COMMUNITY PERCEPTIONS ON CLIMATE CHANGE EFFECT AND HOUSEHOLD FOOD SECURITY IN KARATU DISTRICT, TANZANIA

By

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A Dissertation Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Science in Environmental Management (MSc EM) of Mzumbe University

2019

CERTIFICATION

We, the undersigned, certify that we have read and hereby recommend for acceptance by the Mzumbe University, a dissertation paper entitled **Community Perception on Climate Change Effects and Household Food Security in Karatu District, Tanzania**, in fulfilment of the requirements for award of the degree of Master of Science in Environmental Management of Mzumbe University.

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I, Jacqueline Kyusilu, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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DEDICATION

I dedicate this work to my beloved parents Mr. and Mrs. Kyusilu, for their support and unconditional love through my entire life up to this stage.

LIST OF ABBREVIATIONS AND ACRONYMS

CFCs	Chlorofluorocarbons
EMA	Environmental Management Act
FAO	Food and Agriculture Organisation
FAW	Fall Armyworm
IFPRI	International Food Policy Research Institution
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
LAGs	Local Government Authorities
NASA	National Aeronautics and Space Administration
NATGEO	National Geographic
NSGRP	National Strategy for Growth and Reduction of Poverty
NEP	National environmental policy
NGOs	Non-Governmental Organisations
TMA	Tanzania Meteorological Agency
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisations
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations International Children Emergency Fund
UNFCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
WFD	World Food Day

WFP	World Food Programme
WHO	World Health Organisation
WWF	World Wildlife Fund

ABSTRACT

This study assessed community perceptions on the effects of climate change and household food security in Karatu District, Tanzania. Climate change is leading to occurrence of events like precipitation and temperature changes, strong winds and occurrence of pests and diseases which have negative effects to crops growth. The study specific objectives were to examine community perception on climate change, to determine the effects of climate change on household food security, to determine the adaptation measures applied towards the effects of climate change to household food security and to examine the mitigation measures applied by household to reduce the impacts of climate change. Data were obtained through interview with key informants from the government, and a questionnaire used to interview households from small scale farmers of Ganako and Rhotia Wards in Karatu District Council.

The findings show that community perceived there was changes in precipitation and temperature, occurrence of strong winds and emergency of weeds and insects destroying food crops. Perception of most of the respondents was that climate changes were due to anthropogenic causes and their effects led to the decline of food production and the status of food security to most of the household is low. The adaptation measures applied for climate change effects, were the adaptation of good farming methods that help to raise food production. Mitigation measures applied were raising awareness on environmental protection and conservation to reduce impacts of climate change in order to decrease the effects of climate change to household food security.

The anthropogenic climate change effects led to food insecurity, although there were different adaptation and mitigation measures applied to address effects of climate change to food security but the results are not remarkable. Thus it is important for the government and stakeholders to study community perception on climate change effects, to understand community challenges related to climate effects to household food security, and the findings can be used to improve national policies and

legislations related to climate change and food security, like climate change strategy in Tanzania.

TABLE OF CONTENTS

CERTIFICATION i
DECLARATION AND COPYRIGHT ii
ACKNOWLEDGEMENT iii
DEDICATION iv
LIST OF ABBREVIATIONS AND ACRONYMS v
CHAPTER ONE 1
INTRODUCTION 1
1.0 Introduction 1
1.1 Background to the Study 1
1.2 Statement of the Problem 4
1.3 Objectives of the Study 4
1.3.1 Main objective 4
1.3.2 Specific objectives of the study 5
1.4 Research Questions 5
1.5 Significance of the Study 5
1.6 Scope of the study 6
CHAPTER TWO 7
LITERATURE REVIEW 7
2.0 Introduction 7
2.1 Theoretical Literature Review 7
2.1.1 Definition of key concepts 7
2.1.1.1 Climate 7
2.1.1.2 Climate change 8
2.1.1.3 Community 9
2.1.1.4. Perception 9
2.1.1.5 Food security 10
2.1.2. Climate change and food security 11
2.1.2.1 Climate change 11
2.1.2.2 Community perception on climate change 17
2.1.2.3 Food security 20

2.1.2.3. Climate change and food security 21
2.2 Empirical Literature Review 26
2.3 Research Gap 28
2.4 Conceptual Framework 28
Figure 2.1 Conceptual framework 29
3.0 Introduction 30
3.1 Study Area 30
3.1.1 Description of study area 30
Figure 3.2: Map of Karatu District showing the study area 32
3.2. Research Design 32
3.3 Study Population 33
3.3.1 Sampling Frame 33
3.5. Sampling Unit 33
3.6 Sampling Technique 34
3.7 Sample Size 34
3.8 Types and Sources of Data 35
3.10 Data Analysis 36
3.11 Data Presentation 37
CHAPTER FOUR 38
RESULTS AND DISCUSSION 38
4.0 Introduction 38
4.1 Background Characteristics of the Respondents 38
4.1.1 Age of the respondents 38
Table 4.1: Age distribution of the respondents 38
4.1.2 Sex of the respondents 39
Table 4.2: Sex distribution of the respondents 39
4.1.3 Levels of education of the respondents 39
4.1.4 Households size 40
Table 4.4: Household size distribution 40
4.1.5 Household farm size in hectares 41
Table 4.5: Household Farm Size in Hectares 41
4.1.6 Number of bags produced per each kind of crops 42
Table 4.6: Number of bags produced per each kind of crop. 42
4.2 Community Perception on Climate Change Effects 44

4.2.1 Level of community awareness on climate change 45
4.2.2. Community perception on climate change..... 47
Table 4.7: Community perception on climate change effects..... 47
4.2.4 Most observed climatic change effects in Karatu District 49
4.2.5 Perceptions on the causes of climate change 50
Table 4.8: Perceptions on the causes of climate change..... 52
Figure 4.4: Community perception on the causes of climate change 53
4.2.6 Effects of climate change in Karatu District..... 54
Table 4.5: Community perception on effects of climate change 55
4.3 Climate Change Effects on Household Food Security..... 57
Figure 4.5: Climate change effects on household food security..... 59
4.3.4 Household food security status..... 60
Figure 4.6 Household status of food security 60
4.3.5 Household number of main meals taken per day..... 61
Figure 4.7: Household frequencies of main meals per day..... 62
4.4 Adaptation Measures on the Effects of Climate Change..... 63
4.4.1 Adaptation measures towards the effects of climate change on household food security 63
4.4.2 Contribution of adaptation measures towards household food security 67
4.4.3 Adaptation measures challenges towards household food security..... 69
Figure 4.10: Adaptation measures challenges towards household food security..... 70
4.4.4 Government strategies towards climate change effects to household food security..... 71
4.5 Mitigation Measures Applied to Reduce the Climate Change Effects 72
4.5.1 Achievement of mitigation measures to reduce effects of climate change..... 75
4.5.3 Challenges facing application of mitigation measures 77
Figure 4.13: Challenges facing application of mitigation measures..... 78
4.5.4. Necessity of involving small holder farmers in adaptation and mitigation measures on effects climate change..... 80
CHAPTER FIVE 82
SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS 82
5.0 Introduction..... 82
5.1 Summary of Findings..... 82
5.1.1. Community perception on climate change effects..... 82
5.1.2. Climate change effects on household food security..... 83

5.1.3. Households adaptation measures towards the effects of climate change 83
5.1.4. Mitigation measures applied to reduce climate change effects 84
5.2 Conclusion 84
5.3 Recommendations 86
5.3.1 Recommendations on the study 86
5.3.2 Recommendations for further studies 87
REFERENCES 89
APPENDICES 95

LIST OF TABLES

Table 4.1: Age distribution of the respondents 38
Table 4.2: Sex distribution of the respondents..... 39
Table 4.3: Education distribution of the respondents 39
Table 4.4: Household size distribution 40
Table 4.5: Household Farm Size in Hectares..... 41
Table 4.6: Number of bags produced per each kind of crop..... 42
Table 4.7: Community perception on climate change effects..... 47
Table 4.8: Perceptions on the causes of climate change 52
Table 4.5: Community perception on effects of climate change 55
Table 4.6 Household status of food security.....**Error! Bookmark not defined.**

LIST OF FIGURE

CERTIFICATION i
DECLARATION AND COPYRIGHT ii
ACKNOWLEDGEMENT iii
DEDICATION iv
LIST OF ABBREVIATIONS AND ACRONYMS v
CHAPTER ONE 1
INTRODUCTION 1
1.0 Introduction 1
1.1 Background to the Study 1
1.2 Statement of the Problem 4
1.3 Objectives of the Study 4
1.3.1 Main objective 4
1.3.2 Specific objectives of the study 5
1.4 Research Questions 5
1.5 Significance of the Study 5
1.6 Scope of the study 6
CHAPTER TWO 7
LITERATURE REVIEW 7
2.0 Introduction 7
2.1 Theoretical Literature Review 7
2.1.1 Definition of key concepts 7
2.1.1.1 Climate 7
2.1.1.2 Climate change 8
2.1.1.3 Community 9
2.1.1.4. Perception 9
2.1.1.5 Food security 10
2.1.2. Climate change and food security 11
2.1.2.1 Climate change 11
2.1.2.2 Community perception on climate change 17
2.1.2.3 Food security 20
2.1.2.3. Climate change and food security 21
2.2 Empirical Literature Review 26

2.3 Research Gap 28
2.4 Conceptual Framework 28
Figure 2.1 Conceptual framework 29
3.0 Introduction 30
3.1 Study Area 30
3.1.1 Description of study area 30
Figure 3.2: Map of Karatu District showing the study area 32
3.2. Research Design 32
3.3 Study Population 33
3.3.1 Sampling Frame 33
3.5. Sampling Unit 33
3.6 Sampling Technique 34
3.7 Sample Size 34
3.8 Types and Sources of Data 35
3.10 Data Analysis 36
3.11 Data Presentation 37
CHAPTER FOUR 38
RESULTS AND DISCUSSION 38
4.0 Introduction 38
4.1 Background Characteristics of the Respondents 38
4.1.1 Age of the respondents 38
Table 4.1: Age distribution of the respondents 38
4.1.2 Sex of the respondents 39
Table 4.2: Sex distribution of the respondents 39
4.1.3 Levels of education of the respondents 39
4.1.4 Households size 40
Table 4.4: Household size distribution 40
4.1.5 Household farm size in hectares 41
Table 4.5: Household Farm Size in Hectares 41
4.1.6 Number of bags produced per each kind of crops 42
Table 4.6: Number of bags produced per each kind of crop. 42
4.2 Community Perception on Climate Change Effects 44
4.2.1 Level of community awareness on climate change 45
4.2.2. Community perception on climate change 47

Table 4.7: Community perception on climate change effects 47
4.2.4 Most observed climatic change effects in Karatu District 49
4.2.5 Perceptions on the causes of climate change 50
Table 4.8: Perceptions on the causes of climate change 52
Figure 4.4: Community perception on the causes of climate change 53
4.2.6 Effects of climate change in Karatu District 54
Table 4.5: Community perception on effects of climate change 55
4.3 Climate Change Effects on Household Food Security 57
Figure 4.5: Climate change effects on household food security 59
4.3.4 Household food security status 60
Figure 4.6 Household status of food security 60
4.3.5 Household number of main meals taken per day 61
Figure 4.7: Household frequencies of main meals per day. 62
4.4 Adaptation Measures on the Effects of Climate Change 63
4.4.1 Adaptation measures towards the effects of climate change on household food security 63
4.4.2 Contribution of adaptation measures towards household food security 67
4.4.3 Adaptation measures challenges towards household food security 69
Figure 4.10: Adaptation measures challenges towards household food security 70
4.4.4 Government strategies towards climate change effects to household food security 71
4.5 Mitigation Measures Applied to Reduce the Climate Change Effects 72
4.5.1 Achievement of mitigation measures to reduce effects of climate change 75
4.5.3 Challenges facing application of mitigation measures 77
Figure 4.13: Challenges facing application of mitigation measures 78
4.5.4. Necessity of involving small holder farmers in adaptation and mitigation measures on effects climate change 80
CHAPTER FIVE 82
SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS 82
5.0 Introduction 82
5.1 Summary of Findings 82
5.1.1. Community perception on climate change effects 82
5.1.2. Climate change effects on household food security 83
5.1.3. Households adaptation measures towards the effects of climate change 83
5.1.4. Mitigation measures applied to reduce climate change effects 84

5.2 Conclusion 84
5.3 Recommendations 86
5.3.1 Recommendations on the study 86
5.3.2 Recommendations for further studies 87
REFERENCES 89
APPENDICES 95

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter provides the introduction and context of the entire study. It covers background of the study by laying emphasis on the issues concerning climate change on global and local level, the effect of climate change to household food security and underpinning the community perception to climate change and household food security. This chapter also covers the statement of the problem, objectives of the study, research questions, significance and scope of the study.

1.1 Background to the Study

Climate change is recognised as one of the leading challenges affecting the livelihoods of people for example change of rain season, drought, floods and increase in temperature (Sheffield, 2007). Climate changes have been happening for many years and most of them were naturally occurring unlike the recent changes which are mostly influenced by human being activities. The result of climate changes due to human being activities has increased and observed since the 19thC starting with industrial revolution and it is increasing drastically to date (Wright and Boorse, 2017). Climate change is associated with the warming of the globe and change in climate pattern that led to the changes in the atmosphere, ocean, and land including increased evaporation and precipitation, higher energy storms, melting of ice, sea level rise and other effects (Wright and Boorse, 2017).

Climate change is an inevitable and urgent global challenge with long term implications for the sustainable development of all countries. The globe is facing the major environmental challenges the generations have ever experienced, over the past 150 years. We have changed the stability of our planet by living beyond our resources through burning of fossil fuels and cutting down of forests which would obviously absorb carbon dioxide from the air (United Nations (UN), 2018).

The adverse impacts of climate change are now far reaching and evident in most parts of the world, and the impacts are more pronounced in poor countries like

Tanzania, with the least adaptive capacity (United Republic of Tanzania, (URT) 2012). Different studies indicate that there has been observed increase of temperature over the highland areas as well as decreasing rainfall patterns in most parts of the countries (URT, 2012). Thus, the performance of the agricultural sector which has historically been the backbone of the Tanzanian economy is projected to drops as a result of negative impacts of climate change (Levira, 2009).

One of the major impacts of climate change is the increase of the problem of food security. Climate change can have serious impact on the four elements of food security which are food availability, food accessibility, food utilisation, and food system stability (Poudel *et al.,* 2017). Climate change is claimed to have impacts on food security, and people are considered food secure, when they have availability and adequate access at all times for sufficient, safe and nutritious food to maintain a healthy and active life.

According to United Nations International Children's Emergency Fund (UNICEF), (2018), among the major challenges in achieving food security is climate change. The possible effects of climate change to food security can be due to the location where rain-fed agriculture is the main source of food and income (Shosha *et al.,* 2017). According to World Health Organisation (WHO), (2018), there are about 4 billion cases of food borne diseases globally. This is due to the problems of malnutrition and causes about 1.8 million of deaths annually. Tanzania is vulnerable to the increase climate change impact, and this is expected to have complex, long term consequences for the environment and on the availability of food.

Climate change is a serious threat to global food security, sustainable development and poverty eradication since it undermines the current efforts to address food insecurity and malnutrition problems (Zewdie, 2012). However, food security is among serious socio-economic and health problems but yet less addressed. The consequences of climate change on food security in developing countries are very serious due to the reliance on rain-fed agriculture. Agriculture is important for food security since it produces the food that people eat and it provides the primary source of livelihood for 36 percent of the world's total workforce (Zewdie, 2012). Therefore, if agriculture production is poor, it affects mostly the developing countries

like Asia and Africa with Tanzania inclusive. Thus the developing countries are considered to be most vulnerable to the impacts of climate change.

The topic of climate change and its effects to food security are progressively acknowledged in different parts of the world including Africa. According to different studies that have been done in Tanzania climate change is already affecting or expected to affect availability of food security (Maliondo *et al.,* 2012) and (Kahimba *et al.,* 2015). Most of the studies conducted in Tanzania on the impact of climate change to food security indicate that both extreme drought and floods can occur within one season and this has caused decline in crop production (Kahimba *et al.,* 2015).

Community dependants in agriculture are particularly vulnerable to climate variability and changes and requires adaptation tactics. The understanding of how different communities perceive climate change is very crucial especially for small holder farmers since they are mostly affected by the climate uncertainties. Community perception on climate change varies across and within local context meaning that different ways of understanding and dealing with climate change coexist within the community (Albala and Serrano, 2018).

Few studies prove that communities are aware of changes in climatic condition and their effects on people livelihoods particularly food security (Rankoana, 2016). Individual's perception on climate change, may be influenced by someone's belief about climate change depends on someone interactions with the environment example a farmer and a local record of climate change and weather pattern (Niles and Mueller, 2016).

The understanding of community perception about climate change may be helpful in the introduction of policies and to serve different communities that are vulnerable to climate change hazards. Understanding how residents perceive climate change issues and its effects to food production are crucial for helping local decision makers to adapt strategies and policies to meet community needs (Abel, 2018). This will help to develop interventions to ensure food security. This factor has raised the interest to undertake this study on community perception on the effects of climate change and

food security in Karatu District in, Arusha Region because of the incidences of climate uncertainties and the problems of food production decline.

1.2 Statement of the Problem

The global, including Karatu District climate is changing drastically due to various natural and anthropogenic reasons such as increasing fossil fuel combustion and industrial agriculture activities which emit carbon dioxide and greenhouse gases (Cunningham and Cunningham, 2017). Worldwide, climate change-related impacts have become evident. The related climate change effects experienced in Karatu District due to different studies, includes prolonged flooding, heat waves, drought, sea level rises, and salinity, temperature and rainfall variations have become evident.

Community vulnerability to climate change uncertainties has been observed to different places internationally and locally like in Karatu Districts. Climate change is leading to occurrence of events like drought, floods, temperature changes and occurrence of pests and diseases which have negative effects to crops growth which leads to food insecurity.

The community in Karatu District have been facing food insecurity according to different studies like a study conducted by Owenya *et al.* (2012) and Smalley (2018), relating to climate change effects and food security. There are limited studies on community perceptions towards the effects of climate change and household food security in Karatu District although, climate change effects are causing the problem on food production. Therefore, this study assessed how the community perceive climate change effect in relation to food security in Karatu District in order to identify the community challenges related to climate change effects and household food security. The study findings can be beneficial in improving available national strategies and legislations for climate change.

1.3 Objectives of the Study

1.3.1 Main objective

The main objective was to assess community perception on the effects of climate change in relation to household food security in Karatu District.

1.3.2 Specific objectives of the study

The overall objective was achieved through the following four specific objectives:

i. To examine the community perception on climate change effects.
ii. To determine the climate change effects on household food security.
iii. To determine the climate change adaptation measures applied by households towards household food security.
iv. To examine the mitigation measures applied by households to reduce the climate change effects.

1.4 Research Questions

The research questions used to obtain information for this study were;

i. What is the community perception towards the effects of climate change?
ii. What are the effects of climate change on household food security?
iii. What are the adaptation measures applied by households towards the effects of climate change?
iv. What are the mitigation measures applied by households to reduce climate change effects?

1.5 Significance of the Study

This study provides relevant and important information about community perceptions on climate change effects and household food security. This arises because the community perception on climate change issues and food security is not well documented, and their perception is important in developing strategies for adaptation and mitigation of climate change and ensuring food security. This study was necessary because the local communities are vulnerable to the effect of climate change, but also community have better understanding of the weather uncertainties in their local environment, so their perceptions might be useful for development plans.

The understanding of community perception on climate change and their significant effects on food security in Karatu District will be useful to articulate a local response to the projected effects of climate change on food security especially to smallholder farmers. Studying communities that are vulnerable to climate change and their perception to climate change is also very important in developing strategies to bring awareness about their responsibility to environmental protection.

Community perceptions on climate change effects and food security is important because, people's perceptions matter in making decision that are relevant to their respective areas for climate change control tactics and ensuring food security. Therefore, obtained information is helpful for policy makers to develop appropriate and relevant measures for adaptation and mitigation of climate change adverse effects to food security.

1.6 Scope of the study

The scope of the study was mainly concerned with assessing the community perception on climate change effects and household food security in Karatu District. The study also took account of the community adaptation and mitigation measures applied by households in Karatu District to reduce the effects of climate change on food security.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

A literature review focuses on summarising and discussing the previous related studies, to the current focus of the study. This chapter provides the literature review of the related study of the research concepts, including theoretical concept and empirical study of the related review of the findings from other related study. Also, it includes the identification of knowledge gap from the reviewed study as well as the conceptual framework whereby the study has arranged the set of research concept according to their relationship in the form of diagram.

2.1 Theoretical Literature Review

Theoretical literature review, examines the various theories that exists in relation to the topic being considered (Adebayo, 2018). These are the theories that explain the relationships of the variables. This part discusses the basic concepts related to the study on climate change, community perception and food security. This part also provides the theoretical overview of climate change and food security.

2.1.1 Definition of key concepts

This part provides definition of key concepts; this includes the concept of climate, climate change, community, perception and food security.

