

# Evaluation on the Impacts of Climate Change Towards Food Security in Moshi Rural, Kilimanjaro, Tanzania

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## Review Article

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## ABSTRACT

This study aimed at evaluation of the impacts of climate change and food security in Moshi rural Kilimanjaro, Tanzania. The cross sectional design used to gather data on relatively large number of people at the same time. For instance, questionnaires data was used obtained from more than ten people. The study respondents were urban farmers, villagers, elders and ward executive officer. Data collected through observations, interviews and questionnaires. A questionnaire was set to a sample of 100 in Moshi rural district. Data summarized, coded and analyzed by using SPSS. Data were presented in different ways including descriptive statistics such as charts, graphs, tables, maps, images and statements. The research design included a cross sectional design that focused on the objectives and the questions of the study.

**Keywords:** Questionnaire; Cross sectional design; Statements; Research design; Food security

## ABBREVIATIONS

FAO: Food Agriculture Organization; URT: United Republic of Tanzania; IPCC: Intergovernmental Panel on Climate Change; AGW: Anthropogenic Global Warming; GCM: General Circulation Model; SAR: Specific Absorption Rate; GDP: Gross Domestic Product; AIACC: American Institute Architects California Council; WEO: Ward Executive Officer; VEO: Village Executive Officer

## INTRODUCTION

### Background of the Research Problem

Globally, it is widely agreed by the global community that the world climate was changing and continue to change at and predicted areas. Climate variability was increasingly becoming a global concern as it possesses a challenge to sustainable live hood, economic development and global security. This concern was based on scientific finding and observational evidence provided in existing United Nations report (IPCC) report on impact of climate variability.

The fourth evaluation report of the Intergovernmental Panel on Climate Change (IPCC) shows an increasing of global average air and ocean temperature leading to wide spread melting of snow and ice as well as rising global average sea level. As a result of global warming the type frequency intensity of extreme events such as a tropical cyclone including hurricanes and typhoons, flood, drought and heavy precipitation events were expected to rise even with relatively small average temperature increase changes in some types of extreme events have already been observed for example, increase in the frequency and intensity of heat waves and heavy precipitation events [1].

The fifth assessment report of intergovernmental panel on climate change indicate the pests and disease adversely affect crop production which is the main live hood activity in Moshi rural district, thereby posing more challenges to food security. Survival skills and coping mechanisms adopted by different societies in Tanzania have been impact of climate change on people, many coping mechanism among farmers includes actions that do not have formal system recognized by the agriculture agencies, such that their implications may have both positive and negative effects on coffee farming [2].

During the volcanic eruption, dust particles as well as sulphur compounds mainly sulphur dioxide are released into the atmosphere and may reach the stratosphere. At regional level, the history of the scientific discovery of climate change began in the early 19<sup>th</sup> century when ice age and other natural change in paleo climate were first suspected and the natural greenhouse effect first identified. In the late 19<sup>th</sup> century scientist first argued that human emissions of greenhouse gases could change the climate. Many other theories of climate change were advanced, involving forces from volcanism to solar variation. Globally rain fed agriculture was practiced in 80% of the total physical agricultural land on which 62% of the world staple food was produced [3].

Africa is one among the most affected part of the world by the climate variability from long term substantial inter annual variability in climate resulting into drought and variability in climate resulting into drought and floods with for reaching impacts such climate change extreme are linked to El Nino and la Nina events melting and retreat of glaciers on East Africa Mountains have severe impacts on environment and human being [4].

Tanzania is experiencing impacts of climate change in her economic sectors such as crop production livestock, hunting fisheries and forest which have been identified as the most vulnerable sectors to climate change especially crop production system. The change to growing season have significant effects on agricultural productivity water supply and food security. Likewise, climate change has serious impact on food production. Moshi rural district was adversely affected by climate variability and climate change particularly felt by poor communities because they depend on coffee as cash crop while was mostly affected by the climate change [5].

In spite of all studies undertaken to evaluate the impacts of climate change and variability towards food security in different areas but the study was not much been conducted in Moshi rural District. Therefore, this study was evaluating the impacts of climate change and variability towards food security in Moshi rural district, Tanzania.

### Statement of the research problem

This study of the research intends to realize the impacts of climate variability toward food security. This is due to the reason that many authors have been concentrating much on the solution which was reducing climate variability. The government of the united republic of Tanzania enacted policies concerning determination of factors responsible for climatic variability in Moshi Municipal which was easy to understand the main causative of the climate variability toward food security. There are few scientists explanation and studies that have been conducted in this rural focusing on understanding socioeconomic vulnerability of climate change affecting less developed countries. Therefore, this study was evaluation the impact of climate variability towards food security. A change of rainfall has been considered to affect agriculture production in many parties of the country. Out of 33 meteorological stations in Tanzania records from 26 stations showed that rainfall decreasing, where as an increasing rainfall trend was observed at station [6].

In spite of all studies undertaken to evaluate the impacts of climate change and variability towards food security in different areas but the study is not much been conducted in Moshi rural district. Therefore, this study was evaluating the impacts of climate change and variability towards food security in Moshi rural district, Tanzania.

### Research objectives

**Main objectives of the research study:** The main objective of the study was to evaluate the impact of climate change and variability on food security in Moshi Rural, Kilimanjaro, Tanzania [7].

#### Specific objectives of the research study:

- To determine the adaptation and coping strategies responsible for climate change and variability in food

security in Moshi Rural, Kilimanjaro, Tanzania.

- To examine public awareness on the impact of climate change and variability in food security in Moshi rural, Kilimanjaro, Tanzania.
- To analyze the impact of climate change and variability in food security in Moshi Rural, Kilimanjaro, Tanzania.

#### Research questions:

The study was guided by the following research questions.

- What is the adaption and coping strategies responsible for climate change and variability in food security in Moshi Rural, Kilimanjaro, Tanzania?
- What are community response toward the impact of climate change and variability in food security in Moshi Rural, Kilimanjaro, Tanzania?
- What is the impact of climate change and variability in food security in Moshi Rural, Kilimanjaro, Tanzania?

#### Significance of the research problem

The study was important as it used the posed recommendation in order to solve the problem of climate variability which impact the food production on the environment, so as the people can harvest more production because of the good climate which was favorable to the production [8].

Through this study the way determined to reduce the challenges impacting climate variability toward food production were used to increase the production in the country so as to overcome the problem of food shortage to the people hence food security in the country [9].

## LITERATURE REVIEW

This section consists of both theoretical and empirical review of the previous studies. The reviews of literature were done for the aim of ascertaining what has been researched by other scholars and identify the knowledge gap which was covered present study. The conceptual framework of this study was also presented in this chapter [10].

#### Definition of the key terms

**Climate change:** Climate change is defined as the changes in long term trends in the average weather such as changes in average rainfall and temperature. Also, the Intergovernmental Panel on Climate Change (IPCC) defines climate change as any changes in climate over time whether due to natural variability or as a result of human activities [11].

**Climate variability:** Refers to change in climate patterns such as rainfall weather and climatic patterns. It is variation around the average climate including seasonal variations in atmosphere and ocean circulation such as the El Nino.

**Food security:** Food security exist when all people at all-time have physical access to enough, safe and nutrition food to meet their dietary needs and food presence for an active and healthy life style [12].

#### Pillars of food security

**Food availability:** Food availability is made up of the element related to production distribution and exchange availability of food refers to the supply of food from production, import or stock at an individual national and global level this dimension relates to the availability of sufficient food that is the ability of the food system to meet food demand. It encompasses the agro climatic fundamentals of crop and pastures production and includes all elements related to production, distribution and exchange of food [13].

Food availability determined by the physical quantities of food that are produced stored, processed distributed and exchanged adequacy was assessed through comparison of availability with the estimated consumption requirement for each food items.

This approach was used in assuring that a country food supply was sufficient. The same approach was also be used to determine the adequacy of a house holds food supply. High markets price if food is usually a reflection of adequate availability [14].

**Food stability:** The second dimension of food stability was determined by the temporal availability of and access to food. It was related to individuals who are at risk of losing temporal or permanently their access to the resources needed to consume adequate food either because they are not capable of withstanding shocks or they lack enough reserves to smooth consumption or both. If projected increase in climate variability materializes, these individuals are likely to succumb to emergency situation for which neither the global food system nor affected local food system are adequately prepared to help [15].

**Food accessibility:** The third dimension was food accessibility which was a measure of the ability to secure food entitlement defined as the set of resources including legal political economic and social that an individual requires so as to securing food. Food access cover access by individual to adequate resources entitlement to acquire appropriate food for a nutritious diet.

**Food utilization:** The fourth dimension was food utilization which encompasses all food safety and quality aspects of nutrition including nutritional values, social values and food safety its sub-dimension are therefore relate to health, including the unitary condition across the entire food chain. According to FAO, it was not enough that someone was getting adequate quantity of food if his body was unable to make use of the food [16].

## METHODOLOGY

### Introduction

This chapter represents research methodology that was used in the study; it comprises the following sub-headings; the research design, research approach, targeted population, sample size, sampling procedures, research instruments, data collection procedures and data analysis procedures.

### Research design

Research design refers to the overall strategy that is chooses to integrate different components of the study in a coherent and logical way, thereby, ensure effectively address the research problem. It constitutes the value blue print for the collection, measurement, and analysis of data [17].

This study employed mixed method techniques where by both qualitative and quantitative research approach were used to establish rain records and temperature in the study area. Qualitative research approach was used to establish community member's responses to climate change and climate variability on coffee farming in the study area. More over the study was employed a case study strategy.

### Description the study area

**Location of the study area:** The study was conducted in Moshi rural district, Kilimanjaro region. The district is one of the seven district of Kilimanjaro region of Tanzania. The district is located between latitude 3°10's and 3°48's; and longitude 37°15'E and 37°36E, To the West, while Mwanga district lies to the southeast of this district. To south is bordered by Rombo district, to north is bordered by Simanjiro district which is in Manyara region. The district covers an area of 1529. Kilometer square and administratively the district are divided into four divisions, 31 wards and 165 villages [18].

**Demographic characteristics:** Moshi rural district has a total population of 466,737. It was revealed that there were 225,767 males and 240,970 females. The population density in the district is estimated to be 305.26 people per km<sup>2</sup>. The population growth rate is estimated to be 1.1% per year with average household size of 4.2. The major ethnic group in the district were Chagga.

**Climate:** Moshi rural district has average daily temperature of 26°C. The highest temperatures occur in the months of February, March, April, September October and November with mean maximum temperatures around 31°C. The lowest temperatures are experienced in June, July, December and January experienced at about 15°C. The mean annual rainfall is 1520 mm. The area is characterized by bimodal rainfall patterns, where short rains fall between November and December particularly in the highlands, while long rains fall between March and May with the peak in April. Temperatures are also moderated by altitude [19].

### Sample and sample size

**Sampling frame:** A sampling frame is the set of the source material from which the sample has to be selected or drawn for research. The sampling frame in this study was involved house hold heads in the selected village from ward; the sample also was involved Village Executive Officers (VEOs) and Ward Executive Officer (WEOs) from selected villages and ward.

**Sample size:** Refers to the number of units for a sample which is usually the first question to be which is usually the first question to be addressed by a study team to the sampling consultant Henry. The sample size is importance. The sampling size is an important feature on any empirical study in which the goal was to make inferences about a population from a sample. The sample size of the household heads in the selected villages, were determined by using the following formula;

$$n = \frac{N}{1 + N(e)^2}$$

Where

N=total population/population size

e=level of precision

n=sample size

The population of two selected wards are 22,904 Uru Kusini and 20291 Kibosho Magharibi people given the house hold ratio as 4.0, the estimation of the household will be shown as follows

Total household=totalpopulation/householdratio

$$= n \frac{N}{1+N(e)^2}$$

Where by

n=sample size

N=total population

e= Percentage of error rate at

$$100-90=10$$

$$\frac{10\%}{100\%} = 0.1$$

$$n = \frac{43195}{1 + 43195(0.1)^2}$$

$$\frac{43195}{1 + 43195 \times 0.01} = 99.7$$

Therefore, the sample size of the study area were 99 respondents (Table 1).

**Table 1.** Overall sample size of the target population in the study area.

S/N	Categories of sample size	Number of sample size	Percentage (%) of sample size	Sampling technique
1	Household/farmers	91	91.00%	Systematic random sampling
2	Ward agricultural extensions officer	3	3%	Purposive sampling
3	Villages executive officer	5	6%	Purposive sampling
Total		99	100%	
<b>Source:</b> Own construction				

**Sampling procedures**

Sampling refers to the process of selecting a number of individuals or objects from a population such that the selected group contains elements that can be found in the entire population. The study also was used both probabilities and non-probability sampling procedures. Purposive sampling technique was used to select participants and to obtain information from the people with position in Moshi rural district. People who were having knowledge and formal opinion on climate change and climate variability responses. Sampling unit for this study were house hold heads that has stayed for at least 10 years in the village such measurement helped to have respondent that have the experience on the climate change in the area for that period. The study was conducted in Uru South ward, the ward selected was providing a possibility to study and compare the strategies on climate change adopted by small holder’s farmers under contrasting on farming system.

**Data collection methods and source data**

This section gives a detailed of various research instruments used to gather research data. Both primary and secondary data were used in this study, primary data were obtained directly from the Moshi rural officials. The purpose of primary data was to get fresh information from the participants which were used to generate new knowledge. These data complemented corresponding secondary data; secondary data were obtained from secondary sources, mainly publication report from Moshi rural offices. The intention of secondary data was supplementary primary information in order to bring meaningful logic [20].

**Method of data collection will be used in this study**

**Primary source**

**Interview Method:** This is the technique of gathering data from human by asking questions and getting them to react verbally. This was important because it was a chance to come into contact with individual to get access fact and opinion directly from the person. The interview was done with environmental committee, leaders, village and elders. This study used interview as a complement of the questionnaire which that show directly the inner feelings of

respondent's concerned with agriculture within the study area. The major aim of interview was to gather information and roles played by community in food security and explore their views and suggestion in climate change and variability on food security.

### **Questionnaire for community members**

In the study semi-structured questionnaire was used in all study villages to collect information at the household level. Questionnaire was used to written down item consist number of questions in a definite order at set of forms to which respondents individually responds in writing orally but recorded by a researcher. Kothari recommend that this method is very useful particularly in case of big enquires involving large number of households. A random sampling was used to select household. A household is defined as an individual or group of people who essentials for living. In this study key issues on climate change were used to answer objectives number one which is concerned with the adaptation and coping strategies for the impact of climate change and variability on food security. Also, the same key issues were used to answer objective two which aimed to a community member to know and understand this issue of climate change on food security. And for the objectives number three, for showing how people perception on the climate change and variability on food security.

### **Direct observation**

The observation method was the process of data collection where the information was sought away by researchers experience without asking from respondents. In this study field observation was carried out in order to determine the effect of climate change and variability on food security. The methods were selected because it gives the researcher to look at what takes place in actual situation rather than rely on second hand information. Observation involved direct observation of different socio-economic activities as well as socio-cultural resources available in the study village. It involves collection of pictorial evidence in farms, houses, water resources, farm implement and infrastructural development using a digital camera.

### **Focus group discussion**

Focus group discussion refers to a group of individuals selected and assembled by researcher to discuss as well as comment from personal experience on this topic to be studied, at each village between 8 and 10 people were selected to form one focus group discussion where by village environmental committee's agriculture and food committee and farmers (small scale) were selected. Discussion was centered on various issues regarding perceived threats of climate change and variability and adaptation strategies employed by farmers to cope with be held with village or community leaders, government officials and key informants. Such data collection methods sought to help acquire adequate, reliable useful and detailed information.

### **Secondary source**

**Documentary review:** The document was ready as are a document of community participation profile, national environmental policy, publication about community approach from relevant ministries as well as various community related.

## **DISCUSSION**

### **Research findings presentation, data analysis**

#### **Introduction**

This chapter provides the research results, presentation, analysis, discussion and interpretation of data obtained from the field on the impacts of climate change and variability in food security. The following research questions are addressed, are there causes of climate change and variability in food security. What is adaptation and coping strategies responsible for climate change and variability on food security? How community response towards the impact of climate changes and variability on food security? The impact of climate change and variability on food security.

The chapter provides profile of respondents, data from questionnaires and field observation, precise interpretation and discussion of findings is made in this chapter.

#### **Demographic characteristics of the respondents**

This section shows the demographic of respondents. These include age, sex, education and marital status. The discussion of each those attributes is presented below Table 2.

The researcher wants to understand the characteristics of respondents in term of sex, marital status and level of education. The respondents were 100 that were used by the researcher in the study to obtain the research data. The data were analyzed in the Table 2 below.

**Table 2.** Shows the demographic characteristics of the respondents.

Demographic information	Status	f	%
Sex	Male	67	67
	Female	33	33
	Total	100	100
Marital status	Married	43	43
	Widow	4	4
	Divorced	1	1
	Single	50	50
	Separated	2	2
	Total	100	100
Education level	None	6	6
	Primary	7	7
	Secondary	23	23
	College	19	19
	University	45	45
	Total	100	100
The samples were 100 participants. F: Frequency and %: percentage			

Data from Table 2 from the field expresses the gender of respondents as follows, male were 67 which make (67%) and female were 33 of respondents which make (33%), marital status of respondents was expressed as follows: Single were 50 which make (50%), married were 43 which make (43%), divorced was 1 which make (1%), widowed were 4 that make (4%). This implies that many of the respondents were single and were male.

Education level of respondents were expressed as follows: Not attended school were 6 which makes (6%), primary level were 7 which make (7%), secondary education were 23 of the respondents that make (23%), college education were 19 that make (19%), university education level were 45 that make (45%). In this study the high numbers of respondent were having university education level which means that were having higher thinking capacity of reasoning. Their level of education affects information accessibility, comprehension and adoption of modern agricultural practices, also well-educated farmers can easily access information from various sources about climate change and variability, create knowledge out of the accessed information and use the various information services for better agricultural practices. Therefore, education level had a positive influence on the productivity to the famers. Likely results were obtained by Nguyen who conducted the study on the role of education show that education have a positive effect on choosing better livelihoods, household income and poverty reduction. They suggest that education has an increasing effect on within level income inequality.

**Socio-economic profile of respondents**

This section shows the demographic and social characteristics of respondents. These include economic activity; sources of income, land owned, the ways acquired the land, and sources of water for irrigation. The discussion of each those attributes is presented in the Table 3 below:

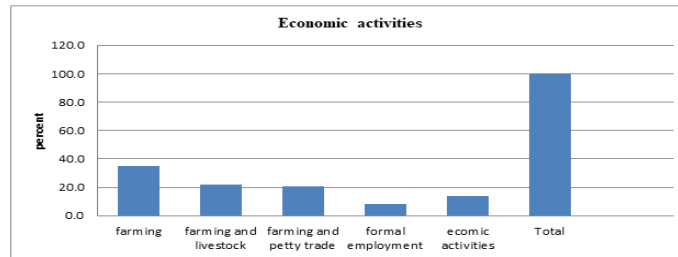
**Table 3.** Show source of income of the respondents.

Source of income	f	%
Sale of crops/vegetable/fruits	42	42
Sale of livestock/milk/eggs	18	18
Pension	4	4
Business/petty trade	36	36
Total	100	100
Source: Field data		

From the Table above, the result show that sale of crops/vegetable/fruits were the major some of income to the respondents at the field area whereby 42 which make (42%) said that their depend on that, on the sale of

livestock/milk/eggs 18 of respondents that make (18%) of the respondents said were depend on that as their source of income, pension 4 of the respondents that make (4%) said pension was their source of income and last one was business/petty trade whereby 36 that make (36%) of the participants depends on that as the source of income. The study noted that majority of respondents the sale of crops/vegetable/fruits were the main source of income in their daily routine, this imply that vegetable or fruits was the business which there have skills and knowledge, this study was similar with Belma who conducted the study on perceived financial needs and subjective financial well-being that were measured by consumer on ability to meet current living expenses in the short term. Also investigate on how income source is related to subjective financial well-being. It was observed that majority of households spends on crops like banana, maize, sorghum and beans some parts of South Nigeria to obtain income and foods from different agricultural activities (Figure 1).

Figure 1. Shows the economic activities of the respondents.

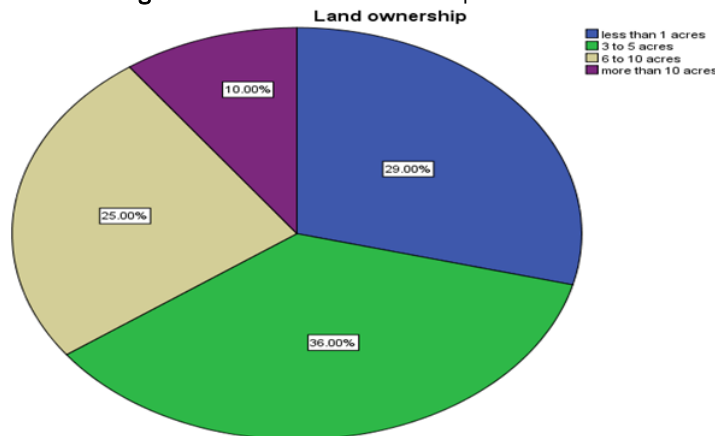


The result Figure 1 above shows that 35 of the participants that make (35%) was economic activities were farming. also 22 of respondents which make (22%) were farming and livestock. Again, 21 of the respondents that make (21%) were farming and petty trade, formal employment were 8 respondents which make (8%) and other economic activities were 14 of the participants which make (14%). The noted that the participants of the given area were practicing farming at large compared to other economic activities. This has connection to the study conducted by Ofuoku, et al., it was noted that most of farmers get their income and all family basic needs through farming activates.

**Land ownership of the respondents**

The researcher wanted to know on the extent on land ownership of the respondents by providing questionnaire to the respondents that shows amount of owning the land in acres and the data were summarized on the Figure 2 below.

Figure 2. Shows the ownerships of land.



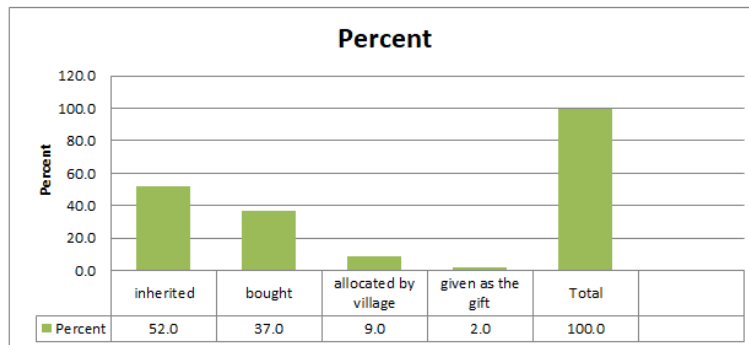
The research in Figure above shows that land ownership less than 1 acre were 29 that make (29%). Again, the respondents that own acres between 3 to 5 acres were 36 that make (36%). Also, the respondents who were own land of 6 to 10 acres were 25 respondents that make (25%). And the respondents that own land more than 10 acres were 10 that make (10%) respondents. The study noted that those farmers were owned more that 3 to 5 acres, this imply that the land owner were those are native at given area, this result is conquered with the chamberlin who conducted the study on inter district variation in farm landholding pattern in Tanzania to determine on how differences in localized farmland structure affect rural household income using nationally representative household panel survey data, small scale farmers operate mostly in rural areas, and are the biggest group in the agricultural sector as a whole and the owner land at big area.

**Acquisition of the land own**

The researcher wanted to understand the ways the respondents acquire the land that they own. The researcher

provide questionnaire to the respondents so to get the information on the ways that they acquire the land. And the data were summarized in the Figure 3 below.

Figure 3. Shows the acquisition of the land own.



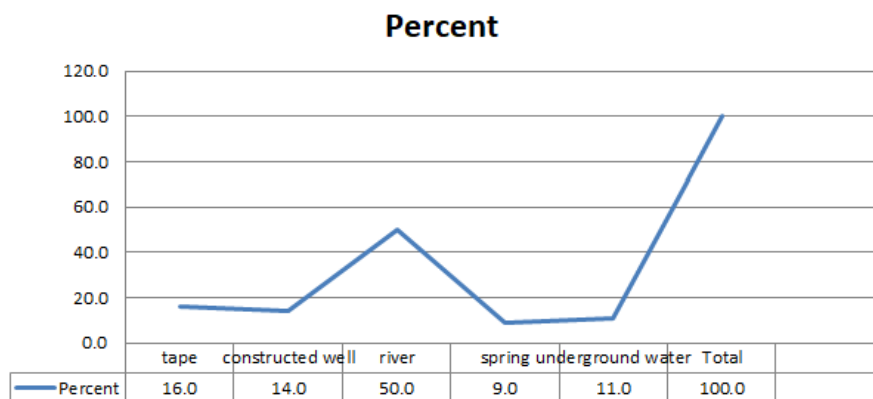
The research findings show that were 52 that make (52%) of the respondents were inherited the land from their relatives. Also 37 of the respondents that make (37%) they bought the land. Again 9 of the respondents that make (9%) were allocated by village and 2 of the respondents which make (2%) were given as gift. The study noted that parent in the study area owned big areas which lead them to give to their children.

However, this study is similar to the study of Devi conducted a study about farmer’s information and requisition needs in rural Manipur, and the results showed that rural communities were getting the land for farms from their parents.

**Sources of water for irrigation**

The researcher wanted to understand the sources of water for irrigation used by the respondents in agricultural activities. The researcher providing the questionnaire to the respondents that shows different sources of water so as to give the information on the sources of water using. The data were summarized in the Figure 4 below.

Figure 4. Shows the major sources of water for irrigation.



Result obtained in the above figure find that, the sources of water for irrigation for tape water were 16 of the respondents that make (16%), constructed well were 14 of the respondents which make (14%). Also, the respondents who were using river as the sources of water were 50 that make (50%), spring was 9 that make (9%) and underground water were 11 of the respondents that make (11%). The study noted that many farmers were obtaining water for irrigation from rivers which found near to their farms. This study conquers with the study of RLD, most of the farmers who doing irrigation were obtaining water from different source that more were getting at rivers this leads to the improvement of agriculture production.

**The factors impeding adaptation to climate change**

The researcher wanted to understand the factors that impeding adaptation to climate change the respondents were supposed to show (SA-Strong Agree, A-Agree, UN-Undecided, SD-Strong Disagree, D-Disagree) on the following statements. The data were summarized in the Table 4 below.

**Table 4.** The factors impeding adaptation to climate change.

Inventories	Strongly agree		Agree		Undecided		Disagree		Strongly disagree	
	f	%	f	%	f	%	f	%	f	%
Inadequate capital and other financial services including credit	48	48	31	31	14	14	3	3	4	4
Inadequate input and veterinary services	23	23	50	50	18	18	8	8	1	1
Inadequate farm implements and other production tools	46	46	33	33	11	11	9	9	1	1
Inadequate man power, sickness and old age	24	24	33	33	26	26	12	12	5	5
Poor knowledge for improving productivity	57	57	19	19	13	13	6	6	5	5
Inadequate formal market	49	49	29	29	11	11	9	9	2	2

The following are the response of respondents regarding the factors impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania. 79 of the respondents which make (79%) were agreed to the inadequate capital and other financial services including credit as the factors that impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania.

Also 73 of the respondents which make (73%) were agreed to inadequate input and veterinary service as the factor that impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania. Also 76 of the respondents that make (79%) of respondents agreed to the inadequate farm implements and other production tools as the factor that impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania. Again 57 of the respondents that (57%) were agreed to the inadequate manpower, sickness and old age as the factors that impeding adaptation to climate change in kibosho Moshi Kilimanjaro Tanzania.

Also 85 which make (85%) also agreed to the poor/inadequate knowledge for improving productivity as the factor that impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania. 78% agreed to the inadequate formal market as the factor that impeding adaptation to climate change in Kibosho Moshi Kilimanjaro Tanzania.

Furthermore, this study is similar with the study of bradshaw. He reported that has implemented local agriculture activities in large place this is because of financial problems but the government must provide big support to their people this it will help to reduce change of crop variety (drought resistance/water logging). And that financial support from the government help to the irrigation shifting to higher ground to avoid floods abandoning most hit areas rainwater harvesting water conservation and reservoir construction. Other are planting trees improving weather forecasts reduce number of livestock selling a side grazing areas and introducing zero grazing reversed by afforestation on the damaged watershed.

**The farm practice they always do as the result of change in weather pattern in order to increase productivity**

The researcher wanted to understand the farm practice they do as the result of change in weather pattern in order to increase productivity. The respondents were required to choose on the way that use to increase in productivity and the data were summarized in Table 5 below.

**Table 5.** Farm practice they always do as the result of change in weather pattern in order to increase productivity.

Farm practices to increase productions	f	%	Total
Use of crop residue/mulching	17	17	17
Chemical weed control	11	11	11
Use of fertilizer	39	39	39
Planting drought tolerant varieties	9	9	9
Improved seed	6	6	6
Irrigation	18	18	18
Total	100		100

The result in Table 5 shows the perceptions of respondents to the change in weather so that to improve their production were 17 of respondents that make (17%) use crop residue as the fertilizer so that to have high yield, 11 that make (11%) were using chemical weed control. Again 39 that make (39%) were using of fertilizer, 9 of the

respondents that make (9%) were using plant drought, also 6 of the respondents that make (6%) were using improved seed and 18 of the respondents that make (18%) using irrigation as the practices so that overcome the change in climate. This implies that respondents were using fertilizer so that to overcome the climate change and this lead to improve in agricultural production.

**Community response toward the impact of climate change and variability**

The researcher wanted to understand the community response towards the impact of climate change and food security in Kibosho Moshi Kilimanjaro Tanzania. The response was summarized in the Table 6 below.

**Table 6.** Community response toward the impact of climate change and variability.

Inventories	Strongly agree		Agree		Undecided		Disagree		Strongly disagree	
	f	%	f	%	f	%	f	%	f	%
Increase in temperature	54	54	35	35	4	4	3	3	4	4
Decrease in rainfall	55	55	28	28	7	7	8	8	2	2
Floods	16	16	44	44	11	11	15	15	14	14
Drought	25	25	31	31	13	13	15	15	15	15
Rainfall variability	48	48	34	34	5	5	8	8	4	4
Late of rainfall	56	56	24	24	8	8	10	10	2	2

The following are the responses of respondents regarding the change on weather patterns that experienced for the past 30 years since 1990 in kibosho Moshi Kilimanjaro Tanzania. 54 of the respondents that make (54%) were agreed to increase in temperature and 83 which make (83%) agreed to decrease in rainfall for 30 years ago in the areas of study.

Again 60 of the participants that make (60%) were agreed to the floods and 56 that make (56%) agreed on drought for 30 years ago, 82 of the participants that make (82%) agreed on rainfall variability for 30 years and 80 of the participants that make (80%) were agreed for the late of rainfall for 30 years in kibosho Moshi Kilimanjaro Tanzania due to the change in weather.

This study was similar with the study of Gregory, et al., said that when peasant disturbed by the increase of temperature in an area the agricultural yields will be negatively changing. Hence the increase of temperature increased the food shortage to households in the study area livelihood and then influenced the people to suffer from food insecurity and instability that in kibosho Moshi Kilimanjaro Tanzania.

**Public awareness on the climate change taking place in the area**

The researcher wanted to know the awareness of the people on the climate taking place in the area of study. The participants were given questioners to fill the part that indicate is correct and the data were summarized in the Table 7 below.

**Table 7.** Public aware on the climate change taking place in the area.

Inventory	Status	f	%
Aware to climate change	Yes	91	91
	No	9	9
	Total	100	100
Sources of information	Own observation	43	43
	Agriculture extension officers	18	18
	Village meeting	9	9
	Mass media	30	30
	Total	100	100
Indicator of climate change	Lengthened growing season	12	12
	Shortened growing season	22	22
	Rainfall coming rate in the season	63	63
	Rainfall coming too early in the season	3	3
	Total	100	100

Effect of rainfall and drought	Yes	91	91
	No	9	9
	Total	100	100

The following are the responses of respondents regarding the climate in their areas. 91 of the respondents that make (91%) they said yes, they are aware with climate change in their place. Again 43 of the respondents that make (43%) they obtain the information of climate change through observation. Also 18 of the respondents make (18%) were obtain the information through agricultural officers were by 9 of the respondents that make (9%) were obtaining the data from village meeting and the last 30 of the respondents that make (30%) obtained the information through mass media.

The respondents observed the climate change through different ways 1 of them that make (12%) observed through lengthened growing season. Again 22 of the respondents that make (22%) through shorten growing season. Also 63 of the respondents that make (63%) observed through rainfall coming to rate in the season, change on weather and finally 3 of the respondents which make (3%) observed through coming early in the season (Figure 5).

Figure 5. Livestock and agricultural activities.



IPCC 2013 tried to show the awareness of the community and about the causes of temperature increase including deforestation, population increase and natural calamities like volcanic eruption. Through observation the study established that the causes of temperature to increase in the study area was deforestation caused by human activities, and these activities especially charcoal burning and firewood collection was caused by lack of modern fuel including natural gases not only availability of alternative sources of energy but also affordability is big problem due to the economic status of the households in the district. Furthermore, according to who presenting that when peasant disturbed by the increase of temperature in an area the agricultural yields will be negatively changing. Hence the increase of temperature increased the food shortage to households in the study area livelihood and then influenced the people to suffer from food insecurity and instability.

**The impact of climate change and variability of food security**

The researcher wanted to know the impact of climate change and variability of food security in Kibosho Moshi Kilimanjaro Tanzania. And the data were summarized in the Table 8 below.

Table 8. The impact of climate change and variability of food security.

Inventory	Strong agree		Agree		Undecided		Disagree		strongly disagree		Total
	f	%	f	%	f	%	f	%	f	%	
Low yield	68	68	23	23	3	3	2	2	4	4	100
Increase risk of food	38	38	48	48	8	8	1	1	5	5	100
Higher risk of water and food borne diseases	21	21	49	49	17	17	9	9	4	4	100
Reduction in pastures, livestock	53	53	36	36	3	3	4	4	4	4	100
Increase in crops pests and disease	40	40	37	37	13	13	3	3	7	7	100

Increase in non-farm and off-farm activities	36	36	43	43	11	11	9	9	1	1	100
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The following are the responses of respondents on the impacts of climate change and variability on food security. Were 91 of the respondents that make (91%) were agreed that there is low yield due to change in climate, also 86 of the respondents that make (86%) of respondents agreed that there is increased risk of food due to climate change in Kibosho. Furthermore, according to Gregory, et al., when peasant disturbed by the increase of temperature in an area the agricultural yields will be negatively changing. Hence the increase of temperature increased the food shortage to households in the study area livelihood and then influenced the people to suffer from food insecurity and instability.

**The incidence of food shortage causes of such shortage and the effect of climate change on food security**

The researcher wants to understand the incidence of food shortage, causes of such shortage and the effect of climate change on food security. The data were summarized in the Table 9 below.

**Table 9.** The incidence of food shortage, causes of such shortage and the effect of climate change on food security.

Statements of incidence of food shortage, causes of such shortage, and effect of climate change on food security		Frequency (f)	Percentage (%)
Shortage of food	Yes	84	84
	No	16	16
	Total	100	100
Causes of such shortage	Crop failure	69	69
	Over population	23	23
	Poor government supply	4	4
	Decrease in supply	4	4
	Total	100	100
Effect of climate change on food security	Damaging crops and persistent low yield	42	42
	Reeducation in pastures, livestock	9	9
	Increase in crops pests and disease	32	32
	Increase in livestock disease	2	2
	Reduction in water resource	15	15
	Total	100	100

The following are the responses of respondents to show that there is incidence of food shortage in their house. 84% said yes there is shortage of food in their home due to climate change and increase in pests and disease in the farm. The respondents observed different causes of that shortage of food in their home, 69 which make (69%) of the respondents said that due to crop failure in the farm that cause shortage of food in their house, 23 that make (23%) of the respondents said that is due to over population, and other 4% is due to poor government supply. In case of effect of climate change on the food security, the respondents noted some indicators on the crops.

Again 42 which make (42%) of the respondents said that damaging crops and persistent low yield also 9 of the respondents which makes (9%) they said that there is reduction in pastures and livestock. This study conquers with the study of TRCNS exposed that the house holds affected by impacts of climate change including drought failed to meet their basic needs especially food which brought the house holds to be in the problem of malnutrition especially dependent population segments that are old people and children.

**CONCLUSION**

The purpose of this study was to identify the impact of climate change and variability in food security in Kibosho Moshi Kilimanjaro Tanzania. All information was treated to examine the adaptation strategies used by farmers in response to the impacts of climate change towards food security in Kibosho Moshi Kilimanjaro Tanzania. Specifically, the study sought to, what is the adaption and coping strategies responsible for climate change and variability in food security in Kibosho ward, what are community response toward the impact of climate change and variability in food security in Kibosho ward, what is the impact of climate change and variability in food security in Kibosho ward which are the research question that have been answered in this study.

The data for this study was collected using questionnaires in which a total of 100 respondents (households) were given questionnaires. Further in-depth interview for key information's was conducted. Data processing and analysis involved checking for completeness of questionnaires, verifying consistency, data coding and entry, computation and

presentation of descriptive statistics.

### Summary of findings

The study found that there were changes in climate which has led to low production, inadequate rainfall and increase in pests in the crops. These changes have affected food crop production leading to decline in production of food in Kibosho Moshi Kilimanjaro Tanzania. The study found that the communities in the study area are highly vulnerable to the effects of climate change on food security. First, this is due to the fact that the local communities highly depend on rain fed agriculture; which is the main economic activity that supports their livelihoods.

The study identified the key impacts of climate change on the livelihood of farmers in Kibosho Moshi Kilimanjaro Tanzania as follows; shortage of food due to crop failure, decrease in income, rise in food prices and emergence of pests and diseases among crops. The identified measures taken by local community included applying fertilizer and animal manure, irrigation, using chemical, requesting for food supply from the government, and livelihood diversification and seeking alternative income generating activities, applying contour farming, using water from the natural environmental.

The study further found that the majority of farmers were facing a lot of challenges in responding to the impacts of climate change and variability towards food security hence realizing very little success in improving food crop production in the study area.

These challenges include; poor capital, pests and diseases, small number of agriculture extension officers, poor technology, poor government support, and negligence of farmers to use major food crops in the study area. The study found that the communities in the study area are highly vulnerable to the effects of climate change on Agriculture.

This rainfall in many times is unreliable and also experiences some persistence drought hence affecting agricultural activities and this forced the farmers to using alternative source of water such as using constructed dams and others like rivers which are found in the areas.

In order to make the adaptation strategies effective in minimizing the impacts of climate change and variability and hence promote food crop production in the study area, the respondents suggested that the following measures should be given priority. This include; providing education and training to the farmers, providing soft loans and credit, promoting reforestation programmer, introducing irrigation projects, supporting farmers to plant drought tolerant crops, constructing food storage facilities, supplying farm equipment and implements like tractors and formulating laws to influence people to conserve their environment to avoid cutting down of trees and burning bushes.

### Areas for further research

This study has managed to identify the following areas for further research;

- Research on the possible alternative income generating activities for the Kibosho ward.
- Sustainable farming methods in the period of climate change and variability.

## REFERENCES

1. Brulle RJ, et al. Sociology and global climate change. *Climate change and society: Sociological perspectives*. Oxford University Press. Newyork. 2015;1:1-31.
2. FAO. Food Security and Nutrition in the age of Climate Change. Food and Agriculture Organization. Rome, United Nations. 2018.
3. Boliko MC. FAO and the situation of food security and nutrition in the world. *J Nut Sci Vitaminol*. 2019;65:4-8.
4. Rowland MJ, et al. Will the sky fall in? Global warming an alternative view. *Antiquity*. 2010;84:1163-1171.
5. Said M, et al. Evidence of climate change impacts on water, food and energy resources around Kilimanjaro, Tanzania. *Reg Environ Change*. 2019;19:2521-34.
6. Mhache EP, et al. The contribution of Indigenous Knowledge Systems (IKS) on food security in Mbokomu ward, Kilimanjaro Region, Tanzania. *Afr J Environ Sci Technol*. 2018;12:96-105.
7. Leyna GH, et al. Food insecurity is associated with food consumption patterns and anthropometric measures but not serum micronutrient levels in adults in rural Tanzania. *Public Health Nutr*. 2010;13:1438-1444.
8. Ojija F, et al. The Impact of climate change on agriculture and health sectors in Tanzania: A review. *Int J Environ Agric Biotech*. 2017;2:238849.
9. Rotich SC, et al. Adaptation to climate change impacts on crop water requirements in Kikafu catchment, Tanzania. *J Water Clim Chang*. 2017;8:274-92.
10. Mushy RB, et al. Adaptation strategies to climate change among smallholder farmers in Moshi rural district, Tanzania. *J Geogr Assoc Tanzania*. 2017;3.
11. Shaffer LJ, et al. Making sense of local climate change in rural Tanzania through knowledge co-production. *J Ethnobiol*. 2014;34:315-334.
12. Craparo AC, et al. *Coffea arabica* yields decline in Tanzania due to climate change: Global implications. *Agric For Meteorol*. 2015;207:1-10.
13. Nkya K, et al. Low cost irrigation technology, in the context of sustainable land management and adaptation to climate change in the Kilimanjaro region. *J Environ Earth Sci*. 2015;5:45-56.

14. Kaganzi KR, et al. Local perceptions of climate change and adaptation responses from two mountain regions in Tanzania. *Land*. 2021;10:999.
15. de Bont C, et al. Neither modern nor traditional: Farmer led irrigation development in Kilimanjaro Region, Tanzania. *World Dev*. 2019;116:15-27.
16. Shabani Y, et al. Perceived effective adaptation strategies against climate change impacts: Perspectives of maize growers in the southern highlands of Tanzania. *Environ Manage*. 2023;71:179-189.
17. Okoko A, et al. The carbon footprints of alternative value chains for biomass energy for cooking in Kenya and Tanzania. *Sustain Energy Technol Assess*. 2017;22:124-133.
18. Said M, et al. Predicting land use/cover changes and its association to agricultural production on the slopes of Mount Kilimanjaro, Tanzania. *Ann GIS*. 2021;27:189-209.
19. Kihila JM, et al. Indigenous coping and adaptation strategies to climate change of local communities in Tanzania: A review. *Clim Dev*. 2018;10:406-416.
20. Elisante F, et al. Enhancing knowledge among smallholders on pollinators and supporting field margins for sustainable food security. *J Rural Stud*. 2019;70:75-86.