PERCEPTIONS AND ADAPTATION STRATEGIES OF FISHERS TO CLIMATE VARIABILITY: A CASE STUDY OF LAKE KARIBA FISHERY, SIAVONGA DISTRICT

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in Environmental and Natural Resources Management

The University of Zambia

2016

Declaration

I, Mulako Kabisa, do hereby declare that with the exception of quotes and work of other people, which I have duly referenced and acknowledged herein, this dissertation, is the result of my own original work. This work has not been presented to another university in pursuit of a degree before.

Mulako Kabisa

Approval

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ABSTRACT

Siavonga district has for the last two decades experienced rainfall that is declining, unpredictable and poorly distributed and increasing temperatures. Climate impact studies on Lake Kariba Kapenta fish stocks show that increased temperature and reduced rainfall are the main climatic factors affecting fish catch. However, very few studies have considered resource users perceptions and their adaptation to climatic variability and change.

The aim of the study was to investigate the perceptions of Kapenta fishers on climate variability and their adaptation to its impact in Siavonga district. Perceptual statements, socio-economic characteristics and adaptation strategies data were collected using a questionnaire. A Likert scale, descriptive statistics and multiple regression using SPSS 16.0 and content analysis using the code of conduct for responsible fisheries and the climate-smart agriculture sourcebook were used to analyze the data collected. A random sampling technique was used to select 90 rigs out of a total of 157 fishing rigs in Siavonga district.

The study showed that the majority of fishers were aware of climate variability (79 respondents, 87.7%). The general perceptions were that, about 44 (49.2%) respondents perceived a decrease in rainfall; about 53 (59%) respondents perceived a decline in fish catches; and 49 (54.1%) respondents did not know if there had been a change in temperature. Multiple regression analysis showed that Age ($p \leq 0.01$), Years of Fishing Experience ($p \leq 0.024$) and Number of Extension Visits ($p \leq 0.054$) had the most significant relationship with perception of climate variability. About 9 (10%) respondents were not adapting to any changes in climate or catches and 81 (90%) respondents were adapting to impacts of climate variability using a variety of strategies. Of the strategies, 64.3% of the strategies used have the potential to be climate-smart.

It is concluded that fishers do perceive climate variability and these perceptions are affected by their socio-economic characteristics. The fishers are adapting to these changes, with the majority of the strategies having the potential to be climate-smart.

To my Husband, Father and Mother

ACKNOWLEDGEMENTS

This project would not have been possible without the support of many people. Many thanks go to my supervisor, Dr. D. Chibamba, who read the numerous revisions of my ideas and helped me with valuable comments and insights. I would like to thank the Food and Agriculture Organization of the United Nations for awarding me a scholarship to pursue my research. I would also like to thank the technical specialists I came into contact with in different capacities from FAO and School of Agriculture for their inputs, particularly Mr. Misael Kokwe, Dr Aslihan Arslan and Dr T. Kalinda. Your help is much appreciated.

Special thanks go to Mr. Wamulume (Fisheries Officer), Mr. Siamatika and Mr. Miyanda (Fisheries Technicians) from the Department of Fisheries who made my camping and navigating the lake possible.

And finally thanks to my husband, Shakayobo Shandavu, my mother and father, Mr. and Mrs. Kabisa, for their unwavering support and love during this long process.

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro-Ecological Zone
CSA	Climate-Smart Agriculture
CPUE	Catch Per Unit Of Effort
DoF	Department Of Fisheries
EAF	Ecosystem Approach To Fisheries
EU	European Union
ESA-IO	Eastern and Southern Africa – Indian Ocean
FAO	Food and Agriculture Organization Of The United Nations
GPS	Global Positioning System
IPCC	Intergovernmental Panel For Climate Change
LIFE	Low Input Fuel Efficient
NAP	National Agriculture Policy
NCCP	National Climate Change Policy
NCCRS	National Climate Change Response Strategy
NGO	Non- Governmental Organization
SNDP	Sixth National Development Plan
SPSS	Statistical Package For The Social Sciences
USAID	United States Agency For Aid And Development
ZMD	Zambia Meteorological Department

CHAPTER ONE: INTRODUCTION

1.1 Background

Climate variability is the tendency of seasons changing from normal to unpredictable trends (Shemdoe and Kihila, 2012) and climate change is a change in climate that can be identified by variability of its properties persisting for an extended period of time, typically a decade and longer (IPCC, 2014). Increased alternating occurrence of droughts and floods are seen to be the predominant effects of changing climate in Zambia (Carouche, 2010).

Zambia is divided into three major agro-ecological zones (AEZ) (FAO, 2015). The distinguishing climatic factor of these regions is rainfall. AEZ I is found in the Luangwa Zambezi rift valley region and receives less than 800mm of rainfall per year. AEZ II is found in central, eastern and southern plateau regions and the western semi-arid plain of Zambia. The region receives 800mm to 1000mm of rainfall per year. AEZ III is the northern high rainfall zone receiving 1000mm to 1500mm of rainfall per year. Lake Kariba is found in the low rainfall area of AEZ I. For the last 2 decades, AEZ I has been experiencing declining, unpredictable and poorly distributed rainfall (USAID, 2012). The report further states that the observed meteorological data suggests that it is currently the driest zone and very prone to droughts and is experiencing the impacts of climate change.

Fishing in Zambia is dominated by artisanal fishers using traditional vessels (Musumali *et al.*, 2009). The expected effect of a changing climate on fisheries is water shortage, disturbing whole ecological systems (Carouche, 2010).

Lake Kariba is a man-made lake located on the Zambezi River forming the border between Zambia and Zimbabwe. It is important for hydro-electric power generation, artisanal and subsistence fishing, industrial (Kapenta) fishing, tourism, water supply and transport. Lake Kariba is an inland capture fishery that has three districts along its shores on the Zambian side. These are Sinazongwe, Gwembe and Siavonga. The Kapenta fishery is pelagic in nature and is semi-industrial. It was opened in the early 1980s (Overa, 2004).

Pelagic zones of African great lake fisheries are known to undergo pronounced climate induced fluctuations and catches of small pelagic fish particularly fluctuate extensively year to year in response to climate driven variations affecting both primary and secondary productivity (Allison and Sarch, 2000).

The impact of changing climate on inland capture fisheries interacts with existing drivers, trends and status of fisheries such as over fishing and management practices. Inland fish stocks affected by pollution, introduction of alien species, habitat alteration will have their challenges further exacerbated by climate change impacts (Daw *et al.*, 2008).

An individual's perception is the mental picture of local climate variability, changes and responses in seasonal changes using individual and cultural experiences (Cortes-Sanchez and Chavero, 2010). How fishermen perceive climate variability impacts on their interactions with other interest groups and consequently institutions that manage the resource (Zhang *et al.*, 2011). Primary resource users are known to be keen observers of climate changes and are actively trying to adapt to changing conditions (Ishaya and Abaje, 2008). It is known that resource users may interpret change in climate from a few recent events (Boissière *et al.* 2013). This means that specific time frames to measure perception may not be necessary if the respondents base their perceptions on recent experience.

Adaptation refers to the initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects (IPCC, 2014). Adaptation strategies recommended in the fisheries sector will require the fisher's perceptions because environmental perceptions are among key elements influencing adoption of adaptation strategies (Nyanga *et al.*, 2011).

Perception precedes measures to adapt to the effects of a changing climate and it is only after perceiving changes in climate that it may influence individuals to undertake required measures to adapt to reduce climate change effects (Swai *et al.*, 2012). Adaptation strategies within the fisheries sector need to be climate-smart in order to reduce vulnerability to climate shocks and ensure sustainable livelihoods. Climate

Smart Agriculture (CSA) is defined by Food and Agriculture Organization of the United Nations (FAO, 2015) as agriculture that sustainably increases productivity, resilience (adaptation) and reduces greenhouse gas emissions. It also enhances achievement of national food security and development goals. Proposed adaptation strategies that are climate-smart are those that comply with the FAO Code of Conduct for Responsible Fisheries as elaborated in chapter three of this dissertation. Climate-Smart adaptation practices consider the biological, environmental, social and economic sustainability of the fishery (Camilleri, 2012).

Studies on perceptions of climate variability and change in Zambia have focused on the small scale farmers in the agricultural sector (Nyanga *et al.*, 2011 and USAID, 2012) and residents of flood prone Peri-urban areas in Lusaka (Simatele, 2010).

Work on climate variability and change impact on Lake Kariba Kapenta fish stocks has been done by Ndebele-Murisa *et al.* (2011a and 2011b), Karenge and Kolding (1995), Chifamba (2000) and Mtada (1987). The authors show that increased temperature and reduced rainfall are the main climatic factors affecting fish catch on Lake Kariba. These factors affect upwelling of nutrients from deeper lake layers (hypolimnion) due to prolonged stratification and reduction of inflow of nutrients from inundated areas respectively. This leads to reduced primary productivity, fish productivity and results in reduced Kapenta fish catch.

These studies however, did not consider resource users perceptions and their adaptation to climatic changes. This study therefore aims to incorporate resource users' perceptions and adaptation strategies into the pool of knowledge on climate variability and change on Lake Kariba.

1.2 Problem Statement

Climate variability and change impact studies have been done on Lake Kariba. These have mainly focused on technical aspects such as the impact of climate on Kapenta fish stocks and aquatic organisms such as plankton. Response to climatic factors is informed by both scientific and local knowledge. Local knowledge has not been taken into account. The studies have neglected the resource users' perceptions and adaptation strategies to climate variability. This is despite scientific knowledge not being readily available or understood by the resource users for them to use to respond to climate variability appropriately. There is inadequate information on fishers' perceptions of climate variability despite their livelihood being largely driven by climatic factors and their perceptions playing a role in how they use the resource. It is also not certain what adaptation measures have been put in place by the fishers to cope with these changes in climate and if these strategies are climate-smart.

The study will therefore investigate the perceptions of local Kapenta fishers on climate variability and how they are adapting to the changes on Lake Kariba fish stocks in Siavonga district.

1.3 Aim

The aim of the study was to assess how fishers' perceived and adapted to climate variability on Lake Kariba, Siavonga district.

1.4 Specific Objectives

The specific objectives of the study were to:

- **i.** Assess fishers' perceptions of climate variability
- **ii.** Determine the relationship between fishers' perception of climate variability and their socio-economic characteristics
- **iii.** Assess how fishers were responding to perceived climate variability and if these strategies were climate-smart.

1.5 Hypotheses

This study hypothesized that:

Hypothesis 1

$H_1: b_1 \neq 0$

Fishers perceived climate variability in terms of temperature and rainfall

Hypothesis 2

$H_1: b_1 \neq 0$

Fishers' socio-economic characteristics influenced their perceptions of climate variability

1.6 Definition of Variables and Concepts

Perception: An individuals' mental picture of local climate variability, changes and responses in seasonal changes using individual and cultural experiences (Cortes-Sanchez and Chavero, 2010).

Adaptation: The process of adjustment to actual or expected climate and its effects (IPCC, 2014).

Climate Variability: The tendency of seasons changing from normal to unpredictable trends (Shemdoe and Kihila, 2012).

Climate Change: A change in climate that can be identified by variability of its properties, persisting for an extended period of time, typically a decade or longer (IPCC, 2014).

Fishing vessel: Fishing rigs used in Kapenta fishing

1.7 Significance of Study

The importance of the study is to understand local people's awareness of climate variability and their responses to these changes. This information can help in better understanding how they observe and understand the changes in the climate. This information may contribute to policy formulation on adaptation strategies that are complimentary to those which may already be employed by the fishers as well as identifying areas that can be improved upon if they are not sustainable. The study will help in giving a voice to the resource users who are often not consulted in interventions such as planned adaptations and it will also provide a foundation for future climate research that can be up scaled to national level and work on aspects not covered within this research. The results of this study can also be used to inform government, civil societies and other stakeholders engaging in future programs targeting integration of resource users' experiences and views in climate variability and change adaptation.

The next chapter will focus on a review of current literature available on perceptions of climate variability and change, the socio-economic characteristics that affect these perceptions and adaptation in the fisheries sector. Special focus will be on research done within the fisheries sector highlighting climate-smart adaptation and frameworks that are available in Zambia aimed at adapting to climate variability and change.

1.8 Organisation of the Dissertation

This dissertation is organized into five chapters. The first chapter gives the background of the study including the hypotheses, problem statement and the study's significance. The second chapter of the dissertation gives an overview of the literature regarding perceptions of climate variability; the relationship between perceptions and socioeconomic characteristics; adaptation strategies to climate variability within the fisheries sector; current literature of adaptation frameworks in Zambia; and the climate-smart adaptation strategies available in the fisheries sector. The third chapter describes the study area and the research methods employed in sample selection, data collection and data analysis. The fourth chapter focuses on the results of the study and discusses the findings in relation to available literature and the fifth chapter gives the conclusions and recommendations of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Perceptions of Climate Variability

Africa's climate has been seen to already be changing and its impacts are already being felt (IPCC, 2014). In Zambia, it has been observed that current climate variability has had a large impact on development through extreme weather events and "high-probability-low impact" events such as erratic rainfall patterns, emergence of pests and an increase in warmer days and nights (GRZ, 2010). The National Climate Change Response Strategy (NCCRS) Report (GRZ, 2010) also shows that temperature in Zambia has increased by 1.3˚C since 1960, averaging 0.29˚C per decade with the largest increase occurring in the winter at a rate of 0.34˚C per decade. The report further shows that rainfall is decreasing at a rate of 1.9mm per month (2.3%) per decade since 1960. The aim of this section is to understand local perspectives of climate variability. It is a now documented fact that Zambia, particularly Siavonga district, is going through increased climate variability (USAID, 2012). An understanding of how climate is perceived is necessary to know how these changes are being experienced.

Perception in the environmental context refers to the way in which individuals receive information or stimuli from the environment and change it into psychological awareness, to learn about the environment and respond to what they perceive (Swai *et al.*, 2012). A study by Ford *et al.* (2009) states that perception is strongly linked to behavior and it will influence how climate variability and change is experienced and responded to. In light of this, Ishaya and Abaje (2008) note that work should be directed towards indigenous knowledge and perception of changing climate because they are keen observers of climate and are actively try to adapt to changing conditions.

Fishers are vulnerable to the impacts of climate variability because they are dependent on a resource that fluctuates with climatic trends (Badjeck *et al.*, 2009). This is supported by Zhang *et al.* (2011) who recognize fishermen as being substantially impacted by changes in climate and have a deeper knowledge of climate variability because of their dependence on the fisheries resource.

A major limitation identified in the current engagement with climate variability and change is that the fisheries communities' perceptions and proposals have received very little attention (Venkatesh, 2012). The authors note that the focus has mainly been on technical studies of the fisheries themselves. Wolfsegger (2005) also notes that current studies have mainly focused on technical, institutional and financial sectors in evaluating the adaptive capacity of a community to climate variability and change and perceptions are almost entirely left out. Farm level adaptation has been studied in farming systems (Below *et al.*, 2012) but largely left out within capture fisheries. Ruddell (2010) also highlights the fact that scholars have examined mainly the physical dimensions of climate variability and change leaving public perceptions of affected populations relatively under-researched, yet their perceptions are important for developing effective policy to mitigate or adapt to climate change impacts.

Haque *et al.* (2012) recognize that as communities are vulnerable to climate variability and change; their perceptions can be used in the development of national adaptation programs of action, climate change strategy papers or sector programs. Institutional arrangements for exploitation of natural resources are always changing and reflect peoples' perceptions (Awen-Naam, 2011). Climate trend analysis and projections, perceptions and adaptation information from people most at risk to climate impacts are inter-connected (Akponikpe *et al.*, 2010). The authors highlight the fact that effectiveness of any policy towards empowerment for holistic climate change adaptation requires consideration of these four aspects collectively. This shows the need to incorporate knowledge of perceptions, which has largely been left out, into climate research.

Nyanga *et al.* (2011) state that the adoption process starts with the adopter's perception of the problem and technology proposed. The argument is that perceptions of adopters are important in influencing adoption decisions. A gap is recognized by Tologbonse *et al.* (2010) in that resource users may not fully understand the effect and appropriate measures to take in the face of changing climate. The appraisal of their knowledge could help identify these gaps and scientists and other stakeholders could provide vital inputs to assist them.

It can therefore be argued that perceptions are an integral part of climate variability and change research to give a more holistic view of its impact rather than focusing mostly on technical aspects such as its effect on the fish stocks. The resource users (fishers) need to be incorporated in order to add both local and expert knowledge into understanding climate effects and impacts as well as understanding how they are adapting to these changes. This is essential in policy formulation and adoption of proposed adaptation strategies to ensure vulnerable communities are more resilient to climate variability effects.

2.2 Perceptions and Socio-economic characteristics

Perceptions are said to be context and location specific due to heterogeneity in factors that influence them such as culture, education, gender, age, resource endowments and institutional factors (Nyanga *et al.*, 2011). This is directly in line with trying to establish the relationships between perceptions and socio-economic characteristics of the fishers in this proposed research.

Perceptions are known to be influenced by socio-economic characteristics of individuals (Nhemachena and Hassan 2007; Aphunu and Nwabeze 2012; Deressa *et al*. 2008) and studies, particularly in West Africa, show the expected effect of these factors. Aphunu and Nwabeze (2012), state that how risk is perceived helps in identifying the best application of risk management practice. The implication is that adoption of an adaptation strategy is due to a perceived risk, which in this case, is risk to climate variability. They further state that coping strategies to combat climate variability impacts to ensure livelihoods are improved and sustained for fishers depend on their knowledge, attitude, practices and belief systems. They argue that increase in factors such as educational status positively influences climate variability perception. The rationale behind this thinking is that higher education means more access to information leading to knowing more about climate hence increased perception of these changes.

A counter argument by Tologbonse *et al.* (2010) is that individuals with high education level may record a low perception due to the fact that they may have other sources of income and so climate has less impact on their livelihood sources. In the case of small scale fishers, their livelihoods are largely from the fisheries resource so a higher education will lead to higher perception because of their high reliance on the resource.

Nhemachena and Hassan (2007) show that gender plays a role in perceptions of climate variability and change. They state that generally, women have limited access to information due to traditional social barriers, so they are less likely to perceive changes in climate. They also attribute income attained as playing a role in perceptions in that higher income is associated with lower discount rates, longer term planning and access to information. Their hypothesis is that higher income will lead to a higher awareness (perception) of change in climate.

It is hypothesized by Deressa *et al.* (2008) that age and number of years of experience influence perception or awareness of climate change. The authors state that age relates to the individual having been around long enough to notice changes in the climate and hence able to perceive these changes more than the younger counterparts. These statements apply to both fisheries and farming.

The implications of the relationships highlighted in the foregoing are that whether a fisher perceives climate variability or not will be influenced by their socio-economic characteristics. It is therefore important to understand that these outlined relationships will affect participation of the fishers in projects by other stakeholders or initiatives by their fellow fishers aimed at adapting to climate variability.

2.3 Adaptation Strategies to Climate Variability in Fisheries

Climate variability and change is viewed to have its greatest impact on poor households because they have the lowest capacity to adapt to changes in climatic conditions (Salau *et al.*, 2012). The adaptive capacity to changing climate is undermined by several factors ranging from limited understanding of the nature and consequence of climate variability and change to economic status.

Adaptation is defined as actions taken by people in response to or anticipation of, changing climatic conditions to reduce adverse impacts or take advantage of opportunities that may arise (IPCC, 2014; Aphunu and Nwabeze, 2012). Bryan *et al.*

(2011) state that adaptation reduces vulnerability making rural communities better able to adjust to changing climate, helping them to cope with adverse consequences and moderation of potential damages. It is assumed that communities have an inborn adaptive knowledge from which to draw and survive in high-stress ecological and socio-economic conditions (Apata *et al.*, 2009). Thus human response is critical to understanding and estimating the effects of climate change on production and food supply for ease of adaptation.

Work by Allison and Sarch (2000) suggests that fishing families or communities have flexible and mobile livelihoods and are adapting to fluctuations that fisheries resources exhibit due to climatic conditions. They state that these coping strategies represent active opportunism that refers to adaptations aimed at maximizing the contribution of fishing to livelihoods and household incomes. These strategies highlight the importance of enhancing the flexibility of fisheries livelihoods as opposed to fixed fisheries quotas, seasons or areas. They further state that climate induced fluctuations in the fisheries that are pelagic in nature, such as Lake Kariba Kapenta fishery, indicate that management of the stocks require understanding of how fishers, distribution chains and markets are coping with the fluctuating supply.

Daw *et al.* (2009) state that adaptation strategies in fisheries are complex and location and context specific with varied suggestions and typologies of how adaptation actually occurs for such livelihoods. Adaptation responses can be conceptually organized based on timing and responsibility. Adaptation strategies to climate change can be broadly categorized into three temporal categories of climatic conditions; long term changes in means or norms, inter annual (year to year) or decadal variability (decade to decade) and isolated extreme events or catastrophic weather conditions. They will vary based on time frame of the climatic stimulus (Smit *et al.*, 1999). Adaptation relative to the climate stimulus may be responsive (reactive), concurrent (during) or anticipatory (proactive) (Smit *et al.*, 2000). In terms of categorization according to responsibility, Shelton (2014) categorizes adaptation as either being Autonomous or Planned. Autonomous adaptation involves changing times or locations for fishing as species arrive earlier or later than anticipated because of changes in climate and are solely implemented by the fisher. Planned adaptation has a specified set of actions in the face of climate variability. Examples of planned adaptation include funding for livelihood diversification and investment in improved post harvesting systems. This approach includes planned action by various stakeholders. A 'no regrets' approach is advised for developing countries to build general resilience because for the most part, long term climate data is unavailable or inconsistent.

Current and potential adaptation strategies in fishery based livelihoods are grouped into three according to Badjek *et al.* (2009)**.** The first is enhancing livelihood platforms, identified by understanding how social capital shapes adaptive capacity, increasing access to early warning systems and providing insurance schemes to avoid livelihood disruption. The second is diverse and flexible livelihood systems like occupational multiplicity, occupational mobility and diversification outside fisheries. Flexible and adaptable policies and institutions are the third strategy through an adaptive management strategy. They involve improved collection and sharing of information, protection of spawning areas and habitats and modified fishing practices. These are largely dependent on the fishery management structures in place (Stewart *et al.*, 2003).

Williams and Rota (2010) propose that adaptation responses to changes in the fisheries sector must center on boosting adaptive capacity and resilience of both communities and ecosystems on which they depend. They recommend investment on local practices and traditions. They suggest adaptation should not focus on altering catch size and effort only but on building communities to adapt and allow only moderate potential damage, take advantage of new opportunities and cope with climate change consequences. Daw *et al.* (2009) agree with this stating that technical approaches to adaptation can underestimate the importance of institutions, particularly informal ones, to facilitate or limit adaptation. Traditional practices or alternative livelihoods are seen as viable options to adapt to declining fish yields. Cultural identities connected with fishing are stated to be factors that may limit adaptation in terms of leaving fisheries. Individuals who identify themselves culturally as fishers are more unlikely to consider leaving fishing activities as an adaptation strategy in comparison to those whose cultural identity is not associated with fishing (Daw *et al.*, 2009).

Green and Raygorodetsky (2010), note that even if global climate change agreements are reached swiftly, the present global responses to climate change either proposed or already implemented will ultimately fail. They attribute this to the fact that these agreements may not be grounded in recognition of basic rights such as the territorial, land and resource rights of local custodians of global bio-cultural heritage, the backbone of strategies for adaptation and resilience. This implies that adaptation within the fisheries sector requires a more holistic solution that does not focus solely on quota allocations or licensing but also on understanding how these communities are already adapting to the changes in climate.

The implication from the reviewed literature is that it is necessary to understand how fishery resource users are adapting. This is in order to come up with more effective management strategies and policies to reduce the impact of climate variability and change. Adaptation in the fisheries sector takes on a variety of forms and is context specific. The focus on adaptation in fisheries should be to incorporate indigenous or cultural practices that are already in use by the fishing communities.

2.3.1 Fisheries Adaptation Frameworks in Zambia

Zambia has a broad legal framework looking into the implementation of climate variability and change programs and projects. They are generally encompassed under the agriculture sector with fisheries being featured as a sub-sector.

The Sixth National Development Plan (SNDP) (GRZ, 2011) recognizes that agriculture remains a priority sector in order to achieve sustainable economic growth and reduce poverty. Fisheries, as a sector within agriculture, will have its management challenges exacerbated by climate variability and change. The proposed response to these changes by the SNDP is harmonizing climate variability and change with all fisheries activities through research.

The National Climate Change Response strategy (NCCRS) (GRZ, 2010) has a more robust framework for adaptation in the fisheries sector as opposed to the SNDP. Adaptation interventions are proposed through research into cross cutting themes. This is to be done by enhancing resilience to climate change through the following objectives:

a) Evaluating natural resource management schemes and determining their effectiveness in providing ecosystem services and adapting to climate change
b) Improving reporting standards and access to fisheries data to improve assessments on climate impacts
c) Carrying out vulnerability assessments of the fisheries resources
d) Investigating the current adaptation strategies being used by fishers and evaluating them for their relevance to future climate change and making necessary recommendations. This study makes a contribution to this objective.

These interventions provide a good basis for climate change adaptation but a problem is recognized in implementation (FAO, 2014b). The current situation in Zambia is recognized in the report as having interventions that are not properly coordinated and are based on insufficient information. It is also noted that the resources to respond to climate variability are available but are not easily accessible and are not used effectively because the intended actions are not well defined.

A report on CSA planning by FAO (2014b) presents the scenario in Zambia as close to ‘Mwadyamweka’ in which there is high and steady economic growth but institutions are weak and unresponsive to risks of extreme climate variability. A report on Zambia’s climate change policy analysis by FAO (2014a) shows that climate change policy shows a great disconnect with the agricultural sector within the country. This is evident in having contradictory sub sectoral objectives e.g. recognizing the impact of climate change on agriculture in climate change in the National Climate Change Policy (NCCP) and championing the need to advocate for increased agricultural productivity and production in the National Agriculture Policy (NAP).

The review of literature shows that frameworks are available for appropriate adaptation within the fisheries sector but the major drawback is lack of implementation and unresponsiveness due to weak institutions and insufficient information.

2.4 Climate-Smart Adaptation Strategies in Fisheries

Climate-Smart Agriculture aims to improve food security, help communities adapt to climate variability and change and contribute to mitigation. This is by adopting appropriate practices, developing enabling policies and institutions and mobilizing needed finances (Meybeck and Gitz, 2013). It is recognized that quantitative and fully causal relationships between climate variability and impacts on fisheries cannot be realistically established. But even with the lack of information, much can be done to reduce vulnerability by using approaches that are practical and by building and maintaining natural ecosystems and human communities that are resilient to changing climate (FAO, 2015).

Climate-Smart practices within the fisheries sector are those that adhere to Article 8 (Fishing Operations) of the FAO Code of Conduct for Responsible Fisheries (Camilleri, 2012) and CSA Sourcebook (FAO, 2010b). Some adaptation options in accordance with the Code include: Low Input Fuel Efficient (LIFE) fishing vessels; reduction in fishing capacity; reducing incentives to overfish; use of fishing gears that reduce by-catch; use of non-destructive fishing methods; applying technologies, materials and methods that reduce ghost fishing or loss of fishing gear; and improving the economic status of fisheries (FAO, 2010a).

The sourcebook highlights that well-designed and responsibly-used fishing gear can reduce the requirement for fossil fuel consumption. The designs of selective fishing gear (appropriate mesh size) can reduce the capture of juveniles and other forms of by-catch as well as reducing discards. The guide advocates the use of technologies like Global Positioning Systems (GPS) and echo-sounders to ensure that fishing gears are not set on sensitive habitats like breeding areas (FAO, 2010a). Innovations in vessel design and fishing equipment coupled with safety training can minimize accidents and loss of life while fishing if the vocation is to lose its reputation of being one of the most dangerous occupations in the world (FAO, 2012).

By-catch refers to any living aquatic resource and any unobserved mortality due to direct encounter with fishing gear (National Oceanic and Atmospheric Administration, 2015). By-catch is typically non-target fish that is caught in the fishing gear. In the case of the Kapenta fishery, it includes juveniles and riverine species such as tiger fish or bream, typically found in the inshore area, which are not the intended targets.

Incentives to overfish on Lake Kariba may be due to the nature of the topography of Siavonga district. The districts along the lake are hilly and soils are very poor making support of agriculture and livestock activities difficult (Chali *et al.*, 2014).

Climate-Smart fisheries practices require context specific and community based adaptation strategies to avoid maladaptation. Maladaptation is any change in natural or human systems that ultimately increases vulnerability rather than reduce it, to climate stimuli (FAO, 2011). Specific systems such as small scale fisheries have response options available that comply with the Code of Conduct of Responsible Fisheries such as the use of passive fishing gear, shifting species mix, timing and locations, adjusting management (e. g size restrictions, closing seasons), adapting fishing gear and also access or developing alternative markets (FAO, 2013).

Specific response options for small scale fisheries that use active gear are given as adapting gear, timing, access/develop alternative markets, adjusting management, reducing energy costs by improving returns, developing alternative livelihoods, developing higher value markets and possibly moving to passive fishing gear (FAO, 2013). These options are particularly relevant to the Kapenta fishing industry as they use rigs which are active fishing gear.

Adaptation can have unintended negative effects on both the environment and people. The concept of sustainable adaptation then comes into play. It is defined by Eriksen *et al.* (2011) as adaptation that reduces vulnerability to climate change and contributes to socially and environmentally sustainable development pathways that include social justice and environmental integrity. This brings out the need to ensure adaptation strategies used by fishers are appropriate and climate-smart so that their livelihoods remain sustainable and their vulnerability to climate change is not exacerbated by these strategies.

Adaptation strategies within the fisheries sector will need to take into account short term (increased frequency and intensity of extreme events) and long term (reduced productivity of aquatic ecosystems) phenomena (FAO, 2010a).

The FAO CSA Sourcebook advocates the use of the ecosystem approach to fisheries (EAF) as an adaptation option in fisheries management (FAO, 2010a). It is a holistic strategy for managing capture fisheries in a way that takes into consideration the socio-economic, institutional and ecological dimensions of management. EAF includes interactions between the people who use the resource and the fish system. The purpose of the system is to plan, develop and manage fisheries in a way that addresses the multiple needs and aspirations of the resource users or society without jeopardizing the chance of future generations to benefit from the goods and services provided by the aquatic ecosystems. The overall objectives of EAF are: applying the precautionary approach in the face of uncertainty; using the best available traditional and scientific knowledge; acknowledging multiple values and objectives of the ecosystem services; encouraging adaptive management; broadening stakeholder participation with specific interest in gender; promoting integration in related sectors and interdisciplinary studies and ensuring distribution of resources to the users (FAO, 2010a).

This approach is necessary in place of the typical top down approach that is clearly not appropriate in the face of uncertainty of the changing climate. It allows room for the integration of knowledge that is constantly being acquired from scientific research and new insights into traditional knowledge and practices as more extreme and unpredictable climatic events occur.

The Department of Fisheries (DoF) in Zambia is currently not undertaking the ecosystems approach in fisheries management. The management style is still the top-down approach that relies on quota allocation and licensing (Kinadjian, 2012). Lake Kariba is one of the best studied fresh water systems in Africa (Kolding *et al.*, 2003). It is a fact that climate change and variability is affecting the fishery (Ndebele-Murisa *et al.*, 2011a). The uncertainty of its impact requires a precautionary approach and management that is adaptive to new local and scientific knowledge. This means some information is available that could be used to effect the precautionary principle in the management system. Information such as nature of species in the lake and hydrological regimes that explain a large proportion of variability in the catch per unit of effort (CPUE), are available and can be used for more effective management. . The precautionary principle or approach stipulates that even in the presence of scientific uncertainty, policies should be put in place that provide insurance against potential negative outcomes from climate change (IPCC, 2001).

Transitioning to CSA will require a shift from business-as-usual system and introduce a comprehensive programme to build adaptive capacity of physical, socio-economic, institutional and human dimensions of farming systems. Significant improvements in access to labor saving and productivity enhancing innovations in the agricultural production systems will be required as well as coordinated large scale and long term multiple stakeholder efforts (Mutamba and Mugoya, 2014) in order for CSA to transition in a meaningful way in the fisheries sector.

The next chapter will give a brief description of the study area. The tools used for data collection and analysis during the course of the fieldwork, the method of sample selection and the variables used will be clearly outlined. The limitations of the study, ethics adhered to during the study and the validity and reliability of the data collected will also be discussed.

CHAPTER THREE: STUDY AREA AND METHODOLOGY

3.1 Study Area

This section describes the characteristics of the study area in terms of temperature, rainfall and topography. The sampling technique, data collection and analysis, the research limitations and ethics are also discussed.

3.1.1 Description of the Study Area

Lake Kariba is the largest man-made lake in Southern Africa and one of the largest in Africa. The lake was built in 1959 after building a dam on Zambezi River, and is jointly owned by the governments of Zambia in the north and Zimbabwe in the south. It is located between latitudes 16.5˚S and 18˚S, and longitudes 27˚E and 29˚E and stretches for 320km with an average width of 19.4km although the widest portion is 40km (Kolding *et al.*, 2003; Syampaku, 1998). The shoreline is approximately 2,164km. At maximum height, the lake holds 157million cubic meters of water with an average depth of 29m and the lake is 486m above sea level (Chali *et al.*, 2014). The lake has the districts Siavonga and Sinazongwe along its shores on the Zambian side (Figure 1).

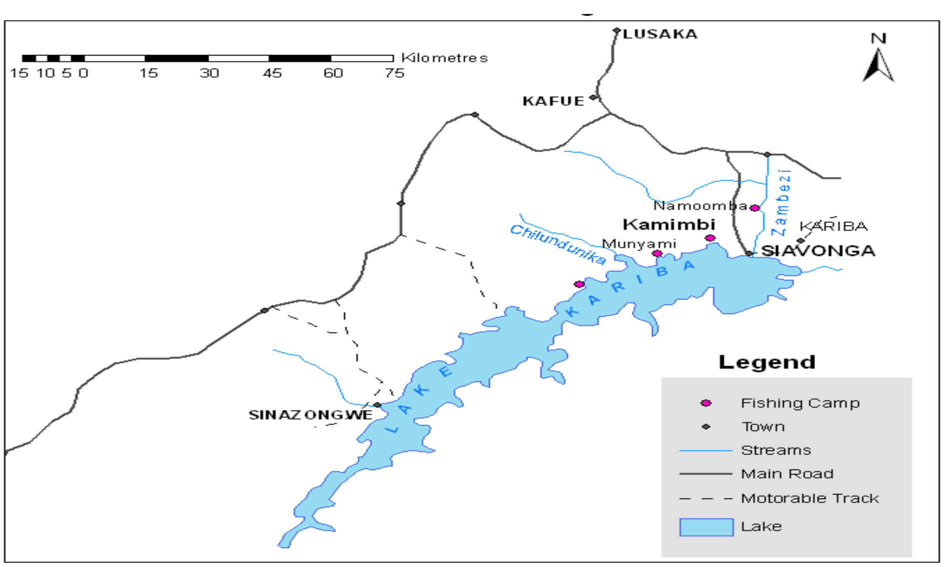

Figure 1: Location of Siavonga district on Lake Kariba

Source: Author (2014)

3.1.2 Topography, Geology and Soils

Siavonga district is found on the northern part of the Zambezi valley. The topography is hilly and broken. Volcanic rocks dominate the geology and water quality is highly mineralized. Most of the districts around the lake have infertile soils.

Lake Kariba occupies part of the Zambezi rift valley and is 3,600km^2, 450m to 1350m above sea level and Siavonga is found on the southern side of a hill formed by Precambrian basement rocks (Davies and Dochanaigh, 1999).

3.1.3 Temperature

The temperature in the area is hot and dry due to its relatively low altitude (Davies and Dochanaigh, 1999). Lake Kariba has four distinct seasons: Rainy (November to February; post-rainy (March to May); Dry-cool winter (June to July); and Dry-hot season (August to October). Typically, the air temperatures have annual mean values ranging from 24.4 to 24.7 degrees Celsius (ºC); the highest range of temperatures is typically in October, averaging around 30.7 ºC and the cold season that occurs during July typically has temperatures around 21.7 ºC (Ndebele-Murisa *et al.,* 2013). The Lake is warm (mean surface temperature 26 ºC), monomictic (overturning occurring in June-July), oligotrophic, has a thermocline that ranges in depth from 15m to 35m at turnover time and it has phytoplankton and zooplankton blooms showing variations in response to the mixing (Kolding *et al.,* 2003).

3.1.4 Rainfall

The average annual rainfall is about 500-700mm but it can vary from 350mm to 1015mm. It is known that the El Nino/Southern Oscillation and the Inter-Tropical Convergence Zone (ITCZ) have the most influence on the unimodal rainfall in the Zambezi Basin occurring from November to March/April responding to ITCZ movements (Ndebele-Murisa *et al.,* 2013). Rainfall in Siavonga district is generally erratic and prolonged drought periods are frequent (Davies and Dochanaigh, 1999), with evidence suggesting it is unpredictable due to climate variability (USAID, 2012)

3.2 Research Methods

This section will discuss the sources of data for the study, the sampling frame, and the instruments of data collection and data analysis.

3.2.1 Secondary Data

The secondary data used in this research consisted of published peer reviewed scientific articles focusing on climate variability and change perceptions, impacts of climate variability and change on fisheries, adaptation in the fisheries sector and climate-smart agriculture (fisheries sector). The FAO database was used for fisheries statistics on Zambia such as number of Kapenta rigs on Lake Kariba. Unpublished Meteorological data about the case-study area i.e. rainfall and temperature was obtained from the Zambia Department of Meteorology (ZMD).

3.2.2 Primary data

Primary data collection was from two groups; the fishers on Lake Kariba and a research officer at the Department of Fisheries (DoF) using a questionnaire and key informant interview guide respectively. Data collection was held over a three week period (1^{st} to 21^{st} April, 2014).

3.2.2.1 Sampling

Lake Kariba has a total of 818 licensed Kapenta fishing rigs on the Zambian side and Siavonga district has 157 licensed rigs (GRZ, 2015). The sampling unit used for the research was a rig. The selection of the sample size was on the basis of Bless and Achola's (1988) 'Rule of Thumb' requiring at least 5% of the population to be sampled:

$$157 \times {}^{5}/_{100} = 8 \text{ rigs}$$

According to the calculation, a population of 157 rigs requires a sample size of 8 rigs. A sample of 90 rigs was randomly selected on the basis of a larger sample giving a better result.

An interview was conducted with the only fisheries officer in the district.

3.2.2.2 Sampling technique

Simple random sampling was used to select the rigs to be interviewed using a questionnaire. Selection was based on a list provided by the DoF on licensed rigs found on the Lake. The rigs were randomly selected using their details (rig name) and one fisher per rig was interviewed from the areas of Siavonga town, Simunjalala, Bbuyu and Kalelezi within Siavonga district. A total of 90 fishers were interviewed from Siavonga district. There were 56 (62.2%) respondents interviewed from Siavonga town, Simunjalala had 19 (21.2%) respondents, Bbuyu 4 (4.4%) respondents and Kalelezi 11 (12.2%) respondents. The fishers interviewed in these areas work for Kapenta fishing companies, camping on those islands, but do not necessarily live there. The interviews were done inland, as well as on the Lake using a boat as the rigs were heading into the water to begin fishing. The areas within Siavonga district were sampled because of the presence of the randomly selected rigs.

The key informant from the DoF was purposively selected based on position, knowledge of study area, opinions/views on climate variability and was interviewed using an interview guide.

3.2.2.3 Questionnaire

A questionnaire (Appendix A) was designed to capture, as much as possible, the information required to achieve the three objectives of the study. It had three sections in total. Section A captured data on personal details and socio-economic characteristics. Section B captured the perceptual statements of each fisher and Section C the adaptation options being used by the fishers. Additional comments were taken down during the course of the interviews to better understand the respondents' answers. A total of 90 questionnaires were used for data analysis after being checked for validity (complete and coherent). Research assistants hired were able to communicate with the fishers without the need of interpreters as they could all speak Tonga in cases where the fishers could not speak English or Nyanja.

3.2.2.4 Key Informant Interviews

A Key Informant Interview was conducted using an interview guide (Appendix B) with an officer at the DoF. The officer interviewed from the DoF was familiar with Siavonga district and its climatic trends as well as Kapenta fish trends on Lake Kariba.

3.2.3 Data Analysis

Data analysis was done using the software packages Software Package for the Social Sciences (SPSS) Version 16.0 and Microsoft Excel. Quantitative analysis was done using a Likert scale, Multiple Regression Analysis and Pearson Correlation Coefficient to establish perceptions of climate variability and factors that influence these perceptions. Qualitative data analysis was done by summarizing the fishers' socio-economic characteristics and categorizing their adaptation strategies using the CSA Handbook, the Threefold Typology of Responses and FAO Code of Conduct for Responsible Fisheries. A summary of the tools used for the analysis of the three objectives are given by Table 1.

Table 1: Summary of Analysis Methods

OBJECTIVE	METHOD OF ANALYSIS
Assessing fishers' perceptions of climate variability	Likert Scale
Determining the relationship between fishers' perception of climate variability and factors influencing these perceptions	Multiple Regression Analysis
Documenting how fishers are responding to perceived climate variability	Typology of Responses Code of Conduct for Responsible Fisheries FAO CSA Handbook

Source: Author (2014)

The perceptions of the fishers on climate variability were analyzed using a 5 point Likert scale on the questionnaire. The Likert scale had a total of 5 perceptual statements on rainfall, temperature and Kapenta catch trends on the Lake. There was a question corresponding to each perceptual statement to answer the 'how' of each response given. An example of the statement was asking if the fisher observed any changes in temperature from the time they started fishing, and the corresponding question was for them to state what change they have observed, i.e. whether there was an increase or decrease for those who observed a change and for those that didn't, the answer was automatically no change for this section. Perception was measured through coding of the responses. The nominal values were 5, 4, 3, 2 and 1. These were attributed to the responses of Strongly Agree, Agree, Disagree, Strongly Disagree and I don't know respectively.

Strongly agree and agree responses were later transformed into the number 1, disagree and strongly disagree into 0 to form a scale of the index of 0 – 1 and I don't know responses were regarded as missing. Scores for each respondent were summed up and divided by the number of statements, five in this case, for each climate variability indicator. The scale was further transformed into two categories of 'not perceiving' for respondents that scored 0.5 and below and 'perceiving' for respondents that scored 0.6 and above.

The fishers' responses were categorized into these groups by establishing the time and responsible party of the strategy. If the response was for the short term and wholly implemented by the individual due to an immediate threat, it was categorized as responsive strategy. If the response was long term and well planned, involved the fisher and an authority such as the government or Non-Governmental Organization (NGO), it was categorized as an anticipatory strategy. If the response involved the fisher getting involved in an alternative livelihood that did not involve Kapenta fishing such as venturing into farming or trade, it was categorized as an alternative response strategy.

Content analysis of questionnaires was done and the main characteristics of these strategies were further summarized. The strategies were assessed and conclusions made whether they were consistent with promoting climate-smart adaptation. A comparison of these strategies was made with Chapter 8 of the code of conduct of responsible fisheries (2000) and CSA sourcebook (FAO, 2013) as reference points for categorization of climate-smart adaptation options.

3.3 Limitations of the Study

The study of climate variability perceptions in other studies incorporates longer term climatic data that was not available for this study from the Zambian Departments of Fisheries and Meteorology.

3.4 Data Validity and Reliability

Data collection tools, in this case the questionnaire and key informant interview guide, were refined to the best possible standard with the help of technical advisors and adaptation specialists to best capture information required for the study. The research assistants were pre-trained before the actual survey, so that the understanding of the questionnaire was uniform and ensuring explanation of the questions was the same across the board of data collectors.

Issues of reliability may have arisen as a result of respondents wanting to give similar answers as the other fishers to try to fit in with what the other(s) have observed or not be truthful about how they are adapting to any perceived changes in climate and catch. This was counter-acted by ensuring the interviews were held individually rather than in a group to ensure all responses were based on individual experience.

In cases were quantitative data was missing or inadequate for annual temperature, rainfall and fish catch, those years were left out to avoid misinterpretation of graphed trends. This is true for rainfall and temperature data for Siavonga district. Data after 2010 for minimum temperature and data after 2012 for mean rainfall in Siavonga district was incomplete so those years were not included in the data set for graphs plotted.

3.5 Research Ethics

The researcher placed an ethical measure by putting it in writing on the questionnaire, as well as verbally informing the fishers, that all information being obtained from them was strictly anonymous.

The next chapter presents the results obtained during the course of the research, the analyses of findings and discussion of the three objectives of the study. These will be discussed one after the other to ensure a smooth transition from one issue to the next highlighting the linkages of related ideas. Challenges and opportunities from the findings will then be highlighted to better understand climate variability perceptions and adaptation strategies of Kapenta fishers on Lake Kariba in Siavonga District.

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter presents the analysis of the results obtained from the field and discusses the findings as well as their implications. The chapter begins with a discussion on documented evidence of climate variability in Siavonga district from available literature and then the results, analysis and discussion of the first objective. The same is done for the other two objectives. The major findings are summarized and the data analysis tools used are briefly discussed.

4.1 Fishers Socio-economic Characteristics

A total of 90 fishers were interviewed on Lake Kariba fishery. Of these, 89 (99%) respondents were male and 1 (1%) respondent was female.

The age range was between 21 and 55. The mean age was 37.3 years. The proportions in age distribution were 32 (35.6%) respondents being between ages 21-30, 38 (42.2%) respondents between ages 31-40**,** 17 **(**18.9%) respondents were between ages 41-50 and 3 (3.3%) respondents were over the age of 50.

The marital status of the fishers showed that 80 (89%) respondents were married, 8 (9%) respondents were single and 2 (2%) respondents were divorced.

The level of education of the fishers varied from not having any formal education to reaching tertiary education. The average number of years of education was 7.8 years. The percentages showed that 7 (7.8%) of the fishers had no formal education, 38 (42.2%) of the fishers were educated to primary level, 41 (45.6%) were educated up to secondary level and 4 (4.4%) were educated up to tertiary level.

The fishers had an average of 6.8 years of fishing experience. Fishers with 1-5 years of fishing experience accounted for 44 (48.9%) respondents, 27 (30%) respondents had 6-10years experience and 19 (21.1%) respondents had over 10 years of experience.

The size of fishers' households varied. The size was an average of 5.6 people per household. About 51 (56.7%) respondents had a household size of 1 to 5 people. A total of 38 (42.2%) respondents had household sizes of between 6 and 10 and 1 (1.1%) respondent had a household size above 10.

The fishers interviewed either worked on or owned a vessel that was registered to the Kapenta Fishers Association or not. Of these, 64 (72.2%) respondents belonged to the association whereas 26 (27.8%) respondents were not association members.

Fishers were also asked if they had any contact with extension officers from the DoF in the past year. Of those interviewed, 69 (76.7%) respondents had access to extension services and 21 (23.3%) respondents did not have access to extension services.

4.2 Climate Variability on Lake Kariba, Siavonga district

The unpublished meteorological data from ZMD on mean temperature in Siavonga district (measured from Chipepo research station) and data from Lake Kariba Fisheries Research Institute (LKFRI) and Zambezi River Authority (ZRA) on temperature on Lake Kariba shows that there has been a general increase of temperature in the area from 1995 to 2010 and more so in the last four decades for Lake Kariba.

Siavonga district is distinguished as currently being the driest zone, prone to droughts and experiencing the impacts of climate change (USAID, 2012). Temperature data for the district reveals that there was a steep increase in minimum temperature from 1996 to 1998 and the highest mean temperature was recorded in 2002. The data is represented by Figures 2, 3 and 4.

In-depth analysis on the maximum and minimum temperatures data of Lake Kariba by Ndebele-Murisa *et al.*, 2011, shows that warming was at a rate of 3.58˚C for maximum temperature and 3.29˚C for minimum temperature per decade showing evidence of climate variability and change on the Lake.

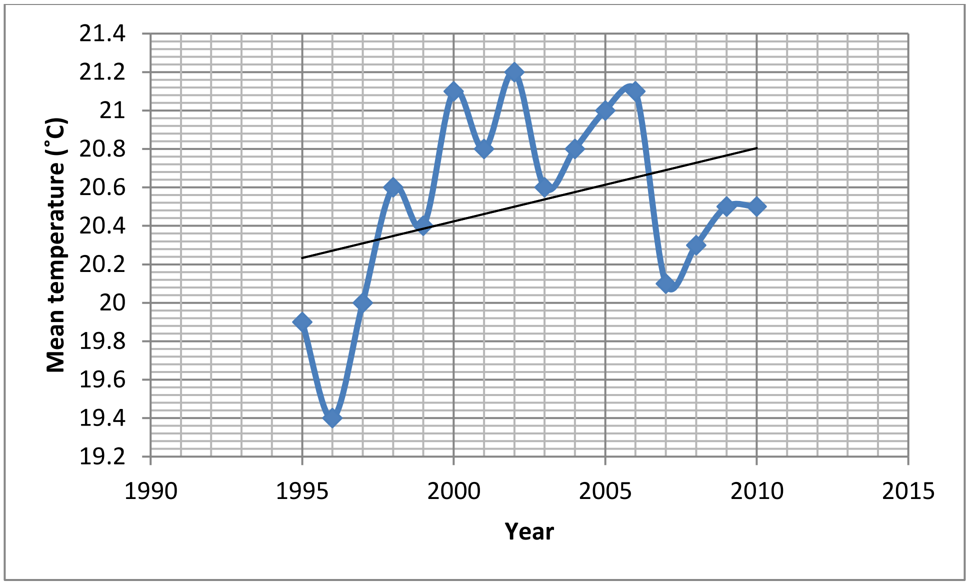

Figure 2: Minimum Temperatures, Siavonga district 1995-2010.

Source: Author’s plot based on ZMD data (2014)

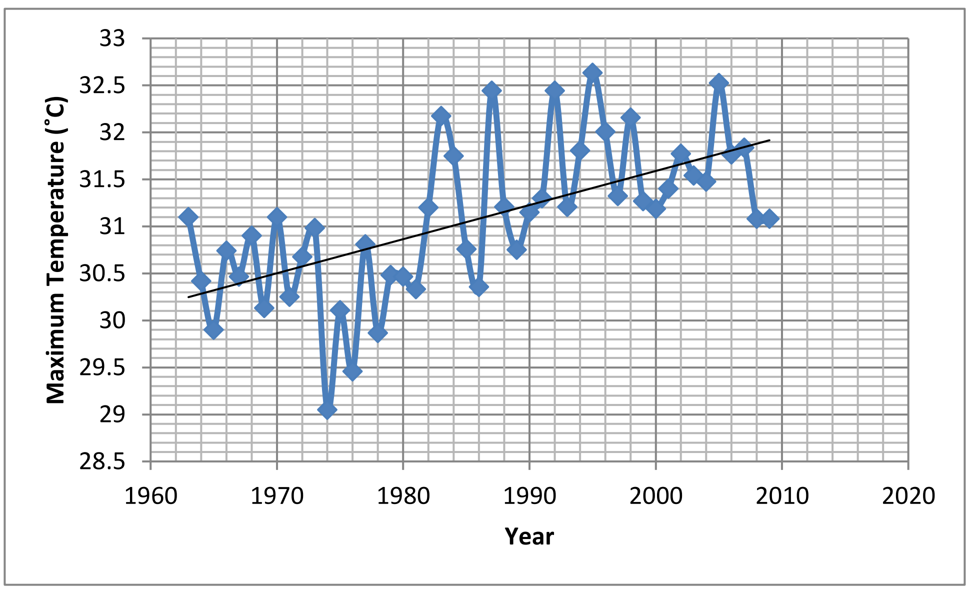

Figure 3: Maximum Temperatures on Lake Kariba 1962-2010.

Source: Author’s plot based on LKFRI data (2011)

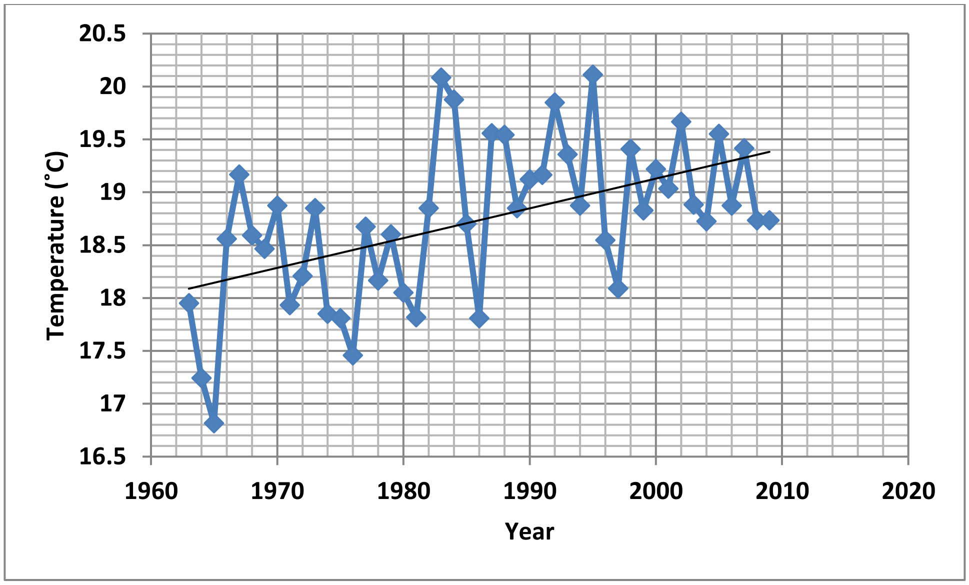

Figure 4: Minimum Temperatures on Lake Kariba 1961-2010.

Source: Author's plot based on LKFRI data (2011)

The rainfall data, illustrated in Figure 5, on Siavonga district, shows that there has been a general increasing trend of rainfall in Siavonga district from 1994 to 2012. The data reveals that the least amount of rainfall was recorded in 1995, evidence of the drought that took place. Longer term data, illustrated in Figure 6, from 1962 to 2009 shows that there is a general reduction in rainfall on the lake. The fluctuations within the years could explain why 25(27.9%) respondents perceived an increase in rainfall whereas 44(49.2%) respondents cited a reduction in rainfall.

These graphs exhibit the high variability of rainfall within the years. This variability is leading to droughts and floods, affecting fish catches and leaving the Kapenta fish industry vulnerable to these extremes. Detailed analysis of the rainfall trends by Ndebele-Murisa *et al.* (2011) revealed that rainfall on the Lake is declining at a rate of 6.3mm per decade.

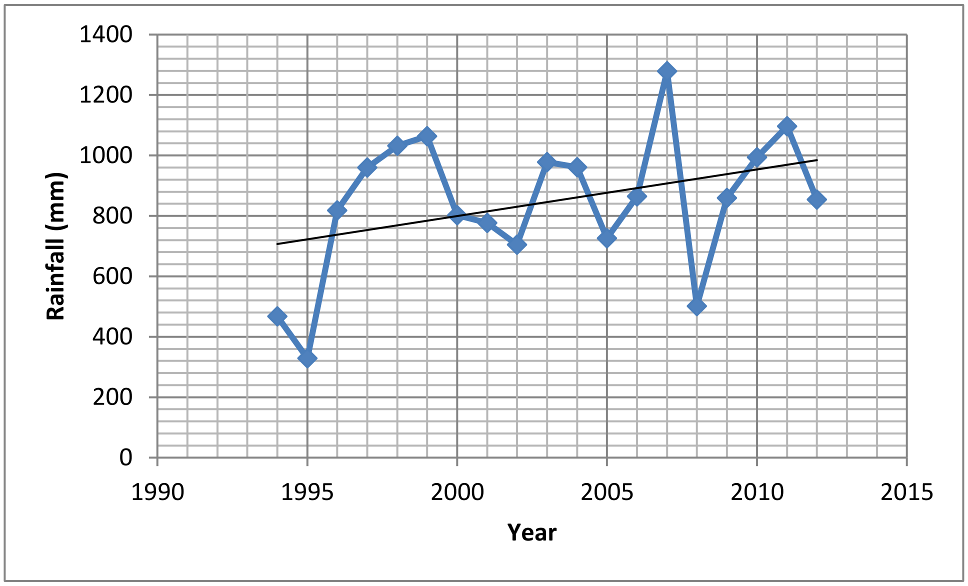

Figure 5: Mean Annual Rainfall in Siavonga District 1994-2012.

Source: Author's plot based on ZMD data (2014)

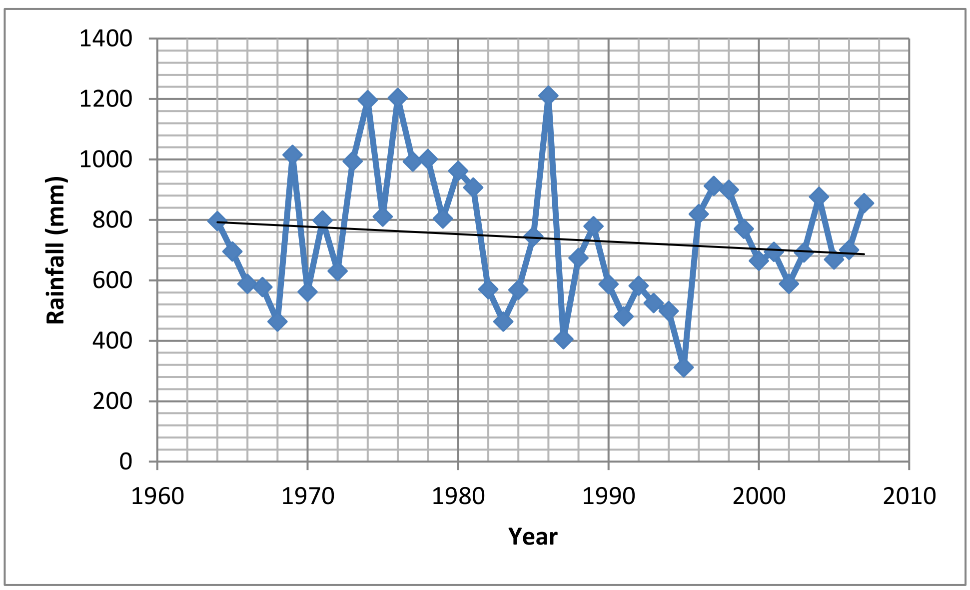

Figure 6: Mean Annual Rainfall on Lake Kariba 1962-2009.

Source: Author's plot based on LKFRI data (2011)

4.3 Perceptions on Climate Variability

The researcher hypothesized that fishers would perceive climate variability in terms of rainfall and temperature. Results from the analysis showed that 11(12.3%) respondents did not perceive climate variability. This was based on them acquiring a score of less than 0.6 on the Likert scale. They stated that the temperature, rainfall and catches had not changed but merely fluctuated with the seasons. The analysis also revealed that 79 (87.7%) respondents perceived a change in climate. These are the respondents that scored 0.6 and above on the Likert scale from perceptual statements.

Of the respondents interviewed, 44 (49.2%) respondents indicated a reduction in rainfall, 25 (27.9%) respondents stated an increase in rainfall and 21 (22.9%) respondents stated that they did not know or were not sure there was a change.

In terms of temperature, 31(34.4%) respondents stated that temperature had increased and 10 (11.5%) respondents stated that temperature had reduced. The remaining 49 (54.1%) respondents stated they did not know if there had been a change in temperature.

In terms of the amount of catches, 53 (59%) respondents stated there was a decrease in the Kapenta fish catch and 15 (16.4%) respondents stated an increase in fish catch. A total of 22 (24.6%) fishers were not sure if there was a change in the fish catches.

The results of this study on fishers abilities to perceive climate variability is similar to those found by Zhang *et al.* (2011). The perceived changes in rainfall and temperature were in line with meteorological data that shows that temperature in the area is increasing; rainfall is highly variable and shows a declining trend over the past decades.

The inconsistent perceptions of temperature in this study are similar to those found by Mulenga and Wineman (2014). They found that farmers in southern province (Siavonga and Choma) detailed mostly rainfall pattern changes rather than temperature changes. This can be seen in the fishers' responses in that 49 respondents were not sure if temperature had changed in comparison to 41 respondents who perceived either an increase or a decrease in temperatures.

4.4 Perceptions on Impact of Climate Variability

The respondents showed differences in their perceptions of the impact of rainfall on Kapenta catches. A total of 32 (36.1%) respondents stated that increased rainfall led to an increase in catches and 26 (29.2%) respondents stated that decreased rainfall led to decreased catches. The remaining 32 (34.7%) respondents did not know if rainfall had an impact on the fish catches. These findings are summarized in Figure 7. These statements were based on the individual fishers' perceptions.

The general perceptions of the fishers are that there has been a decrease in rainfall (49.2%), increase in temperature (34.4%), a decrease in fish catches (59%) and increased rainfall leads to increased catches (36.1%). The fact that 79 (87.7%) of the fishers perceive climate variability in terms of temperature and rainfall shows that the hypothesis stating that fishers will perceive climate variability can be accepted.

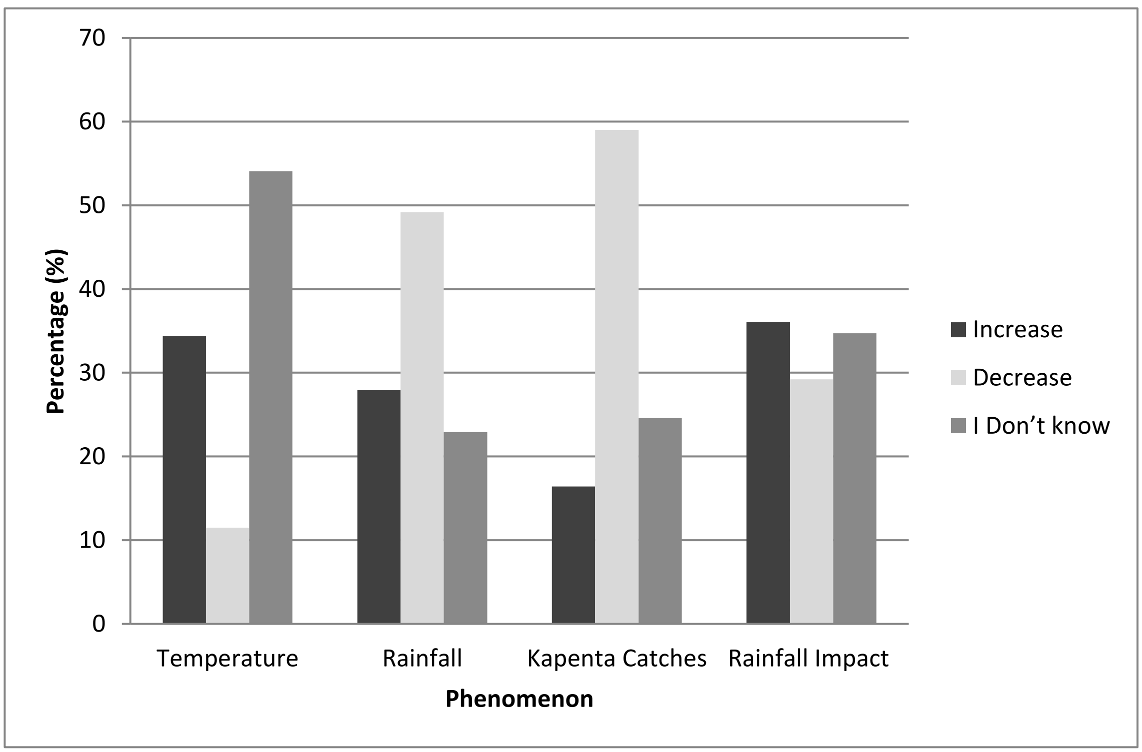

Figure 7: Fishers' Perceptual Statement Responses

Source: Author (2014)

The key informant from the DoF was the fisheries officer for the Siavonga district extension office. He stated that from his 14 years of experience as a fisheries technician then officer at the department, he had observed that there were too many rigs on the Lake. This is similar to findings by Kinadjian (2012) were he states that there are no real access controls leaving the fishery open to illegal, unregistered and unlicensed rigs. This is further validated by a survey carried out by Paulet (2013) that showed that on the Zambian side of the Lake, there were at least four times more rigs than is required for maximum sustainable yield, with many being unlicensed. The fisheries officer stated that climate variability and change is a reality. He also stated that over-fishing and fishing in the breeding areas were the major challenges facing the Kapenta fishery. His observation is similar to that found in the study by Madzudzo *et al.* (2014), were it was found that fishers in desperation, partly due to increasing number of fishers leading to decreased CPUE, encroach the inshore fishery damaging the breeding area. When asked on any interventions he was aware of on mainstreaming climate change strategies into fisheries management, he stated that talk was there but that is where it ended. He did, however, state that the Smart Fish Programme was working on climate change - related projects. When asked if he was aware of CSA, he stated that he only knew of it in the context of agriculture (crops) and not fisheries and so any CSA interventions in the fisheries sector was something he was not aware of.

The Smart Fish Programme is an initiative by FAO, the European Union (EU) and Indian Ocean Commission whose aim was to implement a regional fisheries strategy for eastern and southern Africa and Indian Ocean (ESA-IO) region. The project aimed at contributing an increased level of social, economic and environmental development. The plan was to do so through integration in the ESA-IO region. This integration was to be done through improved capacities for sustainable exploitation of fisheries resources. One of the components of the programme was enhancing food security by implementing actions in improved knowledge and preparedness to climate change impacts on fisheries. Zambia was a beneficiary of this programme and has offices at the head office of the DoF in Chilanga. The first phase of the project was implemented over a 31 month period, from March 2011 to September 2013.

Some of the fishers noticed a change in Kapenta fish stock, with 53 (59%) respondents stating that there had been a decrease in catch. Of the respondents, 15 (16.4%) stated that fish stocks had increased with the others stating that they did not notice any change in the catch. The 53 (59%) respondents who saw a decrease perceived the right trend as Kapenta fish catches have been declining. The trends show that catches have been steadily increasing but this can be related to increased effort on the Lake which has ultimately led to the reduction in catch per unit of effort (CPUE). The catch trends on the Zambian side are summarized in Figures 8, 9 and 10.

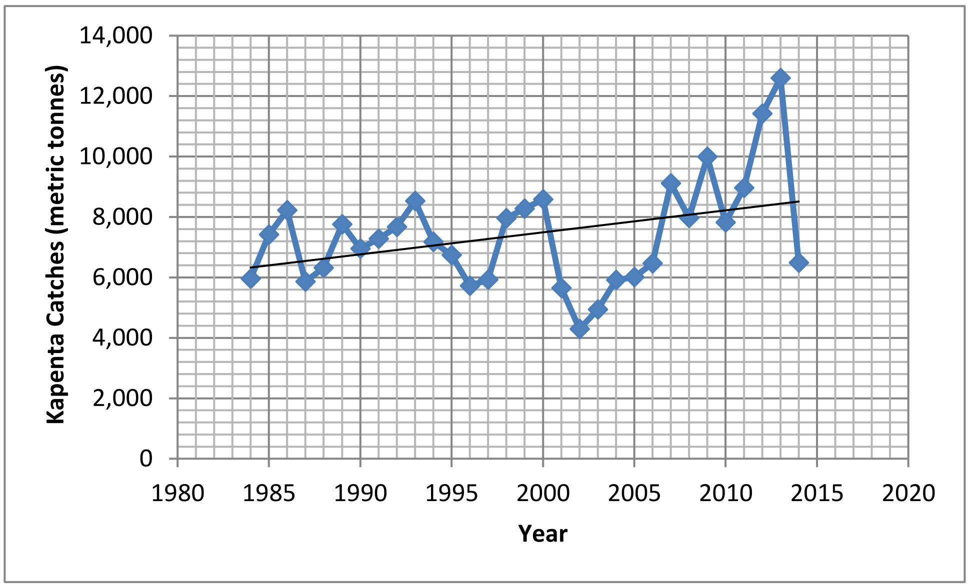

Figure 8: Kapenta Catches on Lake Kariba 1984-2014.

Source: Author’s plot based on DoF data (2015)

The catch data trend on its own does not give a full picture of what is actually happening on the Lake. Combined data on the effort and CPUE shows that even with the seemingly increasing trend of catches, the amount of fish the fishers are actually acquiring has been decreasing because of the increased effort. Figures 9 and 10.

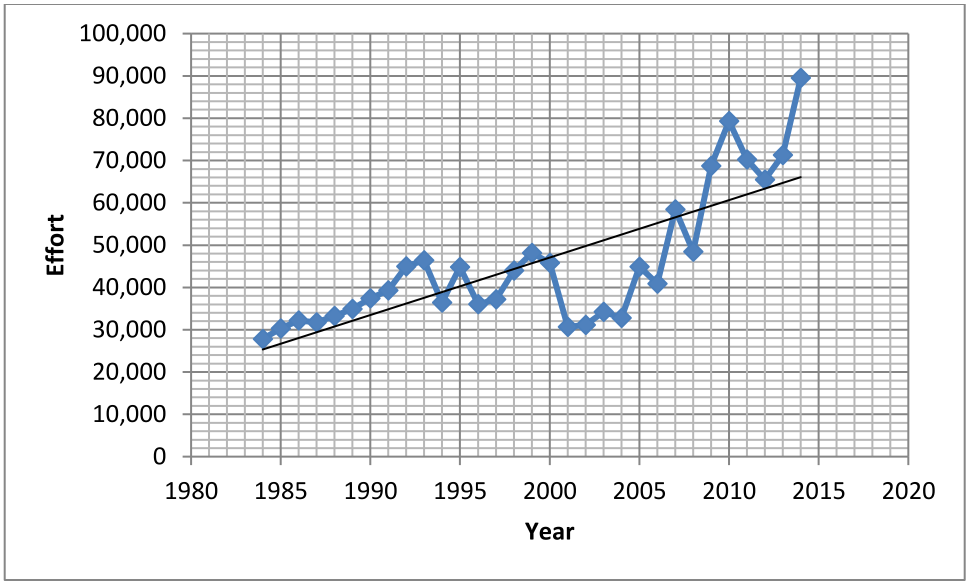

Figure 9: Effort on Lake Kariba 1983-2014.

Source: Author's plot based on DoF data (2015)

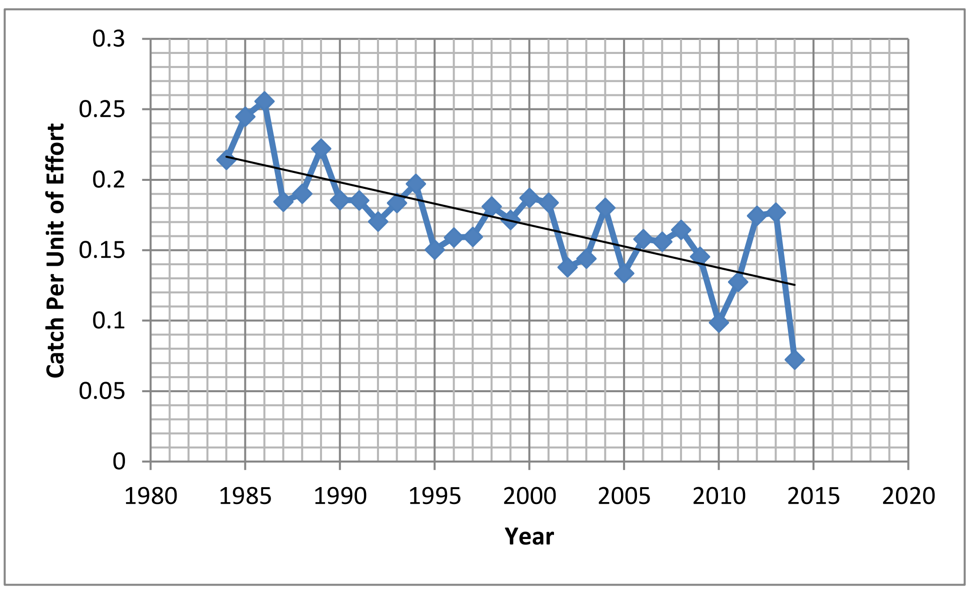

Figure 10: CPUE on Lake Kariba 1983-2014.

Source: Author's plot based on DoF data (2015)

In 2003, production reached an all-time low of 7,000 metric tonnes. Since 2007, fishing effort has increased on average by more than 10% per year and catches are once again declining (Kinadjian, 2012). Analysis of catch trends by (Ndebele-Murisa, 2011) shows that Kapenta fish catches have been declining at a rate of 29.58 metric tonnes per year.

The fishers stated that there were too many rigs on the Lake and that is why they thought fish catches where declining. This observation by the fishers is true and a survey carried out by Paulet (2013) revealed that there had been a 425% increase in the number of rigs on Lake Kariba from 1998 to 2013.They fishers stated that other fishers were not adhering to the rules and were fishing in shallow waters were the Kapenta breed and not observing the closures based on the lunar calendar. Some even recommended the introduction of closures on the Lake to allow, according to them, the fish stocks to recover so that their catches would not be so poor. The study by Madzudzo *et al.*, (2014) noted the same reaction with more experienced Kapenta fishers alleging that partly because of increasing rigs, the fishing effort continued to rise while the yield per unit of effort was decreasing. The same was noted by Musumali *et al.* (2010) stating that increased number of rigs has led to increased effort and consequently reduced catches. Fluharty (2011) states that fish stocks experiencing overfishing and habitat degradation stand to face even more challenges in the face of climate variability and change and this variability will increase uncertainty concerning fish stock productivity, migratory patterns, trophic interactions and vulnerability to fishing pressure. This implies that climate variability and change will interact with already existing challenges leading to declining fish stocks. It will not be solely responsible for changes observed in fish catches.

The fishers further stated that temperature and rainfall did play a role in catches with 32 (36.1%) respondents stating that increased rainfall meant catches would be good and 26 (29.2%) respondents stated that decreased rainfall meant catches would be poor. They also stated that the Kapenta catches fluctuated with temperature, particularly seasons. These observations can be related to the meteorological data on the Lake. This trend can clearly be seen from the temperature, rainfall and catch data on the Lake. The graphs show that catches were lowest around 1995 and 2002 and it is also in these years that rainfall was low and minimum temperature on the lake was high.

These findings on temperature, rainfall and catch perceptions are similar to those found by Zhang *et al.* (2011). They state that the cyclical nature of climate might also influence fishers' perceptions because long term trends co-exist with climate variability. This may have made it difficult for the fishers in this study to differentiate between cycles and trends.

Despite the differences in the nature of the climate variability perceived, fishers interviewed noted the variability in rain, temperature and catches. This is a finding common in climate change perceptions of resource users as noted by Nyanga *et al.* (2011) and Mulenga and Wiseman (2014); Kansiime *et al.* (2013) and; Deressa *et al.* (2008) from Zambia, Uganda and Ethiopia respectively.

The fact that fishers are experiencing the same climatic conditions on the Lake means that it cannot be established if results would be any different if different climatic conditions were being experienced on the lake by fishers in different areas along the lake and if this would have an effect on the perceptions. That is outside the scope of this research but can be consideration for any work that may be similar to this with an appropriate water body.

4.5 Relationship between Perceptions and Socio-economic Characteristics

Multiple Regression Analysis and Pearson Correlation Coefficient were used to analyze the relationship between perception and socio-economic characteristics. Perception was the dependent variable and the socio economic characteristics, the independent variables using SPSS 16.0. A total of eleven variables were used i.e. age, sex, marital status, years of fishing experience, years of formal education, number of fishing rigs owned, size of household, cooperative membership, years of membership, access to extension visits and number of extension visits. Microsoft Excel and SPSS 16.0 were used to summarize the socio-economic characteristics of the respondents.

The formula for the multiple regression used was:

$$Y = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8 + \beta_9 + \beta_{10} + \beta_{11} + \varepsilon$$

Where:

Y = Perception

β_0 = constant

β_1 = Sex

β_2= Marital status

β_3= Years of fishing experience

β_4= Years of formal education

β_5= Number of fishing rigs

β_6=Size of household

β_7=Cooperative membership

β_8= Years of membership

β_9=Access to extension visits

β_{10}=Number of extension visits

β_{11}= Age

ε= error

The results from the analyses are summarized below:

Pearson Correlation Coefficient

Pearson's Correlation Coefficient revealed a range of coefficients between -0.273 to 0.066. The values fell below 0.3 showing that the independent variables were not highly correlated to one another. They had a low strength of association and hence appropriate for multiple regression analysis.

Multiple Regression Analysis

A summary of the Regression model gave an R^2 value of 0.195. The selected socio-economic variables account for 19.5% of the variation of the respondents' perception of climate variability. The Beta values of each variable are as follows; Age had a value of -0.525, Sex was -0.022, Marital Status was 0.220, Fishing experience was 0.316, Years of education was 0.149, Number of Fishing vessels was 0.154, Size of household was -0.076, Cooperative membership was -0.007, Years of membership was -0.172, Access to extension services was 0.001 and Number of extension visits was 0.237. The negative beta values show an inverse relationship between perception and that particular independent variable.

Kapenta fishing is a labor intensive activity because some of the rigs are not mechanized. The major challenges faced by women as observed by Chali *et al.* (2014) that lead to low participation in fishing include: limited access to fishing permits, access to capital (rigs can cost $13,500), cultural hindrances, gender stereotypes and security risks associated with fishing on the lake at night. This accounts for the male domination in the fishery.

The variables with the greatest explanatory power of perception of climate variability via beta values were age (52.5%), fishing experience (31.6%) and number of extension visits (23.7%). Age had a significance value of $p \leq 0.01$, fishing experience $p \leq 0.024$ and number of extension visits with a value of $p \leq 0.054$.

Age and years of fishing experience had a significant relationship with perception. The older the fisher and the more the fishing experience, the higher the likelihood of perceiving climate variability. This finding is similar to that of Tologbonse *et al.* (2010)

where they found that because experience gives knowledge of climate changes in the area, perception will indicate notice of these changes.

Gbetibuou (2009) states that access to extension services is important in analyzing the decision to use an adaptation strategy and that access to extension services is positively related to adoption of new technologies by exposing individuals to new information and technical skills. The results for this research show that fishers who have more frequent access to these services are more likely to perceive climate variability. This is because they have the opportunity to get information from the extension officers about the weather and any news relating to fishing activities.

The results show that hypothesis 2 which states that socio-economic characteristics will influence perception of climate variability can be accepted. Multiple regression analysis revealed that 19.5% of an individuals' perception will be influenced by their socio-economic characteristics.

The results of the regression analysis carried out are summarised in Tables 2 and 3.

Table 2: Summary of Regression Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.441[a]	.195	.081	.303

Source: Author (2014)

Table 3: Regression Coefficients and their Relationship to Perceptions

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.298	.349		3.723	.000
	Age	-.022	.007	-.525	-3.309	.001
	Sex	-.065	.312	-.022	-.209	.835
	Marital Status	.186	.099	.220	1.880	.064
	Fishing experience	.017	.008	.316	2.297	.024
	Years of education	.013	.011	.149	1.237	.220
	# Fishing vessels	.031	.031	.154	.994	.323
	Size of household	-.010	.017	-.076	-.574	.567
	Cooperative member	-.004	.110	-.007	-.040	.968
	Years of membership	-.023	.025	-.172	-.919	.361
	Access to extension services	.001	.083	.001	.009	.992
	# of extension visits	.034	.017	.237	1.955	.054

a. Dependent Variable: Perception

Source: Author (2014)

4.6 Adaptation of fishers to Climate Variability

Content analysis of questionnaires was done and the main characteristics of the strategies were summarized into the threefold typology of responses distinguished as anticipatory adaptation strategy, responsive adaptation strategy, and alternative adaptation strategy (Smit *et al.*, 2000).

The anticipatory adaptation strategy is characterized by long term, structural and often planned and collectively implemented measures. The strategies aiming to adapt mean that the sustaining of livelihood is pursued in order to reach sustainability by implementing adaptation strategies.

Responsive adaptation strategies incorporate the short term responding strategies. They are often less structural, not characterized by long term planning and more often referring to individual response strategies.

Alternative responses are not aimed to sustain a certain livelihood but they can include migration or a total change of one's livelihood. This is being analyzed as a response to climate changes.

From the data analyzed, 9 (10%) fishers reported to not undertaking any adaptation strategy. The remaining 81 (90%) fishers stated that they used one or more adaptation strategies. A variety of strategies were used by the fishers to adapt to changes in catches. A total of 63 (69.9%) fishers stated that they were fishing further away. About 35 (38.4%) fishers stated that they were fishing for longer periods of time and 8 (8.2%) respondents stated that they were catching smaller fish. About 26 (28.8%) fishers stated that they had shifted fishing times and 8 (8.2%) respondents stated that they had changed their fishing gear. The alternative livelihood option was used by 5 (5.5%) respondents and the 'other' option such as fishing in shallow waters and stopping fishing activities was used by 6 (5.8%) respondents. The fishers' responses fell under two categories: the responsive adaptation strategy and the alternative adaptation strategy. The strategies used by the fishers are summarised in Figure 11.

The majority of the strategies used by the fishers fell under the responsive adaptation strategy. In this case, 76 (84.4%) respondents used options that fell under this category. They are referred to as responsive adaptation strategies because they are not coordinated by any other stakeholders but the fishers themselves. The use of these strategies is triggered by environmental stimuli such as Kapenta stock fluctuation and movement. The strategies that fell under this category include shifting fishing times, fishing for longer time periods, fishing further away, changing fishing gear, catching smaller fish and 'other' specified options. The option of 'Other' under the adaptation strategies involved; stopping fishing activities in times when Kapenta was hard to find and fishing in shallow waters. The practice of fishing in shallow waters is illegal as those are the areas in which Kapenta breed. Also, the presence of fishing rigs in the shallow waters is a source of conflict. This action is noted by Madzudzo *et al.* (2014) as encroachment into the inshore fishery damaging artisanal fishers' nets and fishing in breeding areas. The encroachment of the inshore fishing area is also noisy for residential houses or lodges that are along the banks of the lake.

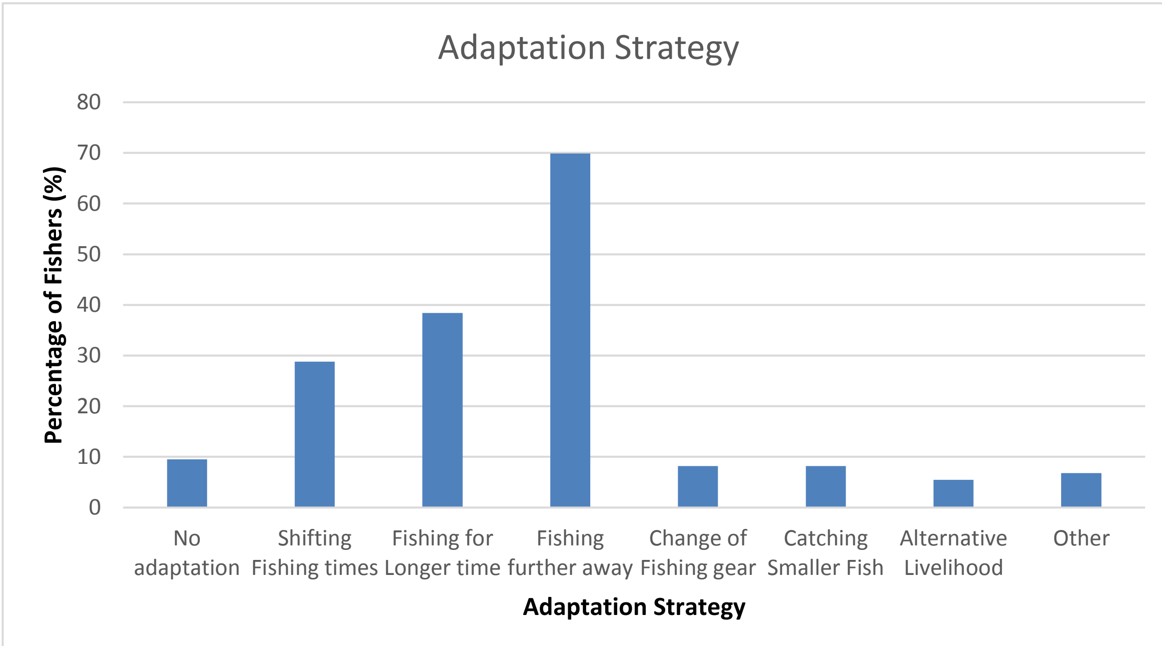

Figure 11: Fishers' Adaptation Strategies.

Source: Author (2014)

The alternative livelihood option could be categorized as an alternative livelihood strategy and only 5 (5.5%) respondents were engaged in it. This could have been primarily due to the fact that money is required to engage in an alternative livelihood. The alternatives to fishing employed by the respondents were engaging in fish trading of other species (breams and tiger fish) and selling of second hand clothes.

The results can further be classified as being climate-smart or not. Response options in specific fisheries systems by FAO (2013) show that small scale fisheries that use active gear, such as rigs, have the options of adapting gear, fish timing, access, adjusting management by using the ecosystem management approach to fisheries, reducing energy costs, reducing post-harvest losses and developing alternative livelihoods to respond to climate impact. Exiting the fishery, promoting adaptive management frameworks and migrating fishing efforts are also noted as potential options for capture fisheries in general. The strategies used by the fishers when compared to interventions proposed show that 64.3% of the strategies have the potential to be climate-smart.

The climate-smart options used by the fishers were: shifting of fishing times and location, the changing of fishing gear though mechanization of the rig in terms of better engines that are more fuel efficient, the stopping of fishing activities during times Kapenta was hard to find and developing alternative livelihoods i. e selling of second hand clothes and fish trading of species such as Bream and Tiger fish.

Shifting the times and locations was based on what they observed as new trends in time and location of Kapenta. If they noticed that a particular fishing area didn't have as much Kapenta as it used to have or the time of year Kapenta was most abundant shifted, they changed their patterns accordingly.

Mechanized rigs meant newer engines that used fuel more efficiently, were being used and also ones with a mechanized winch. This meant there was a reduction in physical labor required to operate the rig apart from fuel efficiency. A study by Chali *et al.* (2014) reveals that 19% of rigs in Siavonga district, on Lake Kariba, have fish finders installed. This is particularly true for the new mechanized rigs. This enables the fishers to locate Kapenta sites efficiently and consequently reduce fuel costs. Mechanization is in line with LIFE vessels because location of appropriate sites ensures the least amount of fuel is used when locating Kapenta. A reduction in fuel cost is climate-smart as it mitigates the release of greenhouse gases from use of fossil fuels.

Selling of second hand clothes meant they had an alternative livelihood to Kapenta fishing. This additional source of income means that they were not solely dependent on fishing.

The fishers who were adapting did not all exclusively use one strategy. Based on the number of strategies employed, 36 (44.6%) respondents used a single strategy, 27 (33.9%) respondents used two, 12 (14.3%) respondents used three, 4 (5.4%)

respondents used four and 1 (1.8%) respondent used five adaptation strategies. This implies that the fishers are diversifying ways to deal with climate impacts on the catch and use a variety of strategies depending on which option is available at the time.

Availability of finance and structural support would help in reducing postharvest losses as a way of adapting to climate variability as the current drying mechanisms are quite primitive and highly dependent on weather conditions. If it rains while Kapenta is being dried, there is a high risk of the catch rotting due to insufficient drying time if freezing is not an available option. About 80% of fish caught in Zambia is traditionally processed by drying (Mwambazi, 1990). Investing in driers that reduce postharvest losses by reducing contamination from dirt and dust, protection from animals like cats and dogs and providing adequate water drainage from wet fish is a climate-smart option.

4.6.1 Constraints to Adaptation

The respondents noted that there were constraints to adapting to climate variability. A total of 66 (82%) of the adapting fishers stated that they faced some difficulties in adapting. Of these, 48 (60%) respondents cited a lack of money as being the main constraint to adaptation and 24 (30%) respondents cited other reasons such as faulty fishing vessels making it difficult to go to areas further away or fishing for longer time periods and lack of money to buy fuel to go to areas further away or to shift fishing areas.

The lack of money referred to inability to mechanize their rigs to improve efficiency or buying a better rig altogether. The mechanization of the rigs leads to improved engines that reduce energy costs in terms of fuel use efficiency and physical labor. The fishers also cited time restrictions that prevent them from fishing for longer time periods because of the lunar calendar which dictates when fishing should stop and the restriction on introduction of new rigs by fisheries authorities preventing them from intensifying fishing efforts.

A total of 8 (10%) respondents stated that lack of information on available adaptation options was a constraint. They stated they were not aware of ‘officially recognised’ options to deal with the changes they perceived and simply responded according to their experience or learnt from other fishers.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions and provides recommendations of the study.

5.1 Conclusions

The aim of the study was achieved. The perceptions, factors influencing these perceptions and adaptation strategies of the fishers in Siavonga district were determined through the study objectives and hypotheses.

5.1.1 Perceptions of Climate Variability

The majority of the fishers, 79 (87.7%) respondents, perceived climate variability but these perceptions of change were interpreted differently. These results showed that hypothesis 1, stating that fishers' will perceive climate variability in terms of temperature and rainfall, can be accepted. This finding offers an opportunity to disseminate and educate fishers on climatic trends that may be helpful in adaptation planning seeing as they perceive climate variability.

5.1.2 Relationship between perceptions and socio-economic characteristics

The multiple regression analysis, revealed that that the younger a fisher was, the less likely they were to perceive climate variability; the more fishing experience a fisher had, the more likely they were to perceive climate variability; and the more extension visits a fisher had, the more likely they were to perceive climate variability. This showed that socio-economic characteristics do influence an individuals' perception hence proving the hypothesis 2, that fishers' socio-economic characteristics influence their perceptions of climate variability, correct.

5.1.3 Adaptation of local fishers to climate variability

A total of 81 (90%) fishers stated they were adapting to climate variability. The fishers' responses fell under two categories: the responsive adaptation strategy that included fishing further way, shifting fishing time, fishing for longer time periods, catching smaller fish and changing of fishing gear and the alternative adaptation strategy that involved trading. The fishers' responses showed that 64.3% of the strategies with the potential to be climate-smart were fishing further away, shifting fishing time, stopping fishing activities, changing fishing gear and the use of alternative livelihoods. This shows that the strategies being used by the fishers can be scaled up with the help of scientific knowledge, coupled with indigenous knowledge, to help fishers adapt appropriately.

The overall conclusion of the study based on these findings is that fishers perceive climate variability in terms of rainfall and temperature; and these perceptions are affected by their socio-economic characteristics. The fishers are adapting to climate variability and the majority of their strategies have the potential to be climate-smart.

5.2 Recommendations

The analysis of information from the fishers on their perceptions, factors influencing these perceptions and adaptation strategies presents opportunities that can be taken to help them adapt to climate variability and change. Capacity can be built on already existing climate-smart adaptation responses. This can be done in a variety of ways as recommended below:

1. The Department of Fisheries should play a key role in coordinating adaptation activities between fishers and various stakeholders that are already engaging in potentially climate-smart activities.
2. Co-operating partners and local microfinance institutions should take a first step in providing finances and structural support for alternative livelihoods and this can be done by providing fishers with: capital to buy clothes or different fish species; having a place to sell, store (freeze, salt, smoke or dry) and transport their fish; and helping them to access markets.
3. The Department of Fisheries should engage the private sector (NGOs or projects engaged in the fisheries sector) in improving extension services through a pluralistic system to offset staff challenges the Ministry of Fisheries and Livestock might be experiencing. The potential for dissemination of correct climatic trends to fishers and adaptation support is an opportunity that can be

used to promote climate-smart adaptation and this must be linked with other forms of institutional support.

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APPENDICES

Appendix 1 Fishers' Questionnaire

INTRODUCTION

My name is……………………. I am conducting research on the Perceptions on climate variability and adaptation strategies of fishers to climate variability. I am asking questions to people who live in the Siavonga district and fish on Lake Kariba for Kapenta,

I have chosen randomly, so that i can get their views. The information provided will be for academic purposes only and will be kept confidential and anonymous. Is it ok for me to interview you?

Thank you.

PART A: PERSONAL DETAILS AND SOCIO-ECONOMIC CHARACTERISTICS

1) AGE
2) SEX Male: Female:
3) MARITAL STATUS Single: Married: Divorced: Separated:
4) YEARS OF FISHING EXPERIENCE

   ……………………………
5) Kgs OF FISH CAUGHT IN 2013

   …………………………….
6) REVENUE OBTAINED FROM SELLING FISH IN 2013

   ……………………………
7) Kgs OF FISH CONSUMED FROM THAT CAUGHT IN 2013

   …………………………….
8) VALUE OF FISH CONSUMED IF IT HAD BEEN SOLD

   ………………………………
9) NUMBER OF YEARS OF EDUCATION

   ……………………………
10) NUMBER OF FISHING VESSELS

    …………………………….

11) CAPACITY OF FISHING VESSEL

…………………………….

12) SIZE OF HOUSEHOLD

…………………………….

13) SEX OF HOUSEHOLD MEMBERS

………………………......

14) MEMBERSHIP TO FISHING COOPERATIVE

Yes: No:

15) COST OF COOPERATIVE MEMBERSHIP

…………………………….

16) NUMBER OF YEARS OF MEMBERSHIP

…………………………….

17) ACCESS TO FISHERIES EXTENSION SERVICES

Yes: No:

18) NUMBER OF EXTENSION VISITS IN 2013

………………………………

19) MONTHS OUT OF 2013 WHEN THERE WASN'T ENOUGH FOOD

………………………………

PART B: PERCEPTUAL STATEMENTS

Use the options below to answer the following questions according to your level of agreement or disagreement:

Code: 1–Strongly Agree, **2**–Agree, **3**–I Don't Know **4-** Disagree, **5**–Strongly Disagree

We would like to know the following from you

1.Do you think there has been a change in rainfall since you began fishing?	2.Do you think rainfall has an impact on fish catch?	3.Do you think there has been a change in temperature since you started fishing?	4.Do you think temperature has an impact on fish catch?	5.Do you think there has been a change in fish catch since you started fishing?
If so, what change have you observed	If so, what impact?	If so, what change have you observed?	If so, what impact?	If so, what change?

PART C: CLIMATE CHANGE ADAPTATION OPTIONS

1. What adjustments in your fishing have you made due to these long-term shifts in temperature and rainfall? Please tick on list below.
    - No adaptation
    - Shifting fishing times
    - Fishing for longer time periods
    - Fishing in waters further away than before
    - Change of fishing gear (from passive to active gear)
    - Diversifying species being caught (not Kapenta only)
    - Catching smaller (younger) fish
    - Alternative Livelihoods (farming, trading etc)
    - Fish farming
    - Other (please specify)………………………………………

2. When did you make these changes to your fishing practices?

   …………………………….

3. How much has it cost to make these adjustments to your practices?

   ……………………………

4. What are the main constraints/difficulties in changing your fishing ways?
   - Lack of information
   - Lack of money
   - Shortage of labor
   - Other (Please specify)………………………………………

THANK YOU!

Appendix 2 Key Informant Interview Form

INTRODUCTION

My name is……………………. I am conducting research on the Perceptions on climate variability and adaptation strategies of fishers to climate variability. I am asking questions to people who live in the Siavonga district and work in fisheries department,
I have chosen randomly, so that i can get their views. The information provided will be for academic purposes only and will be kept confidential and anonymous. Is it ok for me to interview you?
Thank you.

INTERVIEW QUESTIONS

1. How long have you worked for the Department of Fisheries in Siavonga District?
2. In what capacity?
3. Have you noticed any particular trend in Kapenta catches over the years you have worked at the department?
4. Do you think climate variability and change is a reality for Kapenta fishery?
5. There is talk of mainstreaming climate change into fisheries management, are you aware of any efforts to integrate this into your current management techniques?
6. Do you know anything about Climate-Smart Agriculture strategies in fisheries management?

THANK YOU FOR YOUR PARTICIPATION