2.1.1.1 Climate

Climate is defined as the description of the long term pattern of weather in a particular area, over a long period of time of about 30 years (National Aeronautics and Space Administration (NASA), 2017). According to National Geographic (NATGEO) (2017), climate is defined as the long term pattern of weather in a particular area tracked for at least 30 years. Generally, climate can be defined as the description of the long term weather condition of an area over 30 years for a specific region.

Climate of a place is determined by a region climate system, thus there is difference in climatic condition in different parts of the world. The most variable part of climate system is atmosphere with the composition and movement of gases surrounding the earth. The main features of the regions climate includes of average temperature and precipitation, but also other features include humidity, atmospheric pressure, and cloud cover. Climate is the product of many factors like latitude, topography, distance from the ocean and location on a continent. However, there are small variations of climate since climate is not uniform, this is influenced by topographic features such as lakes, and vegetation and cities example in large cities buildings absorb heat from the sun, raising the average temperature of the city.

2.1.1.2 Climate change

Climate change is the change in climate pattern and warming of the globe that led to the changes in the atmosphere, ocean, and land including increased evaporation and precipitation, higher energy storms, melting of ice, sea level rise and other effects (Wright and Boorse, 2017). The Intergovernmental Panel on Climate Change (IPCC), defined climate change as a change in the state of the climate that can be identified by the change in the mean or the variability of its properties and that persists from an extended period typically a decade or longer (United Nations Framework Convention on Climate Change (UNFCC), 2011).

Climate change also refers to a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere (NASA, 2019). Therefore, climate change is a large scale, long term shifts in the planets weather patterns and average temperature. It is a seasonal change over a long period with respect to the growing accumulation of greenhouse gases in the atmosphere.

Effects of climate change include drought, change in precipitation, ocean heat, increase in temperature and disturbance of biodiversity (Wright and Boorse, 2017). Climate change can be a natural process or impact of human activities. Climate change caused by human activities is the current global topic due to its adverse impacts to the environment.

2.1.1.3 Community

Community is a group of people with diverse characteristics who are linked by social ties, share common perspectives and engage in joint action in geographical location or settings (MacQueen, 2001). Community can also be defined as a group of people that care about each other and feel to be belonging together (Pfortmuller, 2017). Also, other definition of community is group of individuals connected to each other by one or more attributes (Zamora, 2005). Generally, community can be defined as a group of people living together with shared values and behaviours in a geographical location. Communities can also have shared goals and historical background. The understanding of community can help funders and evaluators to identify and strengthen the communities they work with (Charis and Lee, 2015). Members of community have a sense of trust, belonging, safety and caring for each other, it comes from shared experience (Charis and Lee 2015). Community also includes feelings and set of interactions among its members.

2.1.1.4. Perception

Perception can be defined as the recognition and interpretation of sensory information, perception also includes how the response to the information (Williams, 2018). Perception is the way in which something is regarded, understood, or interpreted (Oxford Dictionary, 2018). Thought about perception is a process when sensory information is taken from the environment and uses them to interact with the particular environment. Perception allows someone to take the sensory information in and make it into something meaningful.

Perception is the process of recognizing and interpreting sensory stimuli, For example, you recognize your favourite food by its aroma and the way it looks (Williams, 2018). It is the process by which people translates sensory impressions into a coherent and unified view of the world around them. Thought necessarily based on incomplete and unverified (or unreliable) information, it is equated with reality for most practical purposes and guides human behaviour in general (www.businessdictionary.com.). Thus, community perception in this study means thinking of all the ways in which community perceive climate change and its effects

on household food security. The perception is influenced by personal experience and observations as well as historical records track of climate change.

2.1.1.5 Food security

Food security as defined by the UN's committee on world food security is the condition of which all people at all times, have physical social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Programme (WFP), 2018). World food conference of (1974), also defined food as the availability at all times of adequate world food supplies of basic food stuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices. However, world food summit of 1996, defined food security as existing when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active society. Generally, food security can be defined as the physical availability of food and ones access to sufficient and nutritious food.

The concept of food security was established in the 1960s, which includes both physical and economic access to it, which meets their nutritional needs and preferences. For food security objectives to be realised, all four dimensions must be fulfilled simultaneously (Food and Agriculture Organisation (FAO), 2008). The four elements of food security include food availability, food access, food utilisation and food stability.

Food availability refers to the physical availability of food stocks in desired quantities (Swaminathan and Bhavani, 2013). Food availability as defined by FAO, 2008 means the physical quantities of food that are produced, stored, processed, distributed and exchanged. Food availability can also be defined as the existence of sufficient quantities of food with appropriate quality and supplied through domestic production or import (Zewdie, 2012). Thus, food availability can be defined as the physical availability of food in sufficient quantities and on a consistent basis. The physical availability of food in any location within a nation depends on storage and transport infrastructure and market integration within the national territory (Swaminathan and Bhavani, 2013).

Food access means to ensure that all individuals within those households have sufficient resources to obtain appropriate foods example through production, purchase or donation, for a nutritious diet (Gross *et al.,* 2000). Food access also means the food can reach the consumer and the latter has enough money for purchase (Peng and Berry, 2018). Generally, food access means individual or household ability to acquire adequate amount of food through production or purchasing preferred food.

Food utilisation means individual must be able to eat adequate amounts both in quantity and quality in order to live a healthy and full life to realize his or her potential (Peng and Berry, 2018). Food utilisation also refers to the way the body makes the most of various nutrients in the food (FAO, 2008). Generally food utilisation means the amount of food that people eat with the positive nutritional impact. Food utilisation also includes food preparations, distributions and sanitation.

Food stability refers to the ability of the nation, community, household or an individual to withstand shocks to the food chain system whether caused by natural disasters like climate change, earthquakes or those that are man-made like wars or economic crises (Peng and Berry 2018). Food stability is also defined as having an adequate access to food on a periodic basis, risking a deterioration of your nutritional status, with adverse weather conditions, political instability, or economic factors like unemployment, rising food prices (FAO, 2008). Generally food stability refers to the ability to acquire food over time, means the risk bearing capacity of the individual or community. It covers all the three above dimensions of food in availability, access and utilisation.

2.1.2. Climate change and food security

This part provides the detail overview of climate change and its effects as well as food security and one of the elements of food security which is food availability as the core focus of food security in this study.

2.1.2.1 Climate change

The notion about climate change issue is believed to be started by French mathematician and physician Jean Fourier in 1824, when he described greenhouse

effect that is in fact in the core of the climate debate (Rahman, 2013). Greenhouse effect resulted in the warming of the atmosphere and the oceans, change in precipitation and extreme weather events such as hurricanes, floods, drought and heat waves, melting of ice and rise in sea level (Cunningham and Cunningham, 2008). There is observation of drastic increase in temperature traced back on the year 1970s which are responsible for excessively climatic changes (Rankoana, 2016).

According to Rahman (2013), Climate change dialogue belonged to three different paradigms including period of curiosity, period of crisis anxiety and risk concern and period of crisis apparent failure in mitigation diversified policy actors. Each period changed with development of certain perspectives based on relevant assumptions (Rahman, 2013). The three paradigms of climate change with its perspectives and relevant assumptions are analysed as follows.

First paradigm; 19thC from 1824 to 1970, called as the period of curiosity. This was a paradigm of objective view, and the perspective of climate change was considered as a scientific issue (Rahman, 2013. The assumption of this paradigm was that there is little knowledge about climate change so there is a need for knowledge acquisition about climate change.

Second paradigm; 20th C from 1970 to 2000 period of crisis anxiety and risk concern. This paradigm based on eco- centric, means a serious concern over environmental issues. The assumption for this model is that modern society brings about risk, it state that climate change is a consequence of anthropogenic causes (Wright and Boorse, 2017).

Third paradigm; 21st C. from 2000 to 2012, period of crisis apparent failure in mitigation diversified policy actors. This paradigm states about anthropogenic factors and the perspective is that climate change is due to development issues. The assumption for this paradigm is that climate change is more a cause to other development problems and a less consequence of anthropogenic degradation (Rahman, 2013).

The other paradigm, the last one, is climate change in new paradigm from 2012 to date. These paradigm ideologies based on initiating a process for incorporating

diversified actors and increased sharing of responsibility by key developing countries on mitigation and adaptation to climate changes (Cunningham and Cunningham, 2008).

The climate system is extra ordinary complex so the great deal of effort has been made in analysing the situation. Since 1988 the IPCC, has brought together scientists and government representatives from 130 countries to review scientific evidence on the cause and effects of climate change. The fifth assessment report (known as AR5), was published in 2013/2014, representing six years of work by 2500 scientists (Wright and Boorse, 2017).

According to IPCC about 90% of the recently observed climate change is due to human activities, and due to this there is no disagreement that human activities are causing current rapid climate change. The IPCC reports warn about the rapid increase in the temperature. Over the past century human activities have revealed large amount of carbon dioxide and other greenhouses into the atmosphere which are the results of global increase in temperature. All of these are influenced by the increase of human development activities like industrialisation, agriculture and also increase in population as well as increase in pollutants.

Weather and climate affect the key determinant of human health, air food and water, the global climate is changing dangerously due to various natural and anthropogenic reasons such as increasing fossil fuel combustion and industrial agriculture activities which emit carbon dioxide and greenhouse gases (Haque *et al*,. 2012). There is a new report annually about declining of water supplies, unpredictable weather, drought, floods, heat waves and other effects caused by climate change. All these changes are consistent with predictions of climate models, due to the increase of concentration of greenhouse gases in the atmosphere (Cunningham and Cunningham, 2017).

Climate change is threatening the health of the community through increased diseases, freshwater shortage, and worsened smog and more, so there should be an effort to reduce greenhouse gases emissions example should be limited to more than 2^0c (United Nations Fund for Population Activities (UNEPA), 2017). Different studies state that if there are no strategies for reduction of carbon in the atmosphere

in next few years there will be disappearance of ice caps, for example the famous one of Mount Kilimanjaro in Tanzania and the increase of ice melting. Some places depend on mountain snowmelt for fresh water example California in western United States of America and Kilimanjaro in Tanzania (Cunningham and Cunningham, 2017).

Climate scientists come to conclusion that carbon dioxide emission is generating climate change which affects both human and economic terms. The policy makers for example politicians are responsible for establishing new rules to reduce our carbon emission, but still there is a problem in the understanding of the connection climate changes and its effects. The studies warn the need for about immediate action in order to serve from the great dangers of climate change like loss of polar ice (Wright and Boorse, 2017).

The climatologist Wallace Broeker said that "climate is an angry beast and we are poking it with stick" meaning that we assume our climate is stable but our inconsiderate action may be pushing it to sudden and dramatic change (Cunningham and Cunningham, 2009) There are many explanations for climatic catastrophes example massive volcanic eruptions. Although many scientists regard anthropogenic as the most contributor of global climate change and this is not a new idea and it has made climate change to be the most important environmental issue of our times.

The Fourth Assessment Report (AR4) of the IPCC clearly states that climate change is contributing to the global burden of disease and premature death (Sheffield, 2007). Many studies have addressed observed and projected changes in land cover and land use as result of climate change (Alig, 2011). There is observation of drastic increase in temperature traced back on the year 1970s which are responsible for excessively climatic changes (Rankoana, 2016).

The evidence to climate change includes, disappearance of some species like golden toads and rhinos among others, drought and changes in precipitation, bleaching of coral reefs, rise in sea level due to melting of ice and warming of ocean. However other evidence is the rise of global temperature of about 0.6^0C and warming of Polar

Regions and increase in damaging storms like floods and cyclones (Cunningham and Cunningham, 2009).

The adverse effects of climate change globally and even in the community level have been recognised due to development activities, therefore this raised awareness to play a major role to deal with climate change related adverse impact. Weather and climate affect the key determinant of human health, air food and water.

Climate change is due to the increase of greenhouse gases including carbon dioxide, methane and nitrous oxide. This is due to anthropogenic causes and less of natural causes like volcanic eruption. Anthropogenic cause of climate change ranges from more frequent to severe drought to snowstorms due to burning of fossil fuels (Wired, 2018). Among the causes for increase of greenhouse gases that leads to climate change includes of the following:

First, burning of fossil which results to the releasing of harmful products into the environment example burning of wood, coal and petroleum release unburned carbon into the environment (Wired, 2018).

Second, deforestation, this reduce the amount of plant life available on earth's surface to turn carbon dioxide into oxygen (Wright and Boorse, 2017). Farming methods, for example, agriculture causes climate change since agriculture and deforestation goes together, this occurs because agriculture needs an increasing amount of space alongside massive amounts of chemical fertilisers and pesticides used (Perrone, 2017).

Industrial activities and use of industrial products, lead to climate change because emission of gases like nitrous oxide occurs during agricultural and industrial activities which resulted in the increase of greenhouse gases in the atmosphere. Also, the use and application of industrial products like refrigerators contribute to climate change because they emit poisonous gases to the atmosphere leads to the destruction of ozone layer (Wright and Boorse, 2017). Poisonous gases emitted to the atmosphere like chlorofluorocarbons (CFCs) leads to the depletion of ozone layer in which ozone layer acts as a blanket to protect the earth from the direct ultra-violent

from the sun (Nunez, 2019). Direct ultra-violent from the sun leads to increase in temperature and can also leads to health problems like cancer and skin diseases.

However, the climate change has evident effects on ecosystem and people. Climate change is causing an array changes in biological, physical and chemical system on earth. Among the experienced effects of climate change includes of the following:

First; ocean heat content, this is the long-term consequence comes to the equilibrium with the atmosphere, raising temperature overland and in the atmosphere and short-term consequence rise of sea level due to thermal expansion (Wright and Boorse, 2017).

Second; increase in drought, because of absence of vegetation to attract rainfall and decrease and change in precipitation as the impacts of climate change (Wright and Boorse, 2017). Change in precipitation patterns example in some places there is a decrease in rainfall while other places experience heavy precipitation events leading to floods (Perrone, 2017).

Third; seasonal changes spring comes earlier and falls comes later, this leads to the disturbance of ecosystem example some tree species are dying and leads to forest insect's damage (Wright and Boorse, 2017).

Fourth; increase in overall global temperature, leads to the increase of warm temperature on earth. Increase of temperature on earth leads to several problems like melting of ice and health problem (Wright and Boorse, 2017).

Fifth, destruction and disturbance of biodiversity example shifting of fish, disappearance of some plants and animal species and extinction (Wright and Boorse, 2017).

Sixth, ice melting due to the increase of temperature and earth warming example the ice caps, glaciers, and permafrost. As a result impact ice melting leads to the problem of rising of the sea level and decline of earth fresh water.

Lastly, desertification, this may cause severe damage to agriculture and water shortage. Desertification may cause difficulties in good growing of crops and yields as well as shortage of water.

Climate change is recognised as one of the leading challenges affecting the livelihood of people example change of rain season, drought and increase in temperature (Sheffield, 2007). Community dependents in agriculture are particularly vulnerable to climate variability and changes. Socio-ecological systems are highly vulnerable to climate change given the inadequate natural climate unpredictability in the locality. It is necessary to understand local climate process, risks and opportunities, and to understand how local populations perceive such changes and adapt their livelihoods, since inadequate information is available on climate change perception in local communities.

Therefore, an increasing consequence of climate change has made the growing need and interest for better understanding the linkages between the impact of climate change, community perception and their contribution to climate change.

One of the climate change theory states that, mankind's greatest influence on climate is not its greenhouse gas emissions, but its transformation of earth's surface by clearing forests, irrigating deserts, and building cities (Bast, 2010). These explain that climate change is due to human development activities and population increase which also increase demand for resource exploitation. Thus, this theory was used in this study as it explain that climate change is due to anthropogenic causes which is the main contribution of climate change since 1970s when human activities increases rapidly. This helped to understand the problem and come out with new solutions or ideas on how to deal with the problem related to climate change.

2.1.2.2 Community perception on climate change

Climate perception may be influenced by personal beliefs about climate or by looking on the local climate change records observed in a particular area by indigenous member of the society. Therefore, perceptions are supported by observation and prediction on climate changes, by considering temperature and change patterns of rainfall by local communities and researchers worldwide.

Communities are good observers of climate change in their localities through the study of atmosphere and earth's crust. According to different studies, perception of climate change by certain communities focused on the observations of various

indicators of climate like temperature and rainfall patterns, which resulted in excessive heat, increased drought in different parts in the world, change in precipitation and rainfall seasons and strong winds (Rankoano, 2016).

The way different communities perceive climate change is related to whether individual support the policies related to climate and whether they are aware of their own behavior that are related to climate change (Niles and Mueller, 2016). Individual's perception may be influenced by someone's belief about climate change and whether it is due to human activities (Niles and Mueller, 2016). People are directly exposed to changing weather pattern like temperature, precipitation and sea level rises, and indirectly through the changes in the quality of water, air, food, and changes in ecosystem, agriculture, industry, human settlement, and the economy. Human experience with climate and weather events if often mediated by infrastructure design to help communities and land owners overcome local climate like irrigation and extreme events like floods (Niles and Mueller, 2016).

Perception of climate change and its threat to local communities are among the major challenges faced by scientists. This is due to the misconception about its causes and impacts and how to plan for proper ways of adaptation and mitigation hampering the process of ensuring food security and less climate change impacts in general. However, people's perception on climate change may not often reflect reality and also the climatic events may be misinterpreted for various reasons in the communities (Niles and Mueller, 2016). Although the indigenous knowledge is very important for the study of climate of the local area as well as conservation and protection are the excellent but sometimes may lead to interpretation because they are not scientific.

The community noted that traditional knowledge is an important element of their livelihood and that it should remain an important tool for responding to key challenges including climate change (United Nations Educational, Scientific and Cultural Organisation (UNESCO), 2014). Different communities in different societies have their own knowledge of dealing with the problems facing the society like diseases as well as climatic issues example for the protection of environment have different techniques like taboos and community by laws. Indigenous knowledge

has been applied for several generations and has provided mostly the positive impact in the environmental protection and conservation.

However, there has been little consideration and involvement of traditional knowledge to the issue of climate change by different institution dealing with climate issues. Community stated that external agencies did not effectively incorporate traditional knowledge into climate change trainings (UNESCO, 2014). The indigenous knowledge of climate change may be helpful in the development of sustainable adoption policies for environmental protection (Rankoano, 2016).

Different communities perceive the major local climate change problem to be great meteorological events and the patterns in weather, such as the increase in temperature in most parts of the world. However, different studies result show that climate change has already affected local community and for those who have realized the threat of climate changes they are already responding by developing adaptive livelihood strategies (Walshe *et al.*, 2017). Some of the action taken to achieve this is through protection and conservation example by stopping deforestation and encouraging afforestation and protection of water sources.

Perception of climate change by local communities therefore makes a contribution to the significance of understanding the local community knowledge. The understanding of local community knowledge is very potential for the climate change mitigation and adaptation measures. Perception of local community also is very helpful in the development of sustainable adoption policies to assist different communities vulnerable to climate change hazards. Effectively adaptation and mitigation to climate change requires both an understanding of the cause and impacts of climate change.

Different communities stated that there are rapid changes on climate patterns in the past few years comparing to the previous generations. Taking example of rapid climate change from farmer's local records they believed that climate change is occurred like due to local inconsistent from their record like temperature and rainfall uncertainties which also affect their agriculture produce (Niles and Mueller, 2016).

2.1.2.3 Food security

Food is a fundamental human right and yet one in nine people around the world go hungry every day. Food security as a concept originated only in the mid-1970s in the discussion of international food problems at a time of global food crisis. Everyone has the right to basic needs such as food, clothing, housing, medical care, among others (UN 2011). The Right to food is not a new concept, and was first recognized in the UN Declaration of Human Rights in 1948 (FAO, 2006). Universal declaration of human rights, 1948 Article 25 states that 'Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food'.

The issues of hunger and food crisis were also being extensively examined, following the events of the mid-1970s of food crisis (Barichello *et al.,* 2002). Food security is not just a poverty issue it is much larger issue that involves the whole food system and affects every one of us in some way. Concepts of food security have evolved in the last 30 years to reflect changes for official policy thinking. The term first originated in the mid-1970s when WHO (1974), defined food security in terms of food supply assuring the availability and price stability of basic foodstuff at the international and national level (FAO, 2006).

About more than 850 million people in the world are undernourished, a number has hardly changed since the 1990 to 1992 base period for the world food summit and millennium development goal commitments on reducing hunger by half 2015 (FAO, 2006). As of May 2006, 39 countries in the world were experiencing serious food emergencies and required external assistance for dealing with critical food insecurity (FAO, 2006). Due to the rising population and incomes it is expected that the food demand will rise by 2050, by 70 to 100 percent. It is projected that the world's population will increase by 2050; therefore to feed the growing global population agriculture must undergo significant changes. Therefore to meet this demand food production in developing countries will be required to almost double, and global food security is require to be there to encounter the challenge of growing population and to ensure food security.

Adaptation strategies and policy responses to global change including options for handling food security are urgently needed (International Food Policy Research Institute (IFPRI), 2018). Focus on food security is to ensure that food security objectives are incorporated into national poverty reduction strategies which consider impacts at the national, sub-national, household and individual level (FAO, 2006).

The description of household is normally as food secure or food insecure. Food security is one of the important components of food security in analysing the impacts of climate change on food security (Poudel *et al.*, 2017). Food security can be measured through production and the distribution of food to all people, can be determined by local or national agriculture production and the ability to trade and transport essential food supplies from surplus (Poudel *et al.*, 2017).

Impacts on the production of food will affect food supply at global and local levels as well as livelihoods and access to food (FAO, 2008). Agriculture is important for food security in two ways; first it produces the food people eat and second it provides the primary source of livelihoods for 36% of the world's total workforce (FAO, 2008). Food availability depends on the production, distribution and exchange of food, example production of adequate crop, livestock, fisheries and wild foods (Ziervogal and Ericksen, 2010). Food security theory among the theory of food security includes the neo-malthusian theory which analyses food insecurity from the perspective of food production (Scalan, 2003).

Food availability is often used to measure food security although the concepts are usually used interchangeably (Zewdie, 2012). Food availability is determined by the physical quantities of food that are produced, stored, processed, distributed and exchanged (FAO, 2008). Thus, the core discussion in this study was mainly concern with food availability as one of the pillar of food security since food availability is often used to measure food security.

2.1.2.3. Climate change and food security

Understanding the impact of climate change on food security requires understanding the linkage between climate change, food security and its drivers like availability of food (Ziervogol and Ericksen, 2010). Climate change is among the factors affecting

food security (Buheri and Muro, 2016). The possible effects of climate change on food security have tended to be viewed with most concern in location where rain fed agriculture is still the primary source of food and income (Poudel *et al.*, 2017). Among the major challenges in achieving food security is climate change.

The global temperature are beginning to have effect on crop yields, forest resources, water supplies and changing the balance of nature. The effects of climate change on food security have recently received a lot of attention, the focus on the effects of climate change on food security has been on availability and production in particular because is the area where the effects of climate change are likely to be felt the most and the soonest. Policies and institution underpinning adaptation of climate change across the spectrum of food security issues need to be of priority (Ziervogal and Ericksen, 2010).

Climate change can have serious effects on food availability and several studies on the impacts of climate change on food security have focused on crop models which indicate where yield might increase or decrease due global warming (Poudel *et al.*, 2017). Several studies explain that increased incidences of erratic precipitation, landslides, floods and drought have decreased agriculture production and deteriorated food security (Poudel *et al.*, 2017). Among the most significant effects of climate change is the potential increase of food insecurity and malnutrition, it affects all dimension of food security and nutrition example food availability (World Food Day (WFD), 2018).

Climate change is a serious threat to global food security; it has already made an impact of food security. Estimating the effects of climate change on food security has importance to policy of providing of a fuller picture of the consequences of climate change on food security (Zewdie, 2012). Impacts on the production of food will affect food supply at the global and local levels. Most of the developing countries may experience the difficulties in dealing with the problem of food production with the significance increase of relying on food aid (FAO, 2008).

Wild foods are also important to household's food security. Changes in climatic conditions have led to significant declines in the provision of wild foods by a variety

of ecosystems, and further impacts can be expected as the world climate continues to change, could therefore have an impact on the availability of food (FAO, 2008). Households from small scale farmers may experience climate change effects on food production and the household might be forced to reduce their daily food amount because of food unavailability. This might force the able-bodied adults to allocate food especially to certain members like children, sick people and lactating women, because they need it the most.

2.1.3 Climate change strategy in Tanzania (2012)

Climate change strategy was introduced in Tanzania due to the growing negative impacts of climate change in different social and economic sectors like the effects of climate change to the agricultural sector. The effects of climate change to agricultural sector resulted to the decline of food crop production, which led to the problem of food insecurity. The government of Tanzania apprehended the necessity of understanding climate change effects at national level so that the country will be able to address effectively the negative impacts of climate change. For example it is important to understand the effects of climate change in agriculture and food security since agriculture is the backbone of Tanzanian economy, as it employs about 75% of the population.

Various initiatives such as adaptation and mitigation measures has been undertaken at national level in Tanzania to address the effects of climate change which are supported by the national policies and legislations. The initiatives to address impacts of climate change in Tanzania were aimed to build resilience and achieve sustainable development. Among the strategies to address impacts of climate change in Tanzania include "the implementation of National Environmental Policy (NEP) 1997 Environmental Management Act (EMA) 2004, the Tanzania vision 2025, the Millennium Development Goals (MDGs) and the Strategy for Growth and Reduction of Poverty (NSGRP).

The goal of climate strategy in Tanzania is to ensure effective adaptation and participation in global efforts for mitigation of climate change impacts in order to achieve sustainable development goals by 2025 at national level. The specific

objectives of climate change strategy in Tanzania is to build capacity to adapt climate change, to enhance resilience, to enhance the involvement of climate change mitigation activities, bring public awareness, reinforce information system on climate change, enhance institutional capacity to address climate change and mobilization of resources to address climate change issues.

The strategic intervention for climate change involves climate change adaptation strategies and climate change mitigation strategies. The adaption strategy for climate strategy in Tanzania, is deliberately intended to address the existing climate change impacts and the emerging threats of climate change in Tanzania. It is introduced in different sectors, where by the adaptation strategy for agriculture and food security sector is aimed to reduce vulnerability to climate change, to ensure food security. There are several adaptation measures presented in the climate change strategy. The adaptation measures includes identifying suitable crops and appropriate agricultural practices, promoting irrigation system, promoting crops that mature early and resistance to drought condition, improve agro-infrastructural system and agricultural inputs and promote indigenous knowledge practices.

The mitigation strategy for climate change strategy in Tanzania was made to enable the country to reduce the impacts of climate change. There are different mitigation measures introduced per sector. The goal of mitigation measures for agriculture sector is to ensure food security through improving production and sustainability in agriculture production system. The mitigation measures includes promoting agroforestry system example planting fruit trees, management of agricultural waste, the use of efficient fertilizers and promote the best agricultural practices. For example the best agricultural practices is to discourage the use of agro chemicals like industrial fertilizers and pesticides, and encouraging the use of organic manure and promote indigenous knowledge in dealing with pesticides and insects that destroy food crops.

The implementation of climate strategy in Tanzania is arranged at sectorial level. The particular sector example the agricultural sector will be responsible to address the impact of climate change through the relevant departments and agencies, like Local Government Authority (LGAs). The implementation of climate change

strategy in Tanzania requires the financial support, this include the financial support like domestic fund from the government budget and international community like the World Bank Funds, Africa Development Fund Bank, (AfDB), Global Environment Facility and Bilateral funds.

The implementation of climate change strategy in various sectors require monitoring and evaluation framework to measure the performance. The monitoring plan for climate change strategy is intended to ensure collection of information from different agencies and stakeholders. The evaluation plan for climate change strategy is made to measure the extent of the performance of climate change strategy in Tanzania.

2.1.4 Study guiding theory.

The study on climate change developed different theoretical arguments with the evidence that climate change effects has a negative impact on agricultural production and decreases food availability. According to IPCC climatic projection model show that climate change will negatively affect food security. According to The Anthropocene theory of climate change of 1990s, suggest that humanity with its activities and growth is having a most potential effects on changing the characteristics of our planet including climate (UNESCO, 2018). According to this theory it show that climate change is transforming the earth's surface by clearing forests irrigating desserts and building cities in which all of these are the result of human performance.

The negative impacts of these transformation due to human activities is experienced in different spheres of life including agricultural activities as a results it leads to food insecurity due to the drop of agricultural performance. Food production is decreasing due to the negative effects of climate change occurred mostly because of human activities like emission of greenhouse gases, clearing of forests, agricultural practices and industrialization. Therefore this theory which suggests that humanity with its activities and growth is having a most potential effects on changing the characteristics of our planet including climate change is appropriate for this study. The theory guides the explanation on effects of climate change due human activities

and its negative effects to household food security due to the decline of crop production.

2.2 Empirical Literature Review

Empirical literature review is a previous studies found on the relationship between the variables under consideration (Atif, 2017). These reviews the previous empirical studies conducted on the topic by other researchers and the findings that emerged (Adebayo, 2018). Therefore, this part provides the findings from the previous related study on community perception towards the impact of climate change on availability of food security.

Different studies show, the effects of climate change is expected to be greater especially in those countries which are dependent on agriculture as their means of survival especially in developing world like Africa and Asia. Different studies show that effects of climate change on food security include changes in rainfall season, precipitations, and the emergence of pests and diseases that affects crops and livestock (Wreford *et al.*, 2010). Different studies have been conducted on climate change and food security, and most of them have focused on causes, adaption and mitigation of climate change.

Among the studies conducted are a study done on climate change and agriculture-impacts adaptation and mitigation by Wreford *et al.* (2010). The findings from the study show that the effects of climate change on food security involves the rise in food price until 2050 and after then the prices are expected to increase more substantially with further increase in temperature (Wreford *et al.*, 2010). These may also lead to food insecurity and difficulties to adapt to climate change in different regions in the world because of the factors like institutional capacity and technology.

According to a study done by Haque *et al.* (2012) on community perception and climate change, community perceived that climate changes observed recently due extreme weather events such as floods, storms, heavy rains, drought, rise in sea level and induced diseases compared to the past few years, led to the loss of agricultural production due to rainfall patterns brought about the health problems, less agriculture produce which also affect the socio- economy of people and livelihood in general.

Another study was done by Nelson *et al.* (2009) on climate change impact on agriculture and costs of adaptation. The finding from this study indicates that, impacts of climate change include effects on crops, increase in food price and insecurity as well as impacts on per capita income. In developing countries climate change will cause yield debris for, most of important crops example rice, wheat, maize and soybeans and increase of price.

The other study conducted by Kahimba *et al.* (2015) on climate change in Tanzania, analysis of current knowledge and research gaps. The findings show that the countrywide household survey was carried out to establish strategies for addressing negative effects of climate change in food insecure areas of Tanzania. The results indicate a declining trend in productivity of maize and sorghum mainly due to drought, floods, strong winds and excessive rainfall (Kahimba *et al.*, 2015).

The other related study from the one above, was done by Maliondo *et al.* (2012) on climate change and food security in Tanzania; an analysis of current gaps and recommendation for a research agenda. The findings state that the state of preparedness against the adverse impacts of climate change in Tanzania and in Africa in general is limited. The result further indicate that in Tanzania the dimension of food security is already affected or probable due to climate change. The study state that there is need for more research whose results will assist to stabilise the food security in the country (Maliondo *et al.*, 2012).

Another study was done on impact of climate change on food security, a literature review in sub Saharan Africa by Zewdie (2012). The results of the study show that a study conducted in Tanzania in 2011 by 2050 projected seasonal temperature increases by 2 centigrade will reduce average maize, sorghum and rice yields by 13%, 8.8 %, and 7.6% respectively due to climate change (Zewdie, 2012). The impact of climate change on food security is highest among sub Saharan Africa countries where most of the population depend on climate sensitive agro economic activities (Zewdie, 2012).

However, on the other side about climatic changes observed in last few years the study conducted in Karatu by World Wildlife Fund (WWF), show that there are

unexpected winds, heavier thunderstorms and unexpected droughts (WWF, 2018). The study further indicates that ten years ago one could predict the weather but not anymore.

Another study was conducted in Karatu by Smalley (2018) on attitudes adoption and awareness of conservation agriculture techniques by farmers in Karatu highlands show that the effects of climate change in Karatu includes the higher temperature and unreliable rainfall that leads to the decrease in agriculture production. Also, another study was conducted in Karatu by Owenya *et al.,* (2012) on conservation agriculture and sustainable crop intensification in Karatu, show that climate change threatens small holders in the districts in terms of food production that led to the risks of food insecurity.

2.3 Research Gap

There is a lot both theoretical and empirical literature review which shows that there are a lot of studies about climate change and its effects on food security but there are limited studies done about community perception on climate change and how it affects food security. For example, the impacts of climate change include droughts, floods, increase in temperature, water scarcity and eruption of pests and diseases, and it has caused serious problems to the availability of food security.

Thus, this study has assessed how community perceive climate change, since there is less information about it, and climate change is leading to occurrence of events like precipitation and temperature changes, strong winds and occurrence of pests and diseases which have negative effects to crops growth which leads to food insecurity.

2.4 Conceptual Framework

A conceptual framework represents the researcher's synthesis of literature on how to explain a phenomenon (Regoniel, 2015). The conceptual framework used in this study include the indicators of community perception on effects of climate change as independent variables and effects of climate change on food security as dependent variable, as well as community perception as intermediate variables.

The independent variable of this study comprises the effects of climatic change like drought, floods and changes in temperature. The dependent variables included the

problems of achieving food security due to climate change effects like decrease in crops production, crops failure, reduced normal number of meals and increase in food price. The intermediate variables include community perception on climate change effects, perceived decrease in rainfall, perceived changes in rainfall seasons, emergence of floods and drought condition and emergence of pests and diseases.

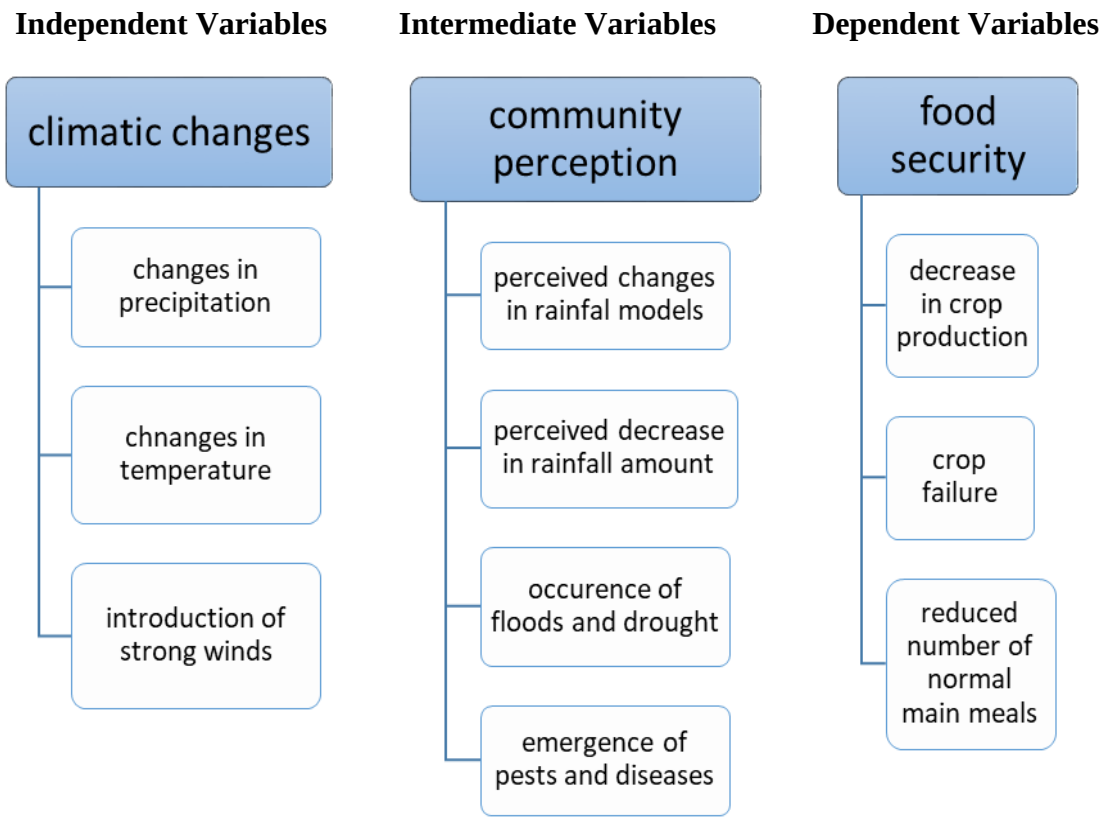

Figure 2.1 Conceptual framework

Source: Researcher's own construction 2019

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the methodology applied in this study. It includes the study area, research design, study population, sampling frame, sampling unit, sample size, sampling technique, types and sources of data, methods for data collection and data analysis.

3.1 Study Area

The study was conducted in Karatu District in Arusha Region. Reason for selection of the study area is due to climatic uncertainty experienced recently. Climate change has caused the problem on food security in Karatu and yet there is little knowledge on how community perceive climate change. This factor raised the interest of studying community perception on climate change effects and food security in this area in order to come out with information that will be reliable for proper plans of ensuring food security in the place.

3.1.1 Description of study area

Karatu District is one of the seven districts found in Arusha Region Tanzania, East Africa. The District is bordered by Monduli District to the east, Ngorongoro District to the north, Shinyanga to the west and Manyara Region to the south (URT, 2012). According to population census of 2012 the population of Karatu District was about 230166, with 45065 households. Geographically Karatu District is located between Latitude 3° 20' (3.3333°) south, Longitude 35° 40' (35.6667°) east, with the elevation of about 1,541 meters (5,056 feet) above the sea level. (URT, 2012).

Economic activities in Karatu District includes of agricultural activities, tourism recreations and trade mostly. Agricultural activities in Karatu are the main economic activity as the District has an area of 102,573 hectors of arable land for cultivation (URT, 2018). The main cash crops are coffee, onion, wheat, barley, pigeon peas and sunflower while food crops comprise of maize, beans, and sorghum.

The main crops diseases are grey leaf spot, coffee berry, Maize Lethal Necrotic Diseases (MLND) and wheat leaf rust. As for trade activities, Karatu District is well

connected to the road from Arusha via Karatu to Mwanza and Musoma passes through the town which makes Karatu town to be an active business centre (URT, 2018). Both local and foreign investors are attracted by the potential economic opportunities available in Karatu considering the fact that Karatu District is a halfway between Ngorongoro crater and Lake Manyara National Park (URT, 2018).

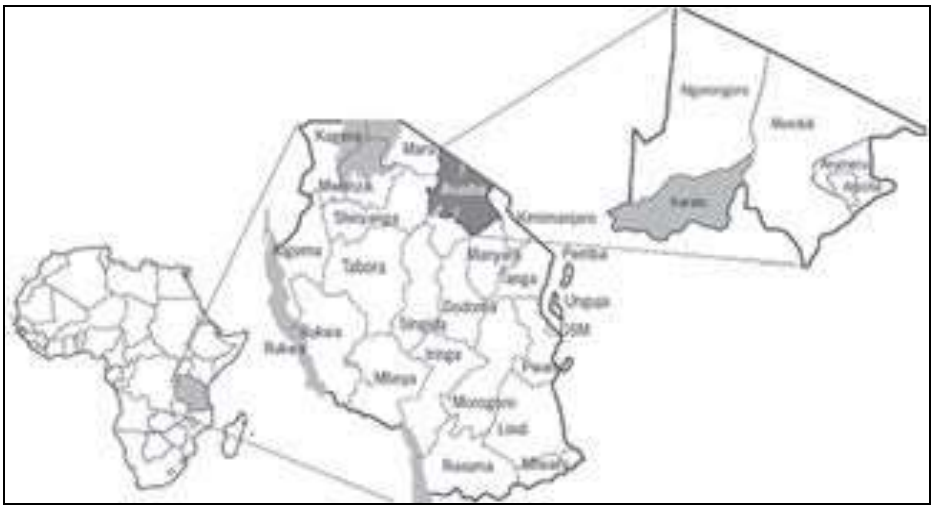

Figure 3.1 Karatu District map showing study area

Source: Maplandia 2016

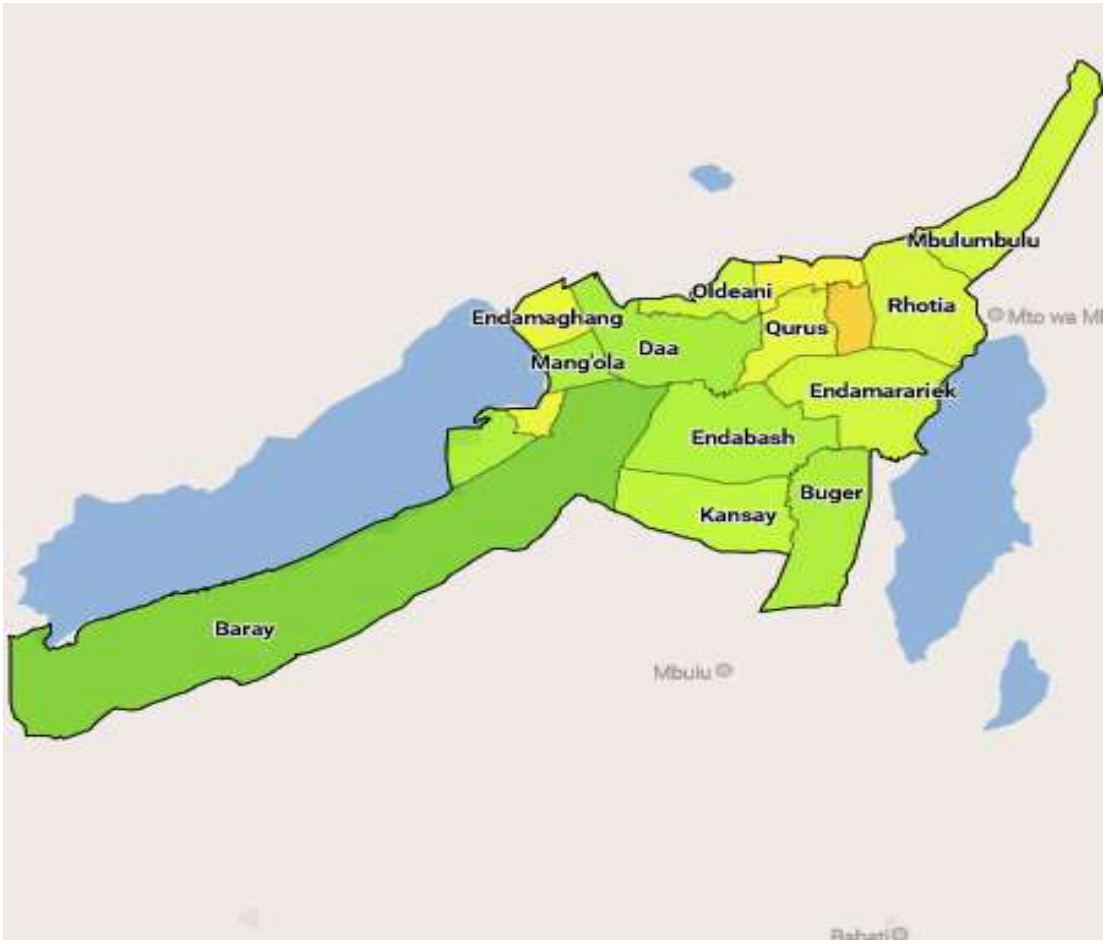

Figure 3.2: Map of Karatu District showing the study area

Source: Maplandia 2016

3.2. Research Design

This study adopted exploratory research design, because there was little information about the study on community perception and climate change effect on food security. The study aimed at scoping out initial ideas on the community perception towards the effects of climate change on food security. Exploratory design provides generation of new ideas, familiarity with basic concepts and approach for gaining background information of the study.

The exploratory study design is flexible and can address research questions of all types like what, how, and why, and also it provides opportunity to define new terms and clarify existing terms. Research design is a comprehensive plan for data collection in any empirical research project (Bhattacherjee, 2012). This is the overall

strategy selected for proper integration of research components like design for the gathering, measurements and analysis of data.

3.3 Study Population

In this study the respondents were the households from small scale farmers of Karatu District. The study also included government officials as key informants, working in Karatu District Council in which their working departments were linked to the study on climate change and food security. A study population encompasses all people with the characteristics of the study example a person, group, organisation, country, object or any other entity (Bhattacherjee, 2012).

3.3.1 Sampling Frame

In this study sampling frame was taken from households of small scale farmers both male and female in Karatu District from the two wards of Ganako and Rhotia. The sampling frame also involved government officials in Karatu District as key informants for official and secondary data information provision. This involved Karatu District Environmental Officer and Wards Extension Officers of Ganako and Rhotia Wards. The study involved District Environmental Officer and Ward Extension Officers because they were believed to be having required information, since their work activities are linked to the study on community perception on climate change effects and food security.

3.5. Sampling Unit

The sampling unit for this study was a household. Households were sampled from small scale farmers which were obtained in Karatu District council from the district's household register, according to 2012 census. Among the households, the heads of households were the respondents, because they were the adults. This is due to the fact that the adults were the ones most likely to have more information about the study on community perception on climate change effects and food security.

Sampling unit also included government officials as key informants like environmental officer and extension officers. These key informants were chosen due to the fact that their activities are directly linked to the study and were assumed to have data on effects climate changes and food security. Therefore, sampling unit

refers to the person, or objects that is target of the investigation (Bhattacherjee, 2012).

3.6 Sampling Technique

Sampling technique is the process of choosing a sample from the sampling frame (Bhattacherjee, 2012). This study applied both categories of sampling techniques, probability and non-probability sampling. For probability sampling, simple random technique was used to get two wards in which one village was selected from each ward. Simple random technique method was also applied to get two village's one from each selected ward. Two wards of Ganako and Rhotia were randomly selected, and also one village was also randomly selected from each ward which were Rhotia Kati Village from Rhotia Ward and Tloma Village from Ganako Ward.

Simple random sampling technique was the method that gave an equal probability of being selected for those two wards as well as one villages from each ward because all wards have almost the same characteristics of weather patterns and human activities like agriculture activities. Non-probability sampling was another sampling technique used in which, purposeful sampling technique method was used to obtain key informants from government officials. These were the District Environmental Officer and two Extension Officers from the two wards. Non-probability sampling technique was used by considering the research objective that the selected key informants were expected to provide reliable information on the study on assessing community perception towards the effects of climate change on food security, because their departments are related to the topic of the study on climate change and food security.

3.7 Sample Size

According to census 2012 data Karatu District has 45065 total numbers of households (URT, 2012). The total number of households in Rhotia Kati village, in Rhotia ward were 1346 number of households and from Tloma village in Ganako ward were 2178. These statistics data on number of village households were obtained from Karatu District Council from their statistics records.

The sample size for this study involved 2 villages one from each two wards, out 14 wards of Karatu District due to limited time and resources. The sample selected the

total number of 68 households from the two villages of Ganako and Rhotia Wards. However, there was 3 key informants that participated in this study. Two were Extension Officers from the two selected wards and 1 Environmental Officer from the District Council of Karatu making a total number of three key informants.

The sample size was obtained using Tare Yamane formula (Yamane, 1967).

$n=N/1+N\ (e)^{2}$ where;

n=sample size

N=population

e= margin error

3.8 Types and Sources of Data

The study collected both primary and secondary data. Primary data refers to the data that investigator collects for the very first time and secondary data refers to the data that the investigator collects from other sources (Reddy, 2018).

3.8.1 Primary data

Primary data was collected from households of small scale farmers and government officials as the key informants in this study. The government officials were ward Extension Officers, and district Environmental Officer.

3.8.2 Secondary data

Secondary data constitute the second hand information that was collected from Karatu District Office and two wards of Ganako and Rhotia. Also, other secondary data were collected from different literatures and reports information on community perception on climate change effects and food security. However, different literatures from internet publications and library were also used to obtain secondary data on climate change and food security.

3.9 Method for Data Collection

There are different methods for data collection for primary and secondary data sources. Data collection is the systematic approach to gathering and measuring

information from variety of sources to get a complete and accurate picture of an area of interest (Rouse, 2016). Methods for primary data collection in this study included questionnaire, and interview.

3.9.1 Questionnaire

Questionnaire was used to collect primary data from households of small scale farmers, on how they perceive climate change issues and its effects on food security. A total of 68 questionnaires scripts which enquired the questions about the respondent's characteristics and community perception on climate change effects and household food security in Karatu District. The questionnaire script were provided to the selected 68 household of Ganako and Rhotia to gather the required information, and then filled questionnaire script were collected from the household of small scale farmers.

3.9.2 Interview method

Interview method was used to collect both primary and secondary data from the three key informants to obtain detail information about climate change and food security. The three key informants that were interviewed were the government officials, one Environmental Officer from Karatu District office and two Extension Officers from Ganako Ward and Rhotia Ward. The interview method was used to collect information by considering the study specific objectives. The collected information from the interview with government officials were about the status of climate change and effects of climate change to household food security in Karatu district. Also the interview contained the questions about adaptation and mitigation measures for climate change in Karatu Districts.

3.10 Data Analysis

The data collected were organized using a research question as a guide for grouping obtained data from the respondents. Data analysis involved qualitative data analysis process from interview with key informants and questionnaire from the household of small scale farmers.

3.10.1 Qualitative data analysis

Qualitative data are the data that are in form of words. Qualitative data analysis processes in this study involved compilation, organization and editing of collected data on climate change effects and household food security. The collected information were organized into concepts and connection of concepts to show how the collected information on climate change effects and household food security are connected and influence one another.

3.10.2 Quantitative data analysis

Quantitative data are the data that are in form of numbers. Quantitative data analysis process involved analysis of collected data on community perceptions on climate change effects and household food security, from household questionnaire. It included the characteristics of the respondents and information about climate change effects and household food security. Quantitative data were compiled, edited and coded; the coded data were summed up to provide frequency and percentage. Data entry was done manually and cross checked to ensure accuracy.

3.11 Data Presentation

The findings are presented by using figures, tables and text, these helped to simplify interpretation and discussions of the findings.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the discussion of the findings of the study on community perception on effects of climate change and food security in Karatu District.

4.1 Background Characteristics of the Respondents

This study considered collecting the information about the characteristics of the respondents like age category, sex distribution; level of education, household's size, household farm size and number of bags produced for each kind of crop. The main purpose of including the background characteristics of the respondent's on the study was to understand the respondents characteristics, concerning the objectives of the study on assessing community perception on climate change effects and food security. This information helped to understand characteristics of respondents and their food production status which also helped to study the status of their food security.

4.1.1 Age of the respondents

The study involved respondents from different age category to get different perception. The respondents were of the age group of 25 to 66 years and above.

Table 4.1: Age distribution of the respondents

Respondents Age Category (Years)	Frequency	Percent (%)
25-39	25	36.8
40-65	34	50
66-85+	9	13.2
Total	68	100

Source: Field Data, 2019

The results in Table 4.1 show that respondents with the age of 25-39 were 36.8% of the respondents, 40 to 65 were 50% of the respondents and 66-85+ and above were 13.2% of the respondents.

The Findings indicated that, about 50% of the respondents were of the age group of 40-65. This arose because the sample of this study involved head of the households as the respondents, and most of them are apparent between the ages of 40 to 65. Few respondents were between the ages of 66 and above, this occurred because people from this age group are older and most of them are no longer engaging in food production activities. Most of people between the age 66-85 and above get support from the other member of their households for food production because they are old to continue working.

4.1.2 Sex of the respondents

The study involved both female and male, and findings from the study show that both sex, female and male participated in the study.

Table 4.2: Sex distribution of the respondents

Sex of Respondents	Frequency	Percent (%)
Male	56	82.4
Female	12	17.6
Total	**68**	**100**

Source: Field data, 2019

The Results in Table 4.2 show that out 68 respondents from different households which participated in this study, 82.4% were male while 17.5% were female.

The Results show that more male participated in the study than female. This occurred because male are the heads of the households in most of the communities, and the sample of this study was collected from households of small scale farmers.

4.1.3 Levels of education of the respondents

The findings of this study show that respondents had different educational levels, as the results show there were respondents with different educational levels like informal education, primary education, secondary education and college or other educations like tertiary. Studying level of education of respondents was necessary for determining respondent's skills.

Table 4.3: Education distribution of the respondents

Education Distribution of Respondents	Frequency	Percent (%)
Informal education	8	11.8

Primary education	38	55.9
Secondary education	12	17.6
Collage/other	10	14.7
Total	**68**	**100**

Source: Field data, 2019

The results in Table 4.3 show that 11.8% of the respondents had informal education, 55.9% of the respondents had primary education, 17% had secondary education and 14.7% of the respondents had college education.

The findings show the level of education of most of the respondents is basic education whereby more than a half of all of the respondents about 55.9% had primary education. Information about education levels of the respondents was helpful in data collection as the study show that most of the respondents were having basic education, primary and secondary education, and for that reason they were able to answer the questions and fill the provided questioners.

4.1.4 Households size

The information about number of people in the households was necessary in this study since the study involves the issue of food security. Knowing the household size is important because it helps to compare their food produce with the number of people available in the household. It also helps to determine if their food production is sufficient to ensure food security in the household since the households is among the measures of food security determinants.

Table 4.4: Household size distribution

Household Number of People	Frequency	Percent (%)
1-3	6	8.8
4-6	21	30.9
7-9	35	51.5
10+	6	8.8
Total	**68**	**100**

Source: Field data, 2019

The Findings in Table 4.4 show that 1-3 members of the family were 8.8% of the respondents, 4-6 were 30.9%, and 7-9 were 51.5% of respondents and 10 and above were 8.8% of the respondents.

The findings from this study show more than half of the families about 51.5% of the respondents contain 7 to 9 members of the households and for this number, quite large amount of food is needed to meet food requirements and to ensure food security.

4.1.5 Household farm size in hectares

Household farm sizes data were collected from small scale farmers in order to know the size of land they own as it influences food production. Household farm size data were necessary in determining the amount of food produced comparing with the farm size. Also, the findings helped to determine if there are factors which influence the amount produced in the yield per land, whether there is high or low production harvest of crops. Most of the farmers were not ready to provide information about their farm size, because they thought that by providing this information they might end up losing their farm lands.

Table 4.5: Household Farm Size in Hectares

	Responses	
Farm Size(Hectares)	**Frequency**	**Percent (%)**
1-4	44	64.7
5-8	17	25
9+	7	10.3
Total	**68**	**100**

Source: Field data, 2019

The Findings in Table 4.5 show that, 64.7% of the respondents own 1-4 hectares, 25% of the respondents own 5-8 hectares and 10.3% of the respondents own more than nine hectares farm size.

The results show that most of the respondents do not possess a large amount of land as the findings show, more than a half, 64.7% of the respondents own 1-4 hectares of land. For this land amount owned by the small holder farmers of Karatu District, ranged from 1-4 hectares, is obvious the household cannot harvest large amount of food if the weather condition is not good to support good growth of crops. Low food production might occur because most of small holder farmers practice poor farming

method like the limited use of improved seeds and fertilizers. Thus, the households with large number of people might experience food insecurity.

4.1.6 Number of bags produced per each kind of crops

The findings show that the respondents are cultivating different types of crops and most of these crops were cultivated in intercropping system whereby more than one crop are planted in the same farm. For example, the same farm may contain maize and beans or maize and pigeon peas. The farming system that involves cultivating more than one crop, helps to increase food production because a single field of crop can produce more than one food crop. Intercropping also this also helps to increase soil nutrients because beans type of plants like beans itself and pigeon peas have nutrients that improve soil which are important for good growth of crops.

The respondents also said that "beans crops were used to be cultivated in two seasons because the form of rainfall is bimodal, but it has changed recently because of changes in precipitation from two rainy season to single rainy season". The rainy seasons are expected to be in October to December for the first rainy season and March to June for second the second rainy season, but recently the rainy season is not predictable and mostly there is one rainy season due to the effects of climate change. These has led to the decline of beans crops produce because the harvest is only once per year in spring season. Studies show that climate change variability are already negatively undermining production of major crops in tropical regions and, without adaptation, this is expected to worsen as changes in precipitation increase and become more extreme (FAO, 2018).

Study on the number of bags produced per each kind of crops in each household, was necessary in order to determine the amount of food produced in the household and also if the amount produced fulfil the food requirement of the particular household.

Table 4.6: Number of bags produced per each kind of crop.

Responses

Bags/ crop	1-6		7-12		13-18		19-25+	
	F	%	F	%	F	%	F	%
Maize	15	22.1	25	36.8	19	27.9	9	13.2
Beans	38	55.9	10	14.7	12	17.6	8	11.8
Wheat	12	17.6	10	14.7	7	10.3	54	7.4
Pigeon peas	30	44.1	15	22.1	5	7.4		5.9

Note: F-Stands for frequency

Source: Field Data, 2019

The results in Table 4.6 show the number of bags produced per each kind of crops, first; maize production show that 22.1% of the respondents produces 1-6 bags, 36.8% of the respondents produced 7-12 bags of maize, 27.9% of the respondents produce 13 to 18 bags and 13.2% of the respondents produce more than 19 bags. Second; beans production shows 38% of the respondents produce 1-6 bags, 14.7% of the respondents produce 7-12 bags, 17.6% of the respondents produce 13-18 bags and 11.8% of the respondents produce more than 19 bags. Third wheat production show 17.6% of the respondents produce 1-6 bags, 14.7% of the respondents produce 7-12 bags, 10.3% of the respondents produce 13-18 bags and 7.4% of the respondents produce more than 19 bags. Last, pigeon peas production show 44.1% of the respondents produce 1-6 bags, 22.1% of the respondents produce 7-12 bags, 7.4% of the respondents produce 13-18 bags and 5.9% of the respondents produce more than 19 bags.

The finding show that maize is the most grown crop with the high produce and each respondents mentioned maize among their food crop cultivation. The harvest of maize for each household per year as indicted in the findings show that number of bags produced in maize cultivations, starts with at least 3 bags for the less produce household to 25 bags and above for the high produce households. The maize crops production has decreased compared to the past years, so the number of bags produced per yield for most of the households are not enough for the household food consumption. Respondents said that, “sometimes we are required to buy more food in order to meet our food demands because the production has decreased”. This means there is food insecurity in most of the households because of the decreased household food production.

Beans is the second major grown food crops in which households are also cultivating beans but most of the respondents said that beans harvests has declined very much recently because of changes in precipitation from two seasons to one seasons because farmers were used to harvest beans in two seasons autumn seasons and spring season. Respondents said that "when weather was certain beans production was very high because the cultivation was in two seasons". This helped to ensure their food security and economic stability because they were selling the surplus but recently the produce is not even enough for household food consumption.

Pigeon peas are the other mainly grown food crops mentioned by the most of the respondents. The respondents said that 'the pigeon peas production has decreased because of short rainy season because pigeon peas takes a long time to mature". Due to the effects of climate change that caused short season rainy, most of pigeon peas plants did not grow well and others are left premature. This has caused low production of pigeon peas crops and decrease in food consumption in household level as well as surplus to sell to meet their economics demands like buying other foods crops they don't grow example rice and fruits to meet their dietary needs.

Wheat is the other mostly grown crop mentioned by respondents in this study that contribute to the food production. Respondents said that "wheat production has also declined because of weather changes like rainfall uncertainty and temperature increase". Temperature increase has caused the decline in wheat production because wheat does not grow well in high temperate weather condition.

The other grown crops with no definite amount of produce for bags as indicated by respondents is banana, flowers seeds, sorghum and sunflowers. Most of these crops have been introduced recently like sunflowers and sorghum because they are type of crops that grows in little amount of rain and can resist drought condition. These alternative crops were perceived by the respondents that have helped to increase food production and income, in which has also has helped to increase food production.

4.2 Community Perception on Climate Change Effects

In this part of the study, on community perception on climate change effects intended to answer the question on what is the community perception towards the effects of

climate change. The objective covered questions on community awareness on the climate change, the community perception on the status of climate change effects in Karatu District, the most observed changes of climate change and the perception on the effects of climate change.

4.2.1 Level of community awareness on climate change

The study sought to understand community awareness on climate change prior to examining their perception on .climate change effects. Studying community awareness on climate change effects was necessary in order to examine if the community were aware about the weather changes in their localities. The perception of climate change effects depends if community are aware about climate change issue.

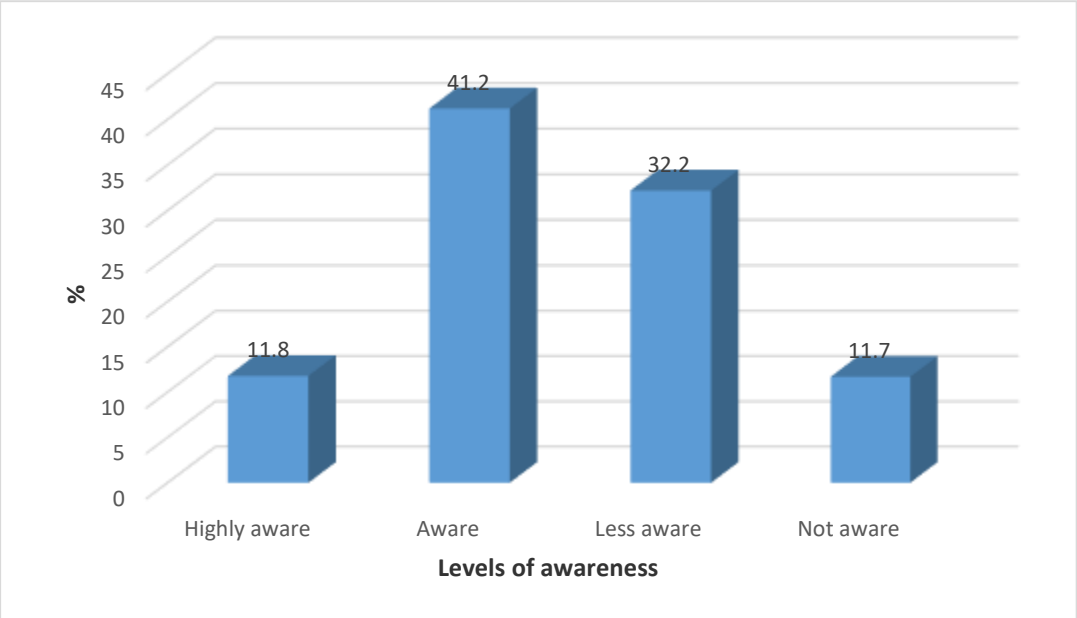

Figure 4.1: Community awareness on climate change

Source: Field Data, 2019

The results in Figure 4.1 show that 11.8% of the respondents were highly aware about climate change, 41.2% were aware about climate change, 32.2% of respondents were less aware about climate change and 14.7% of the respondents were not aware about climate change.

The findings show that the awareness on climate change issues is not very high as it show that the respondents were less aware about climate change although others also

answered that they were aware about climate change. However, the findings from other studies state that community perceived that if they were aware about climate changes they would have greater awareness of the issues of climate to be able to use technology effectively to reduce effects of climate change (Walshe *et al.*, 2017). Therefore, this could contribute to solutions related to the problems of climate change.

The findings on community awareness on climate change were obtained from key informants who were government officials and elite smallholder farmers. Interview findings with Extension Officers as one of key informants indicate that they were aware of rainfall uncertainties like late coming of rainfall season and decreasing rainfall amount.

The interview with Environmental Officer, the other key informants from Karatu District Office showed that there were continuing changes like change in rainfall models from the usual two seasons to one season with the significant decrease in rainfall volume.

Findings from household questionnaire show that the status of climate change is not very bad in Karatu District but there is changes observed in the past few years.

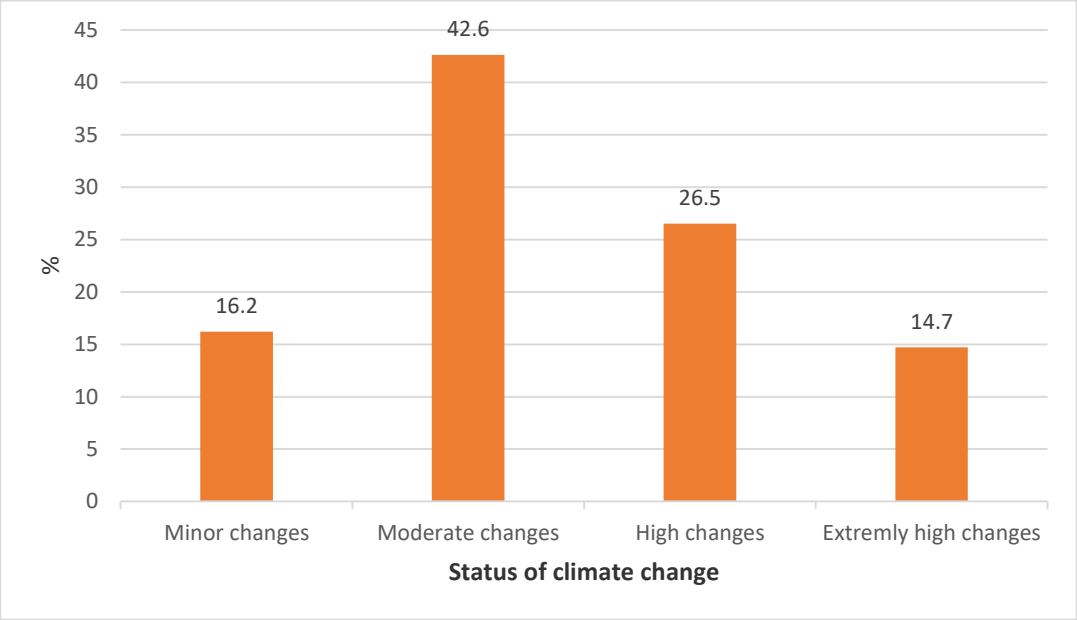

Figure 4.2: Status of climate change in Karatu District

Source: Field data, 2019

The findings in Figure 4.2 show that 16.2% of the respondents mentioned minor changes, 42.6% of respondents mentioned moderate changes, and 26.5% of the respondents mentioned high changes and 14.7% of the respondents mentioned extremely high changes.

The results show that most of the respondents perceived there are changes on climatic condition although the changes are not very high. This means that they had observed climatic changes but there were no severe climate changes observed.

4.2.2. Community perception on climate change

The findings of the study on community perception when answering the question on climate change effects show that there are different climate uncertainties. Community perception on climate change might be influenced by personal belief about climate or by looking on the local climate change records observed in a particular area. Different communities stated that there are rapid changes on climate patterns in the past few years comparing to the previous generations.

Table 4.7: Community perception on climate change effects

Climatic Changes	Frequency	Percent (%)
Decrease of rainfall during rainy season	62	91.2
Decreasing length of rainfall season	61	89.7
Late onset of rainfall season	56	82.4
Increasing of strong winds	56	82.4
Increase of temperature	54	79.4
Increase of rainy during rainy season	7	10.3
Increasing length of rainfall season	6	8.8
Early onset of rainfall season	6	8.8
Decrease of temperature	5	7.4

Source: Field data 2019

The findings in Table 4.7 show that 91.2 % of the respondents said that there is a decrease of amount of rainfall, 89.7% of the respondents indicated the decreasing length of rainfall season despite the decrease of rainy. 82.4% of the respondents indicated the late onset of rainfall season and 82.4% of the respondents too indicated that the increasing of strong winds recently, while 79.4% of the respondents indicated that they experience increase of temperature.

However, 10.3% of the respondents indicated that there is unexpected increase of rainy during rainy season, and 8.8% of the respondents indicated that sometimes there is an unusual increase of rainfall season while other 8.8% of the respondents too indicated the early onset of rainfall season, and lastly 7.4% of the respondents indicated the decrease of temperature especially during the coldly season.

The findings show that number of respondents indicated the decrease of rainy amount during rainfall season as well as decrease of the length of rainfall season. This means there is low amount of rainfall and decline of rainfall or raining in a short period of time, as perceived by the community. Other studies also show that community's perception on climate change include the changes of rainfall patterns, which resulted in excessive heat, increased drought in different parts in the world, change in precipitation and rainfall seasons and strong winds (Rankoano, 2016).

The results indicate that sometimes there is an unexpected increase of rainfall amount during rainfall season as a result of climate change, which leads to floods and destruction of crops, as well as soil erosion in the yields. The respondent's states that "there is short rain season during rainfall season as a result crops are left premature and causing low food production".

The respondents said that "sometimes there is an early onset of rainfall during rainfall season, and also there is a late rainfall arrival during rainfall season and these has effects on the planting and harvesting process". The study also show that there is an increase of strong winds in the past few years and they perceived it is a result of deforestation and climate change because it was not occurring in the previous years. Presence of trees helps to control winds movements, and deforestations can cause occurrence of strong winds due to absence of trees.

Moreover, the respondents state that "there is an increase of temperature with a prolong season during hot days in way that they do not need to cover themselves with sheets and blankets during a day as they used to do in the past." They also said that there is a decrease of temperature with a prolonged season during cold season. Other studies on community perception on climate change states that this rapid

changes has led to the increase of heat during summer not as coldly during winter, and all of this has an effect to agriculture production (Haque *et al.*, 2012).

4.2.4 Most observed climatic change effects in Karatu District

The findings indicate that the most observed climate change effect is rainfall uncertainty. Interview findings with key informant from the District, Environmental Officer and Extension Officers of Ganako and Rhotia, when answering the question on most observed climatic changes agreed on one thing that the most 'observed climate change is rainfall uncertainty'. This means that there is reduction of rainfall amount frequently in recent years and unpredictable onset of rainfall season, in which it mostly arrives late.

Most of respondents from the households when answering the question on most observed climatic changes state that "there is a decrease of rainfall amount and the rainy season is not arriving on time recently". They further specified that there is a threat of drought occurrence, since the received amount of rainy is very little within a short season.

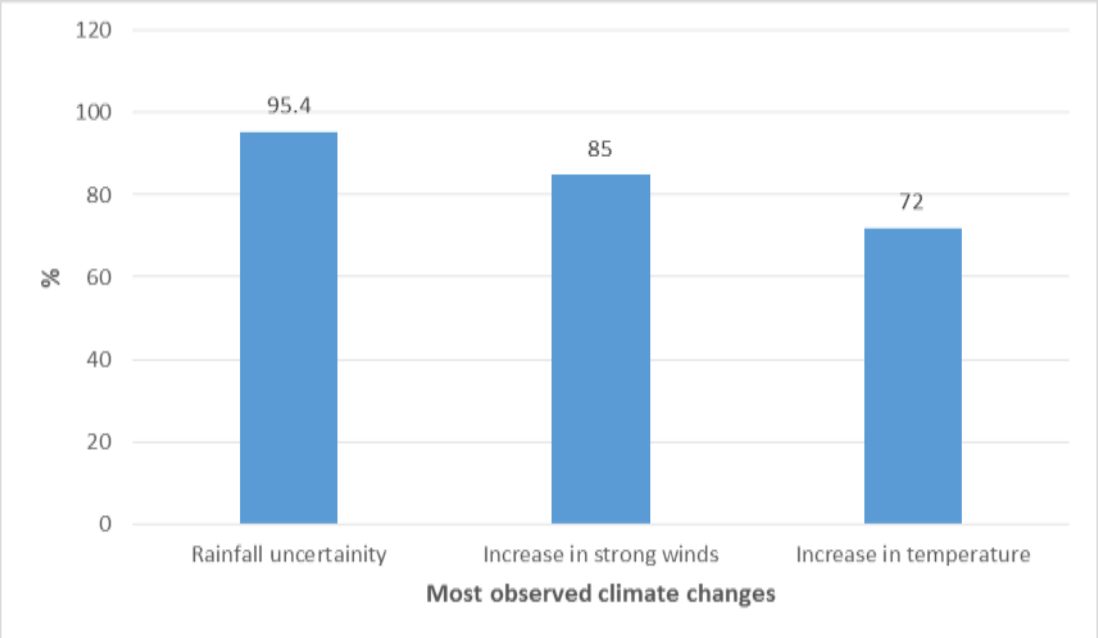

Figure 4.3: Community perceptions on most observed climatic change effects.

Source: Field Data, 2019

The results in Figure 4.3 show that the most observed climatic change effect was severe decrease is rainfall uncertainty indicated by 95.4% of the respondents,

increase in strong winds perceived by 85% of the respondents and increase in strong winds by 72% of the respondents.

The findings show that the most observed climatic changes includes of three changes which were rainfall uncertainty, increase of strong winds and increase of temperature. Rainfall uncertainty was mostly mentioned changes, whereby the respondents said that “there is severe decrease of rainfall amount with the late beginning of rainfall season”. Severe decrease of rainfall amount has affected household food production since their food production depends on rain fed agriculture. Crop production that depends on rain fed agriculture is mostly vulnerable to climatic changes particularly to small holder farmers since they have limited resources and income for other options and this leads to food insecurity (Ochieng *et al.,* 2016).

4.2.5 Perceptions on the causes of climate change

The findings from the study show that there are different causes of climate change. The interview findings with key informants when answering the question on the causes of climate change show that climate change is caused by human activities.

The interview findings with one of the key informants the Environmental Officer states that the “causes of climate change is human activities example the use of chemicals in agriculture activities which leads to the destruction of environment through the introduction of chemicals to the soil and water sources”. Introduction of chemicals to the environments releases greenhouse gases into the atmosphere which leads to the global warming and its effects are climate changes. Reference form other studies show that communities perceive that different human activities and development activities like use of agro chemicals, are the drivers of climate change and climate related problems (UNESCO, 2014). Other studies state that in order to reduce climate change challenges, it is important to reduce chemical fertilizer use and increase usage of organic materials in crop production (Ochieng *et al.*, 2016). This means that agro chemicals contributes to the changes of weather uncertainties as it leads to global warming.

The interview findings with the other key informants, the Extension Officers' show that "climate change is due to the destruction of natural vegetation like trees and overgrazing". For example, all big trees were cut down, and as a result the soil was left uncovered. They also said that farmers have a tendency of cultivating near the water sources. This leads to the destruction of water sources because when it rains, the soil from the nearby farms is easily carried to the water sources, and also farming involves clearing of vegetation which exposes water sources to direct evaporation. However, absence of vegetation like trees leads to occurrence of strong winds because trees helps to control winds movements. Further, trees are source of rainfall because forests help rainfall formation.

The findings on the questionnaire with smallholder farmers when answering the question on the perception of causes of climate change, show that the community perceived that the causes of climate change are categorized in to two categories. First, is about a certain belief and second are the anthropogenic causes. For those who perceived anthropogenic as the cause of climate changes, states that the causes for climate change are due human development activities. Different studies show that the way different communities perceive climate change is related to their own behaviour that are related to climate change or perception may be influenced by someone's belief about climate change and whether it is due to human activities (Niles and Mueller, 2016).

The respondents on the study whose their perception on the cause of climate change was about certain believes, associated the issue of climate change and Gods anger. For those who perceived climate change is due to human activities said that "climate change is due to the increase of human activities like agricultural activities because it involves clearing of forest for the establishment of new farms because of the increase of human population." Results indicate that community perceived the causes of climate change is due to the increase in population, the destruction of natural vegetation especially cutting down of natural forests for settlements, agriculture activities, charcoal burning, and bricks burning. Other human causes for climate changes is environmental pollution, overgrazing, poor farming methods and little awareness and campaigns for environmental conservation and protection.

Other respondents perceived that “climate change did not originate here but it is because of human activities in other places like industrialisation, pollution and deforestation in other places and the negative impacts are experienced in many other places including those who protects there environment.” Respondents perceived that most of the causes for climate change are not originated from their respective areas, this means that the problem did not started in their respective area, as they claimed that they are good in environmental protection example they do not have the bad habit of cutting down trees frequently, and they are also engage themselves on planting of new trees. Therefore, community perception on cause of climate change was that, they are experiencing the consequence of climate change effects but they are just the victim of environmental destruction practised in other places.

The study findings from those who believed climate change is due to certain believe the community perceived that that the reason for climate changes like rainfall uncertainties were happening because God is not happy. Respondents said that “climate change is happening because people do not love each other and also they do not follow Gods commandments”. Results indicate that some of the respondents perceived that what is happening is a curse because of evils and bad acts that are happening within the community. Community perception on climate change effects according to those with certain believes, means that climate change is happening because of the way society is behaving example by not followings God’s commandments, not loving each other and due to quarrels in the society.

Other community perceptions on climate change effects was that climate change are the natural changes and God’s control, meaning it is not in a human capability to control it or having an answer on why it is happening. Responds said that “climate change is in Gods control and human being has nothing to do with it”. Most of these opinions were provided by elders of more than 60 years old as they believed that the current behaviours and acts of the community has changed for the worse compared to their previous generations.

Table 4.8: Perceptions on the causes of climate change

Causes of Climate Change	
Anthropogenic Causes	**Certain Believes**
Cutting down of natural forests	Disobeying gods commands(curse)

Poor farming method	Quarrel within the society(curse)
Overgrazing	Lack of love in family level and in society
Little awareness and campaigns on environmental conservation and protection	It is a natural process (not man- made).
Cutting trees for charcoal and breaks burning	

Source: Field data, 2019

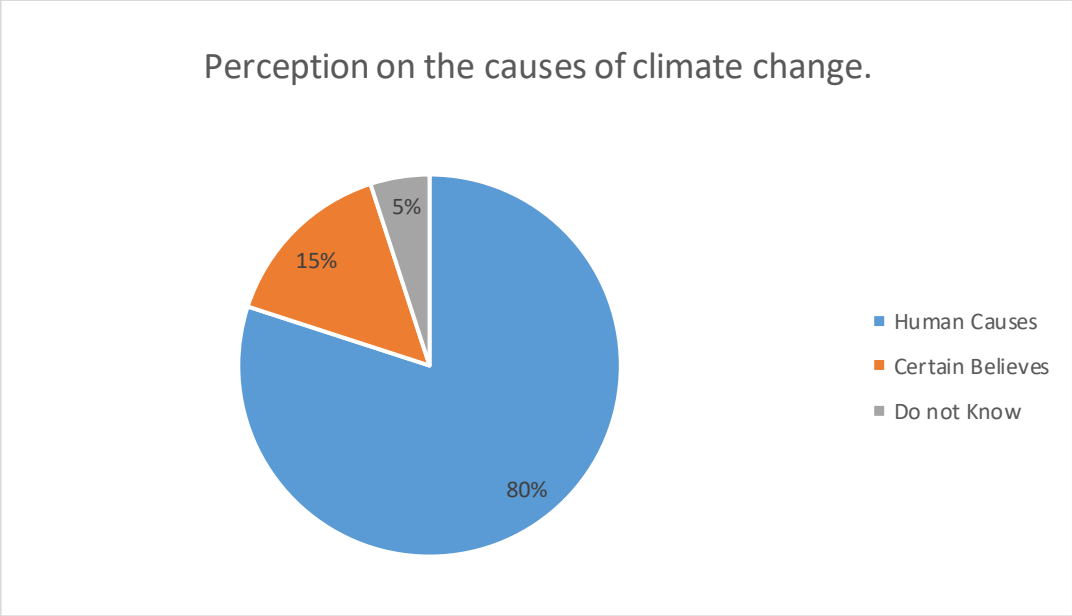

Figure 4.4: Community perception on the causes of climate change

Source: Field data, 2019

The Findings on Figure 4.4 show that causes of climate change as perceived by 80% of the respondents believed that climate change is due to human activities and 15% of the respondents said it occurred because of certain believe like disobeying God and natural process controlled by God. However, 5% of the respondents said were not sure about what cause climate change.

The findings show that most of the community perception is that climate change is due to human activities that involves their development activities, like agriculture and increase in number of people. Climate change due to agriculture activities occurs as a result of changes to land cover by replacing forests with farms or crop lands. The absence of forests leads to the decrease of rainfall since forest are the source of rain. Findings from other studies show that communities attributed that the causes of

climate change are related to anthropogenic climate change. For example economic activities like the use of chemicals in agriculture, agriculture and settlement requires clearing of large tracts of forest resources for land use and raw materials (Walshe *et al.*, 2017).

The respondents from the study also perceived that poor farming methods like the use of agro chemicals like fertilizers and pesticide contributed to the destruction of land and vegetation's. However, the other causes mentioned in the study were overgrazing which also destroys environment as keeping large number of animals destroys land and requires large area for feeding.

4.2.6 Effects of climate change in Karatu District

The findings on the effects of climate change in Karatu District were obtained from interview with key informers from government officials and questionnaire from smallholder farmers when answering the question on the effects of climate change.

The findings from the study as explained from the interview with key informants of Karatu District Environmental Officer and Extension Officers from two wards of Ganako and Rhotia show that the effects of climate change in Karatu Districts were observable.

Environmental officer from Karatu District as one of the key informants, state that the "effects of climate change has caused failure in growing of some plants". By referring to different studies conducted in Karatu Districts Environmental Officer said that "some plants example pine plants and native trees failed to grow well and some species are extinct and other are in danger, because the current climatic condition, is no longer favourable for some plant to grow well". The findings show that failure of some plants is due to low amount of rainfall received currently and increase in temperature due to climate change.

Environmental Officer also said that effects of climate change have caused changes in temperature. The officer said that "there is a prolonged cold season from the usual month of August month to September up to October, as well as prolonged hot season reaching to March in which that month was supposed to be the rainy season". Also,

the results show there is occurrence of floods in some places due to unusual increase of amount of rainy during rainy season.

Findings from the interview with Extension Officer as one of the key informants state that "effects of climate change has caused the problem of food insecurity because food crops are not growing well and this has lowered the production". This is occurring because of rainfall uncertainties and introduction of insects and new weeds that are now favoured with the current climatic condition. All of this has led to the decrease of food production and it is a threat to food security.

The study findings from the questionnaire with smallholder farmers show that there are different effects observed and experienced in their environment that were not happening in the previous years, but are now realized in their respective areas.

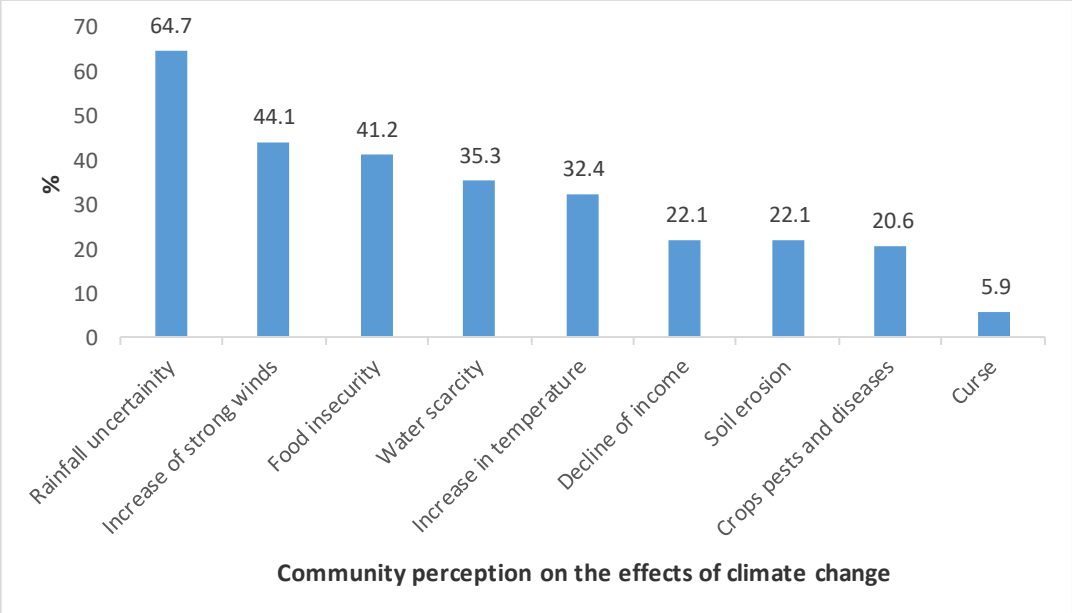

Table 4.5: Community perception on effects of climate change

Source: Field data, 2019

The findings on Table 4.5 show that, there are changes is rainfall regimes as 64.7% of the respondents indicated, increase in strong winds 44.1% of the respondents mentioned that. Food insecurity indicated by 41.2% of the respondents, eruption of pests and diseases including weeds and insects by 20.6% of the respondents, water scarcity indicated by 35.3% of the respondents. However, 32.4% of the respondents

indicated increase in temperature with a prolonged season, 22.1% of the respondent's perceived decline in household income 22.1% of the respondents said climate change has caused soil erosion and 5.9% of the respondents perceived climate change as a curse.

The study show that climate change has negative effects on food security because the effects of climate change has led to the occurrence of weather uncertainties like rainfall uncertainty and temperature changes as well as introduction of weeds, pests and diseases.

The findings indicate that most of the observed effects of climate change are rainfall uncertainty like reduction of amount of rainfall amount, late arrival of rainfall and short rainfall season. Also, there is a threat to food insecurity due to crop failure, increase in farming expenses and spending much on buying food because food crop production is reduced due to climate change effects. Respondents said that "there is food insecurity because there is no enough rainfall to favour good growth of crops". Most of these effects of climate change are likely to affect food production, because small holder farmers depends on rain fed food crop production. Other studies also state that effects of climate changes like changes in rainfall uncertainty may lead to poor yield and crop failure because of delaying in sowing or planting, drought, unexpected increase of rainfall as well as eruption of diseases because of increase of temperature that attract occurrence of some insects and diseases (Singh, *et al.,* 2014).

The findings show that significance changes of rainfall amount and length of rainfall changes is the main climate changes effects observed in Karatu District. These has affected food production because food production practiced by most of smallholder farmers depends on rain fed agriculture. Little amount of rain leads to low production of food because crops are not growing well and sometime leads to premature of crops. The other different studies indicates that decrease in precipitation adversely affects food production and crop failure is possible if severed drought takes place during the reproductive stages, also declining rainfall may be a contributing factor towards declining yields and this may lead to food insecurity (Singh *et al.,* 2014).

Moreover, responses in this study mentioned the problem of water scarcity due to absence of vegetation as a result of land use changes from forests cover to food crop cover, these allows extremely evaporation to take place and destruction of water sources. Also there is low rainfall because of cutting down trees since trees helps formation of rainfall and availability of water.

4.3 Climate Change Effects on Household Food Security

The study intended to collect information on what are the climate change effects on household food security. The study findings from the interview with the key informants and questionnaire with small holder farmers show that there are various climate change effects on household food security. Findings show that effects of climate change on household food security has affected the availability of food in the household's level.

Interview findings with Environmental Officer states that "among the effects of climate change includes introduction of new insects, pests and weeds in the farms that affects food crops production". The insects and weeds had become a great danger to food crops leading to low production and threat to food availability. Environmental Officer further said that "the current weeds called *carrot weed* and insect called *fall armyworm* (FAW) are the trending problems to food crops production in which the small scale farmers are dealing with in the current situation". The presence of these weeds and insects which are now favoured with the current changed climatic condition, affects food crops and leads to low harvest and a threat to food security.

The other effects of climate change to food security, as mentioned by the Environmental Officer state that climate change and food security in the household level has caused other problems like malnutrition, children dropping out of school because there is no food at home. The officer said that "the decrease in food production has caused school dropout because students cannot afford to contribute amount of food needed at school due to the introduced programme of all students having lunch at school'. The study found out that students contributing amount of food to school is a new programme of making students eat lunch at school, to all student as a way of improving teaching and learning process.

The Environmental Officer further said that “climate change effects to food security has caused dropping of household income because of spending much on adaptation measures on the effects of climate change in household level”. Another problem mentioned by the Environmental Officer was breakings of marriage and families because the head of households can no longer provide food for their families, and also sometime it cause quarrels and further sometime head of the household are forced to abandon their families.

On the other side interview findings with one of the key informants, the Extension Officers form Ganako Ward said that “effects of climate change has caused unexpected rainfall patterns particularly from the previous 20 years, for example back to 1999, and in 2000 there was a very low rainfall amount during rainy season”. The officer further said that “there is no longer a definite season for rain onset and mostly it arrives late and sometimes just stops when not expected leaving crops to prematurely dry”. These have caused a decline of food crop production as a result has caused food insecurity because of low food production occurred due to the effects of climate change.

The extension officer also mentioned the introduction of the new insects like FAW which are the great threat to grass plants like maize, as well as several kinds of weeds which are now existing due to the climatic change that favour their presence. Extension Officer, further said “that sometimes there is unexpected increase in rainfall amounts especially staring from 2010 that leads to soil erosion in the farms and washing important minerals for crops growing”. The findings also show that sometime there is late onset of rainfall season like last year 2018 and then it rains a month fully nonstop. These climate change effects has lowered food production according to community perception on climate change effects to household food security.

Study findings from the questionnaire with smallholder farmers perceived that climate change has effect to food security as it caused the decline of food production and has caused a threat to food insecurity in the household level.

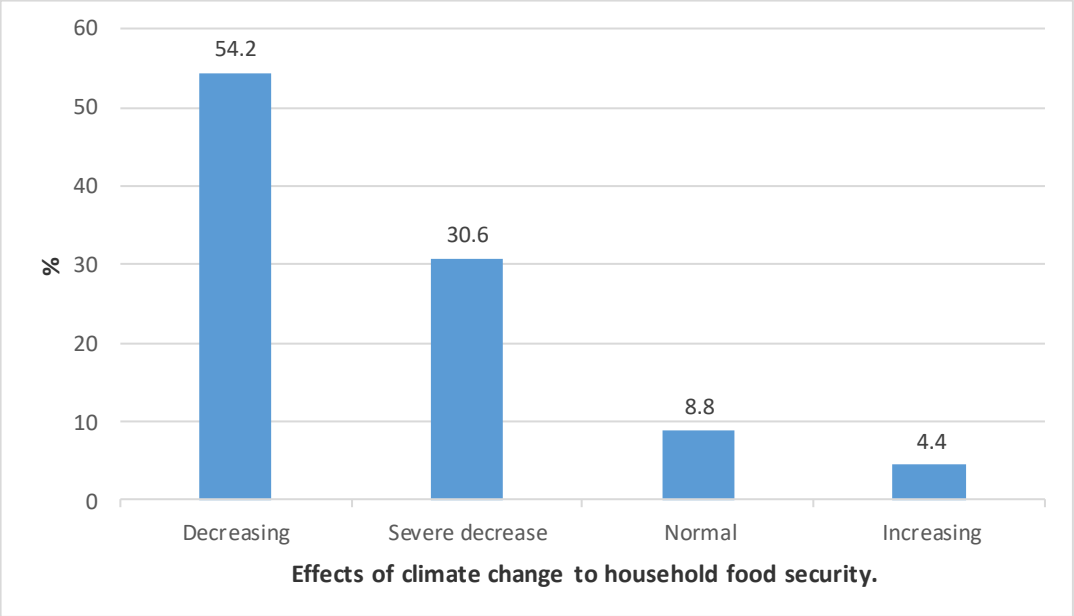

Figure 4.5: Climate change effects on household food security

Source: Field data, 2019

The results in Figure 4.5 show that 54.4% of the respondents perceived that there was a decrease in food availability, 30.6% of the respondents perceived there was severe decrease of food availability, 8.8% of respondents perceived food availability is normal and 6.2% of the respondents said that there is an increase of food security.

The findings show that there is a decrease in food production as perceived by the number of respondents because of weather changes like change in precipitations which involves decrease of rainfall amount with a short length season. Thus, the occurrence of drought conditions has led to the low production of food crops because crops are not growing well. Also, weather changes have caused increase in temperature in which the condition has attracted the introduction of insects like FAW which are dangerous to crops especially grass plants like maize and maize plant is the most grown food crop in this area.

The other respondents said that food production is normal with the increase and decrease tendency depending on the weather condition of the year like the changes in precipitations. Further, other respondents said that food production is increasing because they began to use improved seeds like short-seasons seeds and seeds that resists drought condition. They also said that application of pesticides to kill insects

and diseases that destroy food crops that has erupted due to the effects of climate change, has helped to increase food production and ensure their household food security. Most of the respondents who said there is an increase of food production are those with good farming skills and good economic financials.

4.3.4 Household food security status

Household status of food security was very important information in the study in order to determine if the household has sufficient food and if they were food secure. The food security status of each household lies somewhere along a continuum invaded into four ranges from high food security, marginal food security, low food security, to very low food security (Coleman-Jensen *et al*, 2018).

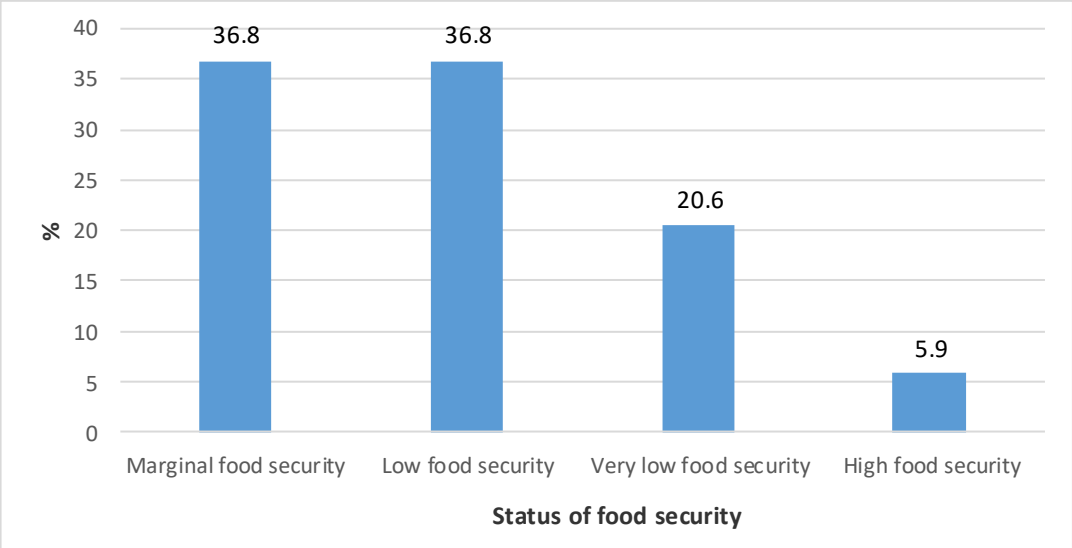

Figure 4.6 Household status of food security

Source: Field data, 2019

Result in Figure 4.6 show that only 36.8% of the respondents had marginal food security, and also 36. 8% of the respondents had low food security, while 20.6% of the respondents had very low food security, and only 5.9% of the respondents have high food security.

Findings on the household status on food security show that most of the household's responses have marginal or low food security as it has indicated by the responses. While there are also many people who are food insecure as indicated by 20.6% of the

respondents that have very low food security, and only few household were high food security. The results of food security status are highly affected with climate changes whereby respondents said that there food production has declined recently due to rainfall uncertainty like decrease of rainfall and late onset of rainfall season. Studies indicates that, households are considered food insecure when at times they were unable to acquire adequate food for one or more household members, couldn't afford to eat balanced diet and fear that they will run out of food because they had insufficient money and other resources for food. (Coleman-Jensen *et al*, 2018).

Respondents said that in previous years there were harvesting enough food for their household for the whole year and still have surplus for sell, this means their economic status was also good too. Nevertheless, production has declined recently because they don't have surplus to sell and still they are required to buy more food because their food production is not enough to feed the family, all due to weather uncertainty particularly rainfall uncertainty. The annual UN report found that climate variability affecting rainfall patterns and agricultural seasons, and climate extremes such as droughts and floods are among the key drivers behind the rise in hunger (WHO, 2018).

4.3.5 Household number of main meals taken per day

The findings found it necessary to study the number of meals taken per day in order to know their food security status. The normal main meal taken per day that ensures there is food security is at least 3 for adults while children, pregnant and lactating women should have more than three meals depending on the age of the child. However adults can also have more than that, but when people cannot take 3 main meals per day because food is not available or cannot afford that is being regarded as food insecurity.

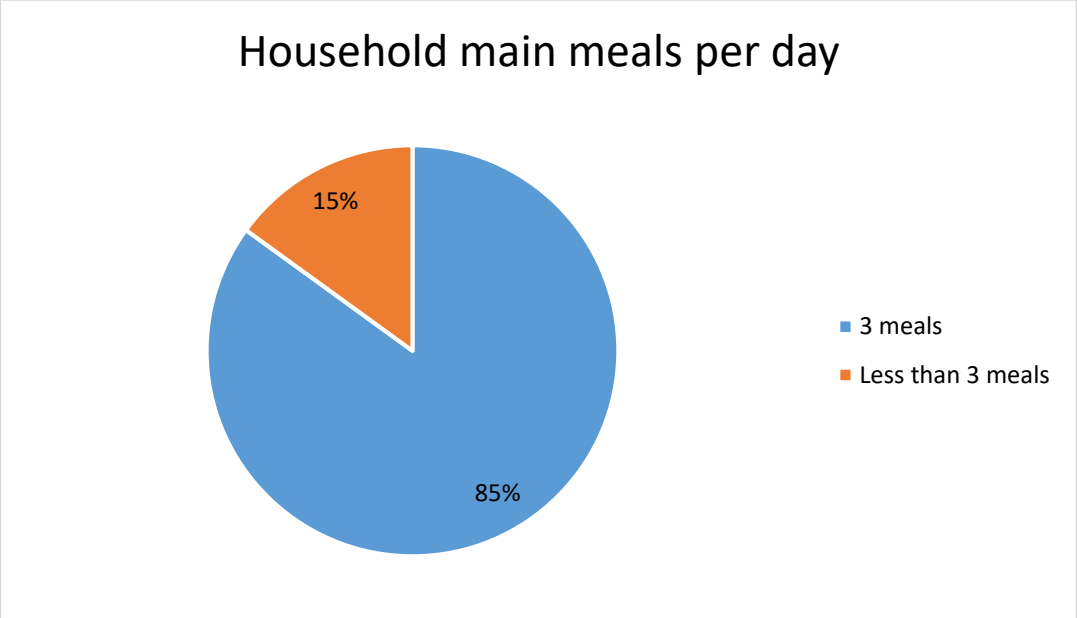

Figure 4.7: Household frequencies of main meals per day.

Source: Field data, 2019

The findings on Figure 4.7 show that 85% of the respondents mentioned that they mostly had 3 main meals per day while 15% of the respondents said that they have less that 3 main meals per day.

The study show that despite the decrease of food crops production but the household level but still 85% household can still afford to have 3 main meals per day. This was possible because of the measures taken to preserve food. Respondents said that they have learned the lesson and experience from the decrease of food availability recently because of the decrease of food production due to the effects of climate change like rainfall uncertainty that affects their yields harvest. Respondents said "that they do good preservation of food so that the little amount produced can last longer at least for the whole year at least up to next harvest season". Respondents also said that they have reduced using food crops for making local breweries as well as they have reduced the tendency of selling food to get money for liquors. Food crops were also used to make local breweries, but due to the decreased harvest household has learnt to preserve food for household food consumption so that they will not experience food shortage.

The respondents said that sometime they are forced to buy food by selling the livestock because household food production has declined. Respondents said that "buying food has affected their household income and if these continue they might not be able to meet their food demands". Their income is declining because of spending much on buying food and agricultural inputs like improved seeds, pesticides and fertilizers to improve their food production in the field.

Other respondents from the study said that, sometimes they are forced to reduce eating their normal food amount or skip meals, and others even said that they are forced to stay hungry because of less food availability or not available at all and the don't have money to buy food. This had occurred due to the effects of climate change that led to the decline of food production.

Previous studies on food security indicates that there is very low food security in households at times during the year, especially during the cultivating season because the amount produced from the previous season is probably already finished or educed due to the decline of food production. Studies indicates that food intake of household members is reduced and their normal eating patterns are disrupted for example the adult had to cut the size of meals or skipped meals, or eaten less than they felt, and also had been hungry but did not eaten the whole day because they could not afford enough food (Coleman-Jensen *et al.,* 2018).

4.4 Adaptation Measures on the Effects of Climate Change

Adaptation measures applied on the effects of climate change was one of the specific objectives of the study. The objective intended to answer the question on the types of measures applied by household as well as government to address the effects of climate change for household food security. It intended to cover adaptation measures applied, its contribution and challenges in the application of those measures applied.

4.4.1 Adaptation measures towards the effects of climate change on household food security

Study shows that there was different adaptation measures applied when answering the question on the adaptation measures on the effects of climate change. The study indicates that different adaptation measures were applied at household levels as well

as by the government. Adapting to climate change means adapting to actual climate to reduce vulnerability to the harmful effects of climate change like food insecurity (NASA, 2019), example by adapting better farming methods with high yield production and less environmental harm.

Findings from interview with Environmental Officer as one of the key informants show that there are several methods applied by the government for the adaptation to climate change and food security. The Officer said “that the steps taken by the government for adaption to climate change effects to household food security, is to advice farmers to consult the professionals example Extension Officers and Environmental Officers”. Consulting Extension Officers will help to obtain knowledge and advice on how to deal with effects of climate change in their farm yields in order to increase household food production.

Other adaption measures taken by the government as provided by Environmental Officer said “that it is to educate farmers on how to deal with climate change effects and to introduce different techniques of dealing with climate change”. This includes guiding farmers to apply good farming methods like use of terraces in the hills to conserve soil water and control soil erosion. The officer also said that other adaptation measures includes to adapt farming methods which also involve livestock keeping so that they can use organic manure from animals, and reduce the use of chemicals like pesticides and industrial fertilizers. However, the Environmental Officer said that “farmers are advised to remove toxic weeds that affect crops like carrot weeds, to use quality seeds that increase production and planting many trees as possible including fruit trees to reduce evaporation and conserve water”. Planting fruit trees helps farmers to get fruit which help to meet their dietary needs, increase food amount and availability as well as to obtain currency through selling fruits that helps to buy food when necessary. Also, another step is to buy quality seeds that increase production and can resist drought condition from the institutions that produce them.

The interview findings with the other key informants the Extension Officers indicate that, the adaptation measures proposed to farmers for climate change and food security includes guiding them to plants crops that matures in a short period of time,

farming without digging deep in the land, and to stop the use of agrochemicals like industrial fertilizers and pesticides and instead they can go back to the traditional methods like use of organic manure. So farmers were advised to adopt type of farming that includes keeping small number of animals that will also be useful in crop farming example use of organic manure from animals and using of cow for cultivation. The Extension Officer said that the "farmers are advised to harvest alternative food crops that can resist drought condition due to the current climate change effects like the decrease of rainfall amount example finger millets, sorghum and sunflowers. Further Extension Officer said that "farmers are advised to plant cover crops that helps to control soil erosion when the amount of rainfall is high and to conserve soil water when there is little rainy with sunny". Examples of cover crops mentioned were pumpkins, cucumber, pigeon peas and other type of beans plants.

Study show that farmers also were educated the importance of preserving food as an adaptation measure, since the productivity has reduced because of climate change effects. The good method of preserving food advised were traditional method that does not involve the use of chemicals. Also, study findings indicates that farmers were advised to take precaution all the time like listening and considering the alerts from Tanzania Meteorological Agency (TMA) and advertisement concerning agriculture and climate change. Different studies show that adaptation of climate changes effects to food security is the appropriate and responsive way for farmers to lower the negative impacts of climate change (Menike and Arachchi, 2016).

The questionnaire with smallholder farmers indicate that there were different adaption measures applied in household level towards the effects of climate change in order to increase their food production to secure their food availability.

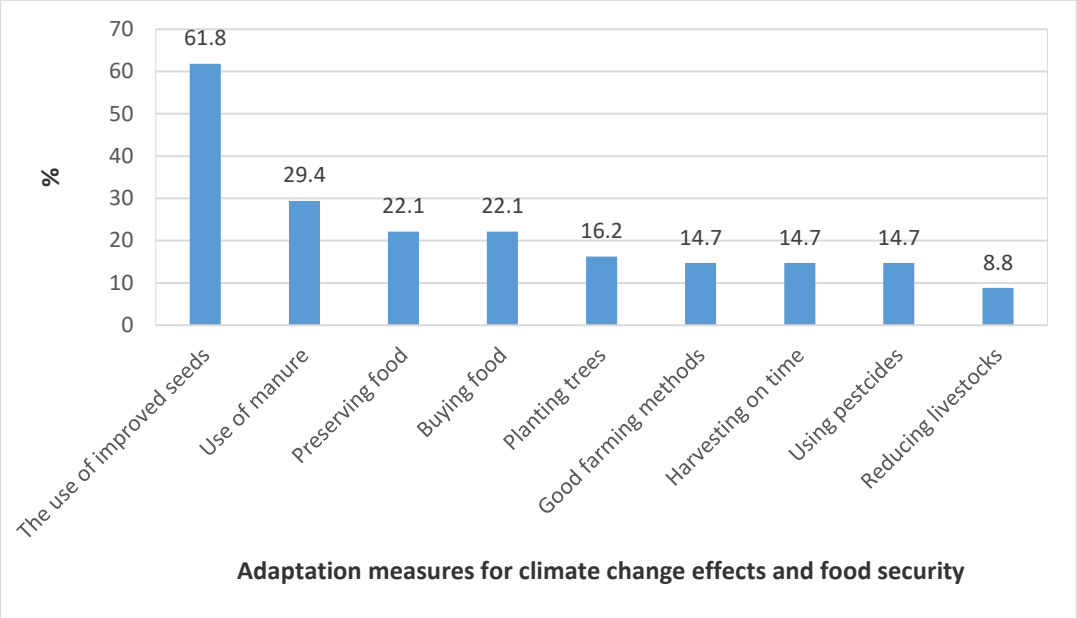

Figure 4.8: Adaptation measures to climate change effects for household food security.

Source: Field data, 2019

The results on Figure 4.8 show that the adaptation method used were the use of improved seeds mentioned by 61.8% of the respondents, use of manure to increase production mentioned by 29.4% of the respondents. Preservation of food was mentioned by 22.1% of the respondents, also other 22.1% of the respondents mentioned buying food as their adaptation method. Planting trees was mentioned by 16.2% of the respondents and 14.7% of the respondents said using pesticides, 14.7% of the respondents said that applying good methods, harvesting on time was mentioned by 14.7% of the respondents and 8.8% of the respondents mentioned reducing the livestock as their adaptation measure.

The results show that most of the respondents mentioned the use of improved seeds as their adaptation measure. Improved seeds helped to increase food crop production because the improved seeds can resist the weather changes like rainfall uncertainties and temperature increase. Planting on time is necessary to comply with the unreliable rainfall. For example improved seeds help to increase produces like short season seeds, planting seeds that are resistant to droughts and changing planting seasons or dates considering the information from TMA about weather information on rainfall

onset. The adaptation measures such as the use of improved crop varieties, planting trees, soil conservation, changing planting dates, and irrigation are the most widely used adaptation strategies where as several socio-economic, environmental and institutional factors and the economic structure are key drivers influencing farmers to choose specific adaptation methods (Menike and Arachchi, 2016).

More adaptation measures mentioned by the respondents include planting fruit trees and trees that consume little amount of water, fruits tress help to get fruits that will help to increase food consumption as well as to meet the dietary needs. Other adaptation measure provided by the respondents were to reduce number of animals because keeping large number of animals leads to land degradation, which destruct presence and good growth of vegetation as well as destruction of arable land for agriculture. Studies show that discouraging keeping large number of animals is good for environmental conservation example through selling livestock (Menike and Arachchi, 2016)

4.4.2 Contribution of adaptation measures towards household food security

The findings show that the contribution of adaptation measures toward the effects of climate change to household food security can be a solution to the increase food production. Respondents perceived that those measures have helped to increase food production although it is not quite impressive because it has not increased in a required amount.

The findings from the interview with one of the key informants, the Environmental Officer state that “application of adaptation measures has helped farmers to apply the best techniques to deal with climate change effects for household food insecurity”. The techniques mentioned include application of improved seeds, preserving food and application of pesticides to kill pests and diseases.

The interview findings with another key informants, the Extension Officer indicated that, adaptation measures has brought awareness to small farmers to use improved seeds and plants that mature within a short period of time due to rainfall uncertainty like decrease in rainfall amount. Other studies indicate that, climate change

adaptation strategies should aim at maintaining, or even increasing, food production (FAO, 2012). This will help to increase production of food crops and ensure food security.

The findings from the questionnaire with smallholder farmers show that application of adaptation measures against the effects of climate change has showed hope to the increase of household food production.

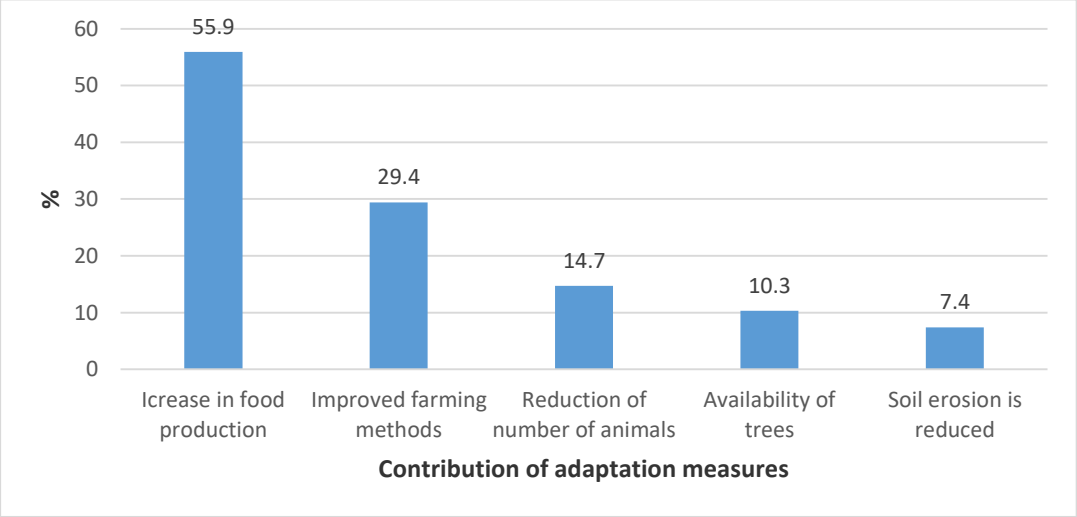

Figure 4.9: Contribution of adaptation measures towards household food security

Source: Field data, 2019

The results in Figure 4.9 show that 55.9% of the respondent thought there is an increase of food production, 29.4% respondents, perceived farming methods has been improved 14.7% of the respondents, perceived that number of animals is reduced 10 3% of the respondents famers said that there is an availability of trees and 7.4% of the respondents thought that soil erosion is reduced.

The findings show that the use of improved seeds, like short season seeds, seeds that resist drought and changing planting time as well as good farming methods perceived as best measures to ensure the increase food production because it has shown some positive results. They also perceived that it's important to use manure and planting grass and trees along the farm and reducing the number of animal keeping because it help to reduce effects of climate change and increase food production. It has been

recognized in different studies that adaptation measures can help to reduce the negative effects of climate change to food security like the use of alternative crops, planting different crops varieties, early warning and use of resistant plant crops (Ochieng and Mathenge, 2016).

4.4.3 Adaptation measures challenges towards household food security

The findings form the study show that there are many adaptation measures applied to improve food production that has been hindered by climate change, and those adaptation measures brought some positive results like increase in food production. However, adaptation measures can incur some challenges in its application. Study findings showed that there were different challenges of application of adaptation measures against effects of climate change towards food security.

The interview findings with the Environmental Officer as one of key informants, indicate that farmers had little awareness on environmental conservation and protection; this is an obstacle in dealing with climate change effects and ensuring food security. The other challenge is hard to convince farmers to adapt good farming methods that are advises by professionals, because they are not ready to change their behaviour from farming methods that are environmental harmful like use of agro chemicals and keeping many animals. Farmers are attached to their farming methods tradition, so it will take time and a lot of efforts to change them to apply modern farming methods that will increase their productivity and ensure food security. For example it is difficult to change them from keeping many animals to few animals as well as adopting good farming methods like the use of good seeds and manure in farming system.

Interview findings with the other key informants the Extension Officer indicate that the challenges of implementing adaptation measures is that the improved seeds are expensive and sometime cannot be affordable to some of the small scale farmers. Also the whole process of farming system is expensive as it involve many things to deal with the effects of climate change in order to harvest the significant amount of food required for household consumption. Environmental Officer said that ‘the District Council sometimes were facing the problem of resources like finance, skills and human resources for proper provision of education of application of adaptation

measures to all farmers'. Other studies also portray that, local government do not always have the information they need to make necessary changes, and also they often lack appropriate decision support tools to present information on a cost-loss level (Mansanet-Bataller, 2010).

There are challenges that are facing application of those adaptation measures as findings from the household questionnaire show.

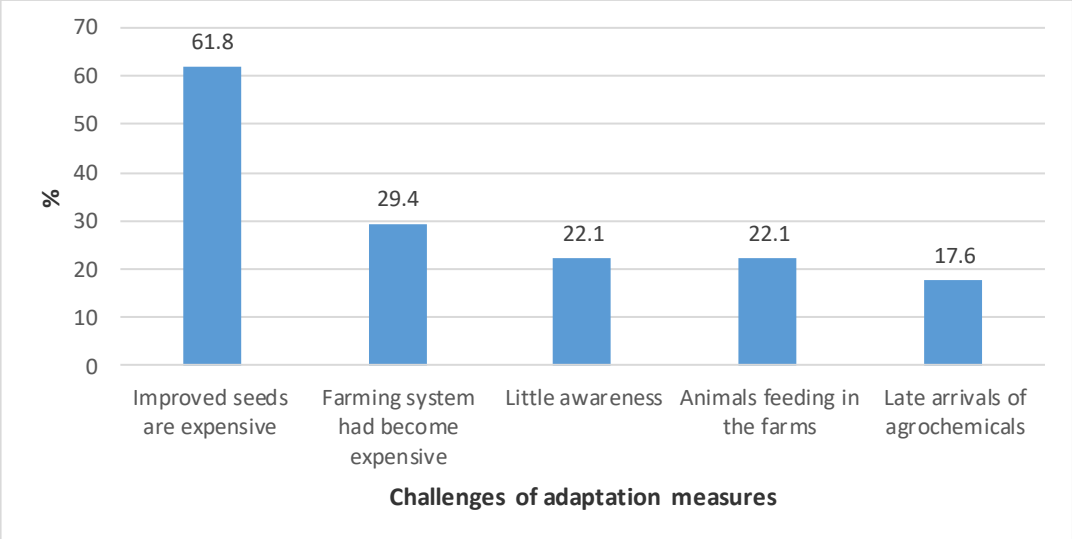

Figure 4.10: Adaptation measures challenges towards household food security
Source: Field data, 2019

The results in Figure 4.10 depict that 61.8% of the respondents said modified seeds are expensive, 29.4% of the respondents perceived that farming system in general has become expensive. Other, 22.1% of the respondents said that there is little awareness and campaign in adaptation measures, 22, 1% of the respondents also said there is an incidences of animals entering to feed on food crops while 14.7% of the respondents said agriculture inputs arrives late in planting season.

Most of the respondents perceived that improved seeds like short season seeds and seeds that resists drought are expensive. Sometime it is difficult for farmers to afford improved seeds and this makes them to fail to apply adaptation measure for climate change effects to household food security. So, adaptation methods sometimes are too expensive because a lot of capital is required for the application of adaptation measures to cope with climate change effects and household food insecurity.

The other adaptation challenges is that agriculture inputs like seeds and fertilizers are not arriving on time during the harvest season, and late planting increase the risk of low production because of rainfall uncertainty like short rainy season that left food crops premature.

However, the increased production is not yet sufficient to ensure household food security because the effects of climate change are still there like change in precipitations and temperature which are the main drivers of decline in food production.

4.4.4 Government strategies towards climate change effects to household food security.

The findings show that there are several strategies taken to address the issue of climate change effects and food security. According to FAO, (2012) the adaptation measures are necessary in limiting the probable risks of climate change recently and in the future, including climate change issues into development policy is a necessary step for sustainable development.

The interview findings with the Environmental Officers as one of key informants state that "among the strategies taken is to provide education to extension officers in each ward and villages, who will help farmers with the necessary assistance needed". The officer said that the farmers are supposed to get advice and education about good farming methods that are profitable without degrading the environments. The government has brought closer availability of improved seeds and pesticides to farmers to their areas like in the wards and village offices and nearby shops. Study found out that providing of seeds closer to farmer was well implemented because seeds were available as it was observed in the village office during the study.

Another strategy taken as provided by Environmental Officer was that teaching farmers the best techniques of increasing their food production while conserving environment and improving health is one of the strategies. For example planting fruit trees to improve their dietary needs while increasing food availability.

The findings from the interview with the Extension Officers as one of the key informants show that "the strategy taken is mostly provision of education and any

necessary help needed by farmers as it was intended by the government". Also, another strategy mentioned by the Extension Officer was to provide recommended quality seeds, and these was observable by the researcher in Rhotia Wards that seeds were available and farmers were seen buying seeds since it was the planting season.

4.5 Mitigation Measures Applied to Reduce the Climate Change Effects

The Findings from the study show that there are different mitigation measures applied to reduce the climate change effects. Mitigation measures include policies concerning energy, transportation, food and agriculture, and land use that will reduce Green House Gases (GHGs) emissions example policies that can promote sustainable practices, enhance food security, promote growth and consumption of fruits and vegetables, and decrease consumption of meat (Levy and Patz, 2018).

The findings from the interview with one of the key informant the Environmental Officer state that "the mitigation measures were applied include provision of campaigns for planting trees at large, introducing and educating farmers to adopt good farming methods that are productive and environmental friendly like the use of organic manure". Environmental Officer also said that "there are programmes that are being introduced like establishment of village forests, and reducing the use of chemicals in crops farming and livestock keeping". Conserving and protecting forests will help to restore rainfall and act as an agent for wind control.

Reducing the use of agrochemicals accentuate to avoid soil degradation and growth of vegetation. Also, the Officer said that there are laws and by laws like laws to regulate protection and conservation of forests and water catchments. Laws help to ensure animals are not grazed in the forests and to discourage the burning and use of charcoal because charcoal burning involves destruction of forests.

The study found that protection of forests is well managed by local government with the support of local community in the particular area. It showed that there are people who were selected by the village council for forest guarding. Findings indicate that there are fines and punishments for those who involves in cutting trees, burning charcoals and selling charcoals when found. All of these regulations were meant to

ensure the mitigation measures introduced are being implemented in order to reduce the effects of climate change as the findings indicate.

The interview with Extension Officer from Ganako Ward as one of key informant's findings show that the mitigation measures for climate change includes planting trees as it was also mentioned by environmental officer. The Extension officer said that "most of the trees were cut down to clear land for agriculture and charcoal burning.

Another mentioned mitigation measure is to discourage overgrazing and the use of disc type of cultivating which is not environmental friendly as it destroys land. Overgrazing destroy land because grazing many animals in one place leads to soil erosion and absence of vegetation while disc type of farming involves digging deep the land which also expose land to the agents of soil erosion like winds and running water. According to FAO (2012), studies depict that agriculture is not only a fundamental human activity at risk from climate change, it is a major driver of environmental and climate change itself. Also, the use of chemicals in agriculture is a major emitter of greenhouse gases through the application of agro chemicals like industrial fertilizers and pesticides. Different mitigation measures for agricultural activities and forest should be taken for environmental protection and conservation.

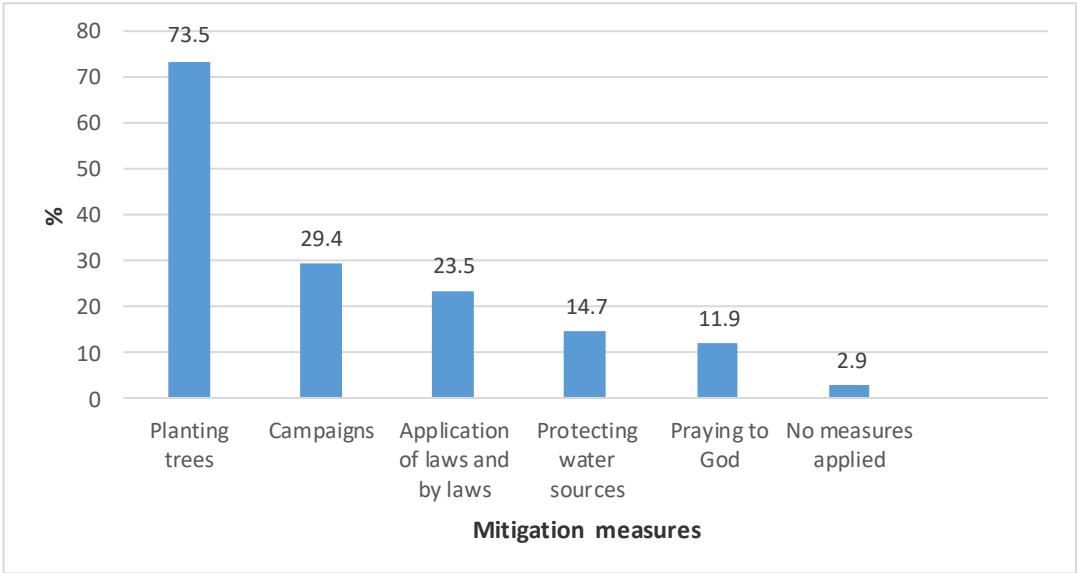

Figure 4.11: Mitigation measures applied to reduce climate change effects

Source: Field Data, 2019

The results in Figure 4.11 show, the methods that are being used to reduce climate change effects include planting trees perceived by 73.5 %, of the respondents, application of laws and by laws mentioned by 23.5% of the respondents, the use of campaigns and provision of education indicated 29.4% of the respondents, 14.7% of the respondent said protecting water sources could be the best mitigation measure, 11.9% of the respondents perceive that praying to God to help to reduce effects of climate change while 2.9% of the respondents said that the is no mitigation measures applied to reduce the effects of climate change.

The findings show that most of the respondents mentioned planting of trees and introducing new forests is the best method to reduce effects of climate change. Most of the communities from different studies their first response to the question of climate change relate climate uncertainties to deforestation (Haque *et al,* 2012). Forests helps to reduce the climatic changes because availability of trees help to regulate weather like attracting rain, reduce strong winds because trees help to control strong winds and also availability of vegetation helps to conserve water catchments, because the covered land helps to reduce the rate of evaporation.

The other mitigation measures mentioned by the respondents were the use of laws and by laws like laws to protect forests, water catchments and discouraging charcoal burning through the introductions of fines and punishments, example of punishments is imprisoning someone who broke the law. According to UNESCO (2014), studies show that different communities in different societies have their own knowledge of dealing with the problems facing the society like climatic issues example for the protection of environment have different techniques like taboos and community by-laws. Indigenous knowledge has been applied for several generations and have provided mostly the positive impact in the environmental protection and conservation.

The respondents from the study also said that provision of education and campaigns is necessary so that people will understand the issue of climate change like what are the causes effects and solutions. Campaigns and education will help the community to understand their role in environmental protections like the importance of protecting and conserving forests and use of good farming methods. To avoid the use

of agro chemicals like industrial fertilizers that contributes to the increase of toxic gases to the atmosphere when evaporation takes place, which leads to global warming and its effects are weather uncertainties. Instead they should use organic manure. Also, education and campaigns will help the community to understand that the provided regulations for environmental management is for the benefit of all and this will help to simplify the implementations of those laws and by laws.

4.5.1 Achievement of mitigation measures to reduce effects of climate change

The result show achievement of the application of mitigation measures is not yet well observable. Mitigation measures like planting trees to reduce climate change effects take time for the positive result to show up. Also, it takes time for people to understand the benefits of environmental management and application of good farming methods although education is provided, it is not easy to observe the achievements of mitigation measures in a short time. The goal of mitigation is to reduce the rate at which greenhouse gases are added to the atmosphere and eventually to bring about a sustainable balance, it helps to reduce the effects of climate change and tackles the causes of climate change (Kabana, 2011).

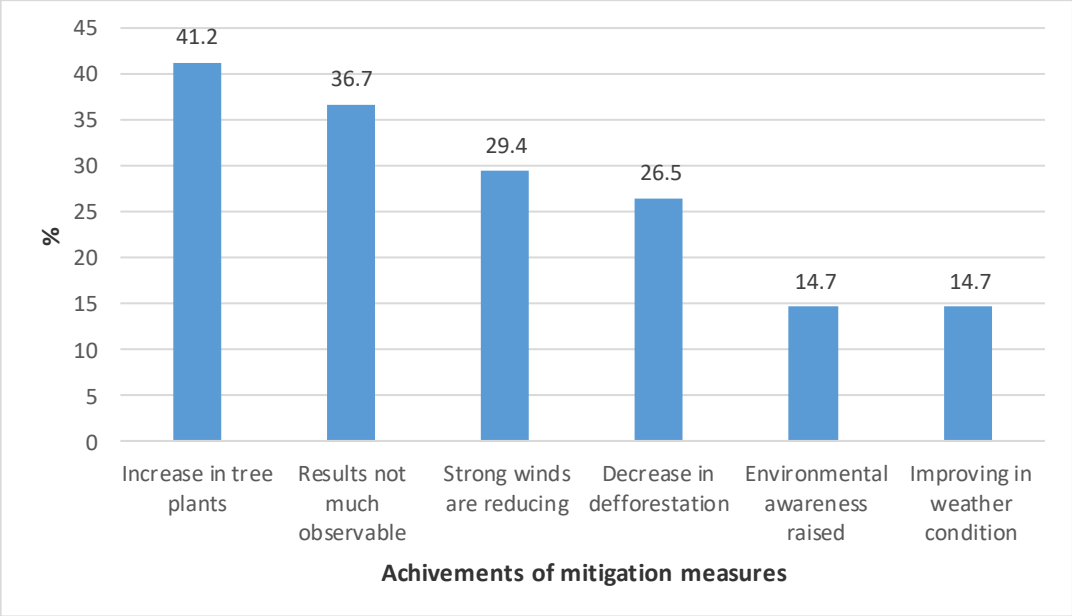

Figure 4.12: Mitigation measures achievements to reduce climate change effects.
Source: Field Data, 2019

The results in Figure 4.12 show that, 41.2% of the respondents believed that there is an increase in trees vegetation, 36.7% of the respondents said that the changes are not yet or much observable. 29.4% of the respondents perceived that increase in trees has helped to reduce and control strong winds movements and 26.5% of the respondents perceived that the rate of deforestation is reducing. However, 14.7% of the respondents said that there is an increase in awareness in the community about environmental protection and conservation, and 14.7% of the respondents too said that weather condition is improving.

The findings show that most of the respondents perceived that growth of vegetation has increased and it has started to be noticeable compared to past few years. This occurred because of afforestation and reforestation efforts made by both the community and the local governments through their campaigns for planting trees and introducing village forests. Other respondents "said that changes due to mitigation measures are not yet much observable and their reason was that the effects of climate change are still there like changes in precipitation'. For example, reduction of rainfall amount with the late onset, increase of temperature and strong winds, while others said that strong winds has reduced since they started planting trees.

More achievements of mitigation measures mentioned were that the rate of deforestation has reduced because of the implementation of laws and by laws for forest conservation and protection, education and campaigns for forest conservation and rise in awareness for environmental protection. Studies show that it is important to protect the forests with afforestation plus awareness and protects all water catchment areas, including the policy framework for discouraging of greenhouse emissions (Kabana, 2011).

Respondents perceived that one of the achievements of mitigation measures is improving in weather condition example the rate of rising temperature and strong winds were someway decreased. Studies show that trees acts as the agent for carbon dioxide absorption so having plenty of them will help to reduce the greenhouse gases and likely its effects (Wright and Boorse, 2017). Also, trees help to balance air quality and help to overcome droughts problems.

The study portrays that the achievements of most of the mitigation measures has been achieved by the help of governments through guidance of Karatu District Council and leaders from ward office in each ward like Extension Officers. Improving institution as well as enhancing coordination and cooperation in governance can help implementation of mitigation options, example through introduction of institutional and legal framework for environmental management (Kabana, 2011).

4.5.3 Challenges facing application of mitigation measures

The study show that there are different challenges that are facing application of mitigation measures due to different factors like cost and motivations. Findings were collected from government officials and questionnaire from small household farmers' perception.

The findings from interview with Environmental Officer as one of key informant state that that "the challenges of mitigation measures includes shortage of human resources who are experts in environmental management". The Officer said that, "shortage of human resource is a problem hindering provision of education to farmers about the climate change and effects to household food security and how to deal with it'.

Another challenge mentioned by the Environmental Officer was financial problems, the Officer, said "there is no enough finance to afford to buy cars to reach to different places easily where service is needed", also financial was said to be a problem problems by the Environmental Officer because the fail to afford to refill petroleum gas and other important tools need for implementation of campaigns to bring awareness about protection and conservation of environment. Different studies show that communities has suggested that for the achievement of application of mitigation measures solution is provision of assistance by external actors particularly financial aid (Walshe et al., 2017).

The interview findings with the Extension Officers among the key informants, state that "people are not aware that most of the environmental destruction and climate change is due to human activities", example the extension officer said that cutting

down off all natural big trees, cultivating in the water sources is done by human as said by extension officer from Ganako, however, the Extension Officer from Rhotia also said that "the challenge to mitigation measure is overgrazing because some of the farmers still keep a large number of animals".

However, perception from smallholder farmers indicate that there are various challenges on application of mitigation measures.

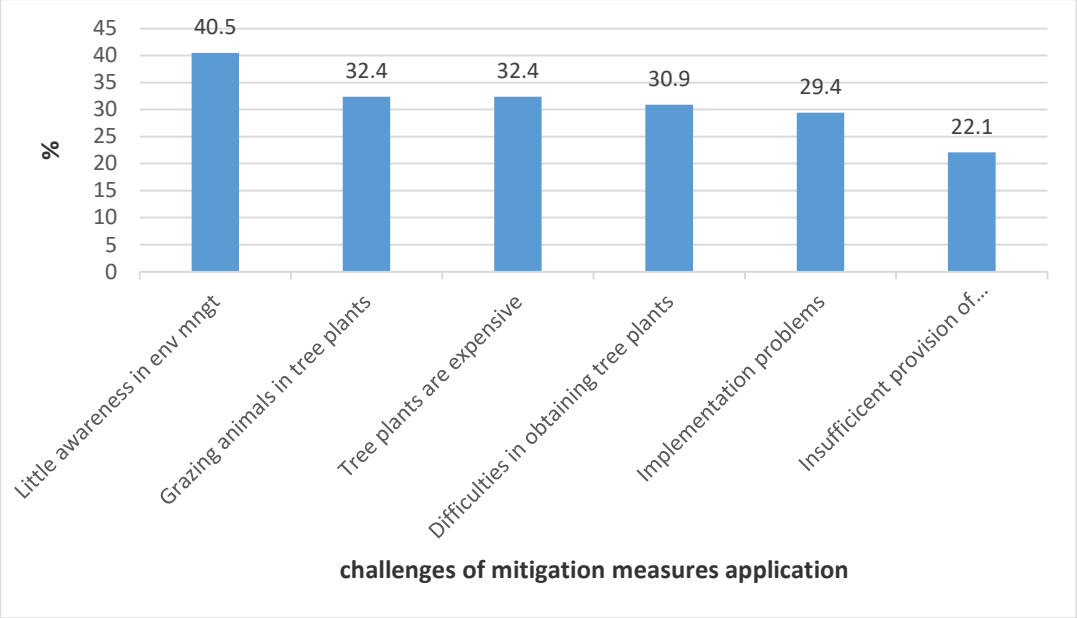

Figure 4.13: Challenges facing application of mitigation measures

Source: Field data, 2019

The results in Figure 4.13 show that challenges for application of mitigation measure include little awareness on environmental protection and conservation perceived by 40.5% of the respondents, 32.4% of the respondent's perceived tree plants are expensive, while other 32.4% of the respondents said that there is a problem of animals to graze on forest and to new planted trees. 30.9% of the respondents said that it is difficult to get the required tree plants and 29.4 % of the respondents said that there are challenges in the implementation of laws and by laws, while 22.1% of the respondents said that there is insufficient provision of education about environmental protection and conservation.

The findings from the study show that the challenges from the application and implementation of mitigation measures includes of insufficient education provisions means that some people are not aware about the best mitigation measures to be applied or the benefits of applying those mitigation measures. This means education and campaign from environmental conservation and protection to reduce the effects of climate change should not stops until all the people are aware about the measures to be taken and their benefits. Further another challenge mentioned was grazing of animals in new tree plants this occurred because the farmers in this area also involve in animal keeping. Findings indicate that sometime animals are grazing in new plant trees because of a little place available to feed their animals since most of the land is covered with crops farms.

The Environmental Officer also said "that there is a problem of increasing of number of people which also require land for their development activities particularly agriculture activities because the increase in agriculture activities requires clearing of land which destroys forests'. Agricultural activities has caused environmental destruction because of the change of land use example from forest cover to food crop cover, and also the use of agro chemicals like industrial fertilizers leads to soil destruction by adding chemicals to the soil.

The other challenges mentioned by the respondents were that tree plants are expensive for some of the community member to purchase in order to implement the campaigns of planting trees. They also said that sometimes it is difficult to obtain the required tree plants whereby the required tree plants are fruit trees and trees that do not consume a lot of water. Required tree plants should resists the drought condition due to the decrease of rainfall recently because of climatic changes that leads to the change in precipitation. The study found out that fruit trees were advised because a part from increasing the number of trees can also help to provide fruits that are important in improving health diet and to ensure food security. Fruit trees helps to raise income and that income can be also used for improving farming methods like buying improved seeds and manure to increase their food production.

Other more challenges is a problem in the implementation of laws and by laws because people continuing to break those laws due to weak supervision little

awareness about their benefits example the respondents said that people are still practising charcoal burning.

4.5.4. Necessity of involving small holder farmers in adaptation and mitigation measures on effects climate change

The information on the necessity of involving community in adaption and mitigation measures on effects of climate change and food security was collected from interview with Karatu District Environmental Officer and Extension Officers from Ganako and Rhotia Wards.

The findings from interview with Environmental Officer show that it is necessary to involve small scale farmers in the process and application of adaptation and mitigation measures on the climate change effects and food security. The Officer said that "it is important to have community perception about adaption and mitigation measures for climate change effects, because climate change is happening within their society and they are the one affected with it". The study conducted by UNESCO, (2014) state that the traditional knowledge is an important element of the community livelihood and that it should remain an important tool for responding to key challenges including climate change. Community perception in climate change is important for them to be aware with it so that they will be able to deal with the changes especially in ensuring their food security.

The Environmental Officer said that, "the community has the traditional methods of dealing with climate changes according to the particular community, example the taboos that involve protection of natural forests and water catchments as well as traditional methods of planting grass surrounding the farm to avoid soil erosion and conserve soil water". Findings from the community in other studies state that external agencies did not effectively incorporate traditional knowledge into climate change trainings (UNESCO, 2014).

The interview findings with the key informants the Extension Officers indicate that "it is necessary to involve community perception on adaptation and mitigation measures process because it brings more co-ordination between government and community, instead of only government doing that'. Extension Officer from Ganako

Ward said that “involving local leaders and elite farmers from the community in adaptation and mitigation is important because they are more familiar to their environment and close to their particular community”. Community adaptation and mitigation measures are perfect to the particular environment and can work out. The Extension Officer said that “the communities has their traditional methods of preserving food without using chemicals as well as protection and conservation of natural vegetation like forests like Taboos’. Findings from the study show that key informants found it necessary to involve community in climate change adaptation and mitigation measures.

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter provides the summary of the findings, conclusion and recommendations of the study and for further studies.

5.1 Summary of Findings

The main objective of this study was to assess community perception on the effects of climate change and household food security in Karatu District. This main objective was accomplished through the four specific objectives which were: first to examine the community perception on climate change effects, second to determine the climate change effects on household food security, third to determine the adaptation measures applied by households towards the effects of climate change and fourth to examine the mitigation measures applied by households in reducing the climate change effects and attain food security.

5.1.1. Community perception on climate change effects

Findings on examining the community perception on climate change effects show that there were different perceptions about climate change. Perception about climate change was that there were climatic changes observed although some respondents said that they were not aware about the issue of climate change. The community perception about climatic changes was changes in precipitation, temperature changes and increase in strong winds. Community perceived that there were observable climatic changes effects, and the most perceived changes occurred is late onset of rainfall season with significance decrease of rainfall amount, short rainy season and sometime unexpected increase of rainy.

Other changes were the increase of strong winds, increase in temperature with prolonged hot season and prolonged cold season. These changes were perceived that had led to the decline of food production and water scarcity. The perception of the community about the causes of climate change mostly was due to human causes as it was perceived by the majority of about 80% of respondents. Few respondents

perceived that climate change is a natural process controlled by God or nature itself it has nothing to do with human and human has no power to control it.

5.1.2. Climate change effects on household food security

The findings on determining the climate change effects on household food security indicate that, climate change has caused food insecurity in their household. Climate change effects resulted in the decline of food crop production due to unreliable rainfall and the introduction of insects, weeds and diseases that affects food crops. Decline of food production has caused food insecurity that forced some household members to reduce their food consumption amount due to the decrease of food availability. Small holder farmers said that the amount of food that is produced has declined so they are required to preserve well the little amount obtained or to buy more food in order to meet their household's food requirements.

Also, this has exacerbated the problems of students' dropouts from school and family quarrels because the head of household cannot afford to feed their families due to food production decline. The households are forced to sell their livestock to buy food, and this on the other side has caused decline of household income because of spending much in buying food and spending on farming expenses like improved seeds, fertilizers and pesticides to increase food production affected by climate changes.

5.1.3. Households adaptation measures towards the effects of climate change

The findings on the adaptation measures applied by households towards the effects of climate change indicate that there were several adaptation measures applied by the farmers. The adaption measures includes the use of improved seeds, use of manure, application of good farming methods, buying food, planting on time, seek advice from extension officer and planting trees. There were also adaption measures advised by the government like keeping few animals that are also beneficial for farming example use of organic manure from animals for crop farming, consulting extension farmers and application of good farming methods like use of cover crop, reducing the use of agro chemicals and use of farm terraces in the hilly farms so as to control and conserve soil moisture. These measures were perceived to help to improve productivity and in some extent increased production of food crops. The challenges

for adaptation measures perceived were difficulties in adapting changes, difficulties to afford improved seeds and little awareness about climate changes.

5.1.4. Mitigation measures applied to reduce climate change effects

The findings show that there were different mitigation measures applied by households to reduce the climate change effects. Results show that the mitigation measures applied was planting trees at large, reducing number of animals, application of good farming methods like reducing the use of chemicals and protecting water sources. Also, findings show that the government has programmes of introducing village's forests and providing education about environmental conservation and protection. These mitigation measures were perceived to help to reduce effects of climate change that affecting food security while managing environment. However, there were challenges mentioned on mitigation measures like tendency of keeping large number of animal's, deforestation, low community awareness on environmental management and difficulties in implementation of mitigation measures.

5.2 Conclusion

Study findings show that climate change effects to food security were observable in Karatu District. The climatic changes effects has caused food insecurity because food crops harvests has declined due to climatic changes effects like rainfall uncertainty and temperature changes which has caused decline in food production.

The perception of different communities about climate change is based on personal factors depending on the interest and interaction with environment. Perception also depends on beliefs, local record of climate changes and experience from the indigenous society through studying the weather patterns. The perception from the community proved that there were different climatic changes observed in Karatu. Community perception on climate change mostly provided was due to different human activities deforestation and the adverse effects of climate change have caused many problems to small holder farmers as perceived by the respondents. The most observed changes were the changes in precipitations, temperature increase and occurrence of strong winds. Therefore, the effect has increased the risks of drought

condition and floods in some areas due to occurrence of unexpected increase of rainfall amount during rainfall season.

The effects of climate change on household food security perceptions of the respondents show that, climatic changes has caused many effects to the production of food crops and it has affected their food security. Climate change effects to food security has caused the decline of food produce as the result show that few number of bags is harvested per hector. This means the amount of food produced is not enough to meet household food requirements so most of the household are food insecure due to the effects of climate changes.

On the other hand, the status of household food security for most of the household is low due to the decline of food production, this means there is risk of food insecurity to most of the households although most of them said that they have adapted measures like food preservation and buying food to meet household food requirements. Respondents perceived that if the situation continue they might be able to afford buying food because of declining food production which also cause the decline of income because of covering effects of climate change to food security.

Different adaptation measures were applied by household towards the effects of climate change to food security by the community of small holder farmers to increase household food production. Most of the adaptation measures were applied in household level example application of improved seeds and application of good farming methods. However, the government through Extension Officers helped to bring awareness to the farmers about the best adaptation measures to be applied by the farmers to increase their food production like the use of improved seeds like short season seeds and can resists drought condition as well as ensuring its availability close to farmers.

The Findings showed that there were different challenges to adaptation measures including financial problems because adaptation measure require finance example buying agricultural inputs like seeds and fertilizers. Perception of local community is very helpful in the development of sustainable adoption policies to assist different communities vulnerable to climate change effects and food security. Thus these

adaptation measures, if well adopted, will help to stabilize the decline of food production and to increase household food security.

Different mitigation measures were applied to reduce the effects of climate change. Among the mitigation measures applied mostly was to planting trees, discouraging cutting of trees and to introduce village forests because availability of vegetation's helps to stabilize weather condition. Trees help rainfall formation, water catchments protection and also help to consume the green houses gases from the atmosphere due to human activities like agriculture.

The application of mitigation measures the government under the environment and agricultural sector has contributed to introduce and implement mitigation measures. For example for environmental protection and conservation like forest conservation and good farming methods was well accomplished through the help of the office of District Council Environmental Officer and Ward offices with the help of Extension Officers. Thus, the government should augment awareness and education on environmental management and ensure implementation of laws and by laws for environmental management to reduce effects of climate change to ensure food household food security.

5.3 Recommendations

5.3.1 Recommendations on the study

To raise awareness about climate change, the government and other stakeholders like NGOs through Environmental Officers and Extension Officers should make efforts to raise awareness and provide education to the community about climate change, because some community members perceived that they are not very aware climate change issues. This can be accomplished through education provision and campaigns on environmental management particularly climate change issues. For example small holder farmers should be facilitated with the techniques that will help them to increase production within the available small piece of land. This means that when farmers think of increasing food production they should think of good techniques for good farming method and not increasing field lands by clearing vegetation, this will help to protect forests and vegetation while ensuring food security.

For climate change effect on household food security, the best recommendations is for the government through environment sector and NGOs dealing with environment related issues, to raise awareness about the necessity of environmental protection and conservation in order to reduce the effects of climate change. The Extension Officers should provide more education about the best mitigation techniques that will increase food production because household food security status is still low as the study indicates.

For the successful application of adaptation measures towards the effects of climate change, the government should reduce the price of improved seeds so that all the farmers can afford in order to raise household food production and ensure food security. The government also should ensure easy accessibility of agriculture inputs like improved seed and fertilizers during planting season so that farmers can plant on time. The government through agriculture sector, should also send professionals to measure the quality of soil so that farmers can decide best type of crop seeds according to the soil type, this will help to raise food crop production.

It is important for different private institution and stakeholders like NGOs to provide education on environmental conservation and protection to different community. These will help community to be able to do adaptation and mitigation and ensure food security. Government also should introduce and implement laws that will help to regulate environmental protection and conservation to reduce effects of climate.

Moreover, government together with the community and other stakeholders like different NGOs should come together to introduce and implements the best farming methods techniques that will ensure food security while managing the environment to reduce effects of climate change. Environmental management and implementation of available regulations for environment; and if well implemented they will help to reduce impacts of climate change and ensure household food security and food security in general.

5.3.2 Recommendations for further studies

Communities have good techniques for climate change adaptation and mitigation measures and that can be included to the national and international plans for

environmental management, and also for policy making and implementation of climate change effects reduction measures and food security insurance. Findings on the study found the necessity for the future studies to focus on community perception and their effective adaptation and mitigation measures that helps to reduce the effects of climate changes. Thus it is important for the government and stakeholders to study community perception on climate change effects, to understand community challenges related to climate effects to household food security, and the findings can be used to improve national policies and legislations related to climate change and food security, like climate change strategy.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Section One: Preliminary Information

1. Name of respondents…….

2. Ward……

3. Village…….

4 .Sex 1.Male 2.Female……..

5. Age of respondents……

6. Education level of the respondents

1. Informal education 2.Adult education 3.Primary education 4.Secondary education 5.Others (specify) ……

7. Please indicate the number of people in your household ……

8. Please indicate your village of origin……..

Section Two: Community Perception on Climate Change Effects.

9. How is your awareness about climate change issues?

1. Quite well 2. Well. 3. Not well 4. I do not know

10. On your perception which are the climatic change in this area (tick where appropriate

Climatic changes perceived	Tick
Increasing of rainy in rainfall season	
Decreasing of rain in rainfall season	
Increasing length of rainfall season	
Decreasing length of rainfall season	
Late arrival of rainfall season	
Early arrival of rainfall season	
Increasing of strong winds	
Increasing of temperature	
Decreasing of temperature	

11. How do you perceive the status of climate change in this area?

1. Normal changes 2. Minor changes 3. High changes 4. Extremely high changes.

12. Mention the most observed changes of climate in this area?.....

13. Please mention the causes of climate change that you know in this area?.....

14. Please mention the effects of climate change in this area……

Section Three: Climate Change Effects on Household Food Security.

15. What is your farm size in hectares?.....

16. How many number of bags produced per each kind of crops? (Specify each).....

17. How does climate change affects food availability in your household?

1. Increasing 2. Normal 3. Decreasing 4. Severe decrease.

18. What is the status of food security in your household?

1. High food security 2. Marginal food security. 3. Low food security 4. Very low food security.

19. How many main meals you take per day in your household? ……..

Section Four: Adaptation Measures Applied By Households on the Effects of Climate Change

20. What are the adaptation measures applied in your household towards the effects of climate change?…….

21. What are the contributions of adaptation measures towards the effects of climate change to food security? …….

22. What are challenges facing application of those adaptation measures? ……
……

Section Five: Mitigation Measures Applied By Households to Reduce the Climate Change Effects

23. What is the mitigation measures applied by your household to reduce the effects of climate change?.....

24. Mention the changes observed due to the application of mitigation measures to reduce effects of climate change?.....

25. What are challenges facing application of those mitigation measures?.....
……

26. Any other opinion or suggestion on this study…….
…….

APPENDIX 2: INTERVIEW GUIDE FOR KEY INFORMANTS.

Section One: Climate Change Perception

1. What is the status of climate change in this area?

2. What are the main causes of climate change in this place?

3. What are the main effects of climate change in this place?

4. Are there any disasters observed in past few years due to climate change effects?

Section Two: Climate Change Effects on Food Security

5. What is the status of food security in this area?

6. How does climate change affects food security

7. What are the strategies taken by government to address the issue of food insecurity caused by the effects of climate change?

Section Three: Adaptation Measures towards the Effects of Climate Change To Food Security

8. What are adaptation measures applied by government to towards the effects of climate change?

9. What are the challenges faced by government and this community to implement the adaptation measure towards the effects of climate change

10. Is it necessary to involve community perception in the process of climate change effects adaptation?

Section Four: Mitigation Measures to Reduce the Effects of Climate Change

11. What are the mitigation measures applied by government to reduce the effects of climate change

12. What are the challenges faced by government and community in the implementation of mitigation measures for climate change.

13. Any other opinion or suggestion on this study.