

**IMPACT OF CLIMATIC CHANGE ON FOOD SYSTEMS ALONG LAKE
NYASA SHORE IN MBINGA DISTRICT**

BY

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
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ABSTRACT

This study was done in three villages along Lake Nyasa shore in Mbinga district to assess the impact of climate change on food systems. A sample of 90 randomly selected respondents of both farmers and fishermen were interviewed using a structured questionnaire so as to acquire their socio economic characteristics and all the matters related to climatic change food systems in their area. The research was conducted from July 2009 to June 2010. The data obtained were then coded and analysed by using SPSS computer program. The average respondent age was 37years, average household size was 4.7 and education status of the house hold was 23.3% have secondary education, 74.5% have primary education and 2.2% have no education. The average production of food crops was 5.5 tons per year. The most vulnerable aspect of food system according to this study was production followed by distribution, exchange and consumption. Despite this vulnerability of food systems it has also discovered that the group at most risk are women and children. People had some adaptations to climate change, and these are farm expansions, intensification of their agriculture through adapting to modern agriculture and introduction of new meal regime. The study also found that the community had some coping strategies like labour selling. I recommended several ways of reducing house hold vulnerability to climate change and these are first by increasing production through intensification of agriculture, secondly, by increasing economic access to food through empowering of local community by strengthening marketing situation, and thirdly through improvements of food distribution, through improvement of rural infrastructures especially roads.

DECLARATION

I Hoops Alphonse Kamanga, do hereby Declare to SENATE of Sokoine University of Agriculture (SUA) that this dissertation is my own original work and that it has not been submitted for a higher degree award in any other University.

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Date

The above declaration is confirmed by

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DEDICATION

I dedicate this work to the everlasting souls of my dad Alphonse Kamanga who laid the foundation of my education and my brother Morris Kamanga who both passed away amid my academic struggles and to my beloved children Britney and Brighton missing fatherly care during my studies.

TABLE OF CONTENTS

ABSTRACT.....	II
DECLARATION.....	III
COPYRIGHT.....	III
ACKNOWLEDGEMENT.....	V
DEDICATION.....	VI
TABLE OF CONTENTS.....	VII
LIST OF TABLES.....	XIII
LIST OF FIGURES.....	XIV
LIST OF PLATES.....	XV
LIST OF APPENDICES.....	XVI
ABBREVIATIONS.....	XVII
CHAPTER ONE.....	1
1.0 OVERVIEW.....	1
1.1 INTRODUCTION.....	1
1.2 PROBLEM STATEMENT.....	2
1.3 PROBLEM JUSTIFICATION.....	3
1.4 OBJECTIVES.....	4
1.4.1 General objective.....	4
1.4.2 Specific objectives.....	4
1.5 RESEARCH QUESTION.....	5
1.6 CONCEPTUAL FRAMEWORK.....	5
CHAPTER TWO.....	8
2.0 OVERVIEW.....	8
2.1 LITERATURE REVIEW.....	8
2.1 DEFINITION OF KEY CONCEPTS.....	8
2.1.1 Food systems.....	8

2.1.2 Food Security.....	9
2.1.3 Climate change.....	10
2.2 OVERVIEW OF FOOD SECURITY.....	10
2.2.1 Food security situation in the world.....	10
2.2.1.2 Global environmental change and food system performance.....	13
2.2.1.3 Trends in global food security analysis.....	14
2.2.1.4 Beyond food security to livelihoods.....	15
2.2.2 Food security situation in Africa.....	16
2.2.2.1 Food Accessibility in Africa.....	17
2.2.2.2 Food supply in Africa.....	18
2.2.2.3 Food Acceptability.....	19
AS A RESULT OF ITS AGRO ECOLOGY, TRADE HISTORY, AND POSITION MOST AFRICAN COUNTRIES HAVE DIVERSE DIETS IN TERMS OF STAPLE FOODS. THIS IS A GREAT ADVANTAGE IN TERMS OF FOOD SECURITY BECAUSE MANY CONSUMERS WILL SUBSTITUTE AMONG THE FIVE BROAD CATEGORIES OF STAPLE - CASSAVA, YAMS AND TUBERS, PLANTAIN, MILLET, MAIZE AND RICE ACCORDING TO NATIONAL AND ALSO TRIBAL TASTE PREFERENCES AND CHANGING RELATIVE PRICES (KENNEDY ET AL., 2004). WOMEN HAVE DISTINCTIVE ROLES TO PLAY IN DETERMINING THE ACCEPTABILITY OF FOOD BASICALLY BECAUSE OF THEIR TRADITIONAL ROLE AS WIVES AND MOTHERS WHO COOK FOR THEIR FAMILIES. TRANSFORMING FOOD FROM ITS RAW STATE INTO PROCESSED OR COOKED FOOD HAS LONG BEEN THE PRESERVE OF WOMEN. AS PREPARES OF FOOD WOMEN CAN GET THE WHOLE HOUSEHOLD TO ACCEPT ONE MENU OVER THE OTHER ENSURING THAT FAMILY MEMBERS ACCEPT ONE AVAILABLE FOOD OVER THE OTHER. (CHRISTIANSEN AND BOISVERT, 2000).....	19
2.2.3 Food security situation in Tanzania.....	19
a) Food Availability.....	20
b) Accessibility to food.....	22
c) Food Utilization.....	23
2.4 THEORETICAL BACKGROUND.....	23
2.5 REVIEW OF PREVIOUS RESEARCH.....	29

YOUNG ET AL., (2006) DISCUSS THE IMPLICATIONS OF GLOBALIZATION FOR COUPLED SESs, DRAWING UPON LITERATURE ON THE INSTITUTIONAL DIMENSIONS OF ENVIRONMENTAL CHANGE, AS WELL AS THE SOCIAL AND ECOLOGICAL VULNERABILITY LITERATURE SUMMARIZED HERE. THEIR ANALYSIS IS HIGHLY RELEVANT TO FOOD SYSTEMS. KEY TO THEIR UNDERSTANDING OF VULNERABILITY IS THAT ADAPTATION TO AVOID IT REQUIRES STRUCTURAL CHANGE WITHIN OR BY A SYSTEM SO THAT THE SYSTEM DOES NOT LOSE ANY OF ITS KEY FUNCTIONS. THIS SUGGESTS THAT AN IMPORTANT ANALYTICAL STEP IS TO DEFINE THESE KEY FUNCTIONS INITIALLY TO UNDERSTAND WHAT VULNERABILITY MEANS FOR A GIVEN SYSTEM. YOUNG ET AL., (2006) CONCLUDE THAT IN MANY SESs TODAY, SOCIAL COMPLEXITY HAS COME TO REPLACE BIOPHYSICAL COMPLEXITY AS HUMANS HAVE INSERTED THEMSELVES MORE AND MORE INTO THESE SYSTEMS. THEY HIGHLIGHT FOUR IMPORTANT IMPACTS OF GLOBALIZATION FOR SESs: IT HAS INCREASED THE CONNECTIONS AMONG DISPARATE SYSTEMS; IT HAS INCREASED THE SPEED WITH WHICH DISTURBANCES AND CHANGE FLOW THROUGH AND BETWEEN SYSTEMS; IT HAS CHANGED THE TRADITIONAL SCALAR RELATIONSHIPS SO THAT THERE ARE NOW TOO MANY CROSS-SCALE INTERACTIONS; AND IT HAS SIGNIFICANTLY DECREASED THE DIVERSITY IN SESs. THESE CHANGES RAISE SERIOUS QUESTIONS ABOUT THE ABILITY OF SYSTEMS TO UNDERGO THE STRUCTURAL CHANGES NECESSARY TO ADAPT TO DISTURBANCES, RATHER THAN MOVING INTO A VULNERABLE OR LESS DESIRABLE STATE.

THE IMPACTS OF GLOBALIZATION ARE ALSO A CONCERN FOR POLITICAL-ECONOMIC AND SOCIOLOGICAL CRITIQUES OF FOOD SYSTEMS SUCH AS THOSE OF LEICHENKO AND O'BRIEN, (2004A). THESE AUTHORS SUGGEST THAT ALTHOUGH VERY POWERFUL CORPORATIONS GOVERN MODERN FOOD SYSTEMS, WHICH ARE CHARACTERIZED BY INDUSTRIAL AGRICULTURAL PRODUCTION, FACTORY-BASED PROCESSING, AND SUPERMARKET-CONTROLLED RETAIL, THE SYSTEMS THEMSELVES MAY BE GENERALLY VULNERABLE TO SHOCKS. THIS VULNERABILITY ARISES FROM THE DEGREE OF SPECIALIZATION AND HOMOGENIZATION, WHICH CAN MAKE IT DIFFICULT TO ADJUST TO CHANGES IN PREFERENCES OR TO SERVE SMALLER MARKETS.....34

CHAPTER THREE.....35

3.0 RESEARCH METHODOLOGY.....36

3.1 OVERVIEW.....36

3.2 DESCRIPTION OF THE STUDY AREA.....	36
3.2.1 Boundaries.....	36
3.2.2 Population.....	37
3.2.3 Land Area.....	38
3.2.4 Administration.....	38
3.2.5 Topography.....	39
3.2.6 Climate.....	41
3.2.7 Soils.....	41
3.2.8Vegetation.....	42
3.2 RESEARCH DESIGN.....	43
3.3 UNIT OF DATA COLLECTION.....	43
3.4 METHOD OF DATA COLLECTION.....	43
3.4.1 Qualitative data.....	43
3.4.2 Focus Group discussion.....	44
3.4.3 Key informants.....	44
3.4.4 Secondary data.....	45
3.5 METHOD OF DATA ANALYSIS.....	45
CHAPTER FOUR.....	47
4.0 OVERVIEW.....	47
4.1 DEMOGRAPHIC AND SOCIO ECONOMIC CHARACTERISTICS OF THE RESPONDENTS.....	47
4.1.1 Age of respondents.....	47
4.1.2 Sex of respondents.....	49
4.1.3 Marital status of respondents.....	50
4.1.4 Household economic status.....	50
Figure 5: Household annual expenditure (Tshs).....	51
4.1.5 Food security Status.....	53
4.2 CLIMATE CHANGE AND VARIABILITY IN MBINGA DISTRICT.....	60
4.2.1 Community Perception of Climate Change.....	60
4.2.2 Rainfall Change and Distribution.....	61

4.2.3 <i>Impact of climate change on Food Production</i>	62
4.2.4 <i>Impact on Food Distribution and Exchange</i>	66
4.3 FOOD SYSTEM VULNERABILITY TO CLIMATE CHANGE.....	67
4.3.1 <i>Vulnerability on production</i>	67
4.3.2 <i>Vulnerability on distribution and exchange</i>	69
4.4 CLIMATE CHANGE ADAPTATION STRATEGIES.....	72
4.4.1 <i>Adaptation on Production</i>	72
4.4.2 <i>Adaptation Strategies on Distribution and Exchange</i>	73
4.4.2 <i>Adaptation Strategies on Consumption</i>	74
4.5 COPING STRATEGIES TO CLIMATE CHANGE.....	74
4.5.1 <i>Coping Strategies on Production</i>	74
4.5.2 <i>Coping Strategies on Distribution and Exchange</i>	75
4.5.3 <i>Coping Strategies on Consumption</i>	75
4.6 GENDER ISSUES ON CLIMATE CHANGES COPING STRATEGIES.....	76
4.7 SUMMARY OF THE CHAPTER.....	77
CHAPTER FIVE.....	79
5.0 CONCLUSION AND RECOMMENDATIONS.....	79
5.1 SUMMARY OF THE MAJOR FINDINGS.....	79
5.1.1 <i>Climate change and variability</i>	79
5.1.2 <i>Impact of Climate Change on Food production and Distribution</i>	79
5.2 COMMUNITY VULNERABILITY TO CLIMATE CHANGE.....	80
5.3 CLIMATE CHANGE COPING PRACTICES.....	81
5.3.1 <i>Improving disaster risk management</i>	81
5.3.2 <i>Enhancing social Protection scheme</i>	82
5.3.3 <i>Strengthening Resilient Community Based Development</i>	84
5.4 MAJOR CONCLUSION.....	86
5.5 RECOMMENDATIONS.....	87
5.5.1 <i>Reducing vulnerability by increasing production</i>	87
5.5.2 <i>Reducing vulnerability improving food distribution</i>	88

5.5.3 <i>Reducing vulnerability by increasing economic access to food</i>	88
5.6 IMPLICATIONS FOR FURTHER RESEARCHES.....	89
REFERENCES	91
APPENDICES	105

LIST OF TABLES

TABLE 1: DESCRIPTION OF AGRO-ECOLOGICAL ZONES OF MBINGA DISTRICT.....	40
TABLE 2: DISTRIBUTION OF RESPONDENTS BY AGE (N=90).....	48
TABLE 3: SEX OF INTERVIEWED RESPONDENTS IN THE SELECTED HOUSEHOLDS (N=90).....	49
TABLE 4: AVERAGE ANNUAL HOUSEHOLD EXPENDITURE PER YEAR IN TSHS.....	52
TABLE 5: AVERAGE HOUSEHOLD SIZE.....	52
TABLE 6: FOOD SECURITY STATUS OF THE INTERVIEWED HOUSEHOLDS (N=90)...	53
TABLE 7: COMPARISON BETWEEN EXPENDITURE AND NUMBER OF MEALS.....	54
TABLE 8: COMPARISON BETWEEN EXPENDITURE AND HH ANNUAL FOOD PRODUCTION.....	55
TABLE 9: CHANGES IN LAKE BEHAVIOUR TREND.....	56
TABLE 10: CHANGES IN RIVER SYSTEMS.....	56
TABLE 11: CHANGE IN RIVER FLOW BEHAVIOUR.....	58
TABLE 12: DRIVERS OF CHANGES IN LAKE NYASA.....	59
TABLE 13: AVERAGE ANNUAL PRODUCTION PER HOUSEHOLD (EXCLUDING LAST YEAR) IN TONS.....	64
TABLE 14: AVERAGE LAST YEAR FOOD CROPS PRODUCTION PER HOUSEHOLD IN TONS.....	65
TABLE 15: PRODUCTION VULNERABILITY DUE TO CLIMATE CHANGE.....	68
TABLE 16: RESPONSES TO DISTRIBUTION AND EXCHANGE SITUATION.....	69
TABLE 17: ADAPTIVE STRATEGIES IN PRODUCTION.....	73
TABLE 18: HH VULNERABILITY TO CLIMATE CHANGE.....	76

LIST OF FIGURES

FIGURE 1: FOOD SYSTEMS ACTIVITIES AND OUTCOME.....	7
FIGURE 2: A MAP OF MBINGA DISTRICT COUNCIL SHOWING STUDY AREA.....	36
FIGURE 3: AGE OF THE RESPONDENTS.....	48
FIGURE 4: DISTRIBUTION OF THE RESPONDENTS' MARITAL STATUS BY VILLAGE	
50	
FIGURE 5: HOUSEHOLD ANNUAL EXPENDITURE (TSHS).....	51
FIGURE 6: RELATIONSHIP BETWEEN FOOD SECURITY AND ANNUAL HH	
EXPENDITURE.....	54
FIGURE 7: MODE OF LAND (FOR CULTIVATION) OWNERSHIP.....	61

LIST OF PLATES

**PLATE 1: CHIIHILA RIVER WHICH HAS BEEN TRANSFORMED FROM PERMANENT
TO SEASONAL.....58**

**PLATE 2: A MAIN CANAL IN KIMBANDE IRRIGATION SCHEME DESTROYED BY
HIGH RAINFALL.....66**

LIST OF APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE.....	105
APPENDIX 2: FGD INTERVIEW CHECKLIST.....	114
APPENDIX 3: PRODUCTION OF MAJOR FOOD CROPS AND RAINFALL DISTRIBUTION FOR THE PAST 20 YEARS.....	116

ABBREVIATIONS

AIDS	-	Acquired Immune Disease Syndrome
AMCOS	-	Agriculture Marketing Cooperative Societies
BMI	-	Body Mass Index
CO ₂	-	Carbon Dioxide
CRDB	-	Cooperative and Rural Development Bank
DADP	-	District Agriculture Development Plan
DALDO	-	District Agriculture and Livestock Development Officer
DANIDA	-	Danish International Development Agent
DNRO	-	District Natural Resources Officer
DSI	-	Development Studies Institute
FAO	-	Food and Agriculture Organization
FGD	-	Focused Group Discussion
GEC	-	Global Environmental Change
ICRA	-	International Cultivar Registration Authority
IPCC	-	Intergovernmental Panel for Climate Change
KIMBANDE	-	Kilosa Mbamba Bay and Ndesule villages
LGCDG	-	Local Government Capital Development Grant
MARD	-	Masters of Arts in Rural Development
MEA	-	Millennium Ecosystem Assessment
MCB	-	Mbinga Community Bank
N ₂	-	Nitrogen
NMB	-	National Bank of Commerce

PHDR	-	Population and Human Development Report
RWSSP	-	Rural Water Sanitation and Supply Programme
SACCOS	-	Savings and Credit Cooperative Societies
SPSS	-	Statistical Package for Social Sciences
SSR	-	Self Sufficiency Ratio
TAGO	-	The Australian Greenhouse Office
TFNC	-	Tanzania Food and Nutrition Centre
UNICEF	-	United Nation Children Fund
URT	-	United Republic of Tanzania
VEO	-	Village Executive Officer
WFS	-	World Food Summit

CHAPTER ONE

1.0 OVERVIEW

This chapter have divided into six sections. Following this overview is a section of introduction, followed by problem statement, problem justification, objectives, research question and conceptual framework.

1.1 Introduction

The concept of food security has evolved significantly over time. Food security may have different meaning to different people but the most famous definition is; Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996).

The food security status of any group can be considered as the principal outcome of food systems, if these systems are defined broadly and generically (Ericksen, 2007). Increases in the efficiency and productivity of food systems have resulted in the successes around the world in reducing the prevalence of hunger and improving nutrition. However, these successes are shadowed by serious concerns about those aspects of food systems that pose threats to social, economic and environmental goals and hence undermine food security. In addition, global environmental change, in the context of social, political and economic changes, may bring unprecedented stresses to bear on food systems and food security.

Both food systems and food security are fundamentally characterized by social and economic change, such as the marked intensification of food production, the tremendous growth of processing and packaging of food products, corporate

concentration in retailing and distribution, and the rising influence of large numbers of urban consumers. Developing policy to ensure food security is a tremendous challenge that requires a comprehensive and integrated analytical approach (Maxwell and Slater, 2003).

1.2 Problem Statement

Global environmental and socio-economic changes are happening simultaneously, and they involve rapid and complex processes with uncertain consequences. Understanding how to manage food systems in this context poses considerable research and policy-making challenges.

The spectre of climate change, together with other global environmental changes such as changes in water availability, and land cover, and altered nitrogen availability and cycling all strongly influenced by human activities, has increased concerns about achieving food security especially for poor people (Gregory & Ingram, 2000; Parry *et al.*, 2001; Rosegrant & Cline, 2003). There is also concern that meeting the global demand for food resulting from higher population and changing dietary preferences will further degrade the environment both through additional destruction of native vegetation and increased intensification of cropped areas (Tilman *et al.*, 2001). This may, in turn, further undermine the food systems upon which food security is based. While there has been a considerable progress in understanding the sensitivities of crop yield to climate change, assessments of climate change effects on food security

remain rather limited. Food security is concerned not only with food availability but also with access to and utilization of, food so that studies, which focus only on crop production provide only a partial assessment of food security and climate change relationships. This is of particular concern as many of the policy based issues that are relevant to the international and sustainable development communities are posed in the context of food security prospects. Engagement of these policy communities requires a much broader and comprehensive research framework.

1.3 Problem Justification

While socio-economic characteristics and resources of individual households are generally considered to be the basic factors responsible for food insecurity (worldwide), the recent change in climate in terms of shocks and trends may exacerbate the problem of food systems. However, while there is adequate amount of information with respect to the influence of climate change of crop plants productivity, there is limited information on the linkage between climate change and food security as a whole and food systems in particular, Gregory *et al.*, (1999) summarized experimental findings on wheat and rice that indicated decreased crop duration (and hence yield) of wheat as a consequence of warming and reductions in yields of rice of about 5% of the temperature rise above 32⁰C. These effects of temperature were considered sufficiently detrimental that they would largely offset any increase in yield as a consequence of increased atmospheric carbon dioxide (CO₂) concentration (Barret and Carter, 2000). Several reviews like Fuhrer, (2003) have further

assessed the potential consequences of changes in climate on the growth and yield of crop plants, concluding that the earlier anticipated benefits of CO₂ fertilization would be largely offset by nutrient limitations, pollutants and further interactions with climatic factors (see also Long *et al.*, 2005). Therefore, there is a need to find out this linkage so as to help provide science-based solutions which accelerate successful adaptation of agricultural systems to climate change for the rural poor and most vulnerable farmers in the country. These solutions (e.g., practices, technologies, policies) will enhance the capacity of farmers, other natural resource users and policymakers to better manage land, the environment and food security in rural Tanzania.

1.4 Objectives

1.4.1 General objective

The general objective of this study is to investigate the impact of climate change on food systems along Lake Nyasa shore in Mbinga District.

1.4.2 Specific objectives

1. To examine the impact of climatic change on food systems components.
2. To assess the areas of food systems and population most at risk in the face of climate change.
3. To evaluate the strategies which people adopt in the face of climate change.

1.5 Research Question

Therefore to better address the food systems concerns that are central to economic and sustainable development agendas, this research will therefore try to address the key questions including:

1. Which aspects of food systems are most vulnerable to climate change?
2. Who are more affected in the face of climate change?
3. What are the strategies adopted by people in the face of climate change?

1.6 Conceptual Framework

The conceptual framework in fig.1 on impact of climate change on food systems includes the major activities and actors involved in food systems, as well as the critical processes and factors influencing the social and environmental outcomes that are also part of a food system. It links these variables so as to explain the nature of the outcomes at a point in time or space. This builds upon the idea that within complex systems it is possible to identify key processes and determinants that influence outcomes, although these outcomes may be contested.

A central notion is that the primary outcome of any generic food system is food security, although in specific contexts food security may not be achieved because actors have multiple objectives, or there are market and other institutional failures. How well food systems fulfil the objective of providing food security is open to interpretation and remains a contested and highly politicized topic. The framework also incorporates food system outcomes that affect the natural resource base and that

contribute to other social capitals or securities such as income, employment and health.

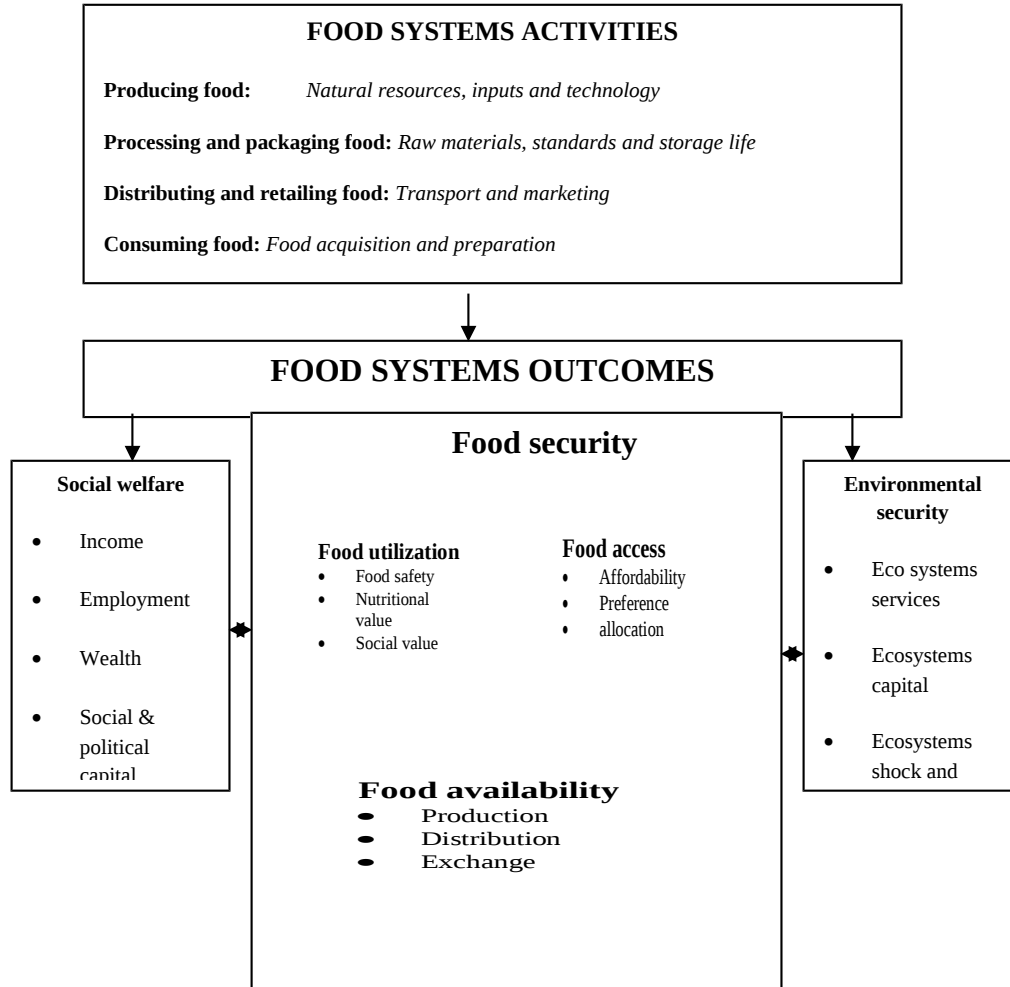


Figure 1: Food systems activities and outcome

CHAPTER TWO

2.0 OVERVIEW

This chapter contains six sections. Below this overview follows the section of definition of key concepts, in this section several terms has been defined, then follows is the section of food security situation globally under this section agriculture and rural livelihood has been addressed, also under this section are overviews of global environmental change and food system performance and trends in global food security analysis has been addressed. Then follows section on food security situation in Africa followed by food security situation in Tanzania. Then follows section on theoretical background and the last section under this chapter is review of previous research related to this study.

2.1 Literature Review

2.1 Definition of Key Concepts

2.1.1 Food systems

There are several definitions of what constitutes food systems, each formulated in relation to a specific range of issues, (e.g. *globalization of the agro-food system*, (Goodman, 1997). *Community food systems* (Gillespie and Gillespie, 2000). *Ecological interests* (Fraser, 2003). For this study purpose I will refer food systems as the specific combination of social (including economic and political) and natural (climate, resources) components that leads to the potential satisfaction of nutrition for a given individual or household through their combination of livelihood activities based on assets and incomes (Canon, 2002).

A food system is generally understood to be the chain of activities connecting food production, processing, distribution, consumption and waste management. Not only does it include the diverse system of agriculture that produces our food, it also includes the natural resource base, e.g., soil and such natural systems as regional watersheds, underground aquifers and the inputs necessary to sustain soil fertility.

2.1.2 Food Security

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (WFS, 1996). Thomson and Mertz, (1997) give two definitions of food security: Firstly, as availability of, stability of, and access to food by each human being. Secondary, as a situation where both food supply and demand are sufficient to cover food requirements on a continuous and stable basis.

In this study food security is defined as a broad concept which is used to determine people's wellbeing. It comprises four pillars of Availability to all people at all times, Accessibility, that people must have physical and economic access to food, Utilization, that people must have sufficient food all the times and finally stability, that people must have safe and nutritious food that meets their dietary needs.

2.1.3 Climate change

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2007).

2.2 Overview of Food Security

2.2.1 Food security situation in the world

Agriculture is sensitive to changes in climatic conditions, with outcomes affecting food security, livelihoods and economic prosperity. Climate change is a threat that, in the shorter term, will significantly affect the rural poor who are the most vulnerable given their limited resources and high exposure to risk (Füssel and Klein, 2006). The poor in the tropics are of particular concern because some impacts of climate change e.g., water availability, droughts and floods are expected to be highly negative in the tropics and sub tropics. As a whole improved knowledge of such vulnerability is needed in order to design appropriate response and mitigation strategies (Christensen *et al.*, 2004).

Although the international community has invested substantially in both climate change impact studies and adaptation programs, less developed countries have not yet been able to successfully incorporate adaptation into their development strategies.

Most developing countries lack effective strategies to manage climate risk locally and on relatively immediate time scale (Stamouli & Zezza, 2003). Strategies need to be devised from a holistic and integrated perspective so as not to further compromise the capacity of the Earth system to support approximately two billion more humans by mid-century. For example, poorly targeted and planned large irrigation schemes intended to respond to decreased rainfall in a given area could disrupt regional hydrological and biogeochemical cycles, leading to negative local and global repercussions.

Also, lacking are effective strategies to manage longer-term climate change, and which is driving much of the important and ongoing major policy developments worldwide. Negative effects of climate change could push up food prices, seriously affecting all poor consumers (Misselhorn, 2005). Climate induced problems will also be exacerbated by changes in the consumption patterns (e.g., rising meat consumption and supermarketization”), urbanisation and land use conversion (Ingram and Barklacich, 2002). Against this background, several key needs related to climate risk management for agriculture can be identified:

- ◆ The need to enhance the resilience of vulnerable farming systems and livelihoods in the face of climate change.
- ◆ The need to protect livelihoods from adverse climatic extreme events through effective safety nets and pro-active coping responses.

- ◆ The need to continually adapt technology (e.g., agro biodiversity, water use) and policy (e.g., land use planning, insurance schemes) to a changing environmental baseline.
- ◆ The need to anticipate and to positively exploit where favourable changes will take place.

The situation is urgent: More than 1.04 billion people are currently food insecure; and two billion live in poverty (FAO, 2009). The poorest are the most vulnerable to negative events and trends, such that these figures are likely to worsen with climate change. Projections indicate significant impacts over the next 50 years. Local to regional changes in agriculture have global economic, environmental and social impacts. Without due caution, current and future policies in agriculture, natural resources and environment and international trade can contribute to the negative effects of climate change on the poor. Unfortunately, our understanding of the interactions among such factors is insufficient.

2.2.1.1 Agriculture, Rural livelihoods and Food systems in the context of Climate change

Agriculture is sensitive to changes in climatic conditions, with outcomes affecting food security, livelihoods and economic prosperity. Climate change is a threat that, in the shorter term, will significantly affect the rural poor who are the most vulnerable given their limited resources and high exposure to risk (MEA, 2005).

Climate change is occurring amidst global economic, demographic and social change, resulting at times in unexpectedly uneven outcomes on rural livelihoods. Minor changes in climate and climate variability may push some areas and households to food insecurity (Devereux, 2000). People are and were facing new threats beyond their experience or capacity to cope. In addition, to local effects, agricultural losses in developing countries will translate into macroeconomic impacts that will exacerbate problems of food access for the urban poor (Ingram and Barklacich, 2002). Negative effects of climate change could push up food prices seriously affecting all poor consumers. Without due caution, current and future policies in agriculture, natural resources and environment and international trade can contribute to the negative effects of climate change on the poor (Ellis and Freeman, 2004). Unfortunately, our understanding of the interactions among such factors is insufficient.

2.2.1.2 Global environmental change and food system performance

Global environmental change encompasses changes in the bio geophysical environment which may be due to natural processes and/or human activities. These changes may manifest at the global scale or they may occur locally but be so widespread that they are a global phenomenon (GECAFS, 2005). Examples include changes in atmospheric composition from the release of greenhouse gases and the consequences such as increased temperatures and variability in precipitation cycles. Food systems also contribute to global environmental change, and future trends such as increased demand for food with increases in incomes and populations will have consequences for global environmental change processes (Conway *et al.*, 2005).

2.2.1.3 Trends in global food security analysis

Most often food security is analyzed in terms of why people do not have it i.e. why they are hungry or malnourished. The society still faces a number and range of food insecure situations, but the nature of food insecurity shifted fundamentally over the 20th century. Social causes are now recognized as fundamentally important (Devereux, 2000). Growth in incomes and agricultural productivity, improvements in market functioning, along with political will to intervene to prevent famines, has improved food security for many in Asia and Latin America, although there are still local and regional distributional inequities (Corral *et al.*, 2000). Throughout Sub-Saharan Africa food insecurity persists. While the impacts of natural hazards or stresses such as droughts may trigger a crisis, long term economic factors such as market failures and poverty contribute, along with political instability and institutional weakness, and conflicts play a large role (Devereux and Maxwell, 2001).

Methodologically, the analytical literature explaining food security has evolved since the late 1970s from a focus on national food production and stocks (or the supply of food), which emphasized available food supply at aggregate levels, to a more nuanced and individual-focused approach, which emphasizes access to food along with consumption patterns and preferences (Maxwell, 2001). Amartya Sen, (1981) is universally credited with establishing the importance of access to food, as opposed to only availability, as critical to food security. Access is determined by how well people can convert their various financial, political, and other assets into food, whether produced or purchased. This insight explains inequity in food distribution and

allocation, based upon income, political and social power. The tremendous growth of urban areas has also spurred a view of food security that emphasizes access and incomes, as more and more people do not grow their own food.

The public health emphasis on nutritional outcomes has further amplified the food security framework by adding utilization. This highlights the influence of age, health and disease on how the human body utilizes food and its needs for different nutrients, calories and protein (Young, 2001; World Bank, 2006; Pelletier, 2002). Utilization is affected by poor hygiene, food preferences and the physiological condition affecting food absorption, as is the case for persons infected with HIV/AIDS (Haddad and Gillespie, 2001). In addition, the impact of contaminated food on health and nutritional outcomes is increasingly recognized (World Bank, 2006). Furthermore, modern food processing has resulted in less healthy foods which, although increasingly popular, contain fats, added chemicals, and high levels of salt and sugar. With this interest in the health outcomes of food, food security becomes a concept that applies to a multitude of consumers in wealthier countries.

2.2.1.4 Beyond food security to livelihoods

Food security in recent years has been seen as one dimension of the broader concept of livelihood security. Chambers, (1988) defines sustainable livelihood strategies as: *“Adequate stocks and flows of food and cash to meet basic needs. Security refers to secure ownership of, or access to, resources and income-earning activities, including reserves and assets to offset risk, ease shocks and meet contingencies. Sustainable refers to the maintenance or enhancement of resource*

productivity on a long-term basis”.

Insights from the livelihoods approach to poverty and vulnerability have further altered views on food security. The most important point is recognizing that households have multiple objectives beyond achieving and maintaining food security (Fussel and Klein, 2006), so they may go hungry but preserve other household assets. Secondly, in many places agriculture is not the primary income generator for rural households, and often people buffer themselves against food and income failures by diversifying out of agricultural production on their own farms (Ellis, 2000; Bryceson, 2000). Third, the natural resource base is an asset on which people depend for their survival, just like financial, social or physical assets. The environment does more than just produce food for people; it is also a source of income and a buffer against a variety of biophysical and social or economic shocks. Fourth important contribution is recognizing that institutions at multiple levels either constrain or foster household livelihood strategies, and thus food security outcomes, often unintentionally (Fussel and Klein, 2006). In conclusion, the pressing issues pertaining to food security today have to do with food systems, encompassing a range of economic and environmental and social features that are undergoing rapid change (Maxwell and Slater, 2003; Lang and Heasman, 2004).

2.2.2 Food security situation in Africa

With regard to food security, the African continent faces special challenges. Between 1990/1999 about 200 million people (28 % of Africa’s population) were chronically hungry, compared to 173 million in 1990/1992. While the proportion of the population living in hunger is dropping slightly, the absolute numbers are rising. Most of the economic opportunities accessible at both the household and the national level

will have to come from agriculture, since agriculture directly affects the lives of between 70% and 80% of Africa's people.

2.2.2.1 Food Accessibility in Africa

It is important to emphasise that more food production does not necessarily mean more food for those who need it. Most experts would agree that the largest part of the production increase has to come from yield increases. Current levels of agricultural productivity and production say little about potential levels, because they are simply a response to present levels of demand and price/market conditions (Christiansen and Boisvert, 2000). It is however important to note that food production is not the same as food availability (production minus exports plus imports), and that aggregate availability and the ability to acquire food (food entitlements) are very different things. The yield of roots and tubers in Africa is the lowest in comparison to the other regions of the world. Whilst food production undoubtedly influences food entitlements, the connections are complex and there are also other matters involved (Gritti *et al.*, 2006). People's access to food depends both on the purchasing power of their income, and on their non-market entitlements, such as rights to land for subsistence farming and foraging purposes (Knack and Keefer, 1997). Households seeking to preserve food security levels may resort to a number of coping strategies to gain access to food. These include: maintaining normal income generating patterns; adaptation by means of innovative use of available resources or some divestment of liquid assets; divestment of productive assets, such as stock or land; and out-migration and destitution. However, the market economy is not expected to grow

rapidly, and many non-market entitlements are in danger of decline. Food entitlements for urban dwellers are most often mediated through the market, whereas for rural dwellers in general and subsistence farmers in particular, these entitlements tend to depend more on the local production (Christiansen and Boisvert, 2000). Clearly, food insecurity is basically a problem of poverty, affecting those social groups with the weakest or most fragile food entitlements, both in terms of access to social networks and safety nets or productive assets (capital, land, agricultural inputs). Malnutrition can thus be a threat to urban and rural dwellers at different times and for different reasons. Urban-rural links are often created in the pursuit of food security, and hence urban dwellers will maintain rural contacts, or even land, to provide food security in case their purchasing power is disrupted, whilst rural dwellers will maintain urban contacts, in part to ensure against the loss of local food entitlements (Dercon and Krishnan, 2000).

2.2.2.2 Food supply in Africa

Agricultural output in Africa has been lagging behind population growth since the 1960s. Between 1965 and 1990, agricultural production grew at an annual rate of 1.7%, while there was annual population growth average of 2.8%. Food imports including food aid in the African region have increased substantially to offset the deficiencies, and in early 1994 represented about 10% of the food consumed. At the current growth rates, the food gap is projected to increase to more than nine times the present gap by 2020 (Agyare-Kwabi, 2003).

2.2.2.3 Food Acceptability

As a result of its agro ecology, trade history, and position most African countries have diverse diets in terms of staple foods. This is a great advantage in terms of food security because many consumers will substitute among the five broad categories of staple - cassava, yams and tubers, plantain, millet, maize and rice according to national and also tribal taste preferences and changing relative prices (Kennedy *et al.*, 2004). Women have distinctive roles to play in determining the acceptability of food basically because of their traditional role as wives and mothers who cook for their families. Transforming food from its raw state into processed or cooked food has long been the preserve of women. As prepares of food women can get the whole household to accept one menu over the other ensuring that family members accept one available food over the other. (Christiansen and Boisvert, 2000).

2.2.3 Food security situation in Tanzania

Poverty is one of the major causes of food insecurity in Tanzania. The prevalence of income poverty is still high in Tanzania. According to the Poverty and Human Development Report PHDR, (2005). There is no significant nutritional status improvement for the under fives in Tanzania. Stunting, though on decline, continues to affect a sizeable proportion of children in the country. It declined from 47 % in 1991/92 to 44 % in 1999 and 38 % in 2004.

It is argued that in aggregate terms, Tanzania has no food shortage (URT and UNICEF, 2001). However, some parts of the country are prone to food shortages due to drought, flood, market and transport constraints that hinder smooth transfer of food from surplus areas to deficit ones. Thus availability of food at national level is not translated into household food security or equal access among all members of the household. At a household level food security entails having adequate supply of food. Adequate refers to quantity and quality that is there should be enough food to meet daily requirements of all members of household. Causes of food insecurity have been identified as being crop failures, storage deficiencies and sale of food in higher proportions than food security would require (TFNC, 1992).

Although the country is not drought prone, but food insecurity in the country is both transitory and chronic in nature. Transitory food insecurity arises from instability of food production, food prices, or household's income is common in marginal areas of the central and northern regions of Dodoma, Singida, Shinyanga, Tabora, some parts of Tanga, Arusha, Kilimanjaro and Manyara. The situation with regard to food availability, accessibility and utilization is as outlined below:

a) Food Availability

In Tanzania the major source of food supply is from local production. On average Tanzania produces about 95 percent of its food requirements (URT, 2006). In some years the country's food self sufficiency measured by the Self Sufficiency Ratio (SSR) is over 100. Although there are pockets of food shortage in some regions and districts even when SSR is over 100. In such years, the problem is mainly the

distribution within the country.

The SSR in Tanzanian case, however, may not capture the extent of food availability in the country because it does not take into account other food commodities that are produced such as livestock and livestock products; wild animals; fish and other marine or aquatic products. With the exception of wheat, food imports do not play a significant role in the total food supply in Tanzania as most of food supply is from domestic production. Most of food imports in the country is comprised of wheat in both surplus and food shortage years. However, the country imports substantial amount of wheat. For example, over the period of 1999 to 2003, the country imported an average of 300 000 tons of wheat to supplement domestic production of 71 000 tons per year (World Bank, 2004).

Food imports, however, increase during drought years. In Tanzania the major factors affecting food availability are low production due to low productivity of land, labour and other production inputs, high incidences of crop and livestock pests and diseases, inadequate processing, storage and marketing infrastructure (URT, 2005). This is caused mainly by inadequate finance to obtain productivity enhancing inputs or capital, limited availability of support services and appropriate technologies. In addition, many rural households are faced with labour shortage, due to the migration of young people to the urban areas in search of employment.

The HIV and AIDS pandemic has also contributed to loss of labour for household

agricultural production, since the infected and those caring for them cannot devote enough time and energy for agricultural production. Other factors affecting food availability include high pre and post harvest losses due to pests, diseases and climatic conditions. Pre harvest losses account for over 30% of all crop losses in the country. It is estimated that post harvest losses range from 30%-40% for cereal grains and legumes, up to 45% for roots and tubers and 40% - 80% for fresh vegetables and fruits. In addition, inappropriate food management at household level diminishes food stocks available for consumption.

b) Accessibility to food

In Tanzania, physical access to food is affected by inadequate infrastructure, mainly transportation network. The spatial distribution of surplus food production areas is such that food production is mainly concentrated in the southern highland regions and peripheral areas of the country (URT, 2006), while the traditional food deficit areas are located mostly in the central corridor and parts of northern areas. Given the fact that the country is vast and there are long distances between food producing and deficit areas with inadequate transportation network there are high costs of transportation involved. High cost of transportation lead to high distribution costs which in turn are reflected in high prices of food in deficit areas and, therefore, affecting access to food by low income rural as well as urban populations (Mwandosya, *et al.*, 2000). Poverty is still a common phenomenon among rural communities and the urban poor, where inadequate employment and lack of income generating activities lead to low purchasing power and hence affect access to food.

c) Food Utilization

According to the Tanzania Demographic and Health Survey, (1999) and Poverty and Human Development Report, (2005) about 38% of the children in Tanzania suffer from chronic protein energy malnutrition (stunting), indicative of chronic food insecurity. Underweight and wasting in children is 30% and 3% respectively, indicative of transitory. In adults, the prevalence of underweight Body Mass Index (BMI) less than 18 years is about 12% in women. About 10% of the adult population in urban areas is obese. The prevalence of vitamin A deficiency is about 30% and that of anaemia is about 32% for the adult population, 66% for children and 80% for pregnant women. Iodine deficiency affects 25% of the population.

2.4 Theoretical Background

The growth in human population over the past two centuries (from about one billion in 1825 to about six billion today) together with an increased consumption of resources has led to marked environmental changes on a global scale.

Global environmental change is evident through a range of interacting factors such as increasing concentrations of gases in the atmosphere, climate variation and change, rising sea level, loss of biodiversity, and changes in cycling of water and nitrogen. Some of these phenomena manifest at a global level due to rapid global mixing (e.g. changes in atmospheric CO₂ concentrations) while others are more local issues but which occur in so many places as to constitute a global phenomenon (e.g. application of N fertilizers).

Despite widespread concern about the implications of these changes (IPCC, 2001), there has been very little concerted action to change patterns of human behaviour so that, for example, global atmospheric CO₂ concentrations continue to increase and are now well outside the range experienced in recent inter-glacial periods.

Mean global temperatures have been increasing since about 1850, mainly owing to the accumulation of greenhouse gases in the atmosphere. The main causes are the burning of fossil fuels (coal, oil and gas) to meet increasing energy demand, and the spread of intensive agriculture to meet increasing food demand, which is often accompanied by deforestation. The process of global warming shows no signs of abating and is expected to bring about long term changes in weather conditions (Carpenter and Gunderson, 2001)

These changes will have serious impacts on the four dimensions of food security: food availability, food accessibility, food utilization and food system stability. Effects are already being felt in global food markets, and are likely to be particularly significant in specific rural locations where crops fail and yields decline (Devereux and Maxwell, 2001). Impacts will be felt in both rural and urban locations where supply chains are disrupted, market prices increase, assets and livelihood opportunities are lost, purchasing power falls, human health is endangered, and affected people are unable to cope (Sobel, 2002).

Until about 200 years ago, climate was a critical determinant for food security. Since

the advent of the industrial revolution, however, humanity's ability to control the forces of nature and manage its own environment has grown enormously (Fischer *et al.*, 2001). As long as the economic returns justify the costs, people can now create artificial microclimates, breed plants and animals with desired characteristics, enhance soil quality, and control the flow of water (Hulme *et al.*, 2001).

Advances in storage, preservation and transport technologies have made food processing and packaging a new area of economic activity. This has allowed food distributors and retailers to develop long-distance marketing chains that move produce and packaged foods throughout the world at high speed and relatively low cost. Where supermarkets with a large variety of standard-quality produce, available year round, compete with small shops selling high-quality but only seasonally available local produce, the supermarkets generally win out (Ingram and Barklacich, 2002).

The consumer demand that has driven the commercialization and integration of the global food chain derives from the mass conversion of farmers into wage earning workers and middle level managers, which is another consequence of the industrial revolution. Today, food insecurity persists primarily in those parts of the world where industrial agriculture, long distance marketing chains and diversified non-agricultural livelihood opportunities are not economically significant (Ellis, 2000).

A topic of particular societal concern is that of GEC and food production. The last decade or so has seen greatly increased understanding of the impacts of global change (especially increasing atmospheric CO₂ concentrations and increasing temperatures)

on components of production systems (Fischer *et al.*, 2001), and hence what this may mean for human concerns such as food security (Gregory and Ingram, 2000). However, the increasing human demand for food and forest products is in itself a major cause of global change contributing substantially to changes in land use and the increase of greenhouse gases in the atmosphere. For example, agricultural production systems have been estimated to account for about 18.4% of annual CO₂ equivalent gas emissions in Australia of which methane from livestock production accounts for just over 60% and nitrous oxide emissions from agricultural soils accounts for about 18% (TAGO, 2002). Similarly, human intervention in the global nitrogen cycle has now become so pronounced that more nitrogen is “fixed” in fertilisers and legumes in agricultural systems than is fixed by natural processes (Parry *et al.*, 1997). The enhanced losses of N from agricultural land to adjacent areas such as watercourses can have major impacts on ecosystem services.

At the global level, therefore, food system performance today depends more on climate than it did 200 years ago; the possible impacts of climate change on food security have tended to be viewed with most concern in locations where rain fed agriculture is still the primary source of food and income (Nicholson, 2001).

However, this viewpoint is short sighted. It does not take account of the other potentially significant impacts that climate change could have on the global food system, and particularly on market prices. These impacts include those on the water and energy used in food processing, cold storage, transport and intensive production,

and those on food itself, reflecting higher market values for land and water and, possibly, payments to farmers for environmental services (Maxwell, 2001).

Rising sea levels and increasing incidence of extreme events pose new risks for the assets of people living in affected zones, threatening livelihoods and increasing vulnerability to future food insecurity in all parts of the globe (Nicholson and Kim, 1997). Such changes could result in a geographic redistribution of vulnerability and a relocalization of responsibility for food security – prospects that need to be considered in the formulation of adaptation strategies for people who are currently vulnerable or could become so within the foreseeable future (Matson *et al.*, 1997).

Since the late 1950s, global agricultural output has increased at rates and to levels that are unprecedented in human history. Much of the productivity increase is attributed to the breeding of high yielding crop varieties, intensive use of inorganic fertilizers and pesticides, expansion of irrigation, and capital intensive farm management (Gregory *et al.*, 2002).

In the 1970s, the euphoria surrounding the 'Green Revolution' was questioned in the wake of the energy crisis and growing awareness of long term environmental consequences. Concern over soil erosion, groundwater contamination, soil compaction, decline of natural soil fertility, and destruction of traditional social systems, led to a reappraisal of what were then considered to be the most advanced agricultural production techniques (Evans, 1998). Since then, agricultural research has

expanded its scope to include sustainable and resource efficient cropping systems and farm management practices.

Since the beginning of the 1980s yet another threat to agriculture has attracted much attention. Many climatologists predict significant global warming in the coming decades due to increasing atmospheric carbon dioxide and other trace gases (Maxwell and Slatter, 2003). As a consequence, major changes in hydrological regimes have also been forecast to occur. The magnitude and geographical distribution of such climate induced changes may affect our ability to expand food production as required to feed a population of more than 10 000 million people projected for the middle of the next century. Climate change could have far reaching effects on patterns of trade among nations, development, and food security.

Beyond what is known about greenhouse gases and the climate system, however, lie great uncertainties: How much warming will occur, at what rate, and according to what geographical and seasonal pattern? What secondary processes will the warming trend induce, and what might be the physical and biological impacts of such processes? Will some areas benefit while other areas suffer, and who might the winners and losers be? And, if such damages are unavoidable, what can be done to adapt or modify our systems so as to minimize or overcome them? These are important and complex questions, and we have only begun to understand them and to develop methods for their analysis (Maxwell and Smith, 1992).

2.5 Review of Previous Research

Before the current interest in vulnerability to global environmental change, agricultural economists and food security analysts developed empirically based theories explaining food security. There is a consensus that households may become food insecure through one or more failures in three types of entitlements: availability, including the need for a stable supply of food; access; and utilization (Maxwell, 2001).

Availability includes not only the production of food, but also distribution and exchange networks. Access comprises affordability, how well markets function, and whether or not preferences are met. Utilization includes the nutritional and social values of food, along with food safety. Most research effort has been aimed at moving beyond environmental determinist explanations of food security. Thus, although environmental stresses contribute to food insecurity, they do so always in combination with other drivers such as poverty, conflict, and land tenure constraints (Devereux, 2000; Devereux and Edwards, 2004; Misselhorn, 2005). Equally important is the understanding that food security is only one of many risks that households manage through their livelihood strategies (Ellis, 2000). Livelihood strategies are therefore very important for household food security status.

Several research works including Long *et al.*, (2005) assessed the potential consequences of changes in climate on the growth and yield of crop plants and concluded that the anticipated benefits of CO₂ fertilization would be largely offset by

nutrient limitations, pollutants and further interaction with other climatic factors. Simulation studies predicted an overall reduction of 10% of maize yield in Africa as a result of climate change. These and related studies point to the veracity that there has been adequate research attention on the relationship between climate change and crop plant productivity.

The burgeoning literature on vulnerability to global environmental change is driven by a concern for understanding what potentially unprecedented ecological and climatic change might do to human well being and the integrity and functioning of ecosystems.

In spite of advances made in the past century, chronic food insecurity persists in parts of the world. Although the causes of this food insecurity are complex, projected changes in demographics and consumption patterns have led many to worry over the ability of some populations to feed themselves in the coming 50 to 100 years, particularly in the absence of adequate policy responses. The marginality of impoverished people and their increased susceptibility to food insecurity continues in a range of rural and urban settings (Stamoulis and Zezza, 2003).

Events of the past decade have heightened awareness of the increasing impact of natural hazards and shocks on food, income, and environmental security: examples are the tsunamis of 2004, hurricane Katrina, and periodic catastrophic floods in various places. O'Brien, (2002) argues that environmental shocks of this type are a major

human security concern with which modern society has little capacity to cope effectively, given the widespread lack of proactive policy and preparedness. Assessments such as the Millennium Ecosystem Assessment and the Global Environmental Outlook conclude with certainty that the ecosystem services enabling food production systems are being eroded through environmental trends such as change in nutrient cycles, change in hydrological cycles, changes in vegetation cover and composition, and pollution (Cassman *et al.*, 2005; Wood *et al.*, 2005). Adding to these concerns are predictions that future climate change will change the spatial and temporal distribution of crop yields as temperatures rise and precipitation patterns change over the next 100 years (Easterling *et al.*, 2007).

Perhaps of greatest concern to food systems, is that although many improvements in human well being depend upon social, political, and institutional improvements, these same mechanisms are inadequate to substitute for ecosystem services in many cases. Thus, the decline in wild fisheries cannot be completely reversed with aquaculture, water management is plagued by inefficiencies and overuse, and agricultural yields are stagnating in formerly intensively farmed high-productivity areas such as Punjab state in India (Cassman *et al.*, 2005; Shah *et al.*, 2005). These losses all have consequences for food systems and food security, and future trends will most likely increase these losses.

Although global environmental change encompasses changes in the biophysical environment caused naturally or caused by human activities (Global Environmental

Change and Food Systems, 2005), the concerns described above largely stem from evidence of the increasing influence of human activities on the biophysical environment. This strong human influence places the concern about the vulnerability of food systems in a broader context of concern about the tensions or tradeoffs between ensuring or improving human well being and maintaining ecosystem services.

A challenge for both fields is to identify the pathways leading to vulnerability. In modern food systems, these are complex because interactions cross spatial and temporal scales and the links between the social and ecological components are often indirect. A shock may not be felt directly, and conflicts may arise among the outcomes, complicating the evaluation of food system vulnerability because one outcome may increase at the expense of another. Another challenge that food systems present is that they are a unique form of coupled SES in that they depend upon ecological variables for their most basic function, yet they are largely driven by social processes and policies; this forces the tensions between human well being and ecosystem services to the forefront of food system assessment.

Fraser, (2003, 2006) borrows from both social and ecological theories to analyze food system vulnerability. He looks at both the structure of food system activities and the resultant pattern of food insecure outcomes for several historical cases. His research highlights key differences between the concepts of ecological vulnerability and social vulnerability when applied to food systems. Social vulnerability as understood by

entitlement theory is most commonly associated with low wealth and economic or social isolation or weak connections (Fraser *et al.*, 2005). This is the opposite for ecological systems as explained by resilience theory; when they are high in wealth and connections, they may be most vulnerable to collapse. The feature common to both is the importance of maintaining diversity to preserve options in a crisis.

Young *et al.*, (2006) discuss the implications of globalization for coupled SESs, drawing upon literature on the institutional dimensions of environmental change, as well as the social and ecological vulnerability literature summarized here. Their analysis is highly relevant to food systems. Key to their understanding of vulnerability is that adaptation to avoid it requires structural change within or by a system so that the system does not lose any of its key functions. This suggests that an important analytical step is to define these key functions initially to understand what vulnerability means for a given system. Young *et al.*, (2006) conclude that in many SESs today, social complexity has come to replace biophysical complexity as humans have inserted themselves more and more into these systems. They highlight four important impacts of globalization for SESs: it has increased the connections among disparate systems; it has increased the speed with which disturbances and change flow through and between systems; it has changed the traditional scalar relationships so that there are now too many cross-scale interactions; and it has significantly decreased the diversity in SESs. These changes raise serious questions about the ability of systems to undergo the structural changes necessary to adapt to disturbances, rather than moving into a vulnerable or less desirable state.

The impacts of globalization are also a concern for political-economic and sociological critiques of food systems such as those of Leichenko and O'Brien, (2004a). These authors suggest that although very powerful corporations govern modern food systems, which are characterized by industrial agricultural

production, factory-based processing, and supermarket-controlled retail, the systems themselves may be generally vulnerable to shocks. This vulnerability arises from the degree of specialization and homogenization, which can make it difficult to adjust to changes in preferences or to serve smaller markets.

Sundkvist *et al.* (2005) maintain that the negative social and environmental consequences of food production result from the current food system marketing structure in Western countries. This structure distances consumers from producers and thus inhibits the recognition of and response to feedbacks in the food supply chain. They identify four main trends responsible for this vulnerability: intensification, specialization, distancing, and concentration and homogenization. Feedbacks within the food system can either be masked, i.e., not perceived, or disregarded, i.e., perceived but not acted upon in response. Often this is because the production takes place at a different point in space or time from consumption, but it also occurs because consumer knowledge of food systems has declined and there are insufficient institutional mechanisms within most food systems to manage feedbacks. The solutions that Sundkvist *et al.*, (2005) propose are to encourage more localized food production, to decrease the distance between producers and consumers, and to improve institutional management to tighten the feedback loops.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Overview

This section presents materials and methods which were used in this study. it starts with the description of the study area, methodology used and type of data analysis.

3.2 Description of the study area

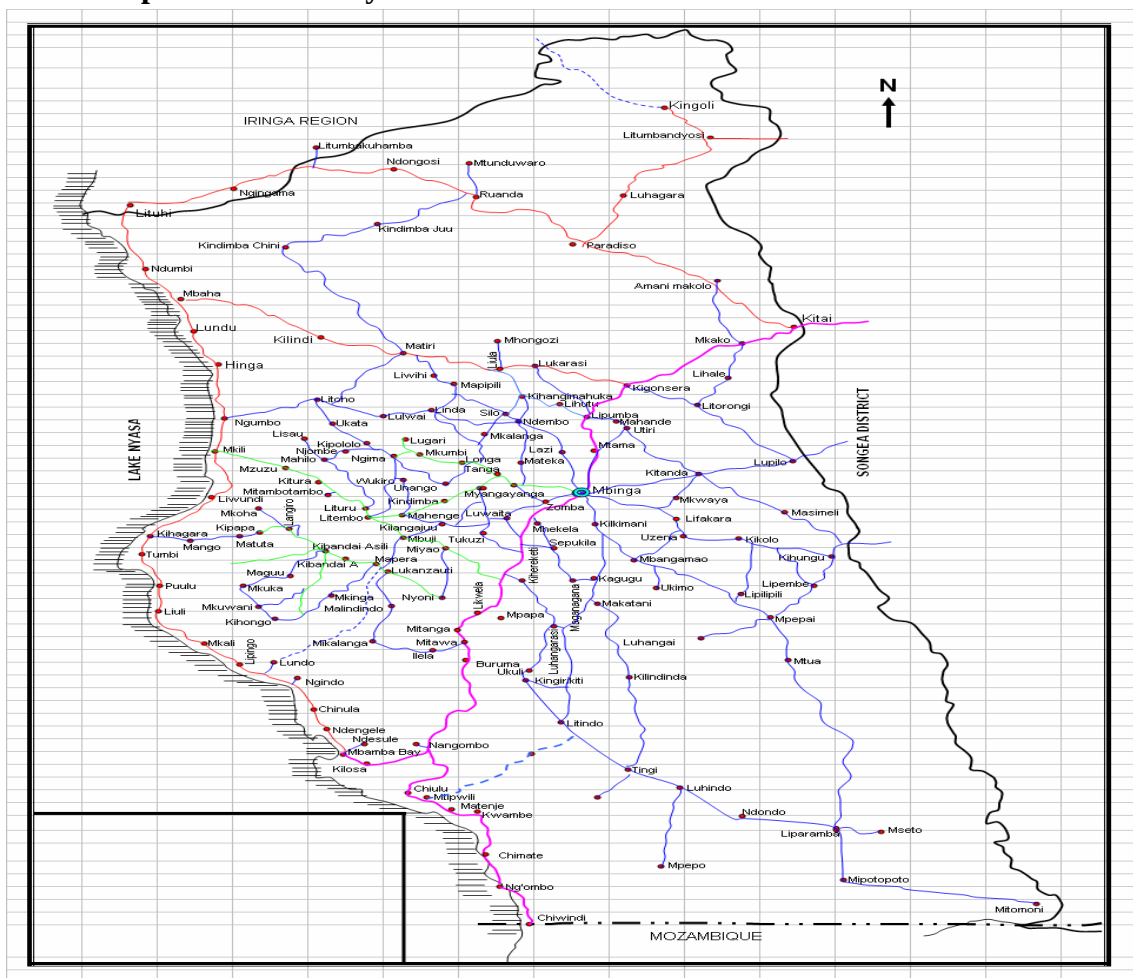


Figure 2: A map of Mbinga District Council showing study area

3.2.1 Boundaries

Mbinga District is situated in the South West of Ruvuma Region where it is bordered by Songea Rural District to the East, Republic of Mozambique to the South, Lake Nyasa to the West and Ludewa District to the North.

3.2.2 Population

Mbinga district comprises of three main ethnic groups, namely the Matengo, Ngoni and Nyasa. The Matengo occupy the highland areas in the centre of the district, the Ngoni mainly in the north-eastern lowland areas, while the Nyasa are found along the coast of Lake Nyasa.

According to the Bureau of Statistics Mbinga district had a total population of 271 845 people in 1988. It was then projected that by 1994 the population would have increased to 320 000 people (Ellis-Jones *et al.*, 1994). Reports from the 2002 Population and Housing Census show that Mbinga district had 403 819 people, including 206 030 females and 197 789 males (URT, 2003). It has average annual population growth of 2.9%, which means the projected population in 2010 was about 507 586. As a result of high agricultural potential Mbinga District has the highest population in Ruvuma Region. The population of Mbinga District is very unevenly distributed with concentrations in the mountainous areas, especially in the Matengo highlands. In these highlands population densities of up to 120 persons/km² are common (Mattee, 1991). Such high population densities give rise to increased land pressure. As a consequence the latter gives rise to intensive agricultural practices and considerable out migration especially of young person and/or families in an attempt to acquire land. Migration is mainly towards the north and south of the district, creating pockets of more dense population in otherwise sparsely populated forested areas, such as Mpepo, Mpepai and Liparamba (Mattee, 1991).

The villagisation programme in Mbinga District did not have as strong impact on settlement patterns as in other parts of the country, probably because of the topography (ICRA, 1991). Another plausible explanation to such observation would be because of the permanent coffee plantations that have made the population to be well established especially in the Matengo highlands. This programme undertaken during the 1970s had the objective to concentrate Tanzania's population on existing or newly created Ujamaa villages and/or development villages, a programme that was later abandoned in the 1980s.

3.2.3 Land Area

Mbinga District has an area of 11 396 square kilometres of this area 2979 square kilometres are covered with water, 2526 sq km are covered by natural forests and 5891 sq. km are suitable for agriculture and livestock keeping which constitutes 51.7% of the total land area.

3.2.4 Administration

The district has 9 divisions, 49 wards, 229 villages and 1345 hamlets. The District had 84 699 households with an average household size of 4.8 persons per household. The population density was estimated to be 188 persons per square kilometre and the sex ratios of males to females was estimated to be 96/100 and the dependency ratio was put at 89/100 active to dependent population.

3.2.5 Topography

Mbinga District is composed of mountains, valleys and plateaus that extend from 800 to 1900 metres above sea level. The district is divided into four major agro-ecological zones representing combinations of unique altitude ranges that have variable characteristic (Table 1).

Table 1: Description of agro-ecological zones of Mbinga District

Agro-ecological zone	Altitude (m.a.s.l.)	Annual rainfall (mm)	Descriptive features
Mountain areas High altitude Low altitude	1600-1900 1400-1600	1400-1600 1000-1400	This zone is characterized by strongly dissected mountains with steep slopes and narrow valleys. Because of altitude and local microclimatic conditions this agro-ecological zone is very suitable for coffee production.
The Hagati plateau	1500	1400-1600	This agro-ecological zone is characterised by gently rolling plateau at the top of the mountains. This zone is located between the mountain zone west of Mbinga and ranges down to Lake Nyasa. The main differences between the plateau and other zones are the shallow soils and unique microclimate (ICRA, 1991). This zone is also suitable for coffee.
Rolling Hills	1200-1300	1000-1200	This is the largest agro-ecological zone covering an area of flat to undulating intra-mountain plains between 1100 and 1400m and intermixed with mountain ranges up to peaks of 1600 m. The landscape is dissected by creeks and streams that give origin to flat and V-shaped valley bottoms. This agro-ecological zone is found in the north and south of the district.
Lakeside	500-600	900-1400	This agro-ecological zone comprises mainly of a flat narrow coastal strip with undulating hilly slopes rising to steep escarpment adjoining the Mbinga Highlands west of the Hagati plateau. It has a hot and humid climate, very different from the rest of the Mbinga district.

Source: Ellis-Jones *et al.*, (1994)

3.2.6 Climate

The climate of Mbinga District is described as temperate to cool tropical climate with a unimodal rainfall pattern. The average annual rainfall for this district is 1224 mm, which ranges from 1000 - 1600 mm (Ellis-Jones *et al.*, 1994). The onset of rains is normally at the end of November whereas the wet season extends from December to April, a period that is generally humid. The growing season extends from six to seven months in the low altitude mountains and up to nine months in the high altitude areas and the plateau.

The average minimum and maximum temperatures for the district are 19-23°C and 29-31°C respectively. Considerable variations are common due to the broken topography of the area which creates small microclimates in some places. Generally, the months of May to October are dry with peaks of the dry season between June and October (ICRA, 1991).

3.2.7 Soils

Soils of Mbinga District are generally classified as Haplic or Humic Acrisols, Oxisols, Ultisols depending on their position in the toposequence (ICRA, 1991). At higher elevations the most common soils used for crop production are of granitic and gneissic origin, deeply weathered, highly leached and well-drained red sandy clays. On the plateau the soils tend to be shallower with impeded drainage in some places. At lower elevations soils are less leached reddish brown sandy clay loams and sandy clays (Ellis-Jones *et al.*, 1994). These soils are very susceptible to erosion because they are very friable and become softened by rain (ICRA, 1991).

At both high and low elevations the major difference in soil type is the presence or absence of top soil horizon due to soil erosion. Where topsoil is present the organic matter content is high, while it is very low where topsoil is absent. In the latter case farmers cultivate the red subsoil. The general perception amongst farmers is that soil fertility has been progressively declining, resulting in poor crop growth coupled by changes in soil colour, from brown to red (Ellis-Jones *et al.*, 1994). This may be explained by loss of organic matter due to intensive cropping, burning and/or soil erosion.

3.2.8 Vegetation

The natural vegetation of Mbinga District ranges in general, is largely miombo woodland type of vegetation that include tree species like *Brachystegia spp*, *Julbernadia glabiflora*, *Burkea Africana*, *Uapaca kirkiana*, *Parinaria exerlsa*, *Parinaria curatefolia*, *Azelia quenzesis*, *Pterocarpus angolensis*, *Adina*, *Vitex*, *Syzygium*, *Acacia albida*, *Acacia polyacantha*, and many other species found in miombo woodland . This vegetation type has almost completely disappeared from the Matengo highlands except for low density remnants on the top of some mountains. At low elevation the dominant vegetation type is secondary wooded grassland. The most dominant grass species are the thatch grass (*Hyperrhenia spp*) and *Hypetheha spp*. Other vegetation types are the Zambezian swamp and afro-montane type of forest. In valleys and along streams, creeks and wetland areas the dominant species comprise of *Khaya nyasica*, *Macaranga capensis*, *Bridelia micranta* and *Treculia africana*. Others include *Fragmitas maritariana* (ICRA, 1991; Ellis-Jones *et al.*, 1994).

3.2 Research design

The study employed a cross-sectional case study design (Casley & Kumar, 1998). This involves collection of information at one point in time. The design was preferred because it is economical in terms of time and money; and can generate reliable data that will cater for the purpose of the study. The method was selected due to the time limit of the study which requires three months for data collection.

3.3 Unit of data collection

The unit of data collection for this research study was the households randomly selected through simple random sampling method. The household referred as the group of people who eat from common pot sharing the same dwelling and cultivate the same land (Katani, 1999). In each selected household the household head was then interviewed to obtain relevant information by using questionnaires. The other unit employed in this study was Focused group discussions and key informants.

3.4 Method of data collection

3.4.1 Qualitative data

In this study primary data was collected by using structured questionnaires, with questions focusing on research question, both open and closed-ended questions), field observations was also used and informal talks was used to gather relevant data required. Sample respondents were drawn randomly from the target population.

Data was collected by using well administered questionnaires, to make sure that sampling errors are minimized. Three wards were selected at random from which

one village from each ward was selected at random. This brought up a total of three villages. In each village thirty households were selected at random, which made a total of ninety households. In each household the household head was interviewed which made the sample size for this study to be ninety.

3.4.2 Focus Group discussion

This study had six Focus Group Discussions two from each village in three villages previously selected for sampling purposes. In each village one FGD was of women and the other for men. The information was obtained by using pre formulated and tested checklists. FGD was used to obtain information aiming at tackling specific objective one and three. Experience has shown that most villagers avoid discussion openly in an interview or village meetings. In this case the study used various methods to try to capture reliable information. For example the use of charcoal as source of energy most of respondents gave false answers, probably they feared to be accused for environmental destruction.

3.4.3 Key informants

One of the important features of good qualitative enquiry is its full exploitation of insights from key informants. By using pre formulated checklists key informants were interviewed so as to add more information and make the result more accurate. In this study key informants were the village old men and women carefully with consultation of the village elders. A total number of three key informants were interviewed in the selected villages and the other two from district level, who are

District Natural Resource Officer and District Agricultural and Livestock Officer. The selected key informants interviewed in the village level were retired village chairpersons.

3.4.4 Secondary data

This study also gathered secondary data so as to trace back the trends of the influence of climate change on food systems. Secondary data was collected from district agricultural office, which included crop production trends for the past twenty years, also meteorological data to show the trend and intensity of rainfall for the past thirty years. This was done so as to have data to compare production and climatic variables such as rain fall and temperature. Also data from markets and the internet was incorporated to compare with those primary data obtained from field.

3.5 Method of data analysis

Primary data collected by using the questionnaires was analysed using computer software known as Statistical Package for Social Science; raw data was edited, verified, summarized and coded. Descriptive statistical analysis then was used for both qualitative and quantitative data to obtain statistical parameters such as mean, frequencies, percentages and cross tabulations, data for objective one and two were analyzed by using percentages and population means, for objective three data were analyzed and discussed by content analysis using answers obtained from FGD. Secondary data and those obtained from interviews and observations were discussed

by the researcher's using content analysis. Data was collected and analyzed based on specific objective so as to capture relevant information to answer all research questions.

For specific objective one which was to examine the impact of climatic change on food system components, i.e. food production, distribution, exchange and consumption primary data was collected by using well administered questionnaires and then data was coded and analyzed by using computer software known as SPSS, also data from FGD and key informants was collected and analyzed by the candidate using content analysis.

For specific objective two which was to assess the areas of food systems and population most at risk in the face of climatic change, primary data was collected by using questionnaires and then was analyzed by using SPSS. Also data from FGD was discussed by candidate by using content analysis. Also secondary data from District Council was analyzed by using SPSS.

For specific objective three which was to evaluate the strategies which people adopt in the face of climatic change, data was collected by using questionnaires and then analyzed through computer software known as SPSS.

CHAPTER FOUR

4.0 OVERVIEW

This chapter presents the major results and discussions arising from the data analysis related to the study. This chapter divided into five sections. Following this overview is a section on socio economic and demographic variables of the respondents. Under this section sex, age and food security status are presented and discussed. Section two presents climate change variability in Mbinga District, under this section perception of climate change, temperature change, rainfall change and distribution and the impact of climate change on food systems components are presented and discussed. Section three is concerned with community vulnerability to climate change under this section vulnerability of food systems to climate change is discussed. Section four is concerned with climate change coping strategies. And the last section discusses gender issues in climate change coping strategies.

4.1 Demographic and socio economic characteristics of the respondents

4.1.1 Age of respondents

Age as a population characteristic variable, is examined in economic activities, because it influence people on the use of natural resources surrounding them for conducting agricultural activities so as to increase production and to perform other non farm activities to generate income.

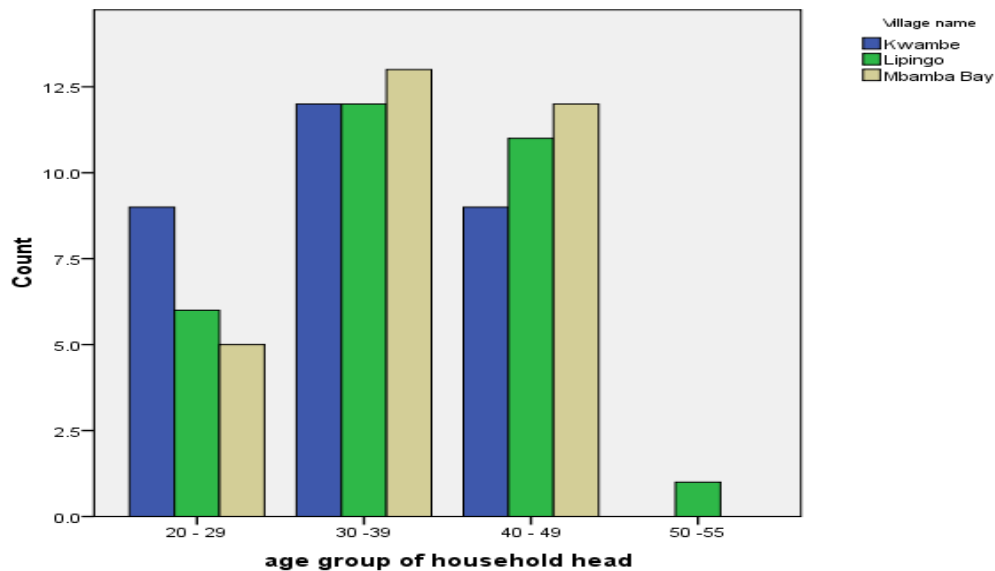


Figure 3: Age of the respondents

The study findings indicated that the mean age is 37 years in all villages in which Lipingo village mean age was 37.9, Mbamba Bay 37.3 and Kwambe was 35.8 while the minimum was 24 years and maximum was 50 years with a total standard deviation of 12.81 (Table 2).

Table 2: Distribution of respondents by age (N=90)

Village	Mean	Std. Deviation	Minimum	Maximum
Lipingo	37.9	7.3	26	50
Mbamba Bay	37.3	6.2	26	48
Kwambe	35.8	7.5	24	49
Total	37.0	7.0	24	50

Categorically the age group between 30 to 49 years are the majority dominating about 76.7% of all interviewed respondents. This age stage is more active in economic activities struggles.

The findings Figure 3 shows that only Lipingo village has one respondent aged 50 years while in Mbamba Bay and Kwambe villages the dominant age was between 24 to 49 years, which explain that in these areas availability of man power is not a problem, and so it is expected that these households will be able to produce enough food given other factors involved in production remain constant.

4.1.2 Sex of respondents

Table 3 shows the sex of the interviewed respondents from selected households in the three villages. Overall 87% of respondents were men and 13% were women. Whereas Mbamba Bay (17%) and Lipingo (14%) had slightly high number of women respondents with Kwambe having only (7%) of women respondents. Given the fact that most of the household activities including farming is being done by women, it shows that the area is have a deficit in manpower for agricultural activities and therefore, affects food security of the area. In this study only HH head was interviewed this indicates that (87%) HH in these areas are male headed HH and (13%) are female headed HH.

Table 3: Sex of interviewed respondents in the selected households (N=90)

Characteristics	Village (%)			Overall
	Lipingo	Mbamba Bay	Kwambe	
Male	86	83	93	65.5
Female	14	17	7	34.5
Total	100	100	100	100

4.1.3 Marital status of respondents

The study findings show that across all villages married respondents dominated at 83.3% (Fig. 4). Furthermore 10.1% of the respondents were single, 4.4% were widowed while divorced were 2.2% respectively. The results that the population is dominated by married couples imply that they would join the workforce and be more productive in an attempt to improve household food security through active participation in farm activities and other income generating activities.

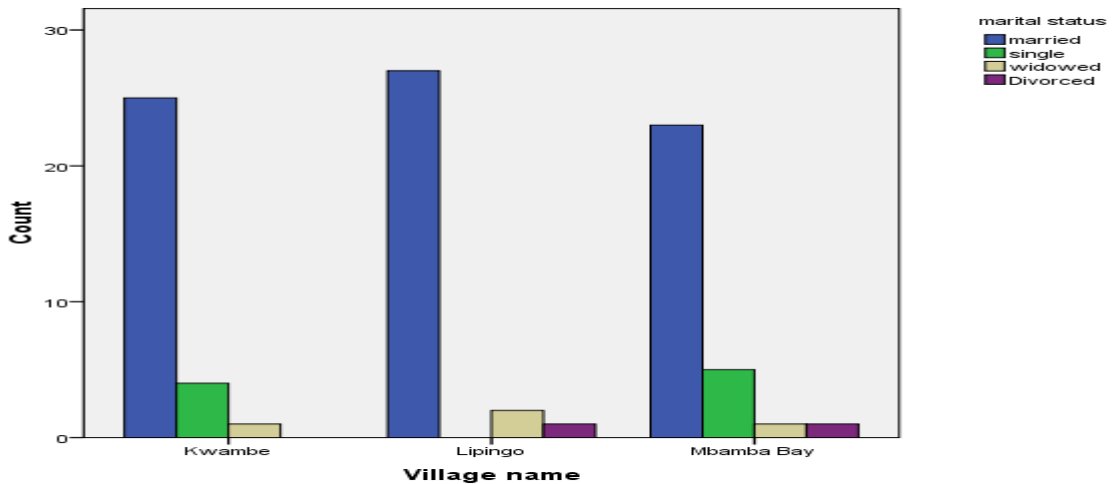


Figure 4: Distribution of the respondents' marital status by village

4.1.4 Household economic status

Figure 5 presents households' average annual expenditure in all three villages, results shows that the majority of households in the area spend between Tshs 200 000 to Tshs 399 000.

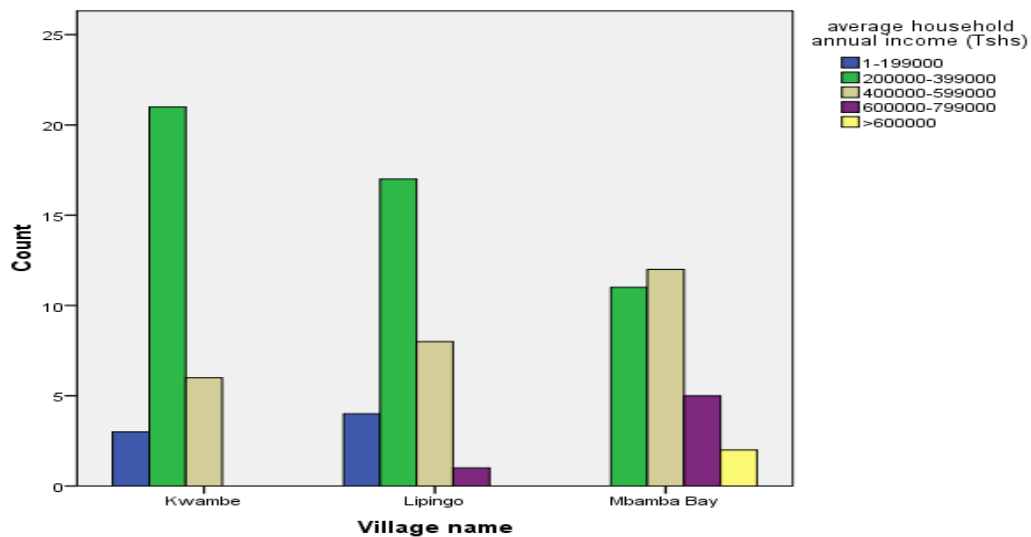


Figure 5: Household annual expenditure (Tshs)

Table 4 presents the average annual expenditure of the households in all three villages. The results show that the area has an average of annual expenditure of Tshs 396 877, which is below the average district per capital income which is Tshs 440 000, and so this indicated that people in these areas were poor compared to people in other areas of the district. This might be associated by lack of cash crops production in the area compared to the people in highlands where coffee production is dominant. As a result the ability of people to buy food in the market in time of shortage will be dented and therefore affect their food security status. As it is known food security does not depend only with production and given that 58.9% of respondents admitted that they also use food which is not produced by them. Mbamba Bay village appeared to have higher HH average expenditure of Tshs 513 433, followed by Lipingo village with Tshs 351 617 and Kwambe Tshs 325 580 this is because Mbamba Bay village is periurban and people engage in various income generating activities than in other

villages. These results might also reflect ethnicity of residents, usually in Mbinga district people from highlands (Matengo tribe) are hard workers compared to people in the lake shore (Nyanja tribe) who do not prefer hard work like farming, rather they do more fishing than farming. Given this fact, Kwambe village is occupied totally by Nyanja tribe, while Lipingo is multi ethnic with Matengo, Poto and Nyanja tribes. As a result Lipingo has higher average annual food crops production than all three villages.

Table 4: Average annual household expenditure per year in Tshs

Village	Mean	Minimum	Maximum
Lipingo	351 617	146 000	730 000
Mbamba Bay	51 433	255 500	1 095 000
Kwambe	325 580	146 000	547 500
Total	396 877	146 000	1 095 000

The difference between minimum and maximum household income shows that the gap between household incomes is becoming higher. The area has also higher household size than that of the district which is 4.6 members for the average household size in the area is 4.7. (Table 5 below).

Table 5: Average household size

Village	Mean	Std. Deviation	Minimum	Maximum
Lipingo	4.9	1.2	3	7
Mbamba Bay	4.7	1.02	2	7
Kwambe	4.5	1.47	2	8
Total	4.7	1.21	2	8

As the number of household become higher also food demand will increase, therefore, production should also increase to meet the requirements of the household members.

Implication of the situation is that households in these areas are becoming poor because, their income is below average district per capital income, given also the higher size of household people will suffer food insecurity.

4.1.5 Food security Status

Table 6 presents food security status of the Household involved in the study. There are several ways of conceptualizing food security status of the household and this study have considered household to be food secured if it takes three or more meals per day and households which take less than three meals per day as food insecure.

Table 6: Food security status of the interviewed households (N=90)

Characteristic	Village (%)		
	Lipingo	Mbamba Bay	Kwambe
Four meals	0.0	3.4	0.0
Three meals	100.0	96.7	86.7
Two meals	0.0	0	13.3
Total	100	100	100

According to the results, it shows that 94.4% of the households in the area are food secure. With Lipingo having 100% taking three meals per day, followed by Mbamba Bay with 3% taking four meals and 97% taking three meals per day. Kwambe appeared to have 13% of households which take less than three meals per day and hence considered as having food insecure households.

Figure 6 presents the relationship between HH food security and average annual HH expenditure. Results shows that there exist a relationship between annual expenditure and number of meals the HH takes per day with the majority spending between tshs 150 000 and above by taking three meals per day.

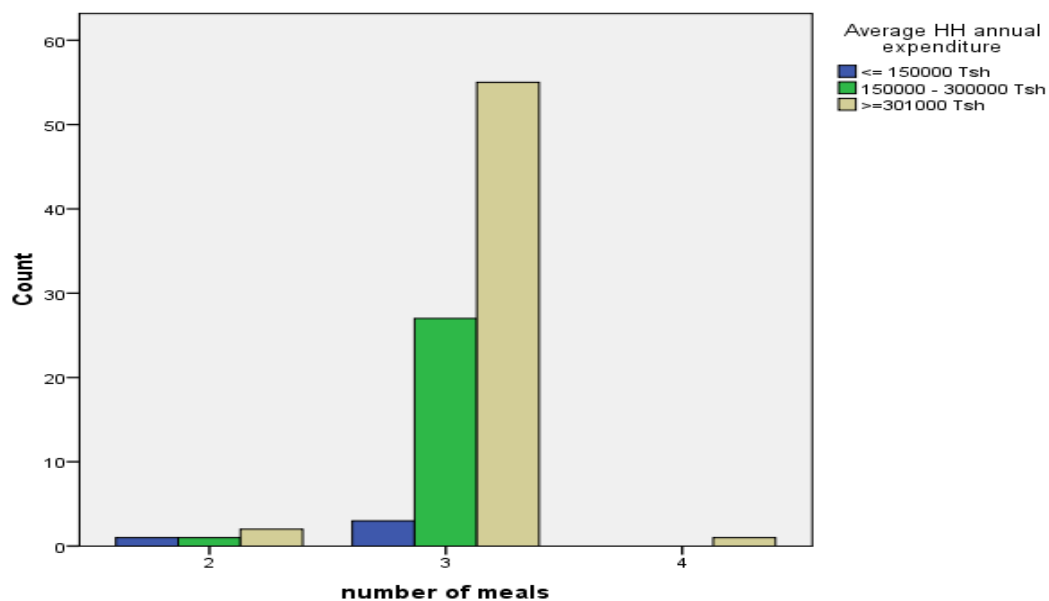


Figure 6: Relationship between food security and annual HH expenditure

Table 11 compare annual expenditure with the number of meals the household take per day.

Table 7: Comparison between expenditure and number of meals

Tshs	Categories of annual HH expenditures			Total (%)
	1 – 150 000 (%)	150 001 – 300 000 (%)	More than 300 000 (%)	
Number of	2	1.1	1.1	2.2
meals	3	3.5	31.8	64.7
	4	0.0	0.0	1.1

Results shows that 64% of HH which take three meals spend more than Tshs 300 000 per year with 31.8% spending between Tshs 150 001 to Tshs 300 000. This situation indicates that HH in these areas spend more of their income on food. Poor people

spend a larger proportion of their income more than half in many countries, on food (Ericksen, 2008). According to these results most of people (about 94.4%) take three meals regardless their expenditure status. This might be due to the fact that in most of our societies we usually take three meals that is breakfast, lunch and dinner if food is available in the household.

Table 8: Comparison between expenditure and HH annual food production

		Categories of annual HH expenditures (Tshs)				Total (%)
		1-200 000 (%)	200 001 – 400 000 (%)	400 001 – 600 000 (%)	>600 000 (%)	
Annual Food production	1-4 tons	3.3	31.1	11.1	2.2	47.8
	4.1-8 tons	3.3	11.1	12.2	4.4	31.1
	≥ 8 tons	1.1	12.2	5.6	2.2	21.1
Total		7.8	54.4	28.9%	8.9	100

Table 8 presents the relationship between average annual HH expenditure and food production. Results indicate that the relationship doesn't exist; this is to say that higher average HH annual expenditure doesn't increase average annual food production. This means that most of HH expenditures do not go to food production but other basic needs. Results show that larger percentage (31.1%) who spend between Tshs 200 001 to 400 000 produce average up to 4 tons annually. Only 4.4% of HH who spend more than Tshs 600 000 produce between 4.1 tons to 8 tons annually.

Given that people in this area depend much in Lake for fishing activities, this study also tried to capture information about the trend in Lake Nyasa physical change. These changes (if any) have more influence in their livelihood because people use the Lake for both as source of income from fish selling and source of nutritious food.

Table 9: Changes in Lake Behaviour trend

Trend	Lipingo (%)	Mbamba Bay (%)	Kwambe (%)	Average
Increasing water level	6.7	0.0	10	5.6
Loss of biodiversity	16.7	20.0	26.7	21.1
Decreasing fish catch	40.0	30.0	36.7	35.6
Decreasing of water levels	23.3	36.7	20.0	26.7
No change	13.3	13.3	6.7	11.1
Total	100	100	100	100

Table 9 show that about 26.7% perceived that there is a decrease in water level in the lake. And on average 35.6% indicated that there is a decrease in fish catch in the area for the past ten years. Also, loss of biodiversity and disappearance of some fish species was observed. The majority of the respondents in Lipingo and Kwambe reported that there is decrease fish catch and this was contradictory to Mbamba Bay where respondents indicated that the decrease in fish catch is not serious. This was due to the fact that the village is semi urban and there are some fishermen which use improved fishing gears.

Table 10: Changes in river systems

Type of Change	Lipingo (%)	Mbamba Bay (%)	Kwambe (%)	Average (%)
Increasing water flow	3.3	0.0	10.0	4.4
Decreasing water flow	36.7	33.3	20.0	30.0
Dried river flow	30.0	40.0	43.3	37.8
Floods	23.3	10.0	16.7	16.7
Loss of river line vegetation	6.7	13.3	10.0	10.0
No changes	0.0	3.3	0.0	1.1
Total	100	100	100	100

There were also notable changes in river systems in these areas. However, the changes were not uniformly distributed, with some villages severely affected than others. Lipingo was found to have a serious problem of decreasing water flow about 36.7% of rivers in the area have decreased water flow. Similarly, there were notable changes in riverline vegetation in Mbamba Bay village (Table 10). This could be, among other things, associated with changing climate. It was observed in all three villages that the total of 11 rivers has transformed from permanent to seasonal rivers, in Mbamba Bay village Chihihila, Chipilimba and other four rivers has been transformed. In Kwambe village Kwambe River and other three rivers has also transformed into seasonal river. In Lipingo Mbawa River which once was planned to generate hydropower electricity has decreased its discharge in the dry season. In Mbamba Bay Mpumbwa and Makata rivers have decreased their discharge and several weed and other plants have established themselves within the river making it difficult for water flow, and as a result flooding has been a regular scenario in recent years. Table 11 also shows that the total of 12 rivers have dried in these areas in the

past twenty years making it difficult for water availability, and leave people in these areas to depend only on seasonal rainfall. This is expecting to hinder the production part of food systems because water is the most important parameter in agricultural production. The results shows that the total of 4 so called big rivers have decreased water discharge making it difficult for small gardens in the area to diminish in numbers and so affect household food security status. Drying of rivers appeared to be a major problem in Kwambe village where 43% of rivers have been drying in the past 20 years.



Plate 1: Chihihila River which has been transformed from permanent to seasonal

Table 11: Change in river flow behaviour

Incidence	Lipingo	Mbamba Bay	Kwambe	Total
Dried river	2	6	4	12
Decreased discharge	1	2	1	4
Shifting flow line	4	12	6	22
Seasonal rivers	1	6	4	11

Table 11 show changes in river flow behaviour in all three sampled villages, these results shows that about 22 rivers in these areas has been shifted from their original flow to new flow this might be due to increased sediments inside the river which cause huge pressure in the rain season which in turn water find new flow line, this has caused people to lose land when river passes in their farms.

Table 12: Drivers of changes in Lake Nyasa

Driver of change	Lipingo(%)	Mbamba Bay(%)	Kwambe(%)	Average(%)
Population pressure	6.7	43.3	10.0	20.0
Illegal fishing gears	60.0	30.0	50.0	46.7
Poverty	16.7	6.7	20.0	14.5
Low rainfall	0.0	0.0	3.3	1.1
Pollution	10.0	20.0	13.3	14.4
Overfishing	6.7	0.0	0.0	2.2
Do not know	0.0	0.0	3.3	1.1
Total	100	100	100	100

The majority of the respondents believed that the major drivers of change in the Lake Nyasa are mainly due to human related influences. Illegal fishing was found to be a major problem in this area as 46.7% of the respondents perceived as a problem The decrease in fish production was reported to be due to poverty ,the use of illegal gears, and population pressure which have resulted into the fishing pressure and over fishing. On average, about 46.67% of the respondents believe that there is an increasing illegal fishing. While the use of illegal fishing was found to be a serious problem in Lipingo (60%). In Kwambe(50%) and Mbamba Bay(30%) population pressure was found to be a more serious problem in Mbamba Bay this is due to the fact that The village is semi urban, and so it is growing fact due to increased rate of

immigration and increased income generating activities. Training on the proper fishing methods can help to reduce the magnitude of the problem, and therefore preserve the lake and its habitats, strong rules and bylaws should be put in place by the authorities so as help to restrict those illegal fishing practises. The government should introduce community based management system, in which community has to take full responsibility in environment conservation to create ownership phenomenon to the local people.

4.2 Climate Change and Variability in Mbinga District

4.2.1 Community Perception of Climate Change

Climate change has affected all components of food systems, in any agricultural production land is a principal factor for production, land ownership in these areas is traditional where land is acquired through inheritance (about 63.3%). Moreover 23.3% of respondents said that they acquired the land they use through forest clearing to have new fertile farms, where 13.4% acquired their land by purchasing, these are commonly fish vendors who originally came to do fish business, but later decided to become residents of the area acquiring land and living in these villages. This mode of land ownership contribute much to environmental degradation through forest clearing, this is more accelerated due to lack of well institutionalized bylaws, people shift to new farm when the old farms are less fertile. About 58.9% of interviewed respondents reported that they are not only using the food which they produce meaning that they supplement the food needed by either buying or gifts from relatives and friends. Also rainfall distribution is not uniform in the area it has

happened in some years rainfall has been delayed up to Mid January. People appeared to be not aware about climate change and its effect in their livelihood. They understand that the going on situations including river dryness and increased temperature as natural process which are brought by God himself and it is out of their control and it means that they can do nothing to control it.

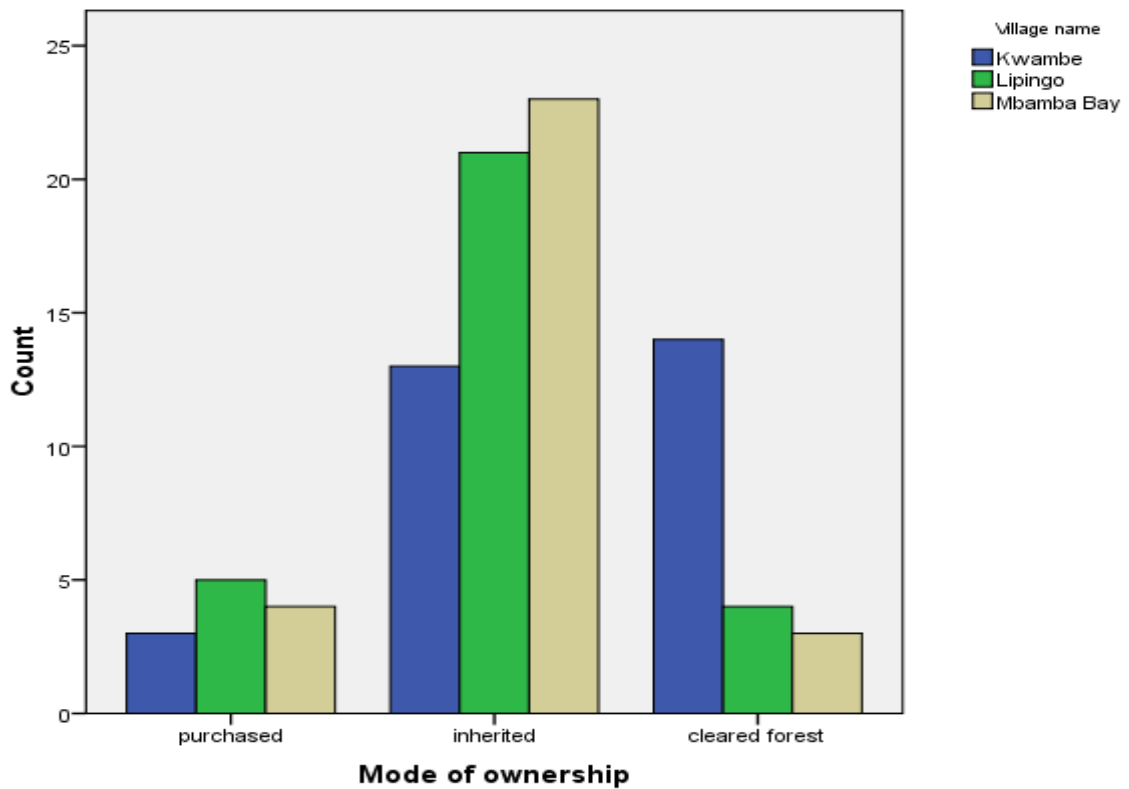


Figure 7: Mode of land (for cultivation) ownership

4.2.2 Rainfall Change and Distribution

Appendix 3 shows rainfall distribution for the past twenty years from 1990 to 2009. It shows the production of the maize crop for the past twenty years so as to be able to compare its correlation with rainfall distribution.

4.2.3 Impact of climate change on Food Production

According to field data 100% of interviewed respondents indicated that there were delays in rainfall start in the past five years, the area gets only one seasonal rainfall which usually starts in mid or late November. But since the mid 1990s this tendency has been changed where in some years e.g. 2005 where rainfall delayed until late January, this has serious effect on crop growth, when rainfall delay it means crop planting also will delay as a result the crops will not meet their normal growing cycle as a result crops will fail to mature and so affect production part of food system. 53.3% of interviewed respondents reported that there were crop failure due to the incidence of pests and diseases; this might be caused by gradual increase of temperature. In some years e.g. 2009 rainfall intensity was high causing flooding in some irrigation schemes where in Mbamba Bay 140 ha of rice farms were destructed by these rainfall and irrigation infrastructure were destroyed. Rainfall and temperature change has affected more food production than other components of food systems.

Usually food production involves the assets available to a person or household that enables them to engage in agriculture. These include especially access to land, water (and sources of irrigation), pumps and related fuels, tools, perhaps traction (some from animals), livestock, and possibly inputs such as fertiliser, compost, pesticides, credit and hired labour. Part of production maybe food for self provisioning, or farm crops (of-ten including foodstuffs) for sale (which can then be realised as food through exchange). A crucial element of the asset portfolio is the ownership and

control over these production assets: Who owns or controls them, are rents applicable and if so how much (Gregory & Ingram, 2000).

In this study food production is not that much better, most of the households lack enough assets required to produce food efficiently, about 67% of the interviewed respondents do not use fertilizers in crop production. There are several reasons as to why these people do not use fertilizer, one being the negative thinking of the side effects of fertilizer to the soil acidity, they believe that using fertilizer can lead to the depletion in soil fertility and in a long run will destroy degrade their land. The other as to why they do not use fertilizers is the high price of fertilizers. These high prices of fertilizers has a great influence to many farmers in these areas not using fertilizers. Although the government has introduced the national input subsidy fund, still the amount to contribute (Tshs 65 000) to be able to get the full set of inputs is so high to local farmers in these areas. Also farmers in these areas lack assets which can transform into money or materials and be able to use them to produce food as a result most farmers are subsistence farmers who produce a small proportion of food only to feed their families, although during the harvesting season these farmers have a tendency of selling the little harvested food to cover costs of their other basic needs. As a result six to nine months later in the year many do not have their own crop or the cash to purchase food from the market, this situation is particularly critical during the rainy season when calories needs are high due to agricultural work and market prices are high due to shortage in supply.

According to interviewed respondents and FGD information obtained, the area has witnessed the fluctuation in food production but in the last 15 years according to key informants interviewed at each village food production has heavily affected, mainly by flooding, this has been due to heavy rainfall which come when it is not needed (i. e. when crops are in the breeding stages). But in the past thirty years the area has witnessed decrease in average fish production from 10 322 in 1984 to 733.7 in 2009, this as stated earlier is caused by the change in Lake behaviour and change in fish catching techniques in the past years.

Table 13: Average annual production per household (excluding last year) in tons

Village	Mean	Std. Deviation	Minimum	Maximum
Lipingo	7.6	2.96	2	12
Mbamba Bay	5.56	2.52	2	10
Kwambe	3.4	1.19	1	6
Total	5.52	2.23	1	12

Table 14 presents the average production of food crops per household annually (in tons). The result shows that the area produce an average of 5.52 tons of various food crops per household per year, with Lipingo village having the higher production of 7.7 tons and Kwambe the lowest with 3.4 tons per household per year. According to *WHO Food Composition table*, a normal person needs 2500 Kilocalories per day. Every kilogram of maize when hulled gives 60 - 80% of flour which contains 334 Kilocalories in every 100 grams. Therefore flour requirements for a normal person per day will be:-

$$\frac{2500\text{Kcal} \times 100\text{gms}}{334 \text{ Kcal}} = 748.5 \text{ gms}$$

This is to say that flour requirements for this person will be 750gms per day. For the whole year flour requirement for this person will be $750 \times 365 = 273\,750$ gms which is 274 kgs of flour. If 1 kg of maize gives 75% of flour then 274 kgs of flour will be 365 kgs of maize. People store their produce in bags which weigh 100 kgs. Therefore a normal person will require 3.65 bags of food crops per year. According to above explanation for the household to be considered as food secured should produce the minimum of 4 bags times the number of household members. With the area having an average 5.5 tons per household per year (which is equal to 55 bags). Having the average of 4.7 household size, the household will need 19 bags of various food crops for household consumption per year. On a nutshell it seems like the area is food secured but in reality it might not be real. This is because people depend on agriculture as the main income generating activity; they sell crops to have money to pay for their health costs, school fees and other household expenditures.

Table 14: Average last year food crops production per household in tons

Village	Mean	Std. Deviation	Minimum	Maximum
Lipingo	8.3	7.27	4	14
Mbamba Bay	6.7	2.8	2	12
Kwambe	3.43	1.6	1	8
Total	6.14	2.16	1	14

Having already looked at average food production per household per year Table 15 present food production per household for the last year in all three villages, and overall results shows that there is an increase in average food production in all three villages with Lipingo leading and Kwambe coming the last. This increase might be a result of the introduction of irrigated agriculture in the area and the usage of fertilizers, though

fertilizer use is not of recommended volume. This as stated earlier that fertilizer cost is high to the extent people can not afford.



Plate 2: A main canal in KIMBANDE irrigation scheme destroyed by high rainfall

4.2.4 Impact on Food Distribution and Exchange

Most of the harvested food is being transported manually by carrying on heads, about 9% of all interviewed respondents in all three villages appeared to be using bicycles and 2% transport their food by man pulled carts, the rest which is 89% transport food from farms on heads.

In these areas infrastructure in general is poor, rural roads are not communicable all year round, bridges are few and not in good condition as this tend to hinder distribution of food and so have negative impact on food distribution. High rainfall rate is the main cause of this, in this rain season several infrastructures have been destroyed, this includes irrigation, bridges and road networks infrastructures. In

2009/10 season 140 hectare of rice farms and irrigation infrastructures in KIMBANDE irrigation scheme were destroyed by heavy rainfall leaving hundreds of farmers food in secure (See plate 2).

The marketing situation (which is essential in food distribution) in the area is still that of traditional system, there are no systematic markets in the area, buyers and sellers do meet in homes and in farms to bargain food price. There are no specialised market places where buyers and sellers can meet to do business.

4.3 Food System Vulnerability to Climate Change

A food system is vulnerable when one or more of the four components of food security i.e. food availability, food accessibility, food utilization and food system stability is uncertain and insecure. *Food availability* is determined by the physical quantities of food that are produced, stored, processed, distributed and exchanged. FAO calculates national food balance sheets that include all these elements. Food availability is the net amount remaining after production, stocks and imports have been summed and exports deducted for each item included in the food balance sheet. Adequacy is assessed through comparison of availability with the estimated consumption requirement for each food item.

4.3.1 Vulnerability on production

Production has been more vulnerable due to climate change, firstly due to variability of rainfall and temperature, as these has caused a decline in actual crops yields as well as fish production in the area. Crop yields depend greatly on weather conditions, even in the most highly mechanized systems. Both crop growth and development processes

are temperature related, and show temperature and precipitation threshold responses that can significantly affect yields (Easterling *et al.*, 2007).

Table 15: Production vulnerability due to climate change

Characteristics	Situation			
	Suffering from illness (%)	Crop failure due to rainfall problem (%)	Crop failure due to pests and disease (%)	Crop modification due to rainfall (%)
Yes	51.1	97.8	53.3	100.0
No	48.9	2.2	46.7	0.0
Total	100	100	100	100

Table 16 shows the real situation in the production related activities in the area. Results shows that in every year farmers do modify their agriculture due to rainfall extremes, in some years rainfall become higher and in some it delays to the extent that they must shift planting dates as coping mechanism. There also notable crop failure due to incidence of pests and diseases of about 53%.

Production of food has been more vulnerable due to change in climate as observed by this study climate change has caused some rivers to dry in the area, which in turn will affect production of food due to the fact that the majority of farmers in these areas depend on rainfall for agricultural activities. Due to decreased river flow discharge. Farmers who used to establish small fruits and vegetable gardens along the river banks have diminished, making availability of nutritious food to be impaired. Also, food production was much affected in 2010 due to flooding and increased incidence of pests and diseases.

Due to increased temperature and so disease vectors food production has appeared to be more vulnerable as work force suffers from increased illness, as observed about 51.1% of interviewed respondents have in each year commonly suffer from diseases mainly malaria and anaemia, with the later associated with some minerals deficiency which would have avoided by eating some type of food, when people become ill and unstable physical fitness it will reduce the rate of their participation in production activities and so affect food production. Due to unreliable rainfall which sometimes can cause soil erosion when is excessive (as it is observed in all three villages), soil erosion cause fertility to migrate to new areas probably in the lower lands and to the lake, leaving the soil in upland less fertile, as this also will decrease food production in affected areas.

4.3.2 Vulnerability on distribution and exchange

Distribution involves the physical transfer of food from the producers or intermediaries to consumers. This component of the food system involves transport systems, storage, management of inventories and the necessary communications involved in making the system work. As in the intermediary processes of exchange (above), there are also losses through damage and pests which need to be considered and which act to reduce the amount of food available for final consumption.

Table 16: Responses to distribution and exchange situation

Characteristics	Situation			
	Crop treatment	Post harvest loss (%)	Place where business is	Who decide the price (%)

	before		being done	
	storage (%)		(%)	
Yes	26.7	97.8	*	*
No	73.3	2.2	*	*
Home	*	*	68.9	*
Market	*	*	31.1	*
Buyer	*	*	*	71.1
Seller	*	*	*	28.9
Total	100	100	100	100

Key * = Not applicable

About 73.3% of interviewed respondents do not treat their crops before storage, as this indicate that post harvest loss of harvested crops is very high in the area. Food distribution in these areas is susceptible due to the poor infrastructure at place rural (feeder) roads are not in good conditions as a result food transport within the area is a problem and cause some areas to have food shortage while in the other areas food is plenty. Poor infrastructure (roads in particular) has caused the rise in food prices particularly for the food which is not produced in these areas. This is because during the rainy season where most of the roads which link the districts are not passable food vendors tend to raise prices due to the fact that they hire transportation trucks at a higher cost and they compensate these costs by increasing the food price. This has a negative impact to the people who first have not enough assets to exchange with their preferred diet. As a result they are food insecure because they depend only on food which is being produced by them which is mainly cassava and a little rice and fish.

Exchange consists of the transfer and transactions between agricultural producers, intermediaries and consumer. It includes transactions in cash or in kind, and does not necessarily mean only market relations (it can include informal reciprocity, exchanges of services between kin and even gifts intended to promote future security). These

exchange relationships are influenced by a range of processes and agencies. These will vary to the extent that the economy is monetised or commodified. Food exchange in these areas are of several ways , first being the normal exchange way whereby food is exchanged for money, the second is a barter system whereby by exchange is involves commodities, in some areas it was observed that women where bringing boiled sweet potatoes, groundnuts and boiled green maize to the fishermen to exchange with fishes, and after that the women do process those fishes and bring them in the local brew bars to sell those fishes to the same fishermen who are now refreshing in the bar. The component has not affected much by the change in climate in the past ten year according to this study. This is due to the fact that climate has no direct relationship with food exchange.

According to this study buyers have more bargaining power to negotiate food price. 68.9% of business is being done at homes and the rest business is done away from homes mainly in churches during Sundays after mass attendance where people gather together in church grounds and buyer come to do business, the business also is done among people themselves. Due to poor infrastructure there is unfair exchange of goods and services between farmers and buyers, where buyer tend to operate on their favour due to the high bargaining power in their hands. Generally food distribution is the second to be more affected due to climate change only behind the production part.

About 98% of interviewed respondents have experienced post harvest loss of their crops, this might be due to the fact that 73% of interviewed respondents do not treat their produce before storage.

4.4 Climate Change Adaptation Strategies

4.4.1 Adaptation on Production

It has observed that the community has some adaptation strategies due to on going environmental change due to climate change, due to decreased crops production people tend to extensify their agriculture by expanding farms in search for more fertile land and to meet demand of growing house hold size, as this in a long run has effect on the environment itself and act as a driver of climate change. People also have started to use chemical fertilizers as observed in Table 17, where 18% of people use fertilizer to adapt to the declining crop yields. People also have now changed to irrigation agriculture where they cultivate rice twice a year, as this increase their production potential and give them extra income to cover the costs of other HH expenditures.

Table 17: Adaptive strategies in production

Type of adaptation	Lipingo (%)	Mbamba Bay (%)	Kwambe (%)	Average (%)
Use chemical fertilizer	23.3	20.7	10.0	18.0
Farm expansion	66.7	13.3	50.0	43.3
Use improved seeds	3.3	30.0	13.3	15.5
Changing to irrigation farming	6.7	36.0	26.7	23.2
Total	100	100	100	100

Table 18 shows that the most adaptive strategy people use in these areas is farm expansion (43.3%), followed by changing to irrigation farming (23.2%).

People join in groups and apply for water from village authority where irrigation infrastructure are in place and by doing so they are able to cultivate rice twice a year, by so doing households have assurance of enough food for the household use and selling surplus. The other adaptation strategy is the use of fertilizer, in Mbamba Bay village for example in 2010 season rice production per acre has been increased from 0.4 ton to 1.3 tons. This great achievement has come as a result of farmers to start use fertilizers. Another adaptation strategy in which farmers practice is shifting planting dated so as to avoid crop failure in case they plant early and the rain stop or delay.

4.4.2 Adaptation Strategies on Distribution and Exchange

Distribution of food depends a lot on the infrastructures which are present, for example rural roads and bridges. Given the vulnerability of food systems to climate change people in these areas are transporting their produce by carrying on heads and

by bicycles to the semi urban villages such as Mbamba Bay where transaction of commodities is high. Currently there is one warehouse in Mbamba Bay Village, which has started to operate in this season for rice producers. This system enables farmers to store their paddy up to the period of good price. Generally farmers in the area lack adaptive information which would help them to cope with vulnerability of climate change. Another adaptation strategy which is yet to applied by farmer is crop treatment before storage, as it is observed that post harvest loss is high in the area.

4.4.2 Adaptation Strategies on Consumption

Traditionally people in these areas take ugali from cassava flour and fish as their staple food. Usually this meal is taken two times a day in the afternoon and during the evenings. In the morning they may take tea with either boiled cassava or rice. But currently due to food shortage and introduction of irrigated rice farming, people have started to take rice in the evening as staple food. This has helped them to have a wide choice of food to eat and so stabilize HH food security status. Food diversification has become one of the useful adaptation strategies.

4.5 Coping Strategies to Climate Change

4.5.1 Coping Strategies on Production

The coping strategy adapted by the community is starting to eat new food varieties which was not consumed and or given more priority in their diet before. Generally food purchase has been an important means of acquiring food for the household during shortage period (Mhinte, 2001). Rural households design different ways to

raise income for purchasing food.

Another coping strategy is labour selling which enable people to use the wage they got to purchase food for their households. Apart from labour selling rural households have several other income generating strategies, which includes; sale of livestock, sale of their crops in harvesting seasons, sale of local brew and other small businesses. Availability of many alternative foods gives a consumer a wide choice while the availability of a single food type limits consumer choice (Ishengoma, 1998).

4.5.2 Coping Strategies on Distribution and Exchange

As results have indicated above about 89% of food is being transported by carrying on heads, this in the first place reduce the transportation costs but the amount transported in small and so increase the costs of doing business, and in case of transportation of crops from farms after harvesting may lead to crop loss due to theft and vermine attack. Also farmers in Mbamba Bay village have started to use warehouse receipt system, where they store their paddy after harvesting and sell them later when the price is reasonable.

4.5.3 Coping Strategies on Consumption

In a short term food shortage some of the family members (especially adults) find it better to skip some meals so that the small amount of available food can be used by the most sensitive members (especially children, old and sick people) of the household. This is mainly occurring in rain season where food need is high, and food availability is a problem.

4.6 Gender issues on Climate Changes coping strategies

With changes in climate, traditional food sources become more unpredictable and scarce. This exposes women to loss of harvests, often their sole sources of food and income women are more dependent for their livelihood on natural resources that are threatened by climate change. For instance, climate change lowered in the lake level, affecting the fishing community (both men and women) not only in terms of fish catch but also with regard to water scarcity. Besides, when the land is inundated, infrastructure (roads and Bridges) are damaged. Large scale migration from inundated areas is expected and much of the burden of migration falls on women.

Table 18: HH vulnerability to climate change

	Responsibilities distribution in the HH			
	Firewood collection (%)	Fetching water (%)	Farm preparation (%)	Fishing (%)
Men	0.0	0.0	24.4	92
Women	100	100.0	75.6	8
Total	100	100	100	100

Climate change may exacerbate existing shortages of water. Women are largely responsible for water collection in their communities and are more affected when the quantity of water and/or its accessibility changes. Table 18 show that women are responsible by 100% in water collection, and firewood collection, and 75% of farm work is being done by women. This makes women more vulnerable than men.

As primary care givers, women may see their responsibilities increase as family members suffer increased illness due to exposure to vector borne diseases such as malaria, water borne diseases such as cholera and increase in heart stress mortality.

Women are particularly vulnerable to climate change because they are more prone to the adverse impacts from climate change. Their limited adaptive capacities arise from prevailing social inequalities and ascribed social and economic roles that manifest itself in differences in property rights, access to information, lack of employment and unequal access to resources. Further, changes in the climate usually impact on sectors that are traditionally associated with women, such as rice cultivation. This means increased hardship for women. Overall according to this study women are more vulnerable to climate change in the area, they have to walk long distances to collect firewood as well as water for the family use. They have also to spend much of the time to take care for the household members who suffer from illness. Given their role in the household women become the number one victim of climate change.

4.7 Summary of the chapter

Generally overall average of respondents age was 36.7 years, also this study found an average sex of men to be 87 % and 13 %. The study area also found to have more household size (4.7) compared to average district household size which is 3.6. The study also reveals that there exist relationships between the amount HH spend annually

and the number of meal the HH takes per day, which means people in these areas spent more of their income on food.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Major Findings

The general objective of this study was to assess the influence of climate change of food systems of people living along Lake Nyasa shore in Mbinga District. This chapter is therefore summarizes the major findings, main conclusions, recommendations and suggests areas of further research.

5.1.1 Climate change and variability

According to primary data obtained from respondents by using questionnaires, FGD and key informants shows that climate change has affected all four components of food systems. Respondents mainly pointed out the rise in average annual temperature and change in rainfall intensity and distribution as the main climate change parameter they have observed in recent years. Rainfall has been delayed in recent years up in the early 1990s rainfall was starting in first week of November and stops in late April. But recently from late 1990s in some years e.g. 2005 rainfall started in late January.

Temperature has been increasing gradually which in turns has affected fish production in the area and in the other hand increase the incidence of pests and diseases, and increase the risk of post harvest loss.

5.1.2 Impact of Climate Change on Food production and Distribution

Predicted changes in climate will have significant impacts on food production.

Warming is likely to shorten the growing season and, together with reduced rainfall, reduce water availability. Warmer climate can also increase crop losses caused by weeds, diseases and pests.

The area will obviously face a number of other climate change impacts. For example, reduced runoff will diminish river flows and decrease the availability of water for irrigation and household use. Wildfires may intensify and cause more damage as the result of greater biomass growth and longer dry seasons. Increasing temperature and rainfall patterns may in turn affect groundwater recharge and water supply in the communities. Yet climate change impacts on agriculture, common pool resources such as forests and pastures, and human health are the most threatening ones from the viewpoint of the majority of the people.

5.2 Community Vulnerability to Climate Change

Local people are the onsite land managers who play central roles in adapting agriculture and food systems to meet their needs under changing climate conditions. The concept of adapting to climate impacts is not new to them. Traditionally, coping mechanisms for adapting to seasonal and annual climate variability have included sharing local knowledge on varieties of crops to be grown, farming systems for example it was found in all three villages people use to cultivate larger ridges in order to conserve little available water, management technologies like storage technologies where crops like groundnuts were tied in plastic bags put over their house roofs. But the need to increase production, coupled with the speed and magnitude of the expected changes in climate, poses new challenges. Traditional coping mechanisms will not be sufficient to ensure food security and prevent effects on nutritional status. They must be complemented by the

introduction of technical innovations and enabling frameworks. More research is needed on the breeding of new and adapted as well as the preservation of traditional, locally adapted varieties that can tolerate climate variability and are suitable for changed climatic conditions. The development of innovative but practical technologies such as alternative cropping systems, conservation and precision agriculture, and sustainable forest management; and the application and improvement of technologies for more efficient use of inputs such as energy, fertilizer, water, seeds. For all technological innovations in agriculture it is crucial that they will be easily accessible and affordable for the communities in need.

Adaptation strategies must also be supported by strong institutions and enabling policy and legal frameworks. Incentives and services for rural producers that can stimulate and guide adaptation processes and link producers to markets are also important supporting mechanisms. Adaptation to climate change can incorporate a range of successfully tested methods and technologies derived from sustainable agriculture and natural resource management and equitable and inclusive rural development approaches. However, adaptation often involves substantial investments and changes in practices that may take a long time to implement or show benefits. It must therefore be complemented by other responses that address the immediate effects of climate change and protect those who cannot adapt.

5.3 Climate Change Coping Practices

5.3.1 Improving disaster risk management

The number of people affected by disasters has more than tripled since the 1990s. In 2007 over 74 million people were victims of humanitarian crisis. As climate change leads progressively towards increased extremes storms, droughts, and high

temperatures the challenge to the humanitarian community is not only to respond to the crises, but also to be better prepared and to be able to manage the risks more effectively.

Recent approaches that integrate relief and response in long-term risk management have begun to influence the way disaster management programs are planned and financed. In order to enhance community safety and resilience, the complex interactions between long-term risk reduction and short-term response need to be better understood. At the same time, the most vulnerable to food insecurity must be protected from the immediate impacts of climate change now.

Planning appropriate risk reduction and response requires an understanding of risks and vulnerabilities in terms of who are the vulnerable, where they are and why they are vulnerable. There is a need for improved monitoring, information systems and forward looking risk analysis. Particular efforts are needed to target the poorest and food insecure people without assets and entitlements.

5.3.2 Enhancing social Protection scheme

The existing inequities in food security, food safety and nutrition are likely to be further widened by the adverse consequences of climate change. Adapting food production systems has the potential to significantly increase the resilience of poor farmers to changing climate conditions. However, the vast majority of the 1 billion undernourished people do not have sufficient capacities and resources in order to adapt to or cope with the risks posed by climate change. They are in urgent need of

public support in the form of social protection schemes, safety nets and other supportive measures. Such public actions have large potential to increase resilience to climate change by contributing to breaking vicious in risk reduction or response interventions. In addition to a rural focus, attention has to be given to urban and semi urban areas.

As vulnerable people and communities themselves should always be the primary owners and drivers of any actions aimed at increasing their resilience to disasters, it is crucial to directly involve them in planning and implementation of disaster risk reduction. at the same time, in order to achieve greater effectiveness, disaster risk management and climate change adaptation management should also be linked and better integrated into national development plans and strategies, starting from poverty reduction strategies, food security strategies and sustainable development.

Moreover, the gaps between sectoral organizations must be bridged in order to share timely and relevant information concerning risks and their management. Climate information must be made accessible to affected communities and decision-makers. Last, but not least, sufficient financial resources are a prerequisite for effective disaster risk reduction. Current practice indicates that less financial resources are being made available for disaster risk reduction than for adaptation.

Here this community has to be trained and empowered to join and formulate Microfinance institutions like SACCOS and AMCOS so as to improve their income and have assurance to resources for food acquisition through either production or

buying.

Cycles that lead into chronic poverty trap, droughts, for example, frequently force poor families to sell off productive assets such as livestock; other shocks often lead to families taking children out of school and to reduction in households' food intake, number of meals, restriction of portion sizes, and purchase of less expensive but less nutritious foods each with immediate and long term physical and mental consequences for children. Eventual recovery becomes much more difficult as a result of such emergency "coping" measures. Environmental risks are among the most frequent, costly and impactful causes of such shocks a problem that will grow immensely with climate change.

5.3.3 Strengthening Resilient Community Based Development

Life saving interventions to protect the food insecure people and their livelihoods from rapid onset emergencies caused by climatic events are essential. It is equally important, however, to create enabling conditions to ensure that communities affected by disasters are able to build back systems which are better adapted to changing climate conditions. Supporting a transition towards "climate-smart" relief, rehabilitation and development that improves the livelihoods of low-income farmers and rural people and thereby increases their overall resilience must be considered the basis of adaptation.

Two thirds of developing country farmers (including in these areas) cultivate on marginal lands, often on degraded soils. They form the majority of the food insecure and are most vulnerable to climate change. Yet experience shows the right strategies can transform their lives and create climate resilient communities. Agro ecological

paths show enormous potential, if combined with equally crucial and often neglected strategies to empower farmers to influence policy formulation and implementation.

Access to formal social protection systems remains very limited in developing countries. At present only 20% of the world's people have access to formal social protection systems. Financing social protection support is complicated by the fact that safety nets need to be financed in a counter-cyclical manner, given that needs are greatest when economic performance is weakest. Effective targeting of the poorest and most vulnerable people is also critical, which fundamentally depends on policymakers understanding the vulnerabilities of these people. Apart from financial resources, formulating social protection policies hence demands significant institutional capacity, which international actors can help to build, and enter a 'virtuous circle' of environmental restoration, renewed productivity, and greater resilience to current seasonal climatic stresses. Agro-ecological measures for delivering food security, climate change adaptation or mitigation typically deliver the other two objectives as well, delivering a "win-win-win" outcome. Achieving resilient communities, which involves people achieving increased material welfare and reduced risk, is bound up with people attaining greater capacity to determine their own destiny. Three factors are crucial: first the prospect of major new investment flows focused on previously neglected lands, secondly incentivizing farmers through investments in agro ecological practices and in providing environmental services, and finally communities influencing policy making and implementation.

5.4 Major Conclusion

In effect, a food system consists of four components, the final one being the point at which people seek to satisfy their nutritional needs through consumption. In each of these, a household were affected by many factors, especially economic and political. Most of these are remote and beyond its control, the household was poor in assets and income. These significant intermediary processes which affect people are entitlements to adequate food, even when they do not themselves have a farm. If a person or household has a deficiency in the one way or more of these components affects them (for instance, inadequate land or credit at high rates of interest will disrupt production opportunities), they are likely to suffer hunger or malnutrition. Disruption of people in access to food in one or more of the components may also cause hunger (for instance changes in marketing systems, prices, availability of land, credit, and terms of trade). Food systems are a sub-set of agriculture, and both are subordinated to the political economy at the regional, national and global levels. The combinations (including subsistence farming, wage earning, bartering, trading) in which many rural people in less developed countries engage to satisfy their nutritional needs are integrated with much wider systems which influence their food systems and strategies for the use of available resources. This study as therefore found that, first the component of food system most affected is production followed by distribution and exchange, which has in return has affected the food systems outcomes which is food security of the house hold.

Second, the most population at risk in the face of climate change are women and children. Women have been exposed to this risk due to their role in daily activities to

support the house hold, they are now have to walk a long distance for gathering and collecting fire woods for energy generation where in the past 15 – 20 years the area was rich in natural forests where women were able to get fire woods nearby their homes. This has come as a result of increasing deforestation in the area for the need of farm expansion, house construction, charcoal making and fire woods. Women also suffer in the way they need to collect water for the household use; given that many rivers have gone dry women become more burdened. Children have affected in the way of acquiring their balanced diet due to the scarcity of some easily caught fish and other nutritious food like fruits and vegetables, as the results there are increased malnutrition cases in recent years.

5.5 Recommendations

5.5.1 Reducing vulnerability by increasing production

Past increases in agricultural production have occurred as a result of both extensification (altering natural ecosystems to generate products) and intensification (producing more of the desired products per unit area of land already used for agriculture. Increased yields per unit area, with a smaller contribution from an increased number of crops growing in a seasonal cycle is expected to be the main way in which crop production will rise to meet demand. In the recent past, such increases have been achieved by a ‘unique conjunction of three innovations’, namely cheap nitrogenous fertilizers combined with semi dwarf genotypes of cereals, effective weed control with herbicides, and the expansion of irrigation. For the future, continued technological developments are anticipated to facilitate the adaptation of crops to changing environments. Modern farming techniques should be employed to intensify

agriculture, so as people should be able to increase production by modernising their farming and not clearing forests for new farms expansions.

5.5.2 Reducing vulnerability improving food distribution

Infrastructural and non infrastructural controls on food distribution can be significant impediments to reduce food system vulnerability in timely manner. By improving infrastructures such as rural roads will enable first food which is not produced in these areas to flow regularly into the area and because roads and bridges will be in good conditions will easy transportation costs and hence food price will be low, Secondly for farmers it will enable food buyers to increase the buying price because transportation costs also will go down. By improving marketing infrastructures will enable buyers and farmers to have agreeable pricing mechanisms for the benefit of both sides.

5.5.3 Reducing vulnerability by increasing economic access to food

Improved economic access food is important development goal, but the means of achieving it and in region-wide political agreement are the subject of much discussion. First price mechanisms and policies could be designed that serve the interest of producers (incentive to produce more food) and consumers (to facilitate access to food) Second, area specialization in food production and area trade would lower production costs and food prices, and therefore, improve access. This important adaptation is as yet hardly pursued. Third economic growth will lead to income and employment generation, both of which will facilitate access to food. Finally, stability

and governance supported by an effective pool of human and institutional resources facilitate the establishment and maintenance of food systems.

In south Asia, studies have examined how income growth has led to changes in diets away from traditional foods. This may have negative impacts on local farmers who grow traditional foods and are not well integrated into markets (Pingali & Khawaja, 2004). The impact of trade liberalization on the poor is a topic of current study, but there is an emerging consensus that they should be protected from negative impacts through the implementation of safety nets (Mahendra Dev *et al.*, 2004).

5.6 Implications for Further Researches

Although progress has been made, considerable gaps in knowledge remain regarding the following:-

- Investigation on how global environmental change will additionally affect food system in different aspects of livelihood of people living in rural poor areas.
- Determine how different categories of producers might adapt their food systems to cope with both global environment change and changing demand for food.
- Assessment of the environmental and socio economic consequences of potential adaptations to food security designed to cope with global environmental change and changing demand for food.
- Provide information and research findings in format that assist policy making for food systems in the context of global environmental change.

Advances in these areas are priorities for advancing understanding of potential consequences of climate change for human society and the natural world, as well as to support analyses of possible responses.

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- (i) Yes
- (ii) No

If yes how many are they.....

13. Are they accessible to any member of the community

- (i) Yes
- (ii) No

If no who are eligible.....

14. How many hours do you spend to reach the drinking water point (in case of none tape water)

.....

15. Was it the same for the past ten yrs?

- (i) Yes
- (ii) No

16. Are there any source of water around where you can get water for agricultural use

- (i) Yes
- (ii) No

If yes what are they.....

17. Do water from these sources are available the whole year

- (i) Yes
- (ii) No

18. Are there any river which has gone dry in the past ten years

- (i) Yes
- (ii) No

19. If yes

mention

.....

.....

20. Are there any change in river system for the past 10 years

- (i) Yes
- (ii) No

If yes what was the most cause

Type of Change	Tick
Increasing water flow	
Decreasing water flow	
Dried liver flow	
Floods	
Loss of river line vegetation	
No changes	

21. Are you using fertilizer in producing crops

- (i) yes
- (ii) no

If yes when did you start (year)..... and why did you decided to use fertilizer

22. Do you produce enough food to feed your household for the whole year?

- (i) Yes

(ii) No

If no where do you get food to to-up the household food requirements.....

23. Are there any changes on the methods of fish harvesting in the past ten years

(i) Yes

(ii) No

If yes mention the type of

changes

.....

What was the reason for

change

.....

24. Are there types of fish which you cannot catch in the past ten years

(i) Yes

(ii) No

If yes

mention

.....

24. Are there any change in Lake behaviour in the past 10 years

(i) Yes

(ii) No

If yes what do you think was the cause

Driver of change	Tick
Population pressure	
Illegal fishing gears	
Poverty	
Low rainfall	
Pollution	
Overfishing	
Do not know	

Changes in Lake behaviour trend

Trend	Tick
Increasing water level	
Loss of biodiversity	
Decreasing fish catch	
Decreasing of water levels	
No change	
Total	

25. How frequently it is happened during the last 12 months that your household did not eat the food you prefer due to shortage of that particular food

(i) Commonly

- (ii) Rarely
- (iii) Very rarely

26. How do you get the food which is not produced here
- (i) buying from market
 - (ii) food aid
 - (iii) gift from relative
27. how many meals your household take per day
- (i) Three
 - (ii) Two
 - (iii) One
28. In case there is food shortage whithin the household what do you do?
-
- Has it happened during the past five years that, you did not get the food you want in the market?
- (i) Yes
 - (ii) No
- If no, what was the reason.....
-
29. Are the roads to the district headquarters communicable all year round
- (i) Yes
 - (ii) No
30. Are the roads between your villages communicable the whole yr?
- (i) Yes
 - (ii) No
31. How frequently you purchase food from the market
- (i) Commonly
 - (ii) Rarely
 - (iii) Very rarely
32. In case of surplus food production, where do you sell your food
- (i) In the market place
 - (ii) Buyers come at home
33. Who decide on the price of food
- (i) Seller
 - (ii) Buyer
34. Do you have any price information about the crop before you produce
- (i) yes
 - (ii) No
35. How do you transport your produce from the farm
- (i) Tractor
 - (ii) Cats
 - (iii) Bicycle
 - (iv) Heads
36. Where do you store food after harvesting
- (i) Sucks
 - (ii) Granaries
 - (iii) Kihenge
 - (iv) Other, specify.....

37. Do you treat your crops before storage
 (i) Yes
 (ii) no
 If yes, what treatment.....
38. Has it happened during the past five years that you have post harvest loss
 (i) Commonly
 (ii) Rarely
 (iii) Very rarely
 If yes which was the main problem?
 (i) Extreme temperature
 (ii) Insect pests
 (iii) Theft
39. Do you process your produce before selling?
 (i) Yes
 (ii) No
 If yes where do you process your food?
 (i) A small factory around the village
 (ii) Local processing facilities
 (iii) A factory owned at home
40. Has it happened in the past five years that extreme weather condition interfered food processing activities?
 If yes
 mention.....,,,.....
,
41. Are the food prices stable the whole year round?
 (i) Yes
 (ii) No
42. How frequently do the household members on average suffer from illness
 (i) Commonly
 (ii) Rarely
 (iii) very rarely
43. Which diseases are commonly invade your household
 (i) Malaria
 (ii) Diarrhoea
 (iii) Pneumonia
44. Is there any food security program going on in your village
 (i) Yes
 (ii) no
 If yes, mention.....
45. Did you involved in identification and planning of it
 (i) Yes
 (ii) No
46. Was it your priority project among many you wanted
 (i) Yes
 (ii) No
47. Do you think that the government is doing enough to support agricultural sector
 (i) Yes
 (ii) No

- 48. Do you know anything about weather forecast
 - (i) Yes
 - (ii) No
- 49. Do you use weather forecast information in producing, processing and marketing of your produce?
 - (i) Yes
 - (ii) No
 - If yes how
- 50. Who do the following job at household
 - (i) Fetching water
 - (ii) Firewood collection
 - (iii) Farm preparation

Appendix 2: FGD interview checklist

1. How do you understand by the term climate change?
.....
.....
.....
2. Can you briefly tell its effects in your community
.....
.....
3. Which aspect of livelihood has been mostly affected
.....
.....
4. How do people acquire land in your area
.....
.....
5. How do you manage the water sources in your area
.....
.....
6. Is there any afforestation program going on in your area, if yes how does it help to improve your environment
.....
.....
7. Are there any observable environmental behavioural change in the past 15 years
If yes mention
.....
8. How these changes affected food production, storage, processing and consumption
.....
.....
9. How many water sources are there in your area.....
Are they the same as the past 15 years
If no what do you think the reason for increase/decrease.....
10. Do you use firewood in cooking if yes
Where do you get them.....

Is there change in distance from where you used to get them 5 years ago

11. Have you changed fish catching technology in the past 15 years.....
If yes what was the reason for that changes
12. What should be done to improve your environment and so agriculture in your area?
13. If you were to meet the authorities what would have advised them the best way to manage the environment in your area

THANK YOU FOR YOUR COOPERATION

**Appendix 3: Production of major food crops and rainfall distribution for the
past 20 years**

Year	Rainfall (mm)	Food crop production
1990	1091	58 912
1991	1047	61 783
1992	1183	66 641
1993	1215	68 533
1994	1111	58 816
1995	1378	79 382
1996	942	44 931
1997	988	51 235
1998	1033	54 127
1999	793	48 128
2000	1322	60 573
2001	1004	53 087
2002	1018	60 735
2003	857	49 684
2004	2314	72 441
2005	766	69 123
2006	1099	66 214
2007	1222	60 642
2008	1056	53 116
2009	1058	77 064

Source: DALDO office - Mbinga District Council