IMPACTS OF CLIMATE CHANGE ON CROP PRODUCTION. A CASE STUDY OF TISAI ISLAND, ONGINO SUBCOUNTY, KUMI DISTRICT.

BY

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JULY, 2015.

DECLARATION

I **Akurut Marion**, declare that this dissertation is my original work and has never been presented anywhere for any award in any other university or institution of higher learning.

Signature:.....

Date:17/7/2015.....

APPROVAL

This is to certify that this dissertation entitled **''The Impacts of Climate Change on Crop Production in Tisai Island, Ongino Sub County, Kumi District"** has been done under my supervision and submitted to the Department of Biological and Environmental sciences.

Supervisor:.....EARU EMMANUEL INNOCENT.....

Sign:.....

Date:.....17TH JULY, 2015.....

DEDICATION

This dissertation is dedicated to my beloved parents Mr. Omuron Silver Jovan and Ocepa Hellen, Mr. Omuna Daniel and my siblings for the love and feel of belongingness, the courage they gave to me which has devoted me to the completion of this course.

ACKNOWLEDGMENT.

Without any support from different people, it would be impossible to accomplish this dissertation.

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LIST OF ABBREVIATIONS

CA	Conservation Agriculture
CC	Climate Change
CCS	Carbon Chapter and Storage
CO_2	Carbon dioxide
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics
GEO4	Fourth Global Environment Outlook
GHGs	Greenhouse Gases
IEA	International Energy Agency
IK	Indigenous Knowledge
IPCC	International Panel on Climate Change
Kwh	Kilowatt hour
NAAC	National Agro forestry Agency Center
NAADs	National Agricultural Advisory Services
NEMA	National Environment Management Authority
REN21	Renewable Energy Policy Network for the 21st Century
SLM	Sustainable Land Management
U.S.A	United States of America
UN	United Nations
UNEP	United Nations Environment Program
USFCCC	United States Framework Convention on Climate Change
USGCRP	United States Global Change Research Program
WMO	World Meteorological Organization

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ABSTRACT

Climate change in Tisai Island is one of the constraints on crop production and has become so rapid especially in the last 10 to 20 years. According to this study, climate change refers to the average weather or statistical description of the mean and variability of relevant quantities over a period of time ranging from months to thousands of millions of years (30 years). The main objective of the study was to explore the impacts of climate change on crop productivity in Tisai Island and the specific objectives were; to find out the causes of climate change, to establish the effects of climate change on crop productivity, to identify the measures used in mitigating climate change effects on crop productivity, and to examine the measures used in increasing crop productivity amidst climate change. The sampling methods were random sampling and judgmental sampling and the sample size was 50 respondents. The instruments for data collection were; questionnaires, interview guides and observation which helped in identifying different climate change phenomenon. During the study, the researcher found out that climate change in Tisai Island is caused by many factors like charcoal burning, bush burning, fossil fuel combustion and deforestation. This has led to various effects such as unreliable rainfall, extreme temperatures, increased pests and disease, floods and soil infertility. However, some mitigation measures are being implemented by the government and nongovernmental organizations to curb down the situation and they are; strict laws and policies, public awareness and participation, aforestation and reforestation and public participation. In conclusion, climate change in Tisai Island is caused majorly by deforestation and bush burning and to a small extent caused by fossil fuel combustion resulting to high temperatures, floods, droughts and unreliable rainfall. However these have been mitigated by measures like awareness creation, public participation, laws and policies, afforestation and reafforestation.

The researcher therefore recommends that development projects like rural electrification programmes, modern agricultural programmes should be extended in the area to help in regulating human activities like deforestation, bush burning and charcoal burning. The National Environmental Management Authority (NEMA) together with the government and other organizations should carry out various projects like afforestation and reafforestation and irrigation. Fines and charges should put in place to combat environmental degradation. Public awareness should increased through adverts on radios, posters and carrying out freely attended seminars and also farmers should also be provided with fast maturing crop varieties to increase their yields. Lastly promotion of food security by encouraging people to store food for their families in the granaries.

CHAPTER ONE
INTRODUCTION

1.1 Background to the study.

According to the World Meteorological Organization (WMO, 2011), Climate Change (CC) is defined as the average weather or statistical description of the mean and variability of relevant quantities over a period of time ranging from months to thousands of millions of years (30 years). Intergovernmental Panel on Climate Change Parry (2007c) reported that scientists were more than 90% certain that climate change (global warming) was being caused by Green House Gases (GHGs) produced by human activities. They indicated that during the 21st century, the global surface temperature is likely to further from 2.6^{0}C-4.8^{0}C causing the effects like heat waves, droughts, floods, heavy rainfall and melting of ice due to shifting temperature regimes thus decreasing crop productivity.

Climate Change impacts on crop yields are different in various areas with an increase in some areas and a decrease in others. In the United States of America (U.S.A), the newly revised and updated productivity statistics in 2014 indicated that agricultural output grew at an average annual rate of nearly 1.5% from 1948-2011. Despite technological improvements that increase corn yields in U.S.A, extreme weather events have caused a significant yield reduction in some years, due to changes in temperature, amount of carbon dioxide, frequency and intensity of weather conditions. Meanwhile for some crops like wheat and soybean, the yields could increase by 30% or more under the doubling of carbon dioxide concentrations (Karl, 2009).

In Europe, agriculture has been a down-ward trend (Pennsylvania, 2009) especially in 2005-2010 where the average annual rate of decline in crop production stood at -3.7% with a great loss in Countries such as Czech Republic, Estonia, Hungary, Latvia among others that joined the European Union in 2004 and 2007. In Africa, a large fraction of its crop production

depends directly on rainfall for example, 89% of cereals in Sub-Saharan Africa are rain fed (Cooper *at el.*, 2004) making the climate to be a key driver of food security (Gregory and Jonathan, 2005). In Tanzania, maize production has been the most important agricultural activity and is considered as the main economic driver (Thurlow and Wobst, 2003) including other cereals like rice, sorghum, millet and wheat. The productivity of these cereals was trailing behind changes in climate with 0.7tons/ha and 0.8 t/ha in the period 1965-1970 and 1970-1975 respectively. Over the period 1965 -1970, cereal productivity in Tanzania had been declining at a rate of 6.6% per annum because of unreliable rainfall received, droughts and pests and diseases. However over the time, Tanzania's cereal productivity has been gradually increasing from 0. 8t/ha in the period 1970-1975 to 1.5t/ah in 2000-2005 due to warmer temperatures that promote faster growth of cereals. The average annual percentage growth of the cereals yield for the period 1965-2010 in Tanzania was 1.9% (FAOSTAT, 2014).

In Uganda, historical data from 1965-2010 shows that average cereal productivity has been less than 2t/ha over the whole period. There has been a gradual decrease in cereal productivity for the period between1960-1980's and Uganda has been slowly but consistently increasing its productivity from 1.1t/ha in 1965-1970 to most recent statistics standing at 1.7t/ha by 2005-2010 (FAOSTAT, 2014). The decline in the late 1990's and part of 2000's were attributed to droughts that were experienced in the various parts of the region.

In Kitgum, the short rains of 1997 negatively affected food crops harvested from December-January due to erratic rains during the season with dry weather in some parts and floods in others and severe infestation of cassava mosaic virus and reduced cassava production from 10t/ha to 7t/ha (FAO,1997). In Kumi district, the grain yield per unit area especially millet was low barely 25% (Wasswa and Odelle, 1995) and figures attest to earlier reports of low and declining grains yields in the district (Esele, 1995; Wasswa and Odelle, 1995). This is because of prolonged droughts and unreliable rainfall received which alter the planting season for crops especially millet.

1.2 Statement of the problem

Kumi district was one of the most productive districts in Uganda during the period of the late 1960's and early 1970's. It experienced reliable rainfall which was always received in the period of March to August with fertile soils that supported high crop production. However, from 1975-2008, the district was experiencing a number of droughts and floods believed to have been as a result of deforestation (FAO, 2013). In 1980-2008, the worst droughts were experienced and worst floods in 2007 and this showed undoubtable phenomenon of climate change that has contributed to the reducing crop yields due to unreliable rainfall and increased incidence of pests and diseases. Drought and flood resistant seed varieties, inorganic fertilizers and a forestation are being practiced as a way of mitigating and adapting to climate change. However, these measures seem not to be effective because crop productivity is greatly decreasing annually thus posing a need to carry out this research.

1.3. Objectives

1.3.1. Main objective

To explore the impacts of climate change to crop productivity in Tisai Island, Ongino sub county, Kumi district.

1.3.2. Specific objectives

The specific objectives of the study were;

i) To find out the major causes of climate change.

ii) To establish the effects of climate change on crop productivity.

iii) To identify the methods used in mitigating climate change effects on crop productivity.

iv) To examine the measures used in increasing crop productivity amidst climate change.

1.4. Research questions

i) What are the major causes of climate change in Kumi district?

ii) How does climate change affect crop productivity?

iii) Which measures can be used in mitigating climate change?

iv) In which ways can crop productivity be increased?

1.5. Scope of the study

The study was conducted in Tisai Island, Ongino Sub County, Ongino County in Kumi district. This study covered the causes of climate change, its effects on crop productivity, mitigation measures and ways to increase crop productivity and it was conducted for a period of five months from March to July, 2015.

1.6. Significance of the study

The study might help in bridging the gap in knowledge about the present and future impacts of climate change by the indigenous people through their clan leaders who might teach the youth about the past mitigation practices and adaptation strategies.

Future researchers and students will benefit in a way that this study will serve as a baseline for studying indigenous knowledge (IK) and climate change adaptation measures in various districts within the country.

The local communities will be empowered through innovations that will enable them learn modern adaptation strategies alongside their IK to climate change in order to reduce their vulnerability hence enhancing their cultural resilience and adaptation capacity.

The local governments and development agents will be offered information that will facilitate integration of socio-cultural values in programs and actions to address climate change causes and impacts through mitigation and adaptation measures.

1.7 Definition of the key terms

Climate change

According to Intergovernmental Panel on Climate Change (IPCC, 2013), it refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).

Global warming

It refers to the recent and ongoing rise in global average temperature near the earth's surface.

Weather

A day to day variation in climate parameters for example temperature, rainfall, humidity to mention but a few.

Green House Gases

Any of the various gaseous compounds (such as carbon dioxide, methane among others) that absorb infrared radiations trap and heat in the atmosphere thus warming the earth.

Crop productivity

It refers to the output produced by a given level of input(s) in the agricultural sector of a given economy (Fulginiti and Parrin, 1998) .

Impact

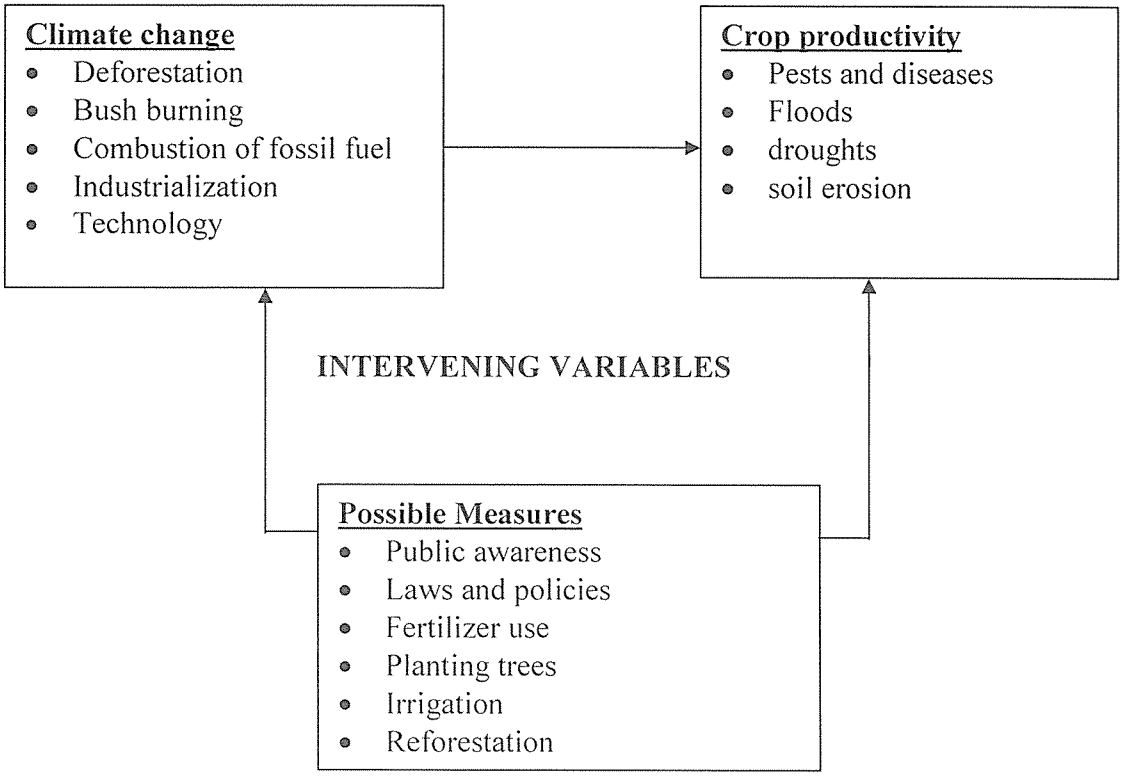
The action of one object forcibly into contact with another.

Mitigation

Action of reducing the severity, seriousness or painfulness of something.

1.8 Conceptual frame work

INDEPENDENT VARIABLE DEPENDENT VARIABLE



Climate change (Independent variable) is caused by different factors such as deforestation for fire wood, timber and land for settlement, bush burning and combustion of fossil fuels like kerosene for lighting, industrialization and technology advancement that increase earth's temperatures. Crop productivity (Dependent variable) is reduced by climate change through floods, droughts, pests and diseases and soil erosion. As a result crop production is affected leading to food shortages in the area.

Therefore, reduced crop productivity becomes visible with effects of malnutrition, diseases like kwashiorkor, and rickets among others due to inadequate food for the population. Some measures (intervening variables) can be put in place to mitigate the effects of climate change like creating awareness on climate change (causes and effects), aforestation, use of organic fertilizers, irrigation, reforestation and law enforcement, among others.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents and reviews secondary data that is related to the causes, effects and methods of mitigating CC effects including the measures used to increase crop productivity.

2.1 Causes of climate change.

Climate change is both as a result of natural and human causes as explained below:

Solar irradiance which is a change in the sun's energy output can cause the climate to change since the sun is the fundamental source of energy that drives our climate system. Studies show that solar variability has played a role in the past climate changes. For example a decrease in solar activity is thought to have triggered the little ice age between approximately 1650 and1850, when Greenland was largely cut off by ice from 1410 to1720's and glaciers advanced in the Alps (Mike, Owens and Jauillard, 2009).

A change in the orientation of the earth's axis is not upright (Laskar and Mayor, 2011). It leans at an angle and this angle changes with time and over about 41000 years it moves from 22.1^0–24.5^0 and back again. When the angle increases the summers become warmer and the winters colder (Kenneth, 1992).

Volcanic eruption which releases large volumes of sulphurdioxide, water vapor, dust and ash into the atmosphere and this have influenced on the atmosphere for years. For example two major volcanic eruptions, Elchichon in 1982 and Pinatubo in Philippine Island in April 1991, pumped sulphurdioxide, water vapor, dust and ash high into the atmosphere where they were converted into tiny particles that lingered for years, reflecting sunlight and blocking the incoming rays of the sun, leading to the cooling and changing of atmospheric circulation patterns (Lean *et al.*, 2005). The drifting of continents for example South Africa and Africa had an impact on climate because it changed the physical features of the landmass, their position and the position of the water bodies. The separation of the landmass changed the

flow of ocean currents and winds which affected the climate. The Himalayan range is rising1mm every year because of the Indian landmass which is moving towards the Asian landmass slowly but steadily (Stampfli and Borel, 2002).

However, according to IPCC (2013), scientists have increased their certainty of human induced warming to 95%. Similarly, IPCC (2007b) Fourth assessment report indicated that the human activities like industrialization, agriculture among others over the past 250 years have warmed our planet. The panel also concluded that there's a better than 90% probability that human produced greenhouse gases for example carbon dioxide, methane and nitrous oxide have caused much of the observed increased earth's temperatures over the past 50 years by absorbing energy from the sun and earth and trapping it near the earth surface (Naomi, 2004b).

The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide from 280parts per million (ppm) to 379ppm in the last 150 years. Carbon dioxide (CO_2) emissions from power plants release enormous amount of CO_2 into the atmosphere. In U.S.A, 40% of CO_2 emissions from the electric utility in industries and 33% from automobiles have increased the amount of gases trapped within the atmosphere from 18-148% resulting to a changing climate (Metz, 2007d).

Deforestation by humans is causing all the necessary functions of forests especially control of climate to be lessened and hence damaging the atmosphere even further (Metz, 2007d). When the forests are cut down not only does carbon absorption cease but also the carbon stored in the trees is released into the atmosphere as CO_2 if burnt or left to decompose (Davidson, 2012). This makes deforestation an important factor in global climate change because the forests store upto100 times more carbon than agricultural field of the same area if not cut (Almeida, 2007). For example deforestation of Amazon forest a tripping point where it starting to die and being turned into savanna or a desert with catastrophic consequences for the world's climate

(Various *at el,* 2001).

In Uganda, deforestation and tree cutting which both affect the carbon stocks is one of the contributing factors to climate change for the past 30years (Majaliwa *et al.*, 2009) and about 25% of Ugandan forests cover was lost between 1990-2005 (NEMA, 2007) because of charcoal burning and firewood (Laurance, 2002).

It is estimated that more than 1.5billion tons of CO_2 are released to the atmosphere due to deforestation, mainly the cutting and of forests every year (Mahmood *et al.*, 2010).

According to IPCC (2007b), agriculture contributes to a quarter ($^1/_4$) emissions of anthropogenic GHGs and by the conversion of non-agricultural lands into agricultural land (Cai, 2012). Agriculture, forestry and land use changes contributed around 20-25% to the global annual emissions in 2010 (Blanco, 2014).

Rising fossil fuel burning and land use changes have emitted and are continuing to emit, increasing quantities of GHGs into the earth's atmosphere. These GHGs include carbon dioxide, methane and nitrogen and rise in these gases has caused a rise in the amount of heat from the sun withheld in the earth's atmosphere, heat that would normally be radiated back into the space. This increase in heat has led to greenhouse effect resulting into climate change (USFCCC, 2006).

2.2 Effects of climate change on crop productivity.

Increased global warming has in turn increased temperatures and as a result, many weeds have thrived under these warmer and wetter conditions. In U.S.A, farmers spend more than 11billion dollars per year to fight weeds (USGCRP, 2009) and the ranges of weeds and pests are likely to expand northwards. This is expected to cause new problems to farmers crops previously unexposed to these species of weeds which will call for increased use of pesticides and fungicides that may negatively affect human health (Rakesh and Kalpana, 2014).

IPCC (2001) stated that, poorer countries would be hardly hit with reductions due to decreased water availability and new or changed insect and pest incidence for example in Africa and Latin America, many rain-fed crops are near their maximum temperature

tolerance so the yields are likely to fall sharply for even a small climate change and this results to a projected falls of 10% in agricultural productivity over the 21st century.

According to USGCRP (2009), more extreme temperatures and precipitation can prevent crops from growing especially floods and droughts which can harm crops and reduce yields. For example in 2008, Mississippi river flooded just before the harvest period for many crops causing an estimated loss of 8 billion dollars for farmers, with droughts becoming a challenge in areas where summer temperatures are projected. In Uganda, Kasese district heavy rains received in 2013 caused the rivers, Nyamwanba, Mobuku and others to burst their banks which led to heavy floods and this destroyed 700 acres of crops mainly for maize, coffee, cassava, groundnuts among others (Thembo, 2013).

Climate change induced by increasing GHGs is likely to affect crops differently from region to region for example average crop yield is expected to drop to 50% in Pakistan (UKMO, 2014) whereas corn production in Europe is expected to grow upto 25% in optimum hydrologic conditions. In the long run, the climatic changes can affect agriculture in several ways that is productivity in terms of quality and quantity of crops through changes of water use (irrigation), herbicides response to CC (Rosenzweig, 2007a).

Periods of drought can have significant agricultural consequences for example subsistence farmers migrating due to drought that leads to dry soils or erosion thus diminished crop growth (Oppenheimer, 2014). In East Africa (EA), recurring droughts have led to desertification which has created grave ecological catestrophies, prompting food shortage in 1984-1985,2006 and 2011 (Mike, 2011). During the 2011 drought, an estimated number of 50,000-150,000 people were reported to have died from EA (Wara, 2011).
In Uganda, the impacts of climate change is mostly impacted on the poorest communities for example Karamoja and the country has registered about seven droughts between 1991-2000 and these affected crop productivity with unprecedented outbreaks of pests and diseases such as coffee wilt disease, banana wilt among others that are likely to be a consequence of climate change (GoU, 2007)

Increasing ocean thermal expansion of the oceans and in combination with melt water from land-based ice cause sea level to rise. Sea levels arose during the 20th century by 0.17metres. By 2100; sea level is expected to rise between 0.18 and 0.59 metres. There are uncertainties in this estimate mostly due to uncertainty about how much water will be lost from ice sheets (Bindoff *et al.*, 2007). For example Greenland is showing rising loss of mass in the recent year (UNEP, 2007) increased melting of sea ice sheets also has the potential to influence global patterns of ocean currents which in turn affects crop production.

2.3 Methods used in mitigating CC effects on crop productivity.

Adoption of Sustainable Land Management (SLM) technologies for example improved crop land management which reduces nitrogen emissions for the soil that presents 2% of agricultural mitigation potential, improved pasture and grazing management, restoration of degraded land and management of organic soils (World Bank, 2006). The potential for mitigation from agriculture by 2030 is estimated to be between 4,500mt CO_2e per year (Caldeira *et al.*, 2004) and 6000mt CO_2e per year (Smith *et al.*, 2014) which can be reached by reducing GHG emissions of which agriculture is an important source, representing 14% of global total.

Carbon Capture and Storage (CCS) is used to capture carbon dioxide from large point sources for example power plants and subsequently storing it a safe way instead of releasing it into the atmosphere. IPCC says CCS could contribute between 10% and 55% of the cumulative worldwide carbon mitigation efforts over the next 90 years (Robinson, 2010). According to Robinson (2010), though it requires up to 40% more energy to run a CCS coal power plant than a regular coal plant, CCS could potentially capture about 90% of all the carbon emitted by the plant. Norway, which was the first to begin storing carbon, its carbon dioxide have been cut by almost a million tons a year or about 3% of the country's 1990 levels (Robinson, 2010) thus reducing a change in climate.

Use of renewable energy flows such as sunlight, wind, tides, geothermal heat among others (IEA, 2002) which are derived from natural processes that replenish constantly. CC concerns and the need to reduce carbon emissions are driving increasing renewable energy industries (UN, 2007). Low carbon renewable energy replaces conventional fossil fuel in three main areas that is power generation, hot water/space heating and transport fuels (REN21, 2010) for example in 2011, the share of renewables in electricity generation worldwide grew was 20.2% with the global share to electricity from hydro power staying roughly constant at 16.3% (REN21, 2013).

IEA (2011) projected that, solar power generators from the atmosphere and wood can be substitute for fossil fuels and carbon intensive may produce most of the world's electricity within 50 years, dramatically reducing harmful GHG emissions (Bensills, 2011).

Pan *et al.*, (2011) stated that reforestation and avoiding potentially reduces CO_2 emissions from the atmosphere by sequestering it in the trees and soils for years or decades. According to him, trees absorb CO_2 from the atmosphere and wood can be substitute for fossