter 8 Discussions and Conclusion

8.1 Discussion

Inland capture fisheries represent a small share of global fish supply; however, for many developing and low-income-food-deficit (LIFD) countries they provide an important source of fish and income to millions of people (Béné et al, 2016). This is particularly evident in many countries in Africa, especially in East Africa, where aquaculture has not yet been fully developed and inland capture fisheries are the main supply of fish (FAO, 2014). In these regions with large rural populations, inland capture fisheries can provide a critical nutrient-dense food source and income, and act as a safety net during climate induced agricultural lean periods. However, due to the nature of the fishery, challenges exist in monitoring and the social and economic value of the sector has largely been invisible. The links between the sector and food security remain poorly documented, particularly in regions highly dependent on natural resources and experiencing climate variability such as in Africa. In addition, limited information exists on the local level impacts of climate change on the sector and dependent livelihoods, which affects the contribution to food security.

The small-scale inland capture fisheries sector is one of the most under-reported and under-valued fisheries sectors and is in one of the most threatened environments globally (Bartley et al, 2015). Few studies have explored the vulnerability context and livelihoods of inland fisheries in depth; going beyond fish availability and fish-related income, and investigating the complex socio-economic and ecological factors that influence food security at the local scale (Darling, 2014; Fiorella et al, 2014). Inland fisheries are typically in regions experiencing climate change and food insecurity, and therefore it is critical to understand the hidden value of the sector for effective management and policy development. Greater recognition for the value of inland capture fisheries and the impacts of climate variability on the sector has been called for to improve management of the sector at the national and local decision-making levels and to identify its contribution to sustainable development (Béné and Neiland, 2003; Bartley et al, 2015; Lynch et al, 2016).

This thesis addresses these gaps and provides timely evidence on the temporal dynamics, characteristics and socio-economic value of an inland small-scale capture fishery. The overarching aim of this thesis was to investigate the contribution of small-scale inland capture fisheries to food security, using the case study of Lake Chilwa, Malawi. This was addressed in **Chapters 4 to 7** investigating the following research questions:

1) What effect do water dynamics have on fish supply?
2) What is the relationship between fishing livelihoods and food security?
3) How do fisherfolk experience seasonality, shocks and fisheries governance, and perception the impacts of these on their livelihoods?
4) How do fisherfolk perceive the benefits and challenges of fisheries in their livelihoods?

The sector presents methodological challenges in working in data-limited environments and rural settings. By adopting a case study and mixed methods approach, combining analysis of remotely sensed lake-level rise with local ecological knowledge obtained through surveys, focus groups, interviews and photovoice, the thesis provides comprehensive evidence that illuminates the hidden value of the sector and its role in local food security. This thesis utilised the sustainable livelihoods framework as an analytical guide to navigate through the complexity surrounding small-scale capture fisheries, livelihoods and the pathways to achieving food security.

To answer the overarching aim of this thesis, this chapter reflects on previously presented chapters (especially results **Chapters 4 to 7**) and discusses key findings in relation to the overall role of small-scale capture fisheries in food security. Following this discussion, I reflect on the limitations of the research, the policy implications of the results and recommend areas for further research, before providing concluding remarks concerning the key messages from this thesis.

8.1.1 Impacts of Climate Variability on Lake Chilwa's Fishery

The causes of food insecurity are driven by a number of social, economic and environmental factors, including poverty and environmental stressors (HLPE, 2014; FAO, 2014). Natural climate variability as well as extreme weather shocks such as drought and floods affect global food systems with implications for the sustainable supply of food (Connolly-Boutin and Smit, 2015). Limited information exists on the effects on climate variability on inland fisheries, and the availability and stability of fish supply, which underpins fishing livelihoods and the contributions to food security. A cross-cutting theme that was explored within **Chapters 4 to 7** was the dynamics of Lake Chilwa's inland capture fishery and fish availability, captured through the perspectives of local fisherfolk engaged in the sector as well as the analysis of secondary biophysical and fisheries catch data. Overall, findings revealed rich new insights into the complexities of inland capture fisheries systems, factors affecting fish catches and patterns of availability.

Chapter 4 explored the effects of water dynamics on fish supply and presented new information at the local level regarding the effects of climate on inland fisheries and the availability of fish. The chapter revealed the fluctuating nature of Lake Chilwa's fishery over 30 years. Despite the lack of time series data, the findings revealed that there is a relationship between water dynamics and fish catches where above and below average rainfall and lake level affected catches for up to three years. Extreme drying of the lake with below average rainfall and lake level for 2-3 years caused the most significant changes to fish catches. The findings support increasing reports in the literature revealing fish production in African inland fisheries, especially in dryland areas, to be significantly impacted by annual rainfall patterns (Jul-Larsen et al, 2003; Kolding and Zwieten, 2012; Gownaris et al, 2018; Kolding et al, 2016). By combining satellite derived data together with traditional methods, the thesis provides a timely update to the knowledge base regarding the effects of water fluctuations over the recent decade and its impact on fisheries at a local scale within a data limited environment. Moreover, **Chapter 4** unravelled the resilience and ecological production of inland fisheries by species and showed that the fish species Mlamba (*Clarius gariepinus*); the most common and affordable species in the lake, is the most resilient fish species to climatic variations affecting lake level. This finding contributes to evidence that reveal pulsed systems to be highly productive and resilient ecosystems (Kolding and Zwieten, 2012). Although the study had limitations in its inferences due to data quality and strength of analyses, the findings provide a new exploratory assessment of Lake Chilwa's fishery and a timely update over the past decade using best available data and innovative technology (Zwieten and Njaya, 2003; Kolding et al, 2012). Many LIFD countries and inland fisheries are likely to experience climate variability and thus findings provide a valuable insight into the effects on fish availability and contribute to the call for more local level assessments on climate change impacts and trends in inland fisheries (Taylor et al, 2016; Béné et al, 2016).

Local ecological knowledge can provide an untapped wealth of information on the status of a fishery and changes in availability of fish, particularly in data limited environments (Moreno-Báez et al, 2010; Cinti et al, 2010; Daw et al, 2011b). **Chapter 6 and Chapter 7** provided rich qualitative information on the perceptions of different fishery users along the value chain. **Chapter 6** investigated how fisherfolk experience seasonality and shocks, and revealed their perceptions of change. Fisherfolk held immense local knowledge on fish availability, seasonality and changes over time, which contribute to understanding how resource users observe and experience change. Climate shocks of floods and drought were identified as the main impacts on fish availability. For example, good fishing years were described by participants as being when lake levels were high, with increased catches expected in the years after a flood, and bad years when lake levels were low. Fisherfolk perceived fish catches to have decreased over 10 years due to drought, with Mlamba being the most resilient fish species. In addition, fisherfolk provided a rich insight into the seasonality of fish availability and outlined when fish species varied according to high and low months which varied by fish species. Furthermore, fisherfolk along the value chain shared similar perceptions of change and identified wider factors affecting the fishery, which included: illegal fishing, increased effort, changes in wind patterns, and habitat change. Further insights into fish availability were obtained from **Chapter 7**, which explored the challenges experienced by fisherfolk. Through the lens of photography, men and women fisherfolk involved in fishing, processing and trade, depicted low lake levels and drought as the greatest impact causing variability in fish availability, as well as seasonal winds.

The qualitative findings from **Chapter 6 and 7** support the quantitative evidence in **Chapter 4** on the high variability of fish availability driven by climate, which together assisted in validating evidence in data limited environments, and strengthening the weaknesses of data and analyses limitations in **Chapter 4**. The thesis contributes to the call for local level assessments on the status of inland fisheries and provides evidence for the value of data triangulation and use of local ecological knowledge in data limited environments (Simelton et al, 2013; Béné et al, 2016). The findings support wider studies such as Daw et al (2011b, pg. 75) which highlight “the importance of multiple information sources to understand dynamics of fisheries”. The findings help in understanding factors driving inland small-scale fisheries and the stability and availability of fish supply, building on wider evidence on the fluctuating nature of inland fisheries. This has important implications for fisheries and water governance, such as managing water resources and flows for multiple uses (fisheries, agriculture etc), as well as understanding the value of fish for livelihoods and food and nutrition security. By recognising the value of the sector and its availability, development initiatives can target strengthening the sector such as through technologies that reduce post-harvest losses.

8.1.2 Livelihood Platform and Food Security Outcomes in Fishing Communities around Lake Chilwa

This thesis provides the first in-depth insight into the livelihoods and food security of small-scale inland fishing communities in the context of vulnerability and considering the inclusion of fisherfolk along the value chain. Livelihoods underpin food security and its pillars of availability, access, utilisation and stability of food supply. The thesis adopted a livelihood approach to understand the building blocks of livelihoods (capital assets), livelihood strategies, vulnerability context and capabilities through which livelihood outcomes and food security are achieved (ACF, 2010; Connolly-Boutin and Smit, 2016). Qualitative and quantitative evidence presented in **Chapters 5, 6 and 7** provided an understanding of the characteristics of fish-related activities, benefits obtained and challenges experienced, and together demonstrated the contributions of small-scale inland capture fisheries to food security.

Livelihoods

Analyses of the livelihoods of fishing and non-fishing households in **Chapter 5** presented new information on the livelihood landscape, platform and vulnerability of households. Engagement in the fishery sector was associated with a higher livelihood platform, reduced vulnerability and positive livelihood outcomes of food security. Fishing and non-fishing households adopted diverse livelihood strategies, which included agriculture, wage labour, and small businesses which is typical in rural communities (Béné et al, 2016). Fish-related activities were the most important income source for fishing households, particularly for processors and traders who had a higher dependence on inland fisheries. The livelihood platform was greater in fishing households who had higher levels of human, physical and financial capital. Fishing households had younger headed households with larger families and a higher proportion were married. In addition, they had higher asset wealth, such as electricity, expenditure and savings showing greater long-term and short-term wealth and financial security. Research presented in **Chapters 6 and 7** also demonstrated that fisherfolk predominantly viewed fish-related activities as profitable and providing a high-income source that enabled them to acquire assets; such as a house and a bicycle, and increase their wealth. The findings support wider evidence of the high income earning potential of inland fisheries in rural communities compared to other natural resource-based livelihood strategies, and contributes to the narrative that fishers are not just the poorest of the poor (Heck et al, 2007; Béné et al, 2016).

Livelihood Shocks

External vulnerability factors: such as climate shocks, trends and seasonality can directly affect people's livelihood platform of capital assets, portfolio of livelihood activities adopted, and the transformation of these into positive livelihood outcomes, such as improved food security (DfID, 1999). **Chapter 5** identified that fishing and non-fishing households experienced similar shocks predominantly relating to climate (floods and drought), as well as high food prices and illness. The shocks caused negative impacts on income, assets, food production and food stocks in both fishing and non-fishing households. The findings corroborate evidence in **Chapters 6 and 7**, which portrayed fisherfolks' perceptions of challenges and found that fisherfolk perceived climate related shocks of floods and drought to be most important affecting the fishery and livelihoods.

The study also revealed differences in shocks experienced by location, with flooding and high prices ranked most severe in the village of Likapa next to a main road, whereas drought, crop disease and death of a family member were most important in the more remote village of Sauka Phimbi. The findings demonstrate that villages even within the same district can experience shocks differently and highlights the importance of understanding local context when investigating livelihoods and vulnerability.

Livelihood Outcomes of Food Security

Research presented in **Chapter 5** revealed that engagement in the fisheries sector was positively associated with household food security. Overall, food security - as measured by universal measurements of food consumption and diet diversity, nutrition, food insecurity coping strategies, and perceived food security over 12 months - was greater in fishing households compared with non-fishing households. Evidence from **Chapters 6 and 7** on the perceptions of fisherfolk and benefits of the sector also corroborate the findings and shed new light on the pathways between fishing livelihoods and food security.

Perceptions of Food Insecurity

Perceptions of food security outlined in **Chapter 5** revealed that fishing and non-fishing households experienced food insecurity over both the short and long term: during the one-week food consumption survey period in July and August 2015, and over the 12 months prior to the survey. Food insecurity was reported to be caused by shocks experienced, predominantly climate-related flooding and drought, which also caused high food prices and reduced earnings. Over the previous 12 months, households mainly worried that they did not have enough food for the household from October to April, coinciding with the wet season. A study in Mozambique found similar evidence in rural communities where food shortage months coincided with the rainy season and increased risk of flooding (Villasante et al, 2015). Peak food insecure months were revealed to be January and February that coincide with the typical agricultural growing and closed fishing seasons. Non-fishing households experienced food insecurity for more months of the year, with over one third of households reporting food insecurity from September to July, compared with fishing households from December to March.

Food Consumption and Nutrition

Chapter 5 presented analyses of household food consumption levels based on the universal Food Consumption Score (FCS) Index that measures diet diversity, consumption frequency and nutrient quality over a 7-day recall period (WFP, 2008). The analyses revealed that fishing households had higher food consumption levels with more diverse and nutritious diets compared with non-fishing households where one quarter were classified as having poor or borderline food consumption levels. Diets included staples such as maize and rice, pulses, vegetables, fruit, meat, fish and milk. The findings support Darling (2014) who found that wealthier and fishing households had higher food consumption and diet diversity compared with non-fishing households in a marine small-scale fishery in Kenya. Evaluation of the nutritional quality of diets using the World Food Programme's Food Consumption Score Nutrition Quality (FCS-N) index demonstrated that fishing households consumed more foods rich in protein, iron and vitamin A which are essential for functioning of the immune system, growth and development (WFP, 2015).

Fish consumption levels also differed between households. Fish is increasingly being recognised in the global debate on food security (HLPE, 2014). Compared with other food sources, fish has been found to be a particularly rich source of micronutrients (vitamins D, A, and B), minerals (calcium, phosphorus, iodine, zinc, iron, and selenium), unique fatty acids and protein, that is 5-15% more bioavailable that plant-based protein sources (HLPE, 2014; Roos, 2016). However, as outlined in **Chapter 2**, the level of fish consumption and its nutritional value is often under-estimated, particularly in regions within Africa, and therefore the links between inland fisheries and nutrition are poorly documented. **Chapter 5** identified that fishing households had higher consumption of fish, and that inland fish added diversity and nutritional quality (protein, iron and vitamin A) to diets, such that fishing households had better nutrition. By analysing the nutritional quality of diets between fishing and non-fishing households, the thesis provides new knowledge on the role of inland fish and small-scale fishing livelihoods to food and nutrition, and provides one of the first case studies to show its value in an inland small-scale fishery in Africa. The findings also build on the growing evidence of the importance of inland fish to protein intake and micronutrients, and its role as a nutrient-dense food source in rural communities (Kawarazuka and Béné, 2011; HLPE, 2014). The contribution of inland fish to animal protein intake have been found to exceed 50% in some communities in West Africa, and act as a critical source of vitamin A to communities in Bangladesh and Cambodia (Kawarazuka 2010; FAO, 2016; HLPE, 2014; Roos, 2016). One study in the Mekong River, also found inland fish to be an efficient and environmentally conserving source of nutrition where replacement with terrestrial sources would have a larger environmental footprint (Lymer et al, 2016).

As outlined in **Chapter 5**, nationally aggregated statistics often under-estimate inland fish supply and consumption, particularly its importance to a sub-set of the population (Verduzco-Gallo, 2014; Lymer et al, 2014; Funge-Smith, 2018). This research sheds new light on the role of inland fisheries to food and nutrition security in Malawi where the sector has largely been under-valued and fish consumption under-reported (Verduzco-Gallo, 2014). Inland fisheries are typically in developing and Low-Income-Food-Deficit countries, such as Malawi, and thus can play a role in tacking micronutrient deficiencies and food insecurity, particularly in rural communities (Kawarazuka and Béné, 2011; HLPE, 2014).

Fishing livelihoods also enabled greater access to fish as a direct food source with on average one third of fish kept for home consumption, whereas non-fishing households reported challenges in accessing fish due to high prices. The findings corroborate with other studies showing fishing households consume more fish (Darling, 2014). However findings also contradict with a recent study in Lake Victoria which found that fisherfolk predominantly used fish as a cash crop (Fiorella et al, 2014). Some other studies also argue that fish is an affordable nutrient dense food source for the poor (Kawarazuka and Béné, 2011). Findings from this study however contributes new knowledge on the accessibility of fish; revealing that non-fishing households who had lower capital assets compared with fishing-households, consumed fish but also had challenges in accessing fish as a food source due to price. Differences in fish species consumed was also identified; fishing households consumed local fish species whereas non-fishing households consumed fish traded from Lake Malawi which may have been because of price. The results contribute new knowledge to the narratives on the utilisation and access to fish in rural communities, and on the 'hidden' supply and trade of fish in remote settings (Welcomme and Lymer, 2012). Cultural preferences and beliefs also influenced the consumption of fish. Research reported in **Chapter 6** on fish consumption preferences demonstrated that religion and beliefs prevented consumption of the most available fish species, Mlamba, because it has no scales and was associated with poor health. The socio-cultural factors that shape how fish is utilised as a resource is important in understanding the links between inland fisheries and food and nutrition security.

Qualitative evidence presented in **Chapters 6 and 7** reveal how fisherfolk utilise their fish-related benefits, and sheds light on the linkages between fishing livelihoods and food security. Evidence suggests that not all fisherfolk make the best use of the benefits derived from their activities and direct it towards meeting household food security needs (Geheb et al, 2008; Fiorella et al, 2014). For example, in Lake Victoria, a study found that men directed their fish-related income towards leisure and alcohol, whereas women prioritised household food needs. Analyses of fisherfolk's perceptions of the benefits of the sector in **Chapter 6** revealed that the majority of fisherfolk perceived the sector to improve their livelihood and food security. **Chapter 7** revealed that fisherfolk strongly valued their fish-related activities in providing a high income source, and utilised their fish-related income to buy food and meet their household's food security needs. For example, a female processor stated; "It is a fish that can help you earn enough money and be able to get your household needs" (Participant B8_F_P), and a female gear owner stated; "Without fishing I would not have been able to buy clothes for my family and food to support them" (Participant A1_F_F).

Food Insecurity Coping Strategies and Vulnerability

Households experienced food insecurity because of livelihood shocks predominantly relating to climate: floods and drought. Analyses of universal food insecurity coping strategies presented in **Chapter 5**, revealed that in the short-term households adopted strategies such as reducing the number of meals in a day and limiting portion sizes to cope with food insecurity. Over the longer term: 12 months prior to the survey, households adopted strategies such as consuming seed stock, purchasing food on credit and intensifying livelihood activities. **Chapter 5** however identified that non-fishing households had higher food insecurity and vulnerability; resorting to more extreme coping strategies such as going without food for whole days, and experiencing food insecurity for more months of the year.

The ability to cope with livelihood shocks and food insecurity is based upon the livelihood platform: capital assets, livelihood strategies and vulnerability context. As outlined in **Chapter 5**, fishing households had higher capital assets; particularly physical and financial capital, and livelihood diversification compared with non-fishing households which increases the ability of households to adapt and cope with shocks in the short and long term. Rich qualitative information from **Chapter 7** provided further evidence and revealed the linkages and pathways between fish-related livelihoods and reduced vulnerability; addressing the limitations of making causal inferences from observed associations in **Chapter 5**. Perceptions of fisherfolk portrayed the benefits and challenges in the sector, and demonstrated how fisherfolk utilised income. Fisherfolk outlined that in order to cope with shocks and sustain their household's needs, they invested their fish-related income in assets: such as a house and bicycle, and in livelihood diversification: such as livestock and businesses (i.e. salon or selling samosas), that increased their wealth and provided a source of income and food during periods of low fish availability. Studies have found fisheries to act as a safety net during climate induced agricultural lean periods (Béné et al, 2016). The findings in **Chapter 4 and 6** contribute a new perspective to the narrative and demonstrates that fish-related livelihoods are also vulnerable to climate shocks; however, they can act as a temporary safety net during climate shocks e.g. at the onset of deficient rainfall and drought, and after flooding.

Other Factors Affecting Food Security

The study also found that food security was associated with location and asset wealth, and weakly associated with gender (**Chapter 5**). Households within the study location with better access to infrastructure and markets were found to be more food insecure which may have been a result of differences in shocks experienced, type of agriculture activities, and how they acquired food (own production or purchases). The findings have implications for priorities in development initiatives and highlights the need to consider local contextual factors more in-depth when investigating the role of inland SSF to food security. These findings support wider studies highlighting the importance of wealth and local contexts in determining food security (Kawarazuka and Béné, 2010; Kleiber et al, 2017; Fiorella et al, 2014; Darling, 2014). Gender had a weak influence on food security with male-headed households having higher material asset wealth and food consumption levels than female-headed households, and also more likely to be married. This finding is comparable with the wealth of evidence showing single and female-headed households have less material ownership and economic productivity, and are more vulnerable to poverty and food insecurity (Sraboni et al, 2014; Kawarazuka et al, 2017; Abdullah et al, 2017; Flato et al, 2017). However, female-headed households who engaged in fishing were more food secure, revealing the benefits of the sector to women. Qualitative evidence in **Chapter 7** on the perceptions of the benefits of the sector revealed that female fisherfolk particularly emphasised the value of fish-related income to household food security. For example, a female fisher stated; "Without fishing I would not have been able to buy clothes for my family and food to support them" (Participant A1_F_F).

The thesis also provided new insights into the vulnerability amongst fishery users along the value chain. **Chapter 6** revealed that fishers, processors and local traders had similar local ecological knowledge on the dynamics of the fishery and fish availability. **Chapter 5** also revealed similar livelihood platforms, capital assets, perceptions of shocks experienced and food security between fishery users. However, findings in both **Chapter 5 and 6** revealed that fishers (crewmembers) held less positive views on the profitability of the sector, had less dependence on the sector, lower expenditure levels and slight lower food security levels compared with those engaged in processing and trading. This contributes to the growing literature on the distribution of benefits within fisheries sectors where those involved in the secondary sector often have higher income (Heck et al, 2007; Daw et al, 2011a; Béné et al, 2016). **Chapter 6 and 7** also revealed that governance of fisheries shaped access to the fishery and affected the benefits obtained. Fisherfolk, particularly fishers (crewmembers) held negative views on Lake Chilwa's closed season from December to February which was considered to affect livelihoods. **Chapter 5** identified that the closed season coincided with the peak food insecure months and fishing households resorted to fishing during the closed season to cope with food insecurity.

8.1.3 Overall Contribution of Small-scale Inland Capture Fisheries to Food Security in Lake Chilwa

This thesis has presented evidence that small-scale inland capture fisheries and fish-related livelihoods contribute to food security in rural communities around Lake Chilwa. Through a case study approach, this research reveals some of the specific pathways by which inland capture fisheries can contribute to food security, and the wide range of factors that mediate relationships. The findings support Kawarazuka (2010) in revealing the positive contribution of inland capture fisheries to food security through a myriad of complex pathways, and revealed linkages beyond direct consumption of fish and income to increase food purchasing power:

1. Fish as a nutrient dense food source contributing to food and nutrition intake via adding diversity and nutritional quality (protein, vitamin A and iron) to diets.
2. Sale of fish for cash, which can generate an income source all year round; increasing household's financial capital and economic access to food.
3. Reduced vulnerability; investment of fish-related income in livelihood diversification and assets that increase wealth and the ability of households to cope with shocks, and where fisheries can act as a temporary safety net during climate related shocks that impact agriculture more immediately.
4. Employment for women: where fisheries can provide a valuable income for women that can contribute to household income earnings, and which can reduce the vulnerability of female-headed households.

Food security was also influenced by location and gender of the head of household, highlighting the importance of local context and the socio-economic status of households in understanding food security.

Furthermore, this study adopted the Sustainable Livelihoods Framework as an analytical guide to understand the complexity of livelihoods with a focus on the livelihood outcome of food security. The SLF was useful in helping navigate the multidimensional concepts of livelihoods and food security as well as to identify variables for data collection and method design. The thesis focused on the livelihoods outcome of food security within the SLF, and investigated food security across its four pillars which framed the discussion of research findings. Several relational conceptual frameworks that visualise some elements of the relationships between fisheries, vulnerability and food security were further built upon to discuss and visualise research findings (Kawarazuka, 2010; HLPE, 2014; Connolly-Boutin and Smit, 2016). A conceptual representation of the different pathways between small-scale inland capture fisheries and food security based on the thesis findings in rural communities in Lake Chilwa is depicted in **Figure 8.1**. The conceptual diagram acts as a visual guide that illuminates more holistically some of the potential linkages between inland capture fisheries and food security in rural contexts. The diagram reveals the multiple factors that mediate the relationship between inland capture fisheries and food security, and is intended to help navigate and understand key contextual factors for further research. The diagram draws upon different elements of the SLF, including livelihood platforms comprised of capital assets and livelihood strategies, vulnerability and governance, and depicts pathways to food security across its four pillars. The relationships between elements can be two-directional, such as adequate food and nutritional security contributing back to the capital assets of the household, and feedbacks exist between many elements. The linkages represent income, fish as food, and reduced vulnerability pathways to food security which build upon Kawarazuka (2010), as well as acknowledges employment opportunities for women which can contribute to household income and reduce the vulnerability of female-headed households. Linkages are dependent upon how fisherfolk utilise fish and fish-related income which can be highly context specific (Fiorella et al, 2014). The conceptual diagram therefore enables a deeper consideration of the household unit (Kawarazuka, 2010). The diagram is intended to illuminate the holistic set of factors that influence the contribution of the sector to food security, however it is limited in revealing differences in the distribution of benefits between fish-related activities, challenges in the sector that affect the pathways (i.e. fish losses due to poor transport and processing), intra-household dynamics and linkages to issues at larger scales.

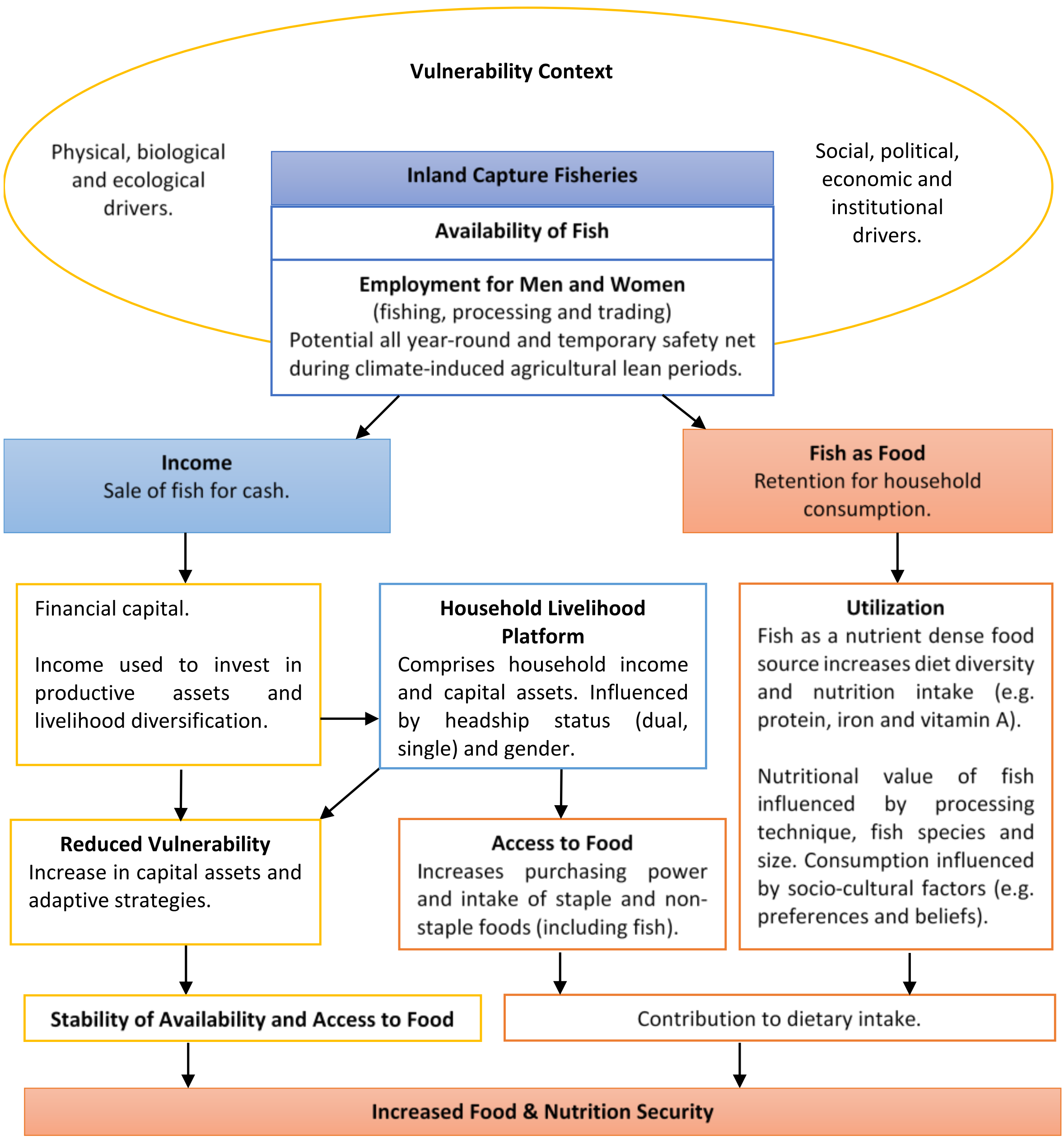

Figure 8-1 Conceptual representation of the different pathways between small-scale inland capture fisheries and food security based on the thesis findings. (Adapted from: Kawarazuka, 2010; HLPE, 2014; Connolly-Boutin and Smit, 2016). Note that many arrows may be two-directional and feedbacks exist. Colours represent different pathways: income depicted in blue, food depicted in orange, and vulnerability in yellow.

8.2 Policy and Future Management

The thesis findings have implications for approaches in climate adaptation, fisheries management and in understanding the availability of fish for food security in complex socio-ecological systems. Climate change will likely increase the unpredictability of floods and drought and effect fisheries, vulnerability and the contributions to food security. In light of uncertain impacts of climate change, effective water resource management will be required to maintain the function of inland fishery ecosystems. Based on the evidence in this study, approaches to increasing adaptation in rural communities may benefit from focusing on strengthening more immediately resilient sectors such as fisheries, enhancing fish-related livelihoods (e.g. through reduced post-harvest fish losses and enhancing income through better functioning markets), promoting livelihood diversification and supporting female-headed households into higher income earning sectors such as fisheries, and adopting an ecosystem-based approach. Further research is warranted in these areas taking a system and landscape approach to fully assess diversified livelihoods and vulnerability in different contexts, and sustainable development in climate change hotspots (Szabo et al, 2016).

Inland capture fisheries and their ecosystem services provide immense benefits for development needs, such as tackling poor access to nutritious food. However, the sector has been largely ignored in policy and global debates on food security. In comparison to marine fisheries, the sector has been paid little attention, being absent from the Sustainable Development Goals and receiving less focus in protected areas and management initiatives (Cooke et al, 2016; Juffe-bignoli et al, 2016). Sustainable management of inland capture fisheries and their freshwater environments are however inter-linked with the Sustainable Development Goals and the Aichi Biodiversity Targets. Some of the challenges that inland capture fisheries experience, such as competing demands for freshwater, can be managed through conservation goals in these global agreements, and sustainable management of inland capture fisheries can also make important inter-linked contributions.

Inland capture fisheries provide a diverse range of ecosystem service benefits that influence human well-being. The sector provides employment for men and women, income and a nutrient-dense food for tens of millions of people. Fish is often an accessible, low cost source of animal protein and essential micronutrients to remote rural communities. In addition, fish can provide livelihood opportunities in areas with few employment opportunities, as a primary or supplementary activity, that can provide income all year round, and act as a safety net such as during climate induced agricultural lean months. Thus, inland capture fisheries have the capacity to support achievement of the Sustainable Development Goals. **Table 8.1** illustrates the direct and indirect contributions of inland capture fisheries to selected SDGs, building on from Heck et al (2007) review of fisheries and the Millennium Development Goals. Inland capture fisheries can directly contribute to Goal 2 - End hunger, achieve food security and improved nutrition. Fish can provide a nutrient dense food source and form part of a diverse diet. Fish can also provide a source of income used for purchasing other food items and contributing to food security. The sector can also contribute to goals relating to poverty alleviation and gender equality, and through its sustainable management can contribute to wider SDGs such as Goal 6 and 15 relating to freshwater ecosystems. Progress and efforts made towards meeting these global agreements can thus not only benefit inland capture fisheries, but also the sector can help contribute towards their goals. An ecosystem assessment of inland capture fisheries and their freshwater environments can make visible the true value of these systems, better inform management on trade-offs and help sustain their ecosystem services to benefit human society and development goals. In addition, further research taking a landscape approach assessing vulnerability in climate change hotspots would provide a deeper understanding of the value and challenges of the sector, and it contributions to SDGs (Szabo et al, 2016)

Table 8-1 Contributions of inland capture fisheries to selected Sustainable Development Goals

Sustainable Development Goal	**Contribution of Inland Capture Fisheries**
Goal 1 – No Poverty	Inland capture fisheries provide income and employment to over 60 million people world-wide. Fish-related income can prevent and or reduce poverty. Fish-related livelihoods are particularly important in rural remote areas where there is a lack of alternative employment, and can act as a safety net during times of shocks, such as in agriculture, and for the landless poor.
Goal 2 – Zero Hunger	Contributes to dietary intake, food and nutritional security which decreases malnutrition and improves health and well-being: fish are an accessible, low cost and high nutrient source of food, and income from fish increases purchasing power for other food items. Women's participation in the sector can also strengthens the link between fish and food security. Fish-related livelihoods can also act as a safety net during times of shocks.
Goal 3 – Good Health and Well-being	Fish provdes a source of affordable proteins and micronutrients that through food and nutritional security improves the health of women during pregancy and child development. Fish nutrients help mitigate the impacts of disease among the poor and are essential for the effective use of drugs. Fish-related income enables fisherfolk to access services such as healthcare and nutrition.
Goal 4 – Quality Education	Indirect benefits through increased income for women and improved health of children.
Goal 5 – Gender Equality	Women strongly engaged primarily in the fishery secondary sector. Enables gains in income, independence and power.
Goal 6 – Clean Water and Sanitation	An ecosystem based approach to fisheries management can contribute towards sustaining freshwater ecosystem services. Inland fish also provide water quality regulating services.
Goal 10 – Reduced Inequalities	Through fish-related employment and income that can prevent and reduce poverty for men and women, and through effective governance of inland capture fisheries.
Goal 13 – Climate Action	Inland capture fisheries can provide a low carbon footprint food source and can also act as a safety net during times of climate induced shocks.
Goal 14 – Life Below Water (marine)	Inland capture fisheries contribute to global fish supply and demand.
Goal 15 – Life on Land	An ecosystem based approach to fisheries management can contribute to sustainable use of freshwater systems.

8.3 Reflections, Limitations and Further Research

Reflections on the Research Conceptual Framework

The research conceptual framework in the thesis had many strengths in helping to advance the understanding of livelihoods and food security. The SLF ordered the complexity of rural livelihoods and provided a useful guide for data collection. The SLF also enabled fish-related livelihoods to be investigated in the context of diverse livelihood strategies which are often not explored in depth in fisheries studies (Darling, 2014; Fiorella et al, 2014). The framework also aided defining boundaries of the thesis, such as focusing on the livelihood outcome of food security and not evaluating wellbeing, and assisted in understanding the multi-dimensions of poverty in fishing communities in terms of human, physical, and financial capital components. A deeper understanding of livelihoods was achieved by combining qualitative and quantitative methods, as highlighted by Macfadyen and Corcoran (2002). The pillars of food security were useful for investigating the multi-dimensions of food security and going beyond availability, to explore stability, and how the sector contributes to access to and utilisation of food which are the major imperatives of food security globally (HLPE, 2017).

However, the SLF and pillars of food security were complex, and limitations arose in trying to understand all components of livelihoods and food security. The thesis was bounded by investigating livelihoods and food security through an inland fisheries lens, and did not explore agricultural livelihoods and wider food sources. The SLF also had several limitations. Through its complexity, not all components were able to be investigated and the thesis was limited in exploring policies and institutions in depth (Scoones, 2009). The thesis also found that data collection on the capital assets was often complex and wide-ranging which led to some indicators being limited in-depth such as on illness and natural capital and types of agricultural systems. In addition, the framework was limited in exploring gender, intra-household relations, issues at wider scales and the role of markets. The latter emerged as a key area for future research in understanding locations and the level of functioning markets and the effects on food security. The thesis also found challenges with understanding the direction of processes and flows, and found that qualitative data was crucial for identifying linkages between the sector and livelihood outcomes. Thus, future research efforts should attempt to address these limitations, and understand wider market influences, community level factors, and livelihood development over time, with qualitative research playing a key role in understanding linkages between fisheries and food security. The new conceptual diagram aims to illuminate some of the foundational factors affecting local food security, which can be built upon and incorporate elements of value chain and food systems thinking.

Limitations

Researching an under-reported fisheries sector in data-limited and rural environments presented many methodological challenges that created limitations to the study. A case study approach enabled an in-depth understanding on local and complex contextual factors however the approach had limitations in generalizability. The findings can however be used to inform wider scale and future research and illuminate the hidden value of a highly under-reported sector. By including men and women fisherfolk in the study, the thesis makes an important first step in considering the separate roles of men and women in the value chain, and their perceptions on challenges and benefits, in a sector where data has tended to be aggregated. However, various factors including class, race and gender, as well as gendered relations and power dynamics within the household can influence livelihoods and food security, and a more detailed gender and intersectionality assessment was out of the scope of the thesis and requires more detailed future research. The thesis combined quantitative and qualitative methods which together provided a deeper insight into the socio-economic and vulnerability factors affecting livelihoods. Qualitative research in particular helped understand the direction of linkages between fish-related livelihoods and food security. However, the temporal dynamics of livelihoods and the history of livelihood development were not explored in great detail. The methods provided a snap shot in time into the livelihoods and food security status of fisherfolk, and did not explore the wet season when communities are often most vulnerable but when access is most challenging. In addition, the snap shot approach captured perceptions at one point in time which may have led to omission of wider community issues, such as during the photovoice component of the study (Bennett and Deardon, 2013; Simmance et al, 2016). However, survey design and photovoice in-depth discussions enabled opportunities for longer term livelihood and food security status to be discussed such as through perceptions of change over the past 10 years, and food security over 12 months. The thesis was limited however in the time spent with communities, and future research would benefit from longer term relationships with communities and investigation of community and larger scale socio-economic factors. Future research on livelihood and household status development would enable a greater understanding of how individuals enter the sector, how the sector can improve livelihoods, and how livelihood and vulnerability changes over time, and help understand socio-ecological poverty traps. In addition, this would shed light on the distribution of benefits of the sector, and enable identification of 'bright' and 'dark' socio-economic profiles and the constraints and positive contributions of the sector (Cinner, 2010; Daw et al, 2011a).

Through a focus on the fisheries lens of livelihoods and food security, diversified agricultural systems and the wider food system were not explored in-depth. Future research would benefit from combing an in-depth agricultural and fisheries lens to understanding food systems and food and nutritional security across diverse livelihoods and landscapes. In addition, the study focused on the livelihood outcome of food security, and future research is warranted into the relationships with multiple dimensions of wellbeing and perceptions of poverty and aspirations. The analyses presented in **Chapter 4 and 5** were also limited in their scope due to sample size and data availability. Through a mixed method approach and triangulation of qualitative and quantitative data, validation of findings was increased. However, future larger-scale research and better capturing of small-scale inland capture fisheries in national surveys, would enable a more comprehensive assessment of household food security with more complex multiple socio-economic factors and consideration of urban and rural linkages which would strengthen the understanding of the role of the sector for livelihoods. In addition, environmental data on landscape variables and fishing effort was limited, and advances in data collection and predictive modelling would enable a more comprehensive analyses of the drivers and pressures on inland fisheries production over time. However, the thesis provided a background on the availability of inland fisheries and their fluctuating nature, which contributed to understanding the vulnerability of fish-related livelihoods. In addition, the mixed methods approach strengthened the validation of research findings and local ecological knowledge provided a rich, untapped source of ecological data in data limited environments, and provided the views and realities of fisherfolk that can be integrated into management processes (Bennett and Deardon, 2013; Kong et al, 2015).

Further Research

The thesis provides a unique contribution to understanding food security at the local level in lakeshore communities experiencing climate variability. Through a mixed method approach and triangulation of data, the thesis responds to the call for more local level assessments on climate change impacts on inland fisheries and the socio-economic value of the sector at the local level. The thesis was motivated by these research gaps and provides an in-depth assessment of the complexities of socio-ecological inland systems. The thesis provides a timely contribution into the hidden value of small-scale inland captures and its role for livelihoods, food and nutritional security. The findings contribute new insights into the livelihood landscape of fishing communities, the employment and income value to men and women all year round, the safety net function in climate variability contexts, and the benefits of the sector for improving access to nutrient-dense foods and reducing vulnerability. The findings build upon and contribute new perspectives on narratives relating to fishers and poverty, utilisation and access to fish in rural communities, and on the 'hidden' supply and trade of fish in remote settings. By doing so, the thesis sheds new light on the role of inland fisheries to local food and nutritional security, particularly micronutrients, which is often under-reported and masked by national statistics. Through the findings of the thesis, new areas for further research have emerged.

As a result of the data limitations in inland fisheries, a case study and mixed methodological approach was employed to overcome data quality constraints and increase data validation. One new innovative database emerged through satellite monitoring that provided lake level information on a water body scale that was comparable with in-field monitoring. This thesis was one of the first to apply the data to understanding climate variability and food security in an under-valued fisheries sector. However, there is potential to utilise the global data set as a cost-effective technique for understanding climate change impacts and change in inland fisheries (**Chapter 4**). In addition, local ecological knowledge provided rich information on the ecosystem and changes over time (**Chapter 6 and 7**) which warrants further exploration in future studies where quantitative data is often poor or limited.

The thesis found interesting differences in food security between locations and identified that further research is warranted into the functioning of markets and types of agricultural systems utilised and their influence on local food security (Daw et al, 2012). Research on gender, intersectionality and history of livelihoods and households would also provide more information on factors influencing household and individual food security. A research incorporating 'bright' and 'dark' spot approaches to profiling winners and losers in the sector would also advance our understanding of the distribution of benefits in small-scale fisheries (Cinner, 2010; Daw et al, 2011a).

A landscape and ecosystem approach to management and assessments across diversified livelihoods and the food-water-fisheries nexus would also provide a greater understanding of the contributions of difference sectors to food and nutritional security which would help decision makers and managers understand trade-offs and management approaches, such as through replacement cost studies of nutritional sources, and prioritising livelihood enhancement or alternative initiatives (Lymer et al, 2016). Finally, larger scale studies investigating fisheries socio-ecological systems with a larger data set and representation, would improve the understanding of the value of the sector across development scales and over time, that would shed light on socio-ecological poverty traps and wider economic and society impacts (Daw et al, 2012).

8.4 Concluding Remarks

Small-scale inland capture fisheries (SSF) are one of the most under-reported and under-valued fisheries sectors worldwide. Understanding the value of inland SSF to livelihood and food security is an important question for poverty alleviation, sustainable resource management and development, particularly for low-income-food-deficit countries experiencing food insecurity and climate variability. This study is one of the first to investigate food security in an inland SSF in the context of vulnerability and by type of engagement in the sector, applying novel methods in data-limited environments (such as remote sensing and capturing local ecological knowledge).

The study finds evidence that the productivity of Lake Chilwa's fishery is influenced by the environment. Fish availability was driven by seasonal oscillations in rainfall and annual lake levels in the previous year. The availability of fish affected fish-related activities and the benefits obtained. However, the study found evidence that fish-related activities significantly improved the livelihood platform and food security in rural lakeshore communities experiencing climate variability. Fish producing households consumed more fish and more diverse and nutritious diets. Direct pathways to food security included consumption of nutrient dense fish from own production, and indirect pathways included increasing income for purchases of food, increasing income and investing in productive assets that helps reduce vulnerability, and in providing women with high independent income which can support the household and reduce vulnerability of female headed households. The study also found location to be an important factor governing food security highlighting the highly context specific nature of livelihoods and food security.

The study provides an important and timely contribution to the understanding of the impact of climate variability on inland small-scale fisheries, and in illuminating the hidden value of the sector to food and nutritional security in rural communities. Further research investigating the value chain in greater detail and location specific factors, such as the functioning of markets and agricultural systems, in a systems approach would improve the understanding of the value and challenges in the sector. The findings are important for promoting effective fisheries and water management, climate adaptation and poverty alleviation development, and identified potential for use of remote sensing and local knowledge in data limited environments. Inland capture fisheries have the capacity to support achievement of the Sustainable Development Goals: directly contributing to Goal 2 - End hunger, achieve food security and improved nutrition and therefore the case study provides a timely contribution in illuminating the hidden value of one of the most under-reported and under-valued fisheries sectors.

Appendix A Supporting Information for Chapter 4

Summary descriptive statistics and trends

Table 1 Summary descriptive statistics of variables

Variable	N	Min	Max	Mean	Std. Deviation	Median	Interquartile Range	Skewness		Kurtosis	
								Statistic	Std. Error	Statistic	Std. Error
Total Fish Catch (tons)	33	.00	23561.94	9295.35	5073.21	7990.14	6693.81	.58	.40	.68	.79
C. gariepinus Catch (tons)	31	.00	5777.61	1721.51	1170.09	1572.06	863.83	2.14	.42	6.00	.82
O. shiranus chilwae Catch (tons)	31	.00	5741.47	2302.98	1244.39	1998.24	1479.84	.40	.42	.91	.82
B. paludinosus Catch (tons)	31	.00	15000.00	4066.11	3195.11	2997.61	4268.66	1.59	.42	3.36	.82
Other Sp. Catch (tons)	31	.00	4520.18	1000.45	1276.06	420.91	1431.40	1.58	.42	1.98	.82
Total Rain (mm)	31	443.00	2021.00	1256.45	346.94	1268.00	475.00	-.23	.42	.04	.82
Delta Rain (mm)	30	-984.00	1192.00	-3.30	505.43	-27.50	538.00	.28	.42	.03	.83
Amplitude Rain (mm)	28	166.90	700.30	366.93	108.32	359.60	127.38	.74	.44	2.21	.85
Lake Height (masl)	31	623.14	626.21	624.89	.74	624.79	.90	-.11	.42	-.09	.82
Delta Lake Height (m)	30	-1.05	1.36	.00	.61	-.08	.92	.41	.42	-.30	.83
Amplitude Lake Height (m)	31	.56	1.94	1.18	.39	1.05	.69	.42	.42	-.97	.82
No. Fishers	23	1045	10287	4699.43	2480.59	4283.00	3538	.53	.48	-.57	.93

Appendix A

Table 2 **Tests of Normality**

Variable	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Total Fish Catch (tons)	.147	33	.069	.962	33	.298
C. gariepinus Catch (tons)	.250	31	.000	.778	31	.000
O. shiranus chilwae Catch (tons)	.113	31	.200	.970	31	.528
B. paludinosus Catch (tons)	.210	31	.001	.861	31	.001
Other Sp. Catch (tons)	.217	31	.001	.772	31	.000
Total Rain (mm)	.075	31	.200	.988	31	.978
Delta Rain (mm)	.139	30	.143	.972	30	.606
Amplitude Rain (mm)	.128	28	.200	.948	28	.180
Lake Height (masl)	.136	31	.149	.966	31	.427
Delta Lake Height (m)	.152	30	.076	.966	30	.429
Amplitude Lake Height (m)	.148	31	.081	.941	31	.088
No. Fishers	.134	23	.200	.949	23	.273

Table 3 Summary of trend and sequential analysis for variables

Variable	**Linear Regression Trend**					**Mann-Kendall Trend**	**Change Point Year^**	
	N	**R2**	**s**	**b**	**p**	**Sig. p≤0.05**	**Mean p≤0.05**	**Variance p≤0.05**
Total Fish Catch (tons)	33	0.13	0.94	-195.51	0.033*	Decreasing trend	1995	2001
C. gariepinus Catch (tons)	31	0.01	1186.94	8.8	0.697	No trend	-	2001
O. shiranus chilwae Catch (tons)	31	0.23	1109.64	-61.89	0.006**	Decreasing trend	1993	1995
B. paludinosus Catch (tons)	31	0.15	2985.09	-130.60	0.028*	No trend	-	2001
Other Sp. Catch (tons)	31	0.33	1059.40	-76.23	0.001**	Decreasing trend	1995	1995
Total Rain (mm)	31	0.02	349.22	-5.14	0.441	No trend	-	1998
Lake Height (masl)	31	0.003	0.75	-0.04	0.760	No trend	1994	-
No. Fishers	23	0.165	2320.23	104.16	0.055	-	-	-

^ Probability = 0.05, cutoff length = 10, Huber parameter = 1.

**p < 0.05

Appendix A

Characterisation of climate regimes

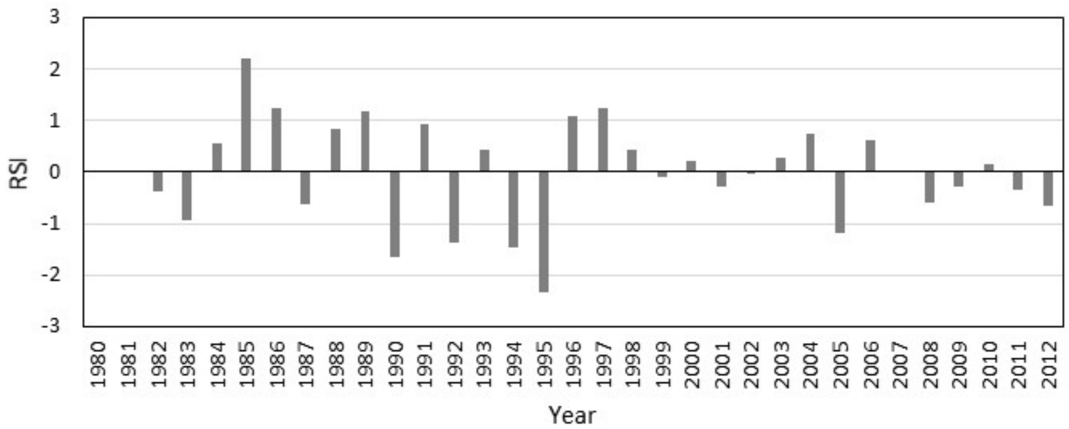

Figure 1 Characterisation of climate regimes: rainfall variability index (RVI)

Table 4 Characteristics of climate regimes according to the Rainfall Variability Index from 1982 to 2012 (Ndebele-Murisa et al, 2017; McKeee al., 1993).

Classification	RSI Values Category	Frequency	Year
Extremely wet	≥2.00	1	1985
Severely wet	1.50 to 1.99		
Moderately wet	1.00 to 1.49	4	1986, 1989, 1996-97
Near normal	0.99 to –0.99	21	1982-84, 1987-88, 1991, 1993, 1998-2004, 2006-2012
Moderately dry	–1.00 to –1.49	3	1992, 1994, 2005
Severely dry	≤–1.50 to –1.99	1	1990
Extremely dry	≤2.00	1	1995

Appendix B Household Survey Part 1-3

PART ONE – CONDUCTED WITH FISHER AND NON-FISHER HHS; LEADING FISHER IN FISHER HHS. HEAD OF THE HH IN NON-FISHER HHS.
PART TWO – CONDUCTED ONLY WITH FISHER HHS; THE LEADING FISHER.
PART THREE - CONDUCTED ONLY WITH FISH PROCESSOR, and / OR, FISHERMEN

FILTER QUESTIONS - PLEASE COMPLETE THESE QUESTIONS BEFORE STARTING THE QUESTIONNAIRE
QUESTIONNAIRE NO: ______________________
INTERVIEWER NAME: ______________________
1. Village: ______________________ 2. Date: ____________3.Time: _________________
4. House ID/No: ____________
5. Family Name: ____________
6. Is any member of the household involved in the fishing / fish farming industry in the last 12 months? Yes […] No [….]

PLEASE CHECK RESPONSE TO Q5 and Q6 AGAINST YOUR ASSIGNED HH TO ENSURE THE HH IS CORRECT; I.E. FISHER HH OR NON-FISHER HH. IF THE HH DOES NOT MATCH THE CRITERIA, PLEASE STOP AND CHECK WITH PRINCIPAL RESEARCHER BEFORE PROCEED. IF THE HH IS CORRECT, PROCEED WITH BELOW.
7. Interview conducted with: Head of the household [……….] Fisher member [……….] Fisher member who is also head of the household [……….]
8. Name of participant: __________________________
9. Have you obtained consent from the participant in order to apply this survey? Yes […] No [….]
IF CONSENT NOT PROVIDED – END DISCUSSION AND MOVE TO NEXT HH. IF PROVIDED – PROCEED.

PART ONE – HOUSEHOLD LIVELIHOOD AND FOOD SURVEY

A) HOUSEHOLD CHARACTERISTICS
1. Gender of the head of the household/fisher: Male [……….] Female [……….]
   Kodi mutu wa banja lanu ndi ndani?
2. Age of the head of the household / fisher: [……….]
   Kodi muli ndi zaka zingati?
3A. Household information: Ethnicity […………………] Religion [……………………]
   Kodi ndinu a mtundu wanji?
   Kodi ndinu a chipembedzo chanji?

3.B. IF MUSLIM (ISLAMIC), PLEASE ASK THE PARTICIPANT IF THEY HAVE BEEN FASTING OVER THE PAST 7 DAYS DUE TO THE HOLY MONTH OF RAMADAN? YES (…………); (NO…………). IF YES, NUMBER DAYS? [………]

4. Residential status of the household
Household lives in village permanently [……….] Household lives in village temporally for seasonal work [……….] Other specify […………]
Kodi ndinu a m'mudzi uno kapena mumangobwelamo nthawi yolima?
5. Marital status of head of the household; Kodi muli pa banja?
Married [……….] Divorced/separated [……….] Never married [……….] Widowed […….]
6. How many adults (16 years and above) and children (below 16 years) are living in the household? Kodi pakhomo pano pali anthu akuluakulu (osachepera zaka 16) angati? komanso ana (osakwana zaka 16) angati?
Adult Male [……….] Adult Female [……….] Children Male [……….] Children Female [……….]

B) HUMAN CAPITAL
1. Number of people in the household able to read and write? [……….]
   Kodi ndi anthu angati amene amatha kulemba ndi kuwelenga pa khomo pano?
2. What is the level of education of the head of the household? Kodi sukulu munafika kalasi yanji?

Nursery / Pre-school [……….] Primary: stnd 1 – 8 [……….] Secondary: form 1 – 4 [……….] University [……….] Training College [……….] Never been to school […….]
3. During the past 4 weeks has any member of the HH suffered from an illness or injury? Kodi musabata zinayi zapitazi alipo munthu amene anavulala kapena kudwala pa khomo pano?
Yes [……….] No [……….]

C) NATURAL CAPITAL
1.a. Do you own agricultural land? Kodi muli ndi malo kapena munda? Yes [..........] No [..........]
IF NO SKIP TO Q2. IF YES, PROCEED TO Q1.B.
1.b. What is the total size? Kodi malowo ndi a akulu bwanji? Acres [.....]Hectares [.....] Other [.....]
1c. What do you do with the land you own? Please tick all that apply: 1= rent it to others […] 2=use it for animal grazing […] 3=farm […] 4=other [……] Kodi malo amene muli nawo mumawagwiritsira ntchito yanji?
1= Kubwereketsa […] 2=Kudyetserapo ziweto […] 3=Kulima[…] 4=Zina ndi zina [……]
2. What are the sources of water for: a) drinking? [..........] b) Washing? [..........] c) Domestic Use? […………]
Please input the source number that apply (more than one can be entered): 1=protected wells, 2= unprotected wells; 3=piped water, 4=river, 5=Lake Chilwa, 6=boreholes; 7= other please specify […………….]
a) Kodi madzi amene mumamwa amachokera kuti b) nanga ochapila amachokera kuti? 1=zitsime zosamalika, 2=pa mpopi, 3= unprotected wells; 4=mtsinje, 5=Ku Nyanja yaChilwa, 6=mjigo; 7= Other please specify […….]

D) PHYSICAL CAPITAL
1. Indicate whether the household possesses the following items, how many?
Kodi mwakatundu uyu ndimungati amene muli naye?
PLEASE READ OUT THE LIST AND INPUT THE NO. OF THAT ASSET OWNED. IF NONE, INPUT ZERO.
PLEASE CHECK WHETHER THE ASSET IS OWNED BY THE HH OR PART OWNED AS A COMMUNITY GROUP. IF GROUP, PLEASE WRITE 'G' NEXT TO THE NUMBER LISTED FOR THAT ASSET.

Asset	**No.**	**Asset**	**No.**
Car/Motorcycle Galimoto/njinga ya moto		Fishing boats / Mabwato	
Plough / Khasu la ng'ombe		Seine nets / Ukonde (including Matemba seine nets, Nkacha seine nets)	
Bicycle / Njinga		Fish pond (please specify number of ponds) zidazogwiritsa ntchito pa ulimi wa nsomba	
Ox cart / Ngolo		Sewing machine / Makina osokera	
<u>Working</u> Cell phone / Foni ya m'manja		Treadle pump	
Radio / Wailesi		TV set / Wailesi ya kanema	
Livestock Ziweto - chicken		**THE FOLLOWING BELOW TO BE <u>OBSERVED</u> ONLY WHERE POSSIBLE AND <u>NOT ASKED</u>:**	
Livestock Ziweto - guinea fowls		House – iron sheeting roofing (Yes; 1 or No; 0)	
Livestock Ziweto - ducks		House – cement flooring (Yes; 1 or No; 0)	
Livestock Ziweto - goats		Modern furniture / Mipando, tebulo, kama ndi katundu wina wa makono wa m'nyumba (Yes; 1 or No; 0)	
Livestock Ziweto - pigs		**Others / Zina:**	
Livestock Ziweto - cattle			

2.a Does your household have access to electricity power? **NOTE: PLEASE OBSERVE** Yes [..........] No [..........]

2.b. If yes, what is the source of electricity power? Please tick all that apply: Grid [……….] Solar Panel [……….] Generator [……….] Other please specify [……….]
Kodi munyumba mwanu mumawunikira chani?

E) FINANCIAL CAPITAL

1.a What are the sources of your household livelihood activities over the last 12 months? Kodi mumapanga chani kuti mupeze zofunikira pakhomo panu mumiyezi khumi ndi yiwiri yapitayi? PLEASE LET THE RESPONDANT ANSWER INITIALLY AND THEN PROBE WITH THE LIST OF ACTIVITIES. (tick all that apply) IF THE HH IS NOT INVOLVED IN THAT ACTIVITY, INPUT ZERO				**1.b** What are the top 4 HH activities by income for the whole year? And what % do these contribute to overall HH income? Tchulani zithu zinayi mwazinthu zimene mwatchula zija zimene zimabweretsa ndalama kwambiri kuposa zinazonse.	**1.c** Of the top 4 income sources, specify how many adults of the HH partake in that activity by gender. Ndi amuna kapena akazi angati amene amatengapo gawo muntchito kapena zinthu zimenene zimabweretsa ndalamazi? IF NONE, INPUT ZERO	
1.a. Source	**Tick**	**1.a. Source**	**Tick**	**1.b. Rank** **INPUT SOURCE NO.**	**1.c. No. Adult Males**	**1.c. No. Adult Females**
1.Farming (crops, vegetables) Kulima mbewu		9.Bird hunting Kusaka mbalame		1st %		
2.Livestock rearing Kuweta ziweto		10.Agriculture wage labour Ntchito zogwira muulimi		2nd %		
3.Fish culture / farming Ulimi wa nsomba/kuweta nsomba		11.Non agri. wage labour Ntchito zimene zili zosagwirizana ndi ulimi		3rd %		
4.Fishing (crew member or gear owner who is actively fishing) Usodzi/kuwedza nsomba		12.Petty business Bizinesi/malonda ang'onoang'ono		4th %		
5.Fish processing Kukonza nsomba		13.Business Bizinesi/malonda				
6.Fish trading Kugulitsa nsomba		14.Urban remittance Ndalama kapena katundu wochokera kwa achibale akutawuni				
7.Other fish-related business		15.House helper/maid Wantchito wapakhomo				

PAUSE – ENSURE CHECK QUALITY:

1. IF NO. 3-7 SELECTED THEN ENSURE FILTER QS ON PG 1 OUTLINES HH IS FISHER HH.
2. THAT ALL % ADD UP TO 100%

Malonda ena okhudzana ndi nsomba			
8.Firewood / Nkhuni		16.Handicraft Luso lamanja	
		17.Others (specify) Zina	

2. For each of the top four ranked livelihood activities, when did your household carry out each of these livelihood activities over the past 12 months?
Muzinthu zinayi mwatchulazo, ndi liti limene munapanga zintu zotsatilazi mu miyezi khumi ndi iwiri yapitayi ?
PLEASE RE-LIST ACTIVITIES AS RANKED IN Q1.B. AND INPUT IN COLUMN Q. Mark X in each month.

Ranked Livelihood Activities from Q1.	**2014 Chaka chatha**											**2015 Chaka chino**			
	Dry Season Chilimwe					**Wet Season Ndzinja/nthawi ya mvula**						**Dry Season**			
Please re-write…	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1st__________															
2nd_________															
3rd_________															
4th _________															

START OF SKIP QUESTIONS: Q3 NOTE: IF RESPONDANT <u>DID</u> SELECT <u>ANY OF 1-3</u> FROM Q1a, PROCEED TO <u>ASK Q3</u>. IF NOT, <u>SKIP TO Q4.</u>
3.a. If you had the choice what would you prefer to farm? Please select one: farming crops […]; farming livestock (e.g. goats, ducks, pigs, etc. **<u>excl. chicken</u>**) […]; farming chicken […]; farming fish […].
Kodi ndi ulimi wuti womwe mungasangalatsidwe kupanga mutate musankhe?
3.b. Why have you selected this preferred farming option? Please tick all the apply: Cheaper to farm […] Higher yields […] Higher income from sale […] Preferred food consumption […] More nutritious […]Ease of practice […] Other please specify […]
Kodi ndichifukwa chani mwasankha ulimi umenewu?
Q4 NOTE: IF RESPONDANT <u>DID</u> SELECT <u>4-7</u> FROM Q1a, PROCEED TO <u>ASK Q4</u>. IF NOT, <u>SKIP TO Q5.</u>
4.a. How many ADULT members of your HH are involved in each fishing role in the fishing industry? Please also specify gender (male: M, or female: F).
Kodi ndi amuna kapena akazi angati apakhomo pano amene amatengapo mbali pa za usodzi wa nsomba?
Fishing (gear owner) [M:.......F:.......] Fishing (crew member) [M:.......F:.......] Fish processing [M:.......F:.......] Fish trading [M:.......F:.......] Other fish business [M:.......F:.......]
PAUSE – QUALITY CHECK – ENSURE NO. OF ADULT MEMBERS MATCH UP WITH Q6 ON PG1.
NOTE: PLEASE ALSO ADMINISTER PART TWO OF SURVEY.
4.b. What is the importance of these fishing related activities for your HH? Please tick all that apply: Income […..] Food […..] Other please specify […..]
Kodi ntchito zosiyanasiyana zimene mumapanga zokhuzana ndi usodzi wa nsomba ndizofunikira bwanji pa khomo panu?
Q5 NOTE: IF RESPONDANT DID <u>NOT</u> SELECT ANY OF 4-7 FROM Q1a, PROCEED TO Q5. OTHERWISE, SKIP TO Q6.
5.a.Would you consider joining the fishing industry? Yes […..] No […..].
IF YES PROCEED TO Q5.B. IF NO, SKIP TO Q6.
Kodi mungafune kuyamba nawo ntchito zosiyanasiyana zausodzi wa nsomba?
5.b.Are there any constraints that have stopped you partaking in the fishing industry?
Yes […..] No […..] **IF YES PROCEED TO Q5.C. IF NO, SKIP TO Q6.**

Kodi pali zovuta zinazllizonse zimene zimakupangitsani kuti musapange nawo ntchito zosiyanasiyana zokhuzana ndi nsomba?
5.c. What are the constraints? Ngati zilichoncho zimakukanikitsani ndi chani. Please tick all that apply: 1. Financial upfront cost of equipment [.....] 2. Financial cost of licences [.....] 3. Skill [.....] 4. Employment as crewmember [.....] 5. Customs [.....] Ban on certain fishing gears [......] Closed seasons [.....] Other (specify) [.....]
END OF SKIP QUESTIONS: CONTINUE TO ANSWER BELOW Qs:
6. If you had the choice to partake in any role in the fishery sector, what fisher income generating activity would you prefer? Kodi ndi bizinesi yanji yomwe mungapange yokhuzana ndi nsomba mutasangalatsidwa kuyamba?
Please select one: No.3 Fish Farming […] No.4 Fishing […] No.5 Fish Processing […] No.6 Fish Trading […] No.7 Other fish-related business [...]

EXPENDITURE SECTION

7.a. Over the (SET PERIOD SPECIFIED BELOW) did you or other members in your HH purchase (item)?
Kodi ndalama zanu mu miyezi yoposera khumi ndi yiwiri yapitayi magwiritsa ntchito muzinthu ngati ziti?
PLEASE READ OUT LIST OF ITEMS. PLEASE TICK ALL THAT APPLY. IF NOT APPLY – INPUT ZERO. SPECIFY TOTAL COST IN MK.

7.a. Expenditure Details	TICK	MK	7.a. Expenditure Details (cont.)	TICK	MK
1 WEEK			**4 MONTHS**		
Charcoal Nkhuni			Clothes Zovala		
Paraffin Mafuta anyale			Gifts Mphatso		
Leisure/alcohol Zachisangalalo/mowa			Laundry, dry cleaning, tailoring fees		
Cigarettes or other tobacco			Kitchen Utensils (Bowls, glassware, plates, cookpots)		
Public Transport- Bicycle Taxi/ Bus/Minibus Mayendedwe			Cleaning utensils (brooms, brushes, etc.)		
1 MONTH			Torch / flashlight		
Milling fees, grain			Business Investments Bizinesi		
Personal beauty, cleaning products (soap, shampoo, toilet paper, hair products, clothes cleaning powder).			Equipment Investments Zipangizo		
Petrol or diesel			Loan repayments Kubwenza ngongole		
Motor vehicle service, repair, or parts			HH Education Maphunziro		
Bicycle service, repair, or parts			HH Health Care Thanzi/chipatala/matenda		
Wages paid to servants			Others: Zina ndi zina		

Mortgage - regular payment to purchase house					
Repairs and maintenance to dwelling					
Repairs to household and personal items radios, watches, etc., excl. battery purchases)					
Recharging batteries, cell phones					

8. What are your household's top 4 priority areas of expenditure? kodi munjira zimene mwatchulazi ndi njira zinayi ziti zimene mumagwiritsa ntchito ndalama zanu kuposa zonse? (this can also include food)
1st [..............................] 2nd [..............................] 3rd [..............................] 4th [..............................]

9. Does your HH have any savings of money? Yes [..........] No [..........]
Kodi muli ndi ndalama zosunga pakhomo pano?

SHOCKS/COPING STRATEGIES FOR HOUSEHOLD - ZINTHU ZOBWERA MWADZIZDIZDI ZIMENE ZINAKHUDZA PANJA LANU

10a. During the <u>**last 12 months**</u>, was your HH affected negatively by any of the following [SHOCKS]? Kodi mu miyezi khumi ndi iwiri yapitayi, nyumba yanu yakumanako ndi zinthu zobwera mwazadzidzi monga izi? **IMPORTANT – THIS QUESTION IS TO UNDERSTAND BIG EVENTS SUCH AS FLOODS AND DROUGHT. ENSURE RESPONDANT DOES NOT JUST SAY YES TO ALL QS, QUESTION THEIR RESPONSE AND PROBE. E.G. ASK THEM WHAT THEY MEAN BY LOW LEVEL OF FISH AVAILABILITY. IF DROUGHT AND FLOOD BOTH TICKED, ASK THEM TO EXPLAIN WHEN BOTH WERE.**	**10.b.** Please rank the three most significant shocks you experienced. Most Severe (1), Second Most Severe (2), Third (3). muzinthu mwatchulazi, ndiziti zomwe zinakukhudzani kuposa zonse?	**10.c**. As a result of this/these [SHOCKS], did your […] READ RESPONSES FOR EACH COLUMN: Increase.... 1 Decrease....2 Did Not Change…3
READ OUT EACH SHOCK ONE BY ONE. Tick all that apply or INPUT ZERO.	PLEASE INPUT SHOCK NO.	

Shock Codes	Tick	1st	2nd	3rd	Income	Assets	Food Productio n	Food Stocks	Food Purchases
1. Drought/Poor Rains									
2. Floods/water logging									
3. Unusually High Level of Crop Pests or Disease									
4. Unusually High Level of Livestock Disease									
5. Unusually Low Level of Fish Availability									
6. Unusually Low Prices for Agricultural Output									
7. Unusually Low Prices for Fishing Output									
8. Unusually High Costs of Agricultural Inputs									
9. Unusually High Prices for Fishing Inputs									
10. Unusually High Prices for Food									
11. End of Regular Assistance/Aid/Remittances From Outside HH									
12. Reduction in the Earnings from Household (Non-Agricultural and non-fishing) (Not due to Illness or Accident)									
13. Serious Ilness or Accident of Household Member(s)									
14. Death of Household Member(s)									

15. Theft of Money/Valuables/Assets/Agricultural Output	
16. Other (Specify)	

F) FOOD CONSUMPTION

1.A		1.B	1.C	1.D	1.E	1.F	1.G	1.H
Over the past **<u>7 days</u>**, did you or others in your HH consume any [FOOD ITEM]? Kodi inuyo kapena anthu ena apakhomo panu munadya chakudya ngati izi musabata yangothayi? **PLEASE READ OUT EACH FOOD ITEM** **INPUT 1. Yes or 2. No** **PROBE Q – Please probe the respondent to ensure familiar with the last 7 day period.**		How **<u>many days</u>** over the past **<u>7 days</u>** did your HH consume that food item? Kodi ndi masiku angati mumadya chakudya sabata yangothayi?	How much of each [FOOD ITEM] came from the following; **<u>1.C. Purchases</u>** 1.D. Own production (crops/animals) 1.E. Food and game you collected / fished / hunted, 1.F Gifts, donations and 1.G Other sources. **PLEASE INPUT % FOR EACH.**					**<u>If purchases were selected</u>**, how much did you spend on purchases per item? **PLEASE SPECIFY MK FOR EACH ITEM SELECTED.**
INCLUDE BOTH FOOD EATEN COLLECTIVELY IN THE HOUSEHOLD AND THE FOOD EATEN INDIVIDUALLY.	**1.Yes** **2.No**	**No. of Days (0-7)** **IF NOT CONSUMED RECORD ZERO.**	**<u>1.C %</u>**	1.D **%**	1.E **%**	1.F **%**	1.G%	**<u>MK</u>**
CEREALS;								
maize, rice, etc **Chimanga, mpunga, chingwa.**								
ROOT AND TUBERS;								
Sweet Potato								
Carrots								
Pumpkin								
Cocoyam (masimbi)								
All Other; e.g. Cassava, plantain, potato, etc. **Chinangwa, mbambata**								
PULSES/LEGUMES/NUTS;								
beans, pigeonpea, nuts etc **Nyemba, sawawa, mtedza**								
VEGETABLES;								
Cabbage								
Nkhwani								
Tanaposi/Rape								
Other cultivated green leafy vegetables								

Other Vegetables: onion, tomato								
FRESH FRUITS;								
Mango								
INCLUDE BOTH FOOD EATEN COLLECTIVELY IN THE HOUSEHOLD AND THE FOOD EATEN INDIVIDUALLY.	**1.Yes 2.No**	**No. of Days (0-7)** **IF NOT CONSUMED RECORD ZERO.**	**1.C %**	1.D **%**	1.E **%**	1.F **%**	1.G%	**MK**
Papaya								
Other Fresh Fruits (e.g banana, orange, apples, pineapple, wild fruits).								
ANIMAL PROTEIN;								
Chicken								
Beef (cattle)								
Goat								
Other red meat (guinea fowl, small animals)								
Pork (ask about pork if non-Muslim)								
Fish? If yes ask for each specie below) Nsomba ;								
Fish 1? …………………								
Fish 2? …………………								
Fish 3? …………………								
Fish 4? …………………								
Eggs Mazira								
Milk and milk products; fresh, butter, cheese etc Mkaka ndizina zochokera ku mkaka.								
OTHER;								
Oil/fats Mafuta								
Sugar/honey Shuga/uchi								
Miscellaneous Zina ndi zina								

PAUSE – QUALITY CHECK – ENSURE THE TOTAL NUMBER OF DAYS DOES NOT EXCEED 7, AND TOTAL % DOES NOT EXCEED 100. IF NOT CORRECT – ASK RESPONDANT TO VERIFY.

2. How many meals per day, including breakfast, are taken on average over the past 7 days in your HH for each HH member? Kodi mumadya kangati patsiku pakhomo panu musabata yangothayi kuphatikiza kadzutsa?
Adult Male [……….] Adult Female [……….] Children Male [……….] Children Female [……….]

SKIP QS
IF FISH WAS SELECTED AS CONSUMED IN Q1, PROCEED TO ASK Q3 – IF NOT SKIP TO Q7.

3. What was the origin / source of each fish species that your HH consumed over the **past 7 days** as listed in Q1? Kodi nsomba zimene munadya munazipeza kuti? INSERT ONE OF THE FOLLOWING NO.S AGAINST EACH FISH SPECIES; 1. FARMED 2. LAKE CHILWA 3. RIVER 4. LAKE MALAWI 5. OTHER (SPECIFY)		**4.** How was each fish that your HH consumed processed? Kodi nsomba zimene munandya zidali zokonzedwa bwanji? INSERT ONE OF THE FOLLOWING NO.S AGAINST EACH FISH SPECIES; 1. FRESH 2. SUN-DRIED 3. SMOKED 4. ICED 5. OTHER (SPECIFY)
PLEASE LIST FISH SPECIES THAT WERE SELECTED AS EATEN FROM Q1.	NO. 1, 2, 3, 4 or 5	NO. 1, 2, 3, 4 or 5
Fish 1? …………………		
Fish 2? …………………		
Fish 3? …………………		
Fish 4? …………………		

5.A. Which members of the HH consumed EACH fish? **PLEASE TICK IN COLUMN A1-4 FOR EACH FISH SPECIES**.
Kodi ndi anthu angati amene anadya nawo nsomba ngati izi ?
IF A MEMBER GROUP DID NOT CONSUME, INPUT ZERO.

5.B. Which part of the fish was consumed? PLEASE SELECT **ALL** THAT APPLY **FROM B CODES** AND INPUT NUMBER INTO COLUMN B 1-4.
Kodi ndi mbali iti ya nsomba imene inadyedwa.?

Fish Species PLEASE LIST FISH SPECIES FROM Q3 ABOVE.	5A.1 Adult Male Amuna a akulu	5B.1	5A.2 Adult Female Akazi a akulu	5B.2	5A.3 Male Children Ana a amuna	5B.3	5A.4 Female Children Ana a akazi	5B.4	**5B. CODES** 1. Whole fish 2. Head of fish 3. Fillet / middle 4. Tail or fins 5. Skin 6. Eggs **7.** Bones
	Tick	No 1-7	Tick	No 1-7	Tick	No 1-7	Tick	No 1-7	
Fish 1? …………………									
Fish 2? …………………									
Fish 3? …………………									
Fish 4? …………………									

6. Do you feel the quantity of fish eaten in the **last 7 days** by your HH is enough? Please tick one.
Kodi mulingo wa nsomba umene unadyedwa pa sabata yathayi unali okwanira? More than enough (___); Enough (___); Not enough (___).

Appendix B

END OF SKIP QS. CONTINUE WITH BELOW QS.

<table>
<tr><td>7.a. What fish species has your <u>HH consumed</u> in the last <u>12 months</u>? Ndi mtundu wanji wasnomba umene mwadya pahomo pano kwa miyezi khumi ndi iwiri yapitayi ? List top 4 species most consumed. NOTE: THIS IS DIFFERENT FROM LAST Q ON 7 DAYS. NEW FISH MAY BE EATEN OVER 12 MONTHS.</td><td colspan="15">7.b. How does your HH consumption of each fish species vary throughout the <u>last 12 months?</u>
Kodi Kadyedwe kanu ka nsomba mwatchulazi kasintha bwanji pa miyezi khumi ndi iwirii yapitayi?
Please mark the months when that fish species was eaten with X.</td></tr>
<tr><td rowspan="3">PLEASE LIST FISH SPECIES BELOW.</td><td colspan="7">2014</td><td colspan="8">2015</td></tr>
<tr><td colspan="5">Dry Season</td><td colspan="6">Wet Season</td><td colspan="4">Dry Season</td></tr>
<tr><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td></tr>
<tr><td>Fish 1? ………………</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fish 2? ………………</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fish 3? ………………</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fish 4? ………………</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

8.a. What is your HH preferred choice of fish species to consume? Please specify one species from Q7a […………………………………..] Kodi pakhomo pano mumakonda kudya mtundu wanji wa nsomba?
8.b. Why does your HH prefer to consume this fish species? Please tick all that apply: Chifukwa chani mumakonda mtundu wasomba umenewu? More nutritious […..] Ease of preparation [….] Good taste [….] Size of fish {………} Low price to buy [….] Available through own production/fished [….] Most available catch [….] Available at market [….] Other please specify […….]
9.a. Over the **last 12 months**, has your household faced any constraints with accessing fish for HH consumption? Yes [……..]; No […….]. Kodi mu miyezi khumi ndi iwiri yapitayi, mwakumanako ndi zovuta zilizonse pakapezedwe kanu ka nsomba?

9.b. IF YES, what access constraints did your household face? Please tick all that apply: Ndimavuto anji amene munakumana nawo? Low own production/catch of fish […….] Fish is too expensive to purchase […….] Fish is not available at market [……..]; Too expensive to travel to market […….] Other please specify […….]
10.a. If your household had the choice, what would your household prefer to eat from the following?: please tick one: Chicken […] Fish […] Chicken eggs […] Beef […] Goat […] Milk […] Other specify [……………………]
Kodi mumakonda zakudya zanji zanyama zomanga thupi?
10.b. What is the reason for this choice? Please tick all that apply: More nutritious […..] Ease of preparation [….] Good taste [….] Low price to buy [….] Available through own production/fished [….] Available at market [….] Other please specify […….]
G) FOOD SECURITY
1. In the **<u>past 7 days</u>**, did you worry that your HH would not have enough food? Yes […..] No [….]
Kodi mu sabata yathayi, munakhalako ndi khawa kuti panyumba panu simukhala ndi chakudya chokwanila?

2. In the past **<u>7 days,</u>** how many days have you or someone in your household had to:
Kwasabata yathayi, kodi inu kapena aliyese wapakhomo pano
PLEASE READ A – E AND INPUT THE NUMBER OF DAYS. <u>IF NO DAYS, RECORD ZERO AND SKIP TO Q4.</u>

3. How worried would you be to adopt each of the following behaviours?
Mungakhale okhudzidwa bwanji kutsatila njila zotsatilazi
PLEASE READ WORRY SCALE AND INPUT THE NUMBER: Not worried=1, A little worried=2, Very worried= 3.

	a. Eat less preferred and/or reply less expensive foods?	b. Limit portion size at mealtimes?	c. Borrow food or money to buy food, or rely on help from a friend or relative?	d. Restrict consumption by adults in order for small children to eat?	e. Reduce number of meals eaten in a day?	f. Going without food for whole days.
Q2. DAYS						
Q3. 1-3						

4. In the **<u>last 12 months</u>**, have you been faced with a situation when you did not have enough food to feed the household? Kodi mu miyezi khumi ndi yiwiri yapitayi munayamba mwakhalapo ndi chakudya chosakwanira chodyetsa banja lanu pakhomo panu? Yes [……….] No [……….]
IF YES PROCEED TO Q5. IF <u>NO, SKIP TO SECTION H</u>; SOCIAL CAPITAL.

5. When did you experience this incident in the **<u>last 12 months</u>**? Kodi ndi liti zimenezi zinachitika mumiyezi khumi ndi yiwiri yapitayi?
Mark X in each month from 12 months ago up to the current month of the interview.

2014 / Chaka chatha							**2015 / Chaka chino**							
Dry Season / Chilimwe					**Wet Season / Ndzinja/nthawi ya mvula**						**Dry Season / Chilimwe**			
Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug

6.How often has your HH experienced this over the **<u>past 10 years</u>**?
Every year […] Every 2-3 year […] Every 4-5 year […] Don't Know […] Other please specify […]

7. When you did not have enough food or money to buy food, did your household have to;
Kodi munapanga chani nthawi imene munalibe chakudya chokwanila kapena ndalama zogulira chakudya cha pa khomo panu?

Appendix B

PLEASE READ EACH ITEM AND INPUT 1. YES OR 2. NO. IMPORTANT – ENSURE PROBE PARTICIPANTS IF APPEAR TO NOT UNDERSTAND OR ARE SAYING YES TO ALL.	
Coping Strategies	**1.Yes** **2.No**
1.Rely on less preferred and less expensive foods? Kudalira zakudya zotchipa komanso zosakondedwa	
2.Borrow food, or rely on help from a friend or relative? Kubweleka chakudya kapena kudalira chithandizo kuchoka kwa achibale	
3.Purchase food on credit? Kugula chakudya pa ngongole	
4.Gather wild food, hunt, or harvest immature crops? Kutolera zakudya kapena kusaka nyama zakutchire, kapenanso kukolora zolima zosakhwima	
5. Intensify fishing/fish processing/fish trading?	
6. Intensify fish farming?	
7. Fish during the closed season in lake or river?	
8. Fish using gears prohibited (e.g. seine nets)?	
9.Intensify other livelihood activities that are non-agriculture and non-fishing/fish farming to bring in extra income to buy food?	
10.Consume seed stock held for next season? Kudya mbewu zolimila chaka china nyengo ya dzinja	
11.Send household members to eat elsewhere? Kutumiza achibale kukadya kwina	
12.Send household members to beg? Kutumiza achibale kukapemphetsa	
13.Limit portion size at mealtimes? Kuchepetsa mulingo wa chakudya nthawi yakudya	
14.Restrict consumption by adults in order for small children to eat? Kuchepetsa chakudya cha anthu akuluakulu kuti ana adye	
15.Feed working members at the expense of non-working members? Kudyetsa anthu ogwira ntchito okha okha	
16.Reduce number of meals eaten in a day? Kuchepetsa chakudya chodyedwa pa tsiku	
17.Skip entire days without eating? Kudumphitsa matsiku osadya	
18. Did not do anything for a coping strategy (IF THIS IS SELECTED THEN ALL ABOVE SHOULD NOT BE)	

8.A. What would you consider to be the cause of the situation? Kodi zinapangitsa kuti musakhale ndi chakudya chosakwanira ndi chani? **LET RESPONDANT ANSWER FIRST. AND THEN PROBE BY READING THE LIST.**	**8.B.** Please list up to 3 reasons from 7.A. in order of importance.

IMPORTANT – THIS QUESTION IS TO UNDERSTAND IF CAUSES ARE BIG EVENTS SUCH AS FLOODS AND DROUGHT. ENSURE RESPONDANT DOES NOT JUST SAY YES TO ALL QS, QUESTION THEIR RESPONSE AND PROBE. IF DROUGHT AND FLOOD BOTH TICKED, ASK THEM TO EXPLAIN WHEN BOTH WERE TO ENSURE UNDERSTAND.		PLEASE INPUT THE CAUSE NO. INTO 1ST 2ND and 3RD BELOW.		
PLEASE READ EACH ITEM AND INPUT 1. YES OR 2. NO.	**1.Yes 2.No**	1st	2nd	3rd
1. Inadequate household stocks due to drought/ poor rains				
2. Inadequate household stocks due to floods / water logging				
3. Inadequate household food stocks due to crop pest damage				
4. Inadequate household food stocks due to livestock disease				
5. Inadequate household food stocks due to small land size				
6. Inadequate household food stocks due to lack of farm inputs				
7. Inadequate household food stocks due to closed fishing season				
8. Inadequate household food stocks due to theft				
9. Food in the market was too expensive				
10. Unable to reach the market due to high transportation costs				
11. No food available in markets				
12. Reduction in income from HH activities				
13. Other (specify)				

9. Which food groups were affected by these causes? Tick all that apply. Ndi gulu liti lazakudya limene linakhudzidwa chifukwa chavutoli?
Cereals; maize, rice, bread etc […] Vegetables […] Pulses / legumes / nuts […] Meat; beef, goat, chicken, guinea fowl, small animals […] Fish […] Fruit […]

H) SOCIAL CAPITAL

1. Do you have relatives? Yes [……….] No [……….]
   Kodi muli ndi achibale?
2. Do you give or receive food to/from these relatives in the last 12 months? Give only [……….] Receive only [……….] Both; give and receive [……….] No [……….]
   Kodi mu miyezi khumi ndi yiwiri yapitayi munapeleka kapena kulandira chakudya kwa achibalewa?
3. Do you give or receive cash to/from these relatives in the last 12 months?
   Give only [……….] Receive only [……….] Both; give and receive [……….] No [……….]
   Kodi mu miyezi khumi ndi yiwiri yapitayi munapeleka kapena kulandira ndalama kwa achibalewa?
4. Have these forms of mutual aid changed over the last 12 months? Increased [……….] Decreased [……….] Same [……….]
   Kodi kuthandizanaku kunasintha bwanji mu miyezi khumi ndi yiwiri yapitayi?

5.a. Is any member of your household affiliated to a local institution/social group? Yes [……….] No [……….]
IF YES, PROCEED TO Q5.B. IF NO, SKIP TO END SURVEY.

5.b. How many members of your HH are affiliated to a local institutions / social group? Kodi ndi anthu angati apakhomo panu amene ali ma membala a magululu osiyanasiyana a m'mudzi mwanu?	**5.c.** What benefits are received? Kodi mumapindula chani mumagulu amenewa? **Input all that apply**: 1=Get help in times of problems, 2=Satisfaction in helping others,

PLEASE READ OUT EACH GROUP AND INPUT NO. OF MEMBERS AFFILIATED INTO THE COLUMN. IF NONE INPUT ZERO.		3=Recognition, 4= Security, 5=Economic benefits; 6=None, 7=Other specify.
Affiliation Type	**No. of HH Members Affiliated** **IF NONE INPUT ZERO.**	**5.c. Benefits** **(Specify if select 7=other)**
Affiliation with political party -Membala wa chipani		
Membership in community committees (school, church, specify)-Membala wa komiti (sukulu, tchalitchi)		
Membership in governance committees (Village Natural Resource Management Committee, Village Development Committee, Agricultural Development Committee, Beach Village Committee, River Village Committee etc) - specify Membership of church/mosque Membala wa ma komiti oyang'anira chitukuko cha m'midzi		
Membership in NGO supported groups (farmers club, irrigation, AIDS, Women Fish Processors Group etc.) specify -Membalaw wa ma gulu a mabungwe a zaulimi		
Participation in community festivals Kutenga nawo mbali mu zisangalalo za m'mudzi		
Other associations (specify)- Magulu ena		

PART ONE SURVEY END

IF THE HH WAS <u>NOT A FISHER HH</u> – <u>END THE SURVEY</u> AND PROCEED TO THE LAST PAGE 'END OF SURVEY' AND COMPLETE COMMENTS.

IF THE HH <u>IS</u> A FISHER HH – <u>PROCEED</u> TO ADMINISTER <u>PART TWO</u> TO THE FISHER YOU ARE CURRENTLY INTERVIEWING.
PART TWO – FISHING INDUSTRY SURVEY
CONDUCTED ONLY WITH FISHER HHS; THE LEADING FISHER.

I) CHARACTERISTICS

1. A.What is your involvement in the fishing industry?
   Kodi kumbali yausodzi mumapanga chani?
   Please select activity: 1. Fishing (gear owner) [...] 2. Fishing (crew member) [...] 3. Fish processing [...] 4. Fish trading [...] 5. Other fish-related business (please specify) [...].
   IF ANY OF PART 1 TO 3 WAS TICKED, PART 3 WILL BE ADMINISTERED. IF MORE THAN 1 WAS TICKED, PART 3 WILL BE ADMINISTERED FOR BOTH ROLES; FISHING AND PROCESSING. PLEASE TURN TO THE START OF PART 3 AND INSERT A NOTE UNDER 'NOTE FROM PART 2'.

   IF MORE THAN ONE WAS TICKED FROM 1A, PROCEED TO Q1B. IF NOT, SKIP TO Q2.
   B. Which is your major activity? […………].
   PAUSE; PLEASE NOTE THAT QS BELOW WILL BE FOR THEIR MAJOR ACTIVITY.

2. How long have you been involved in your [major fisher activity]?

Mwakhala mukupanga [major fisher activity] kwanthawi yayitali bwanji? 0-5 years [...] 6-10 years [...] 11-15 years [...] 16-20 years [...] More than 20 years [...]

3. A. Has there been any time when you stopped your [major fisher activity] for an entire year or more? Kodi nthawi inayake munasiyako (your role in the fish sector] kwa chaka chanthunthu kapena kupitilira apo? Yes [……….] No [……….]. **IF YES PROCEED TO Q3.B. IF NO SKIP TO Q4.**
   B. How often? Please tick one. A. Just once [……….] b. 2-3 times [……….] c. Many times [……….]
4. A. In the **last 12 months**, which are the months that you have partaken in your [major fisher activity]? Mumiyezi 12 yadutsayi, ndi miyezi iti imene mwapangako (major fisher activity)
   Please mark an **X** in each month.
   B. Of these months, are there **HIGH** season months and **LOW** season months for when you partake in your role? Mumiyezi mwatchulayi, ndi miyezi yake iti imene ili yabwino kwambiri, ndi imene siyabwino kwenikweni?
   Please INSERT **H** or **L** for the months marked with **X,** and input below in row B. If the respondent claims that there are no distinct HIGH VS. LOW season months, record **H** (HIGH) for months in which any time is spent partaken in the role.
   PROBE QS: If there is difficulty in identifying months. Start discussion first on the last wet and dry season, then try and detail to the month.

	2014									**2015**			
	Dry Season				**Wet Season**						**Dry Season**		
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
A.Mark X													
B.Input H / L													

5. A. During the last HIGH season, what was your level of engagement in your [major fisher activity]? Mumiyezi yabwino yanchito yanuyi (imene yangodutsayi) , mumagwira nchito yanuyi kawiri kawiri bwanji?
   Please **tick ONE**: 1. Full-time (engaged exclusively only in [major fisher activity]) [...] 2. Part-time (primarily engaged in non-fishing activities and spent some time in [major fisher activity]) [...] Other please specifcy [...................................]
   B.How many weeks were you engaged in the last HIGH season? No. Weeks […..]
   Munagwira masabata angati?
   C. During those weeks, approximately how many <u>days per week</u> did you partake in your major fish role? No. Days / Week […..]
   Mumasabata amenewa, mumagwira nchito yanuyi kangati pa week?
6. How much do you earn on average per week during the last HIGH season? [.........kwacha]
   Mumapeza ndalama zochuruka bwanji pa week (mumiyezi yabwino)?

   IF LOW SEASON WAS OUTLINED IN Q4, PROCEED TO Q7. IF NOT SKIP TO Q9.
7. A. During the last LOW season, what was your level of engagement in your [major fisher activity]? Please tick ONE: 1. Full-time (engaged exclusively) [...] 2. Part-time (primarily engaged in non-fishing activities and spent some time in [major fisher activity]) [...] Other please specifcy [...................................]
   Nanga mu miyezi yobvuta ya nchito yanuyi (imene yangodutsayi), mumagwira nchito yanuyi kawiri kawiri bwanji?
   B. How many weeks were you engaged in the last LOW season? No. Weeks […..]
   Munagwira masabata angati?
   C. During those weeks, approximately how many <u>days per week</u> did you partake in your major fish role? No. Days / Week […..]
   Mumasabata amenewa, mumagwira nchito yanuyi kangati pa week?
8. How much do you earn on average per week during the last LOW season? [.........kwacha]
   Mumapeza ndalama zochuruka bwanji pa week (mumiyezi yobvuta)?

9. What are your household's priority areas of expenditure from income generated from your involvement in the fisheries sector? **Tick all** that apply. kodi munjira zimene mwatchulazi ndi njira zinayi ziti zimene mumagwiritsa ntchito ndalama zanu kuposa zonse?
HH Food [.............................] HH maintenance [.............................] HH health [.............................] HH education [.............................] Personal [.............................] Other, please specify [.............................]

J) START UP

1. What are the reasons you became involved in your [major fisher activity]? Choose all that apply: Kodi chinakupangitsani kuti muyambe [major fisher activity] ndichani?
   Custom/tradition; [...] For income; [...] For food; [...] Due to government project; [...] Due to NGO project; [...] Due to community project; [...] Other (please specify)................ .
2. Where did you acquire the information needed to participate in your [major fisher activity]? Kodi nanga upangiri otimuthe kumapanga nawo [major fisher activity] munaudziwira kuti?
   Choose all that apply: Information from NGOs [...] Information from local authorities [...] Information from other fishers [...] Information from family [...] Information from community groups [...] Radio/TV [...]/ Attend training courses [...] Read relevant literature [...] Other (please specify) [...]
3. Do you consider your [major fisher activity] to be a profitable business i.e. is the income generated is enough to meet you and your family's monthly monetary requirements?
   Kodi inuyo mumaona kuti [major fisher activity] imakupezetsani phindu lokwanira? Mwachitsanzo ndalama zomwe mumapeza zimakwaniritsa zimene inuyo ndi banja lanu limafuna? Yes [...] No [...] Other specify [……………………]
4. **4.** Would you recommend being involved in your [major fisher activity] to other members of the community who are not yet involved? Kodi inuyo mutha kuwalimbikitsa anthuena omwe sapanga nawo [major fisher activity] kuti ayambe? Yes [...] No [...] Don't know [….]

K) SHOCKS

<table>
<tr>
<td colspan="2">1a. During the <u>last 12 months</u>, was your [major fisher activity] affected by any of the following [SHOCKS]?
Mumiyezi 12 yadutsayi kodi nchito yanuyi yasokonezedwako ndi izi (zimene nditatchule apazi)?</td>
<td colspan="3">1.b. Please rank the three most significant shocks you experienced. Most Severe (1), Second Most Severe (2), Third (3).
Chomwe chinasokoneza nambala 1 ndi chiti? Chachiwiri? Chachitatu?</td>
<td colspan="5" rowspan="2">1.c. As a result of this/these [SHOCKS], did […] READ RESPONSES FOR EACH COLUMN:
Chifukwa cha zosokonezazi, eti [chakuti] china…?; (check column just below)

Increase.... 1
Decrease....2
Did Not Change…3
Don't know …..4
Other (please specify)……………..5</td>
</tr>
<tr>
<td colspan="2">PLEASE READ OUT EACH SHOCK CODE ONE BY ONE. Tick all that apply. IF NOT APPLY, INPUT ZERO.</td>
<td colspan="3">PLEASE INPUT SHOCK NO.</td>
</tr>
<tr>
<td>Shock Codes</td>
<td>Tick</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>Amount of fish caught/ harvested</td>
<td>Fish-related Income</td>
<td>Fish-related Assets</td>
<td>Fish Consumption</td>
<td>Food Purchases</td>
</tr>
<tr><td>1. Drought/Poor Rains</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Floods/water logging</td><td></td></tr>
<tr><td>3. Unusually Low Prices for Fishing Activity Output (to sell)</td><td></td></tr>
<tr><td>4. Unusually High Prices for Fishing Inputs (buying fish or gears)</td><td></td></tr>
<tr><td>5. Serious Illness or Accident</td><td></td></tr>
<tr><td>6. Disease of fish</td><td></td></tr>
<tr><td>7. Dangerous animals / predation</td><td></td></tr>
<tr><td>8. Theft of Fishing Equipment/ Fish</td><td></td></tr>
<tr><td>9. Conflict</td><td></td></tr>
<tr><td>10. Other (Specify)</td><td></td></tr>
</table>

2. Since you started partaking in your (major fisher activity), how often have you experienced (1st Ranked SHOCK)? Every Year [……] Every 2 years […….] Every 3- 5 years […….] Other […….] Don't know […….]
Chiyambileni nchito yanuyi, chosokoneza (cha nambala 1 chija) mwakumana nacho kawiri kawiri bwanji?
3. Since you started partaking in your (major fisher activity), how often have you experienced (2nd Ranked SHOCK)? Every Year [……] Every 2 years […….] Every 3- 5 years […….] Other […….] Don't know […….]
Nanga chosokoneza (chachiwiri chija) mwakumana nacho kawiri kawiri bwanji?
4. Since you started partaking in your (major fisher activity), how often have you experienced (3rd Ranked SHOCK)? Every Year [……] Every 2 years […….] Every 3- 5 years […….] Other […….] Don't know […….]
Nanga chachitatu chija, mwakumana nacho kawiri kawriri bwanji?

L) CHANGE AND PERCEPTIONS

1. A. How has the overall amount of each fish species in the lake (river, marsh etc) changed from 10 years ago? Kodi kapezekedwe ka nsomba munzaka khumi zapitazo chasintha? Please input in the table below in column 1.A one of the following next to the list of fish species; increased (+), decreased (-) same (0) or don't know (DK).

	1.A. Amount	1.B. Size
Chambo		
Matemba		
Mlamba		
Other specify:………………		

   B. How has the size of each fish species changed from 10 years ago? Please input one of the following in column 1.B; larger (+), smaller (-) same (0) or don't know (DK).
   Nanga kakulidwe ka nsombazi kasintha bwanji muzaka 10 (khumi) zadutsazi?
2. A. How has the overall amount of each fish species in the lake (river, marsh etc) changed since the recent flood? Kodi kapezekedwe kansomba kasintha chisefukireni madzi? Please input ONE of the following for each species into the table below: 1.More available, 2. Less available, 3. Not changed, 4. Don't know.

Fish;	2.A. Flood	2.B. Next 1 yr	2.C. Future
Chambo			
Matemba			
Mlamba			
Other specify:………………			

   B. How do you see the overall amount changing in the next year? Munkuona kwanu kodi kapezekedwe kansomba mumchaka chikudzachi kasintha bwanji? (as above please insert ONE No. into table below).
   C. How do you see the overall amount changing in the future? Nanga mtsogolomu? (as above please insert ONE number into the table).
3. A. Are there other types of weather events that affect the overall amount of fish in the lake (river, marsh etc)? Yes [….] No […..] Don't know […..] IF YES PROCEED TO Q3.B. IF NO/DON'T KNOW SKIP TO Q4.
   Kodi ziripo nyengo zobwera mwapakanthawi (monga ng'amba, kusefukira kwa m'madzi) zimene zimatha kusintha kapezekedwe ka nsomba mu nyanjamu? (mtsinje etc)
   B. What are the weather events? Don't know […..] Drought / poor rains […] Floods [….] High temperature [….] Low temperature [….] High winds [….] Low winds [….] Other please specify […………………………………………………….]
   Chimabweretsa nyengo zoterezi ndi chiyani? (ng'amba? Kusefukira kwa madzi? Kutentha? Kuzizira? Mphepo?)
4. A. Would you say your life has improved since you started partaking in your [major fisher activity]? Kodi mugati moyo wanu watukuka chiyambireni [your major activity] ?
   Yes [...] No [...]**IF YES PROCEED TO Q4.B. IF NO PROCEED TO Q5.**
   B. If yes, please state reasons (tick all that apply): Mungatiuze njira zimene umoyo wanu wasinthika? I have been able to take care of my family's finances [...] I can employ people [...] My health has improved [...] My family's health has improved [...] We are no longer worried about food insecurity [...] I have increased income [...] Other [...]

5. On a scale of 1-5, how important is your [major fisher activity] as a contribution to HH income, compared to other HH income activities?
   Kodi inuyo mungati mumabweretsa ndalama zambiri bwanji pa banja lanu kutengera ndi ntchito yanuyi[your major activity]
   Please probe with LADDER scale 1-5 below and tick one:
   1. Not very important […] 2. Somewhat important […] 3. Moderately important […]
   4. Important […] 5. Extremely Important […]
6. Has the importance to your HH income changed since the flood? Chisefukireni madzi pali kusintha kuli konse pa ku funikira? Increased [...] Decreased [...] Same [...] Don't know […..].
7. On average, how has the quantity of food that you are eating changed since you started partaking in your [major fisher activity]? Mongoyerekeza, kodi mulingo wachakudya chomwe mumadya chasintha chiyambireni kupanga [your major activity]? More food consumed [...] Same [...] Less [...] Don't know [...]
8. On a scale from 1-5, how important is your [major fisher activity] for your HH food? Kodi inuyo gawo limene mumatenga po pakapezedwe kachakudya pa banja lanu mukamapanga [your major activity] ndi kofunikira bwanji?
   Please probe with LADDER scale 1-5 below and tick one:
   1. Not very important […] 2. Somewhat important […] 3. Moderately important […]
   4. Important […] 5. Extremely Important […]
9. Has the importance to HH food changed since the flood? Kodi kufunira kwake kwa sintha chisefukira madzi? Increased [...] Decreased [...] Same [...] Don't know […..].
10. What general constraints do you experience day to day in partaking in your [major fisher activity]? Kodi mumakumana ndizovuta zanji pochita your [major fisher activity]
    Please READ each out and tick all that apply. Highly variable fish availability […..] Low prices to sell fish […..] High prices to buy fish […..] Limited access to main markets […..] Other specify [……………] None […..].
11. What is the length of time that you consider yourself to continue to partake in [your major activity]? Kodi inuyo mukudziona mukupitiriza kupanga your [major fisher activity] kwanthawi yayitali bwanji? Please tick one: One more year […] 2-5 years […] Indefinitely […] Other – specify […………]Don't know […..].
12. Has the number of people involved in the fishing sector changed since the flood? Kodi chiwerengero chaanthu omwe akupanga zimenezi chasintha chisefukireni cha madzi? More now [...] Less now [...] Same [...] Don't know […..].
13. Has the number of people involved in the fishery sector changed over the past 10 years ago? Kodi chiwerengero cha anthu omwe akuchitanawo ntchito imeneyi chasintha bwanji m'zaka khumi zapitazo? More now [...] Less now [...] Same [...] Don't know […..].

M) GOVERNANCE

1. Are you aware of any laws or restrictions governing fishing in your area? Yes [...] No [...]. **IF NO PROCEED TO Q9. IF YES PROCEED TO Q2.** Kodi mukudziwa za malamulo ena alionse okhudzana ndi usodzi wa nsomba m'dera lanu lino?
2. What type of laws are in place in your area? Government [...] Traditional / village [...] Mixed [...] Other [...]Don't know […..].kodi ndimalamulo ali m'dera lanu lino anakhazikitsidwa ndindani?
3. **A**. Are there any restrictions on which months you are allowed to fish? Yes [...] No [...] IF YES PROCEED TO 3.B. IF NOT SKIP TO Q4.
   B. Please specify months that fishing is restricted by location; Kodi pali miyezi ina imene ndiyoletsedwa kuwedza nsomba? On the lake [………………..] In rivers [………………..]Don't know specific months […..].
   C. Why are those months restricted? Don't know […..]. Specify [……………………………………………]
4. **A**. Are there any restrictions on which gears / fishing practices to use? Yes [...] No [...] IF YES PROCEED TO 4.B. IF NOT SKIP TO Q5.
   Kodi pali malamulo oletsa za zida zomwe mungagwiritse nchito, kapena oletsa njira zowedzera?
   B. Please specify which gears/practices are prohibited: UP TO 3 TO BE OUTLINED; 1 specify [………………] 2 specify [………………….] 3 specify [………………….] Don't know specific gears/practices […..].
   Ndi zida zake ziti kapena njira zake ziti?

C.Which <u>months</u> are these gears not allowed to be used? If the gear is prohibited for every month, insert 'all year'. If the respondent does not know, insert 'DK'. 1 specify [………………] 2 specify […………………] 3 specify […………………] Amaletsa mumiyezi yake iti?
D.What <u>locations</u> are these gears not allowed to be used? Please insert all the No.s that apply for each gear: 1. Lake, 2. River, 3. Both, 4. Don't know.
1 specify [………………] 2 specify […………………] 3 specify […………………]
Amaletsa kugwiritsa nchito kutiko kweni kweni?
E.<u>Why</u> are those gears restricted? Don't know […..]. Specify [……………………………………………]
Amaletsa chifukwa chani?

5. A.On a scale of 0 to 5, to what extent do fishermen/fish farmers in your community comply with rules and regulations governing fishing/fish farming? Kodi asodzi amatsatira bwanji malamulo ndi ndondomeko zimene zilipo zokhudzana ndi usodzi wa nsomba?
Please probe with LADDER scale description below.

No compliance						Full compliance
0	1	2	3	4	5	
Never	Rarely	Sometimes	Often	Very Often	Always	

Scale 0-5 [……….] Don't know [………]
IF 5 WAS <u>NOT</u> SELECTED, PROCEED TO Q5.B. IF 5 or Don't know WAS SELECTED, SKIP TO Q6.
5.B. In your opinion, why do fishermen/fish farmers in your community not fully comply with the rules and regulations governing fishing/fish farming? Tick all that apply. 1. Unaware of the regulations [...] 2. For income and food to meet HH needs [...] 3. Not agree with the regulations [...] 4. Don't know [...] 5. Other please specify [..]
Mmene mukuonera inuyo, ndi chifukwa chiyani asodzi/kapena oweta nsomba samatsatira malamulowa bwino bwino?

6. On a scale of 0 to 5, to what extent are the rules and regulations enforced in your community? Kodi malamulo ndi ndondomekozi zimkhazikitsidwa ndi kutsatidwa bwanji?
Please probe with LADDER scale description below.

No enforcement						Full enforcement
0	1	2	3	4	5	
Never	Rarely	Sometimes	Often	Very Often	Always	

Scale 0-5 […..] Don't know […..]

7. **A.** Have the regulations affected your [major fisher activity]? Yes [...] No [...] Kodi malamulo ndi ndondomekozi zakhuza kapena kusokoneza bwanji ntchito zanu? **IF YES PROCEED TO Q7.B. IF NO SKIP TO Q8.**
B. How have the regulations affected the benefits obtained from the activity? Please tick. Enhanced […] Lowered […] Same […]. Nanga malamulo ndi ndondomekozi zakhuza kapena zasokoneza bwanji phindu ndi zina zomwe zimachokera ku ntchito zanu zokhudzana ndi usodzi wa nsomba?
C. How have the regulations affected your household food security? Increase [...] Decrease [...] Same [...] Malamulowa akhudza bwanji kapezekedwe ka chakudya pakhomo panu pano?
<u>D. How have the regulations affected your household income?</u> Increase [...] Decrease [...] Same [...] Malamulowa akhudza bwanji nkhani za chuma pakhomo panu pano?
8. Since the regulations have been in place, do you think the overall amount of fish in the lake (river, swamp etc) has changed? Increase [...] Decrease [...] Stayed the Same [...] Don't know [...] Other [...] Chikhazikitsireni malamulowa, inu mukuwona kuti kapezekedwe ka nsomba kasintha?
9. Do the government/ local authorities and other stakeholders provide any support to fisherfolk in the area? If so, what kind of support do they provide?
Kodi alimi a nsomba amathandizidwa ndi boma kapena mabungwe ena apadera? Ngati chithandizo chikuperekedwa, ndi thandizo lanji lomwe alimi amalandira?

Organisations Mabugwe	**Do you have access to these organisations/individuals ? Yes 1, No 2** Kodi muli ndi kuthekera kuthandizidwa ndi	**Frequency of Contact over past year (no of visits/month)**	**Type of support received. 1 Monetary (credit) 2 Technical advice 3 Marketing Assistance 4 Other**	**Satisfaction level about the quality of services 1. Very satisfied; 2. Somewhat satisfied; 3. Neither satisfied nor unsatisfied; 4.**

	mabungwe awa? Eya 1, Ayi 2	Mu chaka chapitacho, mwakumana nawo kangati? (kangati pa mwezi)	Chithandizo chomwe chinalandilidwa (munjira yanji) 1 Ndalama (ngongole) 2Ulangizi pa ukadaulo (Ntchito za alangizi) 3.Chinthandizo pa za malonda 4 Zina	**Somewhat unsatisfied; 5. Very unsatisfied** Kakhutisidwe ndi nchito za alangizi 1. okhutitsidwa; 2. Okhutitsidwa pang'ono; 3. okhutitsidwa komanso osakhutitsidwa; 4. Osakhutitsidwa pang'ono; 5. Osakhutitsidwa
Government Extension Services Ntchito za ekisiteshoni				
NGOs/ Donor Organisations Mabungwe oti si aboma				
Research Institutes Malo a kafukufuku				
Other (specify) Zina				

END OF PART 2 INTERVIEW

PART THREE

NOTE FROM PART TWO; RESPONDANT SELECTED FISHING ACTIVITY AS;
FISHERMEN (gear owner or crewmember) […..] OR FISH PROCESSOR [….]

PART THREE ONLY TO BE ADMINISTERED IF THE LEADING FISHER YOUR ARE INTERVIEWING, SELECTED THAT THEIR FISHING ROLE(S) IS ONE OF THE FOLLOWING – PLEASE SEE RESPONSE IN PART 2, SECTION I Q1B;

A. ROLE IS **FISH PROCESSOR** – THEN PROCEED TO **SECTION N**.
B. ROLE IS **FISHING** (CREW MEMBERS OR GEAR OWNER ACTIVELY INVOLVED IN FISHING) – THEN PROCEED TO **SECTION O**.
C. **OTHER – END SURVEY** – PROCEED TO LAST PAGE 'END OF INTERVIEW'

IF RESPONDANT IS A FISHER AND PROCESSOR; ADMINISTER BOTH PARTS.

N) MAIN ROLE IS FISH PROCESSOR

1. How much did you spend as capital to start partaking in [SELECTED ACTIVITY]?
   Kodi mpamba oyambira kuti muzipanga (SELECTED ACTIVITY] unali wochuluka bwanji?
   [………………kwacha] What year was that spent year [….] don't know [….]

2. Where did you get the capital from? Kodi mpamba umenewu munaupeza bwanji? Farming […], fishing […], labour work […], loan […], other sources please specify […]
3. How do you purchase fish (tick all that apply)? Buy from fisher [...] Buy from trader [...] Provided for free from family fisher members [...]
   Kodi nsomba mumagula kwa ndani? asodzi[...] ogulitsa nsomba[...] kungopatsidwa ndi achibale kapena asodzi[...]
4. What type of processing do you partake in? Smoking [...] Sun drying [...] Both [...]
   Other [……………………………….]
   Kodi nsomba zanu mumazikonza bwanji? kuotcha[...] kuumitsa ndi dzuwa[...] zonse[...]
5. What equipment do you use? Traditional [...] Modern/new (such as solar drying facilities and new kilns) [...] Both […]Other [……………………………….]
   Kodi mumagwiritsa ntchito zipangizo zanji pokonza nsomba?
6. A. What fish species do you process? Please tick all that apply.
   Kodi ndimitundu yanji ya nsomba imene mumakonza?
   B. What method do you use to process the species? Please input 1. Sun dried or 2. Smoked.
      Kodi mumagwiritsa njira zanji pokonza mtundu wa nsomba umenewu? Kuumitsa ndi dzuwa kapena. Kuotcha?
   C. Why do you select that fish species for your processing activity? Please input all numbers that apply. 1. Most available catch, 2. Lower buying price, 3. Higher selling price.
      Kodi ndi chifukwa chani mumakonza mtundu umenewu wa nsomba?

Fish;	**4.a.Tick**	**4.b.Processing Method**	**4.c.Preference for selection**
Chambo			
Matemba			
Mlamba			
Other specify:……………….			

7. What % of each species purchased for processing do you sell or consume directly in your HH? Kodi ndi mulingo wanji wa mtundu uliwonse wa nsomba umene mumagula kuti mokonze mumagula kapena kudya pa khomo panu?

Fish;	**Consume Directly**	**Sell**
Chambo		
Matemba		
Mlamba		
Other specify:……………….		

8. Who do you usually sell the processed fish to? Direct to consumer [...] Trader [...] Other [...] **IF sold to a trader**, what market is the fish destined for? Local [...] Zomba town [...] Blantyre [...] Other [...] Kodi nsomba zomwe mumakonza mumagulitsa kwa ndani? Ngati mumagulitsa kwa munthu wa bisinesi yogulitsa nsomba, nsombazi amakazigulitsa kuti?
9. Are you a member of a fish processing group? Yes [...] No [...] Kodi ndinu membala wa gulu limene limakonza nsomba?
10. Are you a member of a Beach Village Committee or River Village Committee? Yes [...] No [...] Kodi ndinu membala wa Beach Village Committee kapena River Village Committee?

O) <u>MAIN ROLE IS FISHING</u>

1. How much did you spend as capital to start partaking in [SELECTED ACTIVITY]?
   Kodi mpamba oyambira kuti muzipanga (SELECTED ACTIVITY] unali wochuluka bwanji?
   [………………kwacha] What year was that spent year [….] don't know [….]
2. Where did you get the capital from?
   Kodi mpamba umenewu munaupeza bwanji? Farming […], fishing […], labour work […], loan […], other sources please specify […]
3. Are you a gear owner or a crew member? Gear owner […] Crewmember […] Both […]
   Kodi ndinu mwini wake wa zipangizo zogwilira nsomba kapena wongothanizira? **IF SELECTED GEAR OWNER PROCEED TO Q4. IF NOT, PROCEED TO Q5.**
4. If you are a gear owner, what gear do you own? Please input how many of each.
   Ngati ndinu mwini wake wa zipangizo zogwilira nsomba, ndizipangizo ziti zogwilira nsomba zimene mulinazo?

Gears;	**Number Owned**

Seine net - Nkhoka	
Gill nets / Ukonde	
Hook and Line / Mbedza	
Fish traps / Misampha ya nsomba	
Cast or scoop nets / Mono	
Other1?.......................	
Other2?.......................	
Other3?.......................	

5. Do you own a fishing boat or rent? Own […] Rent […] None […].
   Kodi muli ndi bwato lanu kapena mumabwereka?
   IF YES, what type of boat? Tick all that apply: Plank boat without engine […] Plank boat with engine […] Dugout canoe […] Plank canoe […]
   Ngati muli ndi bwato, ndi mtundu wanji wa bwato limene mulinalo?
6. Where do you fish? Tick all that apply: 1. River […] 2. Mouth of River [….] 3. Open Lake [….] 4. Marsh [...] Kodi mumakawedza kuti?
7. Does this vary by species? Please insert no. 1 – 4 for each species. Kodi malo amene mumakawedzako kumatengera mtundu wa nsomba umene ukupezekako?.

Species	**Location 1-4 where fish are caught**
Chambo	
Matemba	
Mlamba	
Other specify:……………….	

PAUSE – QUALITY CHECK - PLEASE ENSURE RESPONSES ARE CONSISTENT BETWEEN Q6 AND Q7 ON LOCATIONS, AND CORRECT WHERE NECESSARY.

8. A. What fish species do you catch? Please tick all that apply.
   Kodi ndimitundu yanji ya nsomba imene mumakonza?
   B. What % of each species purchased for processing do you sell or consume directly in your HH?
   Kodi ndi mulingo wanji wa mtundu uliwonse wa nsomba umene mumagula kuti mokonze mumagula kapena kudya pa khomo panu?

Fish;	**8a.Tick**	**8.b. Consume Directly**	**8.b. Sell**
Chambo			
Matemba			
Mlamba			
Other specify:……………….			

9. Where do you usually land your fish/bring your fish on land to? Kodi nsomba zanu mumafikira nazo kuti? Kachulu landing site […] Mposa landing site […] Swang'oma landing site […] Other […]. Does this change? Kodi mumasinthasintha malo amene mumafikira ndi nsomba zanu? Yes […] No […]
10. Do you stay on a floating village ('zimbowera') on the lake to fish? Yes […] No […]
    Kodi mumakhala pa zimbowera pa Nyanja mukamapanga usodzi?
11. What fish gears do you use during a typical year? Please mark X against each month
    Kodi ndi zipangizo ziti zowedzera nsomba zimene mumagwiritsa ntchito pa chaka nthawi zambiri?

LIST TO BE FINALISED	**Wet Season**						**Dry Season**					
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Gears;												
Seine net - Nkhoka												
Gill nets / Ukonde												
Hook and Line / Mbedza												
Fish traps / Misampha ya nsomba												
Cast or scoop nets / Mono												
Other1?.......................												
Other2?.......................												

Other3?.......................												

12. Are you a member of a Beach Village Committee or River Village Committee? Yes [...] No [...]
    Kodi ndinu membala wa Beach Village Committee C kapena River Village Committee?

END OF INTERVIEW.
ASK: ANY FINAL QUESTIONS OR THROUGHTS TO ADD?

……
……
………
……
……
………
……
……
………

END OF INTERVIEW
Thank you for your cooperation in participating in this study... **NOTE TIME ENDS:**
Zikomo kwambiri podzipereka ndi kutenganawo mbali pakafukufukuyu
INTERVIEWER REMARKS
Respondent's cooperation was: Very good Good Fair Poor
The quality of respondent's answers were: High quality Generally reliable Unreliable

What was the main reason for the questionable or unreliable quality of the interview? ………
……
………

Comments:
General?
……
……
………
……
……
………

Other discussions that interviewer had with respondent? Record interesting wider notes.
……
……
………
……
……
……… Unanswered Qs?
……
……
………

Did the HH match the criteria of fisher or non-fisher? Explain if Not.
……
……
………

Appendix CKey Informant Interview Guide

The following table provides a total list of guided questions which will be used to guide the expert interview. Please feel free to open up discussions.

	Questions / Topic	Sub- Questions
	Could you briefly describe your role and work within your organisation?	
	Can you please tell me about your experience or involvement in the [capture fisheries/food security/water/climate change] sector in Malawi?	
	National Fisheries	
1	In your opinion what is the importance of inland fisheries to Malawi?	How does capture fisheries contribute to this?
2	Can you describe the current role of fish to food and nutritional security in Malawi?	How does capture fisheries contribute to this?
3	Can you please describe the trends in fisheries?	What are the trends for capture fisheries? In your opinion, how might this change in the future?
4	Can you tell me about the development of fisheries in Malawi?	What is the development for capture fisheries?
	Lake Chilwa Fisheries	
5	Can you please describe the trends in Lake Chilwa capture fisheries?	How are the fisheries monitored?
6	Can you describe the factors that may have contributed to these trends?	How are the factors monitored, evaluated and quantified? In your opinion, what are the biggest gaps in understanding these?
7	In your opinion what is the importance of Lake Chilwa capture fisheries?	Is there spatial variation? How is this monitored, evaluated and quantified? What are the biggest gaps in understanding this?
8	Can you tell me about the problems of Lake Chilwa fisheries?	Can you describe how communities and the ecosystem respond to these? In your opinion, what are the biggest gaps in understanding these?
9	Can you describe the access to the fisheries?	Are there spatial variations in access to certain fishing grounds? Are there any conflicts on fishing grounds? What factors contribute to access?

10	Can you describe the relationship between different water users in the catchment?	
11	Can you tell me about the legislation, policies and management plans for Lake Chilwa fisheries?	Do you think these have been effective? How is the effectiveness monitored and evaluated? How do these fit into the national fisheries policy? Is there an integrated policy across sectors for the management of the wetland?
12	What are the future management plans and developments for Lake Chilwa fisheries?	
13	In your opinion, what are the top priorities for research on Lake Chilwa?	
	Lake Chilwa Water Level	
1	Can you please describe the trends in Lake Chilwa water level?	How are these monitored? What factors have contributed to these patterns? Are these patterns 'natural'? What are the biggest gaps in understanding these?
2	What are the biggest problems to water level in Lake Chilwa?	Are there spatial variations and why? What are the biggest gaps in understanding these?
3	How will water level change in the future in Lake Chilwa?	
4	What are the most important benefits of water in Lake Chilwa?	
5	How has/does climate change affect the ecosystem in the basin?	Which changes cause the most impact? What are the biggest gaps in understanding these?
6	How has/does climate change affect the livelihoods in the basin?	Which changes cause the most impact? What are the biggest gaps in understanding these?
7	What is the relationship between different water users?	
8	Can you tell me about the legislation, policies and management plans for climate change in the basin?	Do you think these have been effective? Is there an integrated policy across sectors for the management of the wetland?
9	What are the future management plans and priorities for water level in the basin?	Are capture fisheries incorporated and how?
10	In your opinion, what are the top priorities for research on Lake Chilwa?	
	Lake Chilwa Climate	

1	Can you please describe the climate trends in Lake Chilwa catchment?	How are these monitored? What factors have contributed to these patterns? Are these patterns ‘natural’? What are the biggest gaps in understanding these?
2	How are these trends likely to change in the future?	
3	How has/does climate change affect the ecosystem in the basin?	Which changes cause the most impact? Are there spatial differences? Can you describe how the ecosystem responds to these? What are the biggest gaps in understanding these?
4	How has/does climate change affect the livelihoods in the basin?	Which changes cause the most impact? Are there spatial differences? Can you describe how the communities respond to these? What are the biggest gaps in understanding these?
5	Can you tell me about the legislation, policies and management plans for climate change in the basin?	Do you think these have been effective? Is there an integrated policy across sectors for the management of the wetland?
6	What are the future management plans and priorities for climate change in the basin?	How does this fit into national policy?
7	In your opinion, what are the top priorities for research on Lake Chilwa?	
	Thank you for your time to participate in this interview. Is there anything else you would like to add to the discussion?	

Appendix D Focus Group Discussion Guide

EXERCISE 1	PROBING QUESTIONS
Fish Availability calendar - What fish species are available in the lake (river, marsh etc) for fishermen to catch? - *During a typical year, which months of the year are each of those species available for fishermen to catch? I will mark with an X. - What are the peak months and the lowest months when each fish species is available to catch? I will give them X beans to rank. I will record rank number in 1 colour. - During the typical months, what locations are the fish found? Write down per month.	**Questions relating to calendar first:** Seasonality - What are the seasonal characteristics of the availability of each fish species in the lake, river marsh etc? Are there any differences in the wet and dry season? - What are the reasons for this fluctuation? - Are there peak months and low months? What are the reasons for this fluctuation? - What do you think are the reasons why each species varies? - Why do some species vary more than others? - What are the seasonal characteristics of where the fish are located to catch? What do you think are the reasons for this location for each species?
Shocks – cyclical - When there is a flood, and the lake level is very high, are there any changes in the amount available of each species to catch? Please mark with an X months available during a flood year. Ask them, of those, what are the peak and low months when each species is available. Record in colour the score. - During the flood year, what locations are the fish found? Write down per month.	**Shocks – cyclical** - What effects, if any, does floods and high lake level have on the availability of each species? How long does the flood or high lake level effect fish availability? Is the effects immediate, over a few months, or years? - What do you think are the reasons why this effects / or does not affect each fish species? - Why are some species effected and some species not? - What effects does the flood have on where the fish are located to catch? What do you think are the reasons for this for each species?
- When there is a drought, and the lake level is very low, are there any changes in the amount available of each species to catch? Please mark with an X months available during a flood year. Ask them, of those, what are the peak and low months when each species is available. Record in colour the score. - During the drought year, what locations are the fish found? Write down per month.	- What effects, if any, does drought and low lake level have on the availability of each species? How long does the drought or low lake level effect fish availability? Is the effects immediate, over a few months, or years? - What do you think are the reasons why this effects / or does not affect each fish species? - Why are some species effected and some species not? - What effects does the drought have on where the fish are located to catch? What do you think are the reasons for this for each species?

	Other - Aside from regular annual patterns of fishing, are there cyclical changes that occur across years e.g. very good years for fishing occurring every three years or every five years? - Can you please tell me your experiences over the past 5 or even 15 years, of years that have been very good for fishing? What were the reasons for this? - Can you please tell me your experiences over the past 5 or even 15 years, of years that have been very bad for fishing? What were the reasons for this?
MATRIX 10 YEARS - How has the overall amount of each fish species in the lake (river, marsh etc) changed from 10 years ago? List each fish species from before, and input +, - or 0, or DK. - What are the reasons for each species, write down. - Can you rank the reasons for this change with the beans? - How has the size of each species changed from 10 years ago, repeat the same? - What are the reasons for each species? - Can you score each reason with the beans?	- Can you tell me more about this change? Has the change been gradual, or have you experienced increases and decreases? - What do you think about this change in each species? - Why are those reasons most important? - What do you think about this change in each species? - Why are those reasons most important? - Are there any fish species that were available to catch in the past that are no longer available? Why? - What would you say are the main causes effecting fish availability?

EXERCISE 2	PROBING QUESTIONS
Fish consumption and preference ➢ **What type of fish do people consume** ➢ **What is their preference for each fish species** **Calendar** - In the past year, what fish species have you consumed? - Where are each fish species from? - When do you consume fish over the year? Input X. - What are the months when you consume a lot of that fish species, and what are the months when you consume little of each species? please score using the beans? - How does this compare to a period of flood? Mark X in a new colour. - How does this compare to a period of drought? Mark X in a new colour.	Qs Open: - What are the reasons for these fluctuations in each species consumption over a normal year? (e.g. availability, religious event, etc). - What are the reasons for these fluctuations in each species consumption during a flood year? - What are the reasons for these fluctuations each species consumption during a drought year? - Are there any fish species that were available to eat in the past that are no longer available? Why?
Fish Preference Matrix Scoring Exercise - What factors do you consider when choosing a fish to eat? List in column (probe – is size important, price, taste, how processed, hygiene, availability, nutrition, norms) - Please can you score what is the most important using the beans. A greater score (max 10 beans) represents greater importance). Record weight number. - Then list the fish species consumed again. - For each species, what are the reason you consume that species – please score from the preference list column using the beans (10 most important).	Qs - What are the reasons for your preference criterion? - Why is X more important? - What are the reasons why you have mentioned that preference for each species? - Why does this differ between species?

Appendix D

EXERCISE 3	PROBING QUESTIONS
Gears / Technique by season What gears / processing techniques do you use? What are the months when you use that gear/technique? When there is a flood, does the months when you use that gear change? When there is a drought, does the months when you use that gear change?	Why do you use that gear / technique? Why do you use that gear at different times of the year? Are there any constraints on using the gear / technique at different time of the year? What are the reasons for this? What do you think about this? What effects if any does flood have on the months that you use that gear? What are the reasons for this? What effects if any does drought have on the months that you use that gear? What are the reasons for this?
Gears by species Of the gears / techniques you use, re-list. What fish are caught / processed with which gear/ technique? What is the location that you use that gear for that species. How does the location where you use that gear for that species change when there is a flood, drought?	What are the reasons you use those techniques for that fish species? Why do you that gear in those locations? Are there any constraints on where you can use that gear? What are the reasons for this? What do you think about this? What effects does the flood / drought have on the location you use gears? What are the reasons for this?
Species Selection Preference for Fishing What are the reasons why you select to fish/process certain species? Please list. What would you consider to be the most and least important features? Please rank 10 most using beans. What species do you catch/process? List.	Number of months available, Size, Consumer preference Price sold, Ease of fishing, Tradition practice, other. What are the reasons for your choice? What are the reasons for your choice?

Which species is best for (each criterion); size, no. months available etc. Use the beans to rank; 10 most. Work across row of species for each criterion.	

Appendix EPhotovoice Manual

Eight step methodology:
1. COMMUNITY CONNECTION and CONSULTATION; Building trust.
2. PLANNING; Funding, logistics, ethics.
3. RECRUITMENT and TRAINING Participant identification, introduction, camera distribution and instructions
4. PHOTOGRAPHY ASSIGNMENT and COLLECTION; Periodic check-in on participants, camera collection and development.
5. DISCUSS PHOTOGRAPHS THROUGH INTERVIEWS; Develop narrative, reflect on images.
6. DATA ANALYSIS; Coding of main topics and themes.
7. PRESENTATION OF FINDINGS and DISCUSSION OF OUTCOMES; Cross-check interpretations, discussion on outcomes and implications.
8. DISSEMINATION; Ownership, desired audience- academia, public, policy.

A. PRIOR TO THE EXERCISE (STEPS 1and2)
1. Identify case study villages and plan all field logistics accordingly.
2. Introduce the aims of the study to community traditional leaders within the case study villages. Build a level of trust with the community via regular communication and transparency in study aims.
3. Identify adult females actively engaged in capture fisheries from the case study villages.
4. Try to locate fishers from a diverse range of wealth status and years of experience in the fishing sub sector.
5. Provide training to the translator and ensure that he/she is informed of the entire procedure in advance of presenting the exercise.

B. PRESENTING THE EXERCISE (STEPS 3 and 4)
1. Recruit a group of 7 to 10 participants via a combination of snowball and purposive sampling of participants. Invite participants to a training workshop in order to present the project.
2. At the moment of presenting the project discuss the following aspects:
    a. The objectives of the research project.
    b. The parties involved.
    c. Their rights to refuse participation or withdraw from the exercise at any time.
    d. The use we intend to give to the images collected (stress that they are not for commercial use).
    e. Any form of compensation that may be provided (none, on this occasion, except for giving back all pictures they took).
3. Ask participants to sign the consent form (**attached to this document**) or record a verbal agreement with use of a Dictaphone.
4. Explain the following to all participants:
    a. <u>**Time and length of exercise**</u>: For this study, participants will take pictures about the topics detailed below for a total of <u>two weeks</u>. Explain that each participant will be given a camera and that they only have a limited number of photos to take (specify total cap of photos). Each participant is to therefore think carefully about the questions and ensure pictures that are captured cover each topic. A research member will check-in on participants after 1 week to ensure the exercise is progressing fine. A telephone number will also be provided should participants have queries or problems throughout the exercise. Explain that the exercise does not finish when they return the camera but that you will come back to ask a few questions about the pictures she took after the pictures have been taken.
    b. <u>**How to operate the camera**</u>: Use **visual aids** to facilitate instructions of the project. Explain how the camera works. Use a spare camera for this purpose. Make sure participant understands how it works. Remind participants of the following aspects:

- The camera has up to (specify total number of pictures) takes and that there is a counter available.
- Explain that the camera does not reload automatically.
- Show them how the flash works for takes in the dark.
- Explain that it is waterproof and that participants are encouraged to take photos whilst actively carrying out activities in relation to fishing.
- Explain that if they want to take pictures of people or specific objects, they should not be too far away or too close (usually in between 2 to 5 meters).
- Remind them to be careful with mud and dust since the cameras are not rugged.
- Once you have explained these topics, hand over the spare camera to the participant to show you that she understood.

c. **Topics**: Tell the participant that we would like her to take pictures about the following three topics below. After you explained the subjects. Ask the participant to take one picture for each topic with the spare camera. Review why they took those pictures so as to make sure they understood the subjects.
- **WHAT ACTIVITIES** do you carry out in relation to capture fisheries? Ask participants to capture pictures about their day to day involvement in the fishery. Use the visual aid to explain examples of what this might include (see attachments).
- **WHAT BENEFITS** do you receive from capture fisheries? Explain to participants that they are to capture pictures about benefits arising from their involvement in the fishery. Explain that this may include: increased fish/food for the household, increased income, etc. Ask participants to take pictures about a range of perceived benefits.
- **WHAT CHALLENGES** do you experience in capture fisheries? Ask participants to take photos about challenges experienced in the fishery. Use the visual aid to explain examples of what this might include (see attachments).

d. **Safety considerations when taking pictures:** Discuss the following topics with the participants:
- Remind participants that the cameras are rather inexpensive and have a single use (i.e., they are disposable). Consequently, the risk of theft is minimal; however, they should ensure that they do not expose it too much to avoid conflicts.

e. **Ethical considerations when taking pictures:** Remind participants that they cannot take pictures of people freely. In particular remind them the following:
- They can freely take pictures of their family members but if they want to take pictures of other individuals, they should ask for permission.
- There are no restrictions for taking pictures of objects or landscapes (as long as it is safe).
- They MUST not take pictures of very ill or very old people. That is, those who cannot refuse to have their pictures taken.
- They MUST not take pictures of naked people, including children.
- They MUST not take pictures of people in a compromising situation (e.g., in the toilet, conducting illegal activities or after an accident).

f. Once participants have understood the instructions, **agree on a date and time** suitable for the participant for you to **collect the camera** in two weeks' time. Confirm any necessary telephone contact details should the time/date need to change or the participant has any questions during the exercise (reminding them that a research member to check-in in 1 weeks' time).

g. After the pictures have been revealed at a local camera/printing store, **agree on a date and time** suitable for participants to carry out an **interview about what the photographs** mean to participants.

C. DISCUSSING THE PICTURES (STEP 5)

1. On the interview day you should bring all the pictures that the participants took during the 2 week period.
2. Proceed in the following manner:

a. Ask the participant to select **<u>ONE</u>** picture that better illustrates the activities she carries out in relation to fishing
b. Once the picture has been selected ask the participant to tell you:
   i) *What's in the picture?*
   ii) *Why did they take the picture?* (explore any special meaning that the objects in the picture may have or if there are any stories / memories associated to this picture)
   iii) *Why did they select this picture, what makes it different from the other pictures they took?*
c. Proceed in the same way with the other two topics: benefits and challenges.
d. Now, taking into consideration **<u>all the activities-related pictures</u>** the participant has taken, ask her the following:
   Imagine that, of all the pictures you took, we will show ONE picture to others outside of your community to talk about fisheries activities in your village. Which one would you choose?
   Once the participant picked a picture, proceed to ask the following questions:
   - *What is in the picture?*
   - *Why did they take the picture?* (explore any special meaning that the objects in the picture may have or if there are any stories / memories associated to this picture)
   - *Why did they select this picture? what makes it different from the other pictures?*
   - *What would they like to tell to others with this picture?* What message do they want to transmit?
   - *Why would it be important to give this message to others?*

3. Reflect on conclusions and finalise any comments.
4. Thank participants for their time and inform them that you will return in a weeks' time to validate findings and return the photographs.

D. OUTCOMES, VALIDATION and DISSEMINATION (STEPS 6, 7, 8)

<u>FINAL PHOTOVOICE GROUP SESSION</u>
The aims of this final Photovoice group session are to:
- Share the meanings and stories behind the stories and to ensure that participant voices are accurately captured and represented;
- Discuss outcomes of the project and dissemination activities;
- Capture group perspective on the Photovoice experience.

Before we kindly begin the session, are you happy for me to record the session via a Dictaphone?

<u>1.PARTICIPANT CHECKING/REFLECTION:</u>
a. During this exercise, all participants will have the opportunity to share their main messages captured during the discussion over 1-2 weeks ago. Each participant will also be able to ensure that the key messages captured are correct and specify whether you would like to add any further comments.
b. To begin the exercise, we have printed out all pre-selected images captured for topic 1, 2, 3 and overall for each participant. Please take the time to review these photographs in front of you.
c. We will now relay the key messages captured for these images one-by-one for each participant. Participant 1: core activity and message; core benefit and message; core challenge and message; overall core message. Are there any amendments or further comments?
d. REPEAT FOR ALL PARTICIPANTS.
e. AT END OF INDIVIDUAL DISCUSSION ASK THE GROUP WHETHER THEY HAD ANY FURTHER GROUP PERSPECTIVES ON 1) ACTIVITIES; 2) BENEFITS; 3) CHALLENGES.

<u>2.DISSEMINATION ACTIVITIES</u>
a. We would now like to ask all participants whether you have any wishes for how the findings will be disseminated. This will be an opportunity for you to think about how you want to share your pictures and stories with others in the community and beyond.
b. To begin, we would like to know who you may want to hear your stories? Who do you want to be your target audient- other fisher communities, stakeholders such as the Department of Fisheries, international organisations and other communities world-wise?

c. Secondly, how would you like your stories and pictures to be shared with the target audience? public exhibition, international academic conferences, online.
d. As a student, I would like to disseminate your findings via a public exhibition and at international conferences. Would you be happy for me to display these photographs in front of you along with the messages captured?

3.REFLECTION ON PV PROCESS

a. We would like to finish this session by asking for group feedback on your experience of participating in the project. This information will be greatly appreciated and will help assess the value of using photography in research projects.

1. What has been your overall experience participating in this project?
2. Was taking photographs a significant or meaningful part of your experience?
3. Has your understanding of yourself and fishing changed throughout this project?
4. Do you feel like you have gained confidence and/or comfort by participating?
5. What has been the community response to the Photovoice project? Have you seen any changes (in attitudes or action)?
6. Do you feel like your voice and story was heard in this project? Why or why not?
7. How would you change this project if you were to participate again?
8. Is there anything else you'd like to add?

Appendix F Photovoice Paper

Published Photovoice Paper (Simmance et al, 2016):
Simmance, A., Simmance, F., Kolding, J., Madise, N., Poppy, M. G., 2016. In the Frame: Modifying Photovoice for Improving Understanding of Gender in Fisheries and Aquaculture. Pages 77- 90 in W. W. Taylor, D. M. Bartley, C. I. Goddard, N. J. Leonard, and R. Welcomme, editors. Freshwater, fish and the future: proceedings of the global cross-sectoral conference. Food and Agriculture Organization of the United Nations, Rome; Michigan State University, East Lansing; and American Fisheries Society, Bethesda, Maryland. ISBN 978-92-5-109263-7.

In the Frame: Modifying Photovoice for Improving Understanding of Gender in Fisheries and Aquaculture

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Abstract
Understanding the role and value of small-scale fisheries to livelihoods and food security is a key challenge in conserving fishery resources. This is particularly true for small-scale inland fisheries, one of the most under-reported and under-valued fisheries sectors, and which increasingly face environmental and societal change. Gender plays a central role in the different ways in which inland fisheries contribute to food and nutritional security in developing countries. The role of women in inland fisheries is significant with millions of women contributing to dynamic capture fisheries and aquaculture supply chains. The role of women in inland fisheries, however, is less visible than the role of men, and is often overlooked in policymaking processes. The need for participatory community based approaches has been widely recognised in natural resource management literature as a means to capture people's perspectives and empower marginalised groups. The Photovoice method is increasingly used as a participatory tool in health, social, and environmental research, but has had little adoption in inland fisheries research to date. The aims of this paper are: (1) to review and evaluate the effectiveness of an emerging participatory method, Photovoice; and (2) to present a modified Photovoice method, applicable to the context of small-scale fisheries, to advance understanding of gender and socio-ecological dimensions. We outline the strengths and limitations of the method and highlight that it can be used as a tool for triangulation of mixed research methods or independently. We argue that Photovoice, as a participatory tool in fisheries research, has the potential to provide rich qualitative, context specific, untapped sources of knowledge to advance fisheries research and management. The use of Photovoice in the context of small-scale inland fisheries and aquaculture research is a timely endeavour given heightened interest to obtain insights into the previously overlooked aspects of gender and the need for more policy relevant information.

1. Introduction

The role of women in the capture fisheries sector has traditionally been less visible with a long-standing assumption that the sector is dominated by men worldwide (Davis and Nadel-Klein, 1992; Bennett, 2005; Williams et al, 2004). This incorrect assumption has been reinforced by the exclusion of women from registering in the sector in some countries (HLPE, 2014). Women and men, however, are increasingly viewed as both having an important role in fisheries and aquaculture worldwide (Allison and Ellis, 2001; FAO, 2006; FAO, 2012). For instance, a recent study by Mills et al (2011) provided the first known estimate of gender characteristics in the capture fisheries sector worldwide. The authors estimated that 50% of the 120 million fishers employed in capture fisheries were women, with the vast majority employed in post-harvest activities (such as processing and packaging) of small-scale fisheries in developing countries. In terms of the aquaculture sector, comparable estimates about gender characteristics to those for capture fisheries do not exist. However, entry into aquaculture is known to have fewer gender barriers than capture fisheries, resulting in more women actively participating in diverse aquaculture activities (including pre-harvest, harvest, and post-harvest activities) (Weeratunge et al, 2010; Williams et al, 2012b).

As a result of limited gender data in fisheries and aquaculture, little policy attention has traditionally been given to the gender dimension in these sectors. Nevertheless, there have been some recent promising attempts to promote a more holistic view of fisheries and aquaculture in policy, including greater attention to gender (FAO, 2012b; Williams et al, 2012a; FAO, 2015). For example, the FAO (2015) led Voluntary International Guidelines on Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) recognises the important role of gender in relation to equitable access to resources, decent work, management voice, and activities, among others. The expansion of fisheries policy discourses to include a more holistic approach to fisheries management, is resulting in an increasing need to include gender in the understanding of both social (Weeratunge et al, 2010; Williams, 2010; Harper et al, 2013; HLPE, 2014) and ecological systems (Kleiber et al, 2014). For example, a recent review by the High Level Panel of Experts (HLPE, 2014) on Food Security and Nutrition highlights that gender can influence the different mechanisms that determine access to fish and nutrition, both within the general population (as consumers) as well as population groups directly involved along supply chains (as producers, processors, and traders). Women can also play a dominant role in prioritizing food for household members (Quisumbing et al, 1995; Porter, 2012) and have been identified as providing an untapped potential source of valuable local ecological knowledge (LEK) for improved fisheries management (Kleiber et al, 2014).

A gap in understanding gender patterns in fisheries and aquaculture, however, continues to be widely reported in the literature (Neis et al, 2005; FAO, 2009; FAO, 2014; Bene et al, 2016). More specifically, a dearth of gender-disaggregated data in the fisheries and aquaculture sectors exists which limits the accurate understanding of how these sectors function (Geheb et al, 2008; FAO/IFAD/WB, 2009; Harper et al, 2013). A recent review by Kleiber et al (2014) highlights that biases in sampling methods and research have led to significant gaps in gender-relevant data in small-scale fisheries. This paper aims to address this information gap by: (1) reviewing and evaluating the effectiveness of Photovoice as an emerging method in community based participatory research; and (2) presenting a modified Photovoice method, applicable to the context of small-scale fisheries, to advance understanding of gender dimensions and socio-ecological aspects of fisheries and aquaculture. This review aims to connect thinking about gender dimensions in fisheries and aquaculture with respect to: a) the roles and contributions of women and men; b) the varying socio-economic benefits they obtain; c) the constraints they experience, and d) the characteristics of the fishery. We argue that Photovoice serves as a lens to provide a richer understanding of socio-ecological dimensions of small-scale fisheries and aquaculture.

2. Photovoice – Addressing the Need for Gender Sensitive Methodological Approaches in Fisheries

The use of participatory approaches in research have arisen to provide a more in-depth analysis of the views of local people that could otherwise not be achieved through standard social methods such as questionnaire surveys (Chambers and Conway, 1992; Petty et al, 1995; Schreckenberg et al, 2010). The application of participatory approaches, during the past two decades, has increased in literature associated with the management of natural resources. The drive to include a more participatory approach to fisheries research has largely arisen from a number of perspectives, including the move towards interactive governance and participation in fisheries management, as well as the importance of collaborative learning in small-scale fisheries (Wiber et al, 2009; Jacobsen et al, 2011; Kolding et al, 2016; FAO, 2015).

Participatory research is described as having considerable, yet often unrealised, potential in advancing fisheries research globally (Wiber et al, 2009). In fisheries literature, a range of participatory methodologies have been implemented which have been classified into four models as described by Hoefnagel et al (2006): 1) Deference Model- requiring the role of fishers as research assistants, e.g. Ticheler et al (1998); 2) Experience-Based Knowledge (EBK) Model- emphasises fishers' observations as a supplement to research-based knowledge, e.g. Wilson et al (2006); 3) Competing Constructions Model- understanding differences in stakeholder objectives leading to biases in presenting knowledge, e.g. Finlayson (1994); and, 4) Community Science Model- promotes collaborative fisheries science through incorporation of models 1-3 with effective communication. Hoefnagel et al (2006) suggests that the ideal method to participatory fisheries research is the Community Science Model of Interaction, which provides a more collaborative and holistic approach to the development of research by scientists and fishers. Although a range of qualitative and quantitative methods have been applied in fisheries and aquaculture research, flexible and creative tools have been called for to: a) capture the complexity of context specific factors (Harper et al, 2013; Kleiber et al, 2014); b) produce policy relevant results (Wiber et al, 2004); and c) to integrate the views and realities of fishers within the management process (Jacobsen et al, 2011).

One innovative Community-Based Participatory Research method that has been increasingly reported in the literature as having the potential to offer considerable promise for use with marginalised, often neglected, illiterate populations is the Photovoice process (hereafter referred to as Photovoice). Photovoice is a unique form of Community-Based Participatory Research founded on the principles of feminist theory, constructivism, and documentary photography. The originators, Wang and Burris (1997, pg. 369) describe Photovoice as a process by which ''people can identify, represent and enhance their community through a specific photographic technique.'' The Photovoice process involves providing participants with the opportunity to take photographs of a particular community issue that are then used to facilitate participant's critical reflection. Throughout the process, participants have control over what they document, what conclusions to report, and how to catalyze change in their communities (Wang and Burris, 1997). The Photovoice process typically comprises several stages, including: recruitment and training, photography assignment, group or individual selection and discussion of photographs, coding of themes from the photographs and a final phase to create research outputs (Wang and Burris, 1997; Castleden et al, 2008). The theoretical principles underpin the overarching goals of Photovoice, which are: "(1) to enable people to record and reflect their community's strengths and concerns; (2) to promote critical discussion and knowledge about important community issues through large and small group discussions of photographs; and (3) to reach policymakers" (Wang and Burris, 1997). At its center, Photovoice seeks to make community needs more visible and to empower illiterate participants to advocate for changes at the individual, community and policy level (Wang and Burris, 1997). As a participatory method, Photovoice offers considerable promise for use in working with vulnerable, uneducated, and marginalised populations, such as women in the fisheries sector, due to its flexibility in design and use of photography as a means of language. Photovoice uses the means of photography to capture community issues and interests through a research process directed towards equal sharing of research decisions and empowerment of participants. The participatory method has proven to be successful in capturing complex context specific issues, as well as producing high quality, richer, and policy relevant research (Bennett and Deardon, 2013; Kong et al, 2015). Furthermore, by facilitating closer participant-researcher interactions, Photovoice provides a promising tool in meeting the desired Community Science Model of Interaction in participatory fisheries research. Lastly, Photovoice may be effective in gathering sensitive gender information, which as highlighted by Williams et al (2012b), is best achieved by gathering data about "gender roles and contributions […] within their context and characterised with respect to economic, social and individual assets and people's needs".

3. Review of Photovoice in Natural Resources Studies

A comprehensive overview of the application of Photovoice in public health and related disciplines can be found in the work by Hergenrather et al (2009) and Catalani and Minkler (2010). Given the increasing application of Photovoice within the field of natural resource management, a comprehensive literature review was carried out to evaluate the use of Photovoice within this broad area of research. The literature review included the search terms - 'Photovoice; 'Photovoice'; 'Photo voice'- in two main search engine domains: Science Direct and Web of Knowledge. The initial search using these keywords resulted in 113 peer-reviewed articles. After reviewing all abstracts and removing those that did not lie within natural resource management literature, a total of 10 studies were identified for evaluation (Bosak, 2008; Castelden et al, 2008; Baldwin and Chandler, 2010; Beh, 2011; Tanjasiri et al, 2011; Berbes-Blazquez, 2012; Bennett and Deardon, 2013; Bisung et al, 2015;Crabtree and Braun, 2015; Kong et al, 2015). From this evaluation and building on work by Palibrodo et al (2009), a summary of the advantages and limitations of applying the Photovoice method was drawn (see Table 1). The use of Photovoice in fisheries and aquaculture research has, to our knowledge, only been applied to a small number of studies, with only one reported study carried out in a developing country, and no reported studies within the context of small-scale or inland fisheries (Bennett and Deardon, 2013).

Overall, the evaluation reveals growing recognition that Photovoice provides a powerful tool in addressing complex social-ecological issues and in capturing unique perspectives of marginalised populations in diverse settings (Berbes-Blazquez, 2012; Bennett and Deardon, 2013; Kong et al, 2015). In addition, a few studies highlight that Photovoice generated more enriched data and opportunities for mutual learning between researcher and participant than traditional research methods such as semi-structured interviews, and is a valuable tool for triangulation of mixed methods (Bennett and Deardon, 2013; Kong et al, 2015; Baldwin and Chandler, 2010).

4. Modified Photovoice Methodology for Fisheries and Aquaculture Research

Participatory research tools must be adaptable to a community's particular circumstances and context. It is not surprising, therefore, to find that during the previous decade, Photovoice has evolved into a more flexible participatory methodology from Wang and Burris's (1997) original static description. As evident from the review presented here, Photovoice has increasingly been modified and applied to fit a diverse set of cultures, research topics and geographical contexts (Castleden et al, 2008; Bennett and Deardon et al, 2013).

Although many successful modifications of the Photovoice method exist, the development of an improved version of the Photovoice process was deemed necessary within this review to address: 1) inherent challenges in participatory small-scale fisheries research; and 2) limitations reported with applying Photovoice.

Standard stages involved in the Photovoice process were modified based on standard steps from Wang and Burris (1997) and on best practices of steps taken from studies (see Appendix A). Taken into account, these modifications and steps suggested by other studies (Castleden et al, 2008; Bennett and Deardon, 2013), an improved eight step Photovoice process was developed as described below:

1. Community connection and consultation- building trust;
2. Planning- funding, logistics, ethics;
3. Recruitment and group training session- participant identification, introduction, camera distribution and instructions;
4. Photography assignment and camera collection - periodic check-in on participants, camera collection, and development;
5. Discussion of photographs through individual interviews- development of narratives through critical reflection on images;
6. Data analysis- coding of main topics and themes;
7. Group discussion- verification of key messages, identification of dissemination activities, and evaluation of the Photovoice experience; and
8. Dissemination- communication of outcomes to targeted audiences.

Changes were made to the recruitment, training session, and interview format, length of study, photography assignment, and evaluation stages. The changes address limitations outlined in **Table 1.**

The modified process serves as a flexible tool for application within the context of small-scale fisheries, and to be adaptable to fit the particular needs, budget, and timescale of a research project. Box 1 outlines in detail the steps and proposes questions that aim to understand socio-ecological aspects of small-scale fisheries through a gender approach.

5. Conclusion

Photovoice has increasingly been modified and applied to fit a diverse set of cultures, research topics, and geographical contexts (Castleden et al, 2008; Bennett and Deardon, 2013). Limitations have been reported that are deemed manageable, and the strength of Photovoice as a participatory tool providing rich qualitative and context specific data has been highlighted by several studies. A modified version of Photovoice is presented, which addresses limitations, builds on Wang and Burris (1997) and best practices applied, and which can be taken forward in the context of small-scale fisheries in a gender sensitive approach. Through the lens of Photography, the method serves to portray context specific ´real life´ imagery of community issues through the unique perspectives of participants over and above what other traditional methods can capture (Kong et al, 2015, Bennett and Deardon, 2013). In addition, the Photovoice process allows marginalised peoples to become empowered and more able to advocate for change at the individual, community and policy levels (Wang and Burris, 1997). This paper describes a modified and flexible Photovoice method applicable to understanding rich context specific social and ecological information in diverse small-scale fisheries contexts. This improved Photovoice method, applicable to small-scale fisheries, contributes to the growing methodological literature in fishery research and provides a timely endeavor to advancing wider social-ecological understandings of small-scale and inland sectors.

6. Acknowledgements

This work is supported by the World University Network (WUN) and the Economic and Social Research Council Doctoral Training Centre (ESRC-DTC) University of Southampton.

Appendix G Supporting Information for Chapter 5

COPING STRATEGY INDEX

Table 1 –Coping Strategy Index severity weights

Food Coping Strategy	**rCSI Weights** (Maxwell and Caldwell, 2008)	**Perceived Severity Weights***
Eating less preferred food	1	2.62 (0.65)
Limiting portion sizes	1	2.46 (0.74)
Borrowing food or money to buy food	2	2.68 (0.62)
Limiting adult intake	3	2.39 (0.85)
Reducing the number of meals	1	2.46 (0.81)
Going without food for whole days	n/a	2.92 (0.33)

*Note: Mean (standard deviation) of household respondents based on a 3-point scale: 1. Not worried; 2. A little worried; and 3. Very worried.

PRINCIPAL COMPONENT ANALYSIS

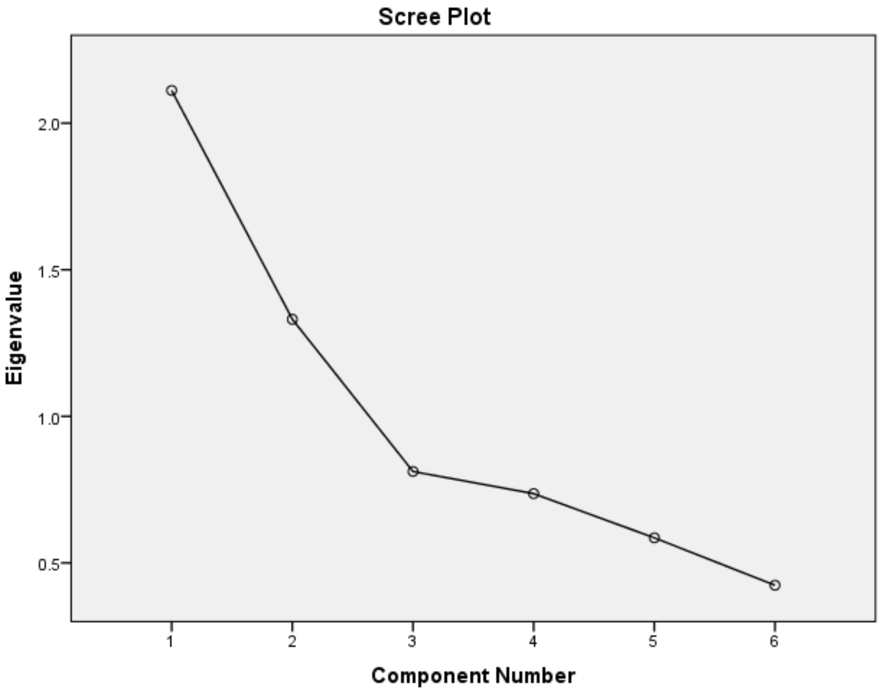
The component matrix, communalities and scree plot is presented for the Principle Component Analysis of asset variables.

Table 2 – Principal Component Analyses loadings created for the Asset Index.

Household Asset Ownership Item	**Components**	**Communalities**
Presence of Asset Cement Floor	**.801**	.641
Presence of Asset TV	**.655**	.429
Presence of Asset Modern Furniture	**.643**	.413
Presence of Asset Iron Roof	.596	.356
Presence of Asset Phone	.377	.142
Presence of Asset Bicycle	.361	.130

Note: Bolded items indicate major loadings for each item.

Figure 1 – Scree Plot for PCA of One Factor Solution of Household Asset Ownership Items


Scree Plot
Eigenvalue
2.0
1.5
1.0
0.5
1
2
3
4
5
6
Component Number

Appendix H Ethics Application Form

UNIVERSITY OF SOUTHAMPTON (SSEGM) ETHICS SUB-COMMITTEE APPLICATION FORM: APPROVED (Reference: 14728)

1. Name(s): Fiona Simmance

2. Current Position Post Graduate Researcher

3. Contact Details:

Division/School Faculty of Natural and Environmental Sciences

Email fs2g13@soton.ac.uk

4. Is your study being conducted as part of an education qualification?

Yes ● No 0

5. If Yes, please give the name of your supervisor

Guy Poppy and Kate Schreckenberg

6. Title of your project:

The value of small-scale capture fisheries for food security in Lake Chilwa, southern Malawi, and the impacts of climate variability on this.

7. Briefly describe the rationale, study aims and the relevant research questions of your study

The purpose of this project is to understand the relationship between small-scale inland capture fisheries, climate variability and food security in Lake Chilwa, southern Malawi.

There is a global gap in understanding the current status of small-scale inland capture fisheries in terms of yield and trends, their role to food security and poverty alleviation, and understanding the drivers of change. This has been due to the complex characteristics of small-scale inland capture fisheries; informal, multi-gear, multi-species, dispersive and remote. As a result, the sector has often been underreported, undervalued, assessed using inappropriate methods (based on traditional marine fisheries science), and mal-managed.

Lake Chilwa in southern Malawi has been characterised as one of the most productive lake fisheries in East Africa, but also one of the most highly unpredictable. Due to the lakes shallow depths, it is highly sensitive to climate variability and has experienced extreme water level variability throughout its history. It has been argued that the fisheries are adapted to water level change and are highly resilient. Within the lakes catchment, 1.5 million people depend on its natural resources, including fisheries, for their livelihoods and food security. It has also been argued that communities are well adapted to the lakes high variability via adopting diverse livelihood strategies; 'fisher-farmer' strategy.

These theories have led to the argument that fisheries management measures are not appropriate as fisheries are governed by the short term changing environment rather than fishing effort. In addition, it has been outlined that fishing is unselective in small-scale inland capture fisheries and are sustainable as a balanced harvest rather than being destructive through single species selection. Lake Chilwa basin however is experiencing multiple stressors of increased population growth, increased demand on natural resources, increased competition for water use, increased lake water level fluctuation and a decline in capture fisheries yields.

The project aims to understand the relationship between capture fisheries, climate variability and food security which will be investigated via the following key questions:

1. How does water dynamics effect fish supply?
2. Do fisher households eat more fish and have higher food security than non-fisher households?
3. Do fishers experience differences in fishing patterns, catch and fish consumption seasonally and during environmental shocks?

4. What is the role of gender in the fishing industry and do differences exist by gender in the perceived differences?

8. Describe the design of your study

This application refers to the second and final phase of field work of this project.

Building on phase I of this study (completed in July, 2014), this phase of the study will use a mixed methods approach to address objectives 2 to 4. Methods will include both quantitative and qualitative approaches: quantitative household surveys (HHS) and fisher producer surveys, and qualitative participatory rural appraisal exercises, Focus Group Discussions (FGDs) and the Photo-Voice methodology. The strength of this approach is that it enables 'triangulation' of results where the weaknesses of one method will be supported by the strengths of another. Adopting an interdisciplinary and mixed methods approach is widely viewed as an effective approach when investigating the complex socio-ecological relationships between capture fisheries and livelihoods.

Two villages located around Lake Chilwa will be purposively selected as case study villages based on a technical criteria, accessibility and acceptability by the community members and chief. The sampling procedure of the villages will not be designed to be statistically representable to larger populations, at the district or national scale, from which the samples will be drawn. The intention is to spend one month in each of the two case study villages to undertake the mixed method surveys. Two villages will be selected based on the following technical criteria; characterised as a fishing village, next to a fish landing site/beach/lake shore, women processors present, male fishermen present, one village near to a main market, one village further away from a main market, safely accessible by road. Based on this criteria, the two villages selected are as follows; 1. Likapa village next to the main fish landing site; Kachulu, and 1 hour from Zomba market, and 2. Sauka Phimbi village which is further away from Kachulu. Both are within the district of Zomba. Reserve villages are Mchenga which is also next to Kachulu and within the district of Zomba. Finalisation of village selection will be undertaken in the field with further confirmation from the District Officer and local Fisheries Officer that the villages will still meet the criteria after the floods in January and February, and with acceptance of the Village Headman for two villages.

Quantitative household surveys: HHS will be used to investigate objective 2; the role of fish to household food security and livelihoods of fisher and non-fisher households, as well as to part investigate objective 3 and 4. The survey will be in the form of closed questions that include ranking and multi-choice options. The questionnaire will be carried out in the two case study fishing villages located around Lake Chilwa. The household head and fisher members in the household will be surveyed. On approval of working in the selected villages, a listing of households will be undertaken. A short filter questionnaire with a key village informant (Village Headman) will be undertaken to identify households involved in the fishing industry and those not. Typical villages in the districts are between 20 – 200 households. Stratification of the households by involvement in the fishing industry (yes or no) will be undertaken. From the fishing industry group, I will aim to select 40 households. I will further stratify these fisher groups by gender to ensure that women processors are represented. Selection of the fisher group households by gender will be done using a random number generator. A minimum number of 5 women processors will be selected, with the aim of 10 to be selected. From the non-fisher group I will aim to select 20 households using a random number generator.

Focus Group Discussions (FGDs): FGDs will be primarily used to investigate objectives 3 and 4 in depth. Semi-structured interview guides will be used to obtain in-depth knowledge about the changes in fisheries production, the importance of fisheries as a livelihood, perceptions of governance and the role of fisheries to food and nutritional security at the community level. A semi-structured guide will be used to provide consistency across groups as well as to provide flexibility to probe for local knowledge, values and experiences by the participations. The target population for the FGDs is adult fishers who are actively involved in Lake Chilwa's fishery. Participants will be purposively selected based on: gender, years of experience of fisher and intensity of fishing activity (large-scale, small-scale). In terms of geographical spread, participants will be selected from the two case study villages located around Lake Chilwa in Southern Malawi. An estimated six FGDs will take place in each of the two villages (groups separated by gender). The interviews will incorporate the use of the following Participatory Rural Appraisal exercises: seasonal calendars, timelines and matrix ranking exercises.

A modified Photo-Voice methodology will also be used as a final qualitative tool to capture the views of women involved in the fishery through the use of photography for objective 4. The target group will be adult women involved in the Lake Chilwa fishery who will be purposively selected from each of the two case study villages. A small group of women; approx. 5, will be selected in each village and each participant will be given a disposable camera to capture their experiences of their involvement in the fishery and values of the fishery to their livelihood. An interview will then be organized to develop a narrative behind the photos and gather an in-depth understanding about the participant's views and experiences.

By spending time within each community, it is hoped that a level of confidence and trust will be earned by the researcher so that community members will feel confident with discussing characteristics of the fishery, their livelihoods and perceptions of governance. The sequence of methods will be undertaken in the most sensitive way such as starting with KIIs with elders on timeline of villages, FGDs, HHS and ending with KIIs with governance leaders.

The data obtained from this study will be analyzed quantitatively and qualitatively. The software- SPSS and NVivo- will be used to analyze the data obtained.

All survey information including participant information sheet and consent form will be translated into Chichewa.

Please note that the surveys and tools attached are to be finalized after piloting in the field.

9. Who are the research participants?

The proposed samples will be adult members (above 16 years) of fishing / farming communities and adults who are involved in the Lake Chilwa fishery value chain.

10. If you are going to analyse secondary data, from where are you obtaining it?

Secondary data will be obtained from the existing collaborator: the WorldFish Centre, as well as from the Department of Fisheries.

11. If you are collecting primary data, how will you identify and approach the participants to recruit them to your study?

Please upload a copy of the information sheet if you are using one – or if you are not using one please explain why.

Case study fishing villages will be purposively selected and identified with assistance from experts from the WorldFish office in Malawi (an existing collaborator to this project). Once two villages have been selected based on technical and logistic criteria, participants will be approached through traditional community leaders who will be approached with the assistance from local authority extension workers. If recruitment is insufficient, alternative village case studies will be found. A letter of invitation for members of the community to participate in this project, accompanied by a summary of this project, will be provided to the traditional community leaders. Communication will also be assisted by experts from the WorldFish office in Malawi who have direct experience of working with a diverse range of local fishers and stakeholders in this field. As a researcher with a professional background in fisheries management, I have a good track record of success using this approach.

An information sheet will be provided to participants from each community and will also be covered verbally with the participants at the outset of the interview/survey. This information is scripted and is included in the Participant Information Sheet document. All survey information including participant information sheet and consent form will be translated into Chichewa.

12. Will participants be taking part in your study without their knowledge and consent at the time (e.g. covert observation of people)? If yes, please explain why this is necessary.

No

13. If you answered ‘no’ to question 13, how will you obtain the consent of participants?

Please upload a copy of the consent form if you are using one – or if you are not using one please explain why.

No, the participants will be informed in advance regarding the aims of the survey/interview. Participants will be briefed verbally regarding the nature of the study and what the interview or survey will involve when they are recruited, and this will be reiterated more fully at the start of the interview. A written information sheet and consent form will be used as part of the consent process. Consent will be obtained in either written or recorded verbally form according to the preferences/illiteracy of the participant, and the consent form will be constructed such that it can provide a script to this oral consent where this is appropriate.

14. Is there any reason to believe participants may not be able to give full informed consent? If yes, what steps do you propose to take to safeguard their interests?

When interviewing or carrying out the survey it is likely that the interviews will be conducted with the participation of an interpreter, which may affect the clarity of communication regarding consent. Attempts will be made to recruit an interviewer with experience of research, and the interpreter will be interviewed at the outset of the process which will help to establish the importance of consent through their own experience.

15. If participants are under the responsibility or care of others (such as parents/carers, teachers or medical staff) what plans do you have to obtain permission to approach the participants to take part in the study?

Not applicable.

16. Describe what participation in your study will involve for study participants. Please attach copies of any questionnaires and/or interview schedules and/or observation topic list to be used

Participants will be approached, either by the researcher and translator, or a community member (who has been asked to recruit participants) and will be informed of the research process (including what the research is about, time needed to participate and payment given) and asked if they would like to participate.

Consent will be given (see above) and the research will commence. Depending on the type of research, participants will be asked to give between 1 hour and half a day of their time and payment will be made accordingly to the amount of time taken. The researcher will ask questions to the participants, which will be translated by the translator. The translator will then translate the responses back to the researcher.

Participants will be asked to be interviewed individually or as part of a group of 6-8 people. Specific questions will be asked by the researcher to guide group interviews, but the intention is that the semi-structured nature of the FGDs and more participatory nature of the Photo-Voice method will allow participants to discuss topics amongst themselves and with the researcher. During the HHS, participants will be asked more structured questions. The attached surveys and interview schedules, will be used as a guide for the researcher in the FGDs, Photo-Voice and HHS methodologies. All methods will be conducted with the aid of an interpreter, and it will be audio recorded.

Once the session is complete, the researcher will summarise the points made by participants, ask if participants have any questions or further items they wish to discuss, and then the researcher will thank the participants for their time, and make any payments necessary. The ASSETS project in Malawi which is run by Southampton University, to which this project is linked, has a compensation policy, where these payments are not 'compensations' for time but actually to be seen as a way of saying thank you to the participant.

17. How will you make it clear to participants that they may withdraw consent to participate at any point during the research without penalty?

This will be made clear during the provision of information at the outset of the interviews/surveys as part of the consent process. It will be stated that the participants can withdraw their participation at any time while answering the questionnaire/interview guided questions and there will not be any follow-up communication. At the conclusion of the interviews/surveys, the participant will be informed that it has been completed and asked whether they are still happy for the conversation to be used as part of the research. Full personal contact details will be established for the individual to contact if they decide at a later date that they would prefer to withdraw their consent. In addition, details of a local point of contact kindly provided by my collaborator; the WorldFish Centre, will be provided so that this opportunity is accessible to them and the researcher can be informed.

18. Detail any possible distress, discomfort, inconvenience or other adverse effects the participants may experience, including after the study, and you will deal with this.

Some of the questions posed request for the participants' personal details and perceptions of existing rules governing their livelihood or fishing activity. The participants may feel a bit uneasy to share their personal details and experiences regarding these questions. The participants will also be required to reflect on changes in their livelihoods and nature of fishing activities. They may feel obliged to answer or feel a bit uneasy to answer some of these questions, particularly if the changes occurred are negative. To overcome possible distress, participants will be reassured that their answers will only be used for this study and individual answers will not be shared with anyone. In addition, the surveys/interviews will be conducted at the participant's pace, the semi-structured approach of interviews will allow participants to direct the conversation away from topics that they consider to cause them discomfort; and/or participants will be reminded that they can choose not to respond to the questionnaire. In the event that the participant is distressed, the opportunity to move to another topic, take a break, postpone the interviews/surveys to a future occasion or withdraw from the process will be offered. Full contact details will also be provided should participants have any concerns post the interview.

19. How will you maintain participant anonymity and confidentiality in collecting, analysing and writing up your data?

Should participants wish to endorse anonymity and confidentiality with respect to their views expressed in the interviews/questionnaires, then pseudonyms will be used for all individuals' referred to in transcripts and all other research output so that the views of these individuals cannot be identified. Audio recordings, transcripts and other documents will be stored electronically and password protected. In any materials released, such as reports or articles, pseudonyms will be used for any quotes and the use of other identifying information such as dates and locations will either be avoided or changed. The focus will be on the meaning attached to experiences and views rather than the historical content of these which could be linked back to the participant. Interviewers participating in the study will sign a confidentiality agreement and be fully briefed prior to and following interviews, which will include clarifying confidentiality requirements of the study.

20. How will you store your data securely during and after the study?

The University of Southampton has a Research Data Management Policy, including for data retention. The Policy can be consulted at http://www.calendar.soton.ac.uk/sectionIV/research-data-management.html

Data stored electronically will be password protected and stored on a laptop and backed up on a secure online location and in a hard drive for ten years (in accordance with section 5 of the Research Data Management Policy). The password will only be known to the researcher and supervisor. The laptop will be either in the direct supervision of the researcher or locked up at all times during the study.

Paper records will be kept to a minimum during the study, and will be kept in a locked location when not in use or while being transported. Personal information will only be included on printed information where it is essential (e.g. consent forms or interview schedules) and this will be either scanned for secure electronic storage and destroyed, or placed in locked storage, immediately after use.

After the study only electronic records of personal data will be retained and stored securely as above.

21. Describe any plans you have for feeding back the findings of the study to participants.

Participants will be offered the opportunity to receive a summary of the findings following the research, which may be provided by my in-field collaborators from WorldFish Centre in an appropriate form such as radio station, or a final meeting in each village with the leaders to feedback immediate results.

22. What are the main ethical issues raised by your research and how do you intend to manage these?

There may be particular ethical sensitivities that arise when reflecting on livelihood and fishing activity experiences. Some of the questions will be asking for the participants' opinions and reflection on livelihood and fishing activity experiences as well as personal details. Participants may feel un-easy to answer these questions. However, the use of semi-structured interviews, the opportunity to not respond to questions and voluntary nature of the methods will enable the participant to stop or move on within the interview/survey questions. For this reason, the process of endorsing confidentiality will be transparent. English and Chichewa are Malawi's two official languages and the translator will translate the questions into the local participant's language.

23. Please outline any other information you feel may be relevant to this submission.

In the context of much international work, personal relationships and in the field contacts are paramount in the success of any project. This PhD study is linked with the University of Southampton led ASSETS project which involves collaborators with two organisations in Malawi: the WorldFish Centre and LEAD. This project is fortunate to have gained the support of both organisations with the lead collaborator being Joseph Nagoli from the WorldFish Centre. My colleague Joseph Nagoli has been engaged in this project right from the beginning and has kindly provided support in the selection of villages and in securing arrangements, such as office space, in the field.

I carried out the first phase of data collection in Malawi last year. Having visited the field site and successfully completing the objectives of phase I, I feel confident and have strong competencies to carry the proposed methods of this final phase.

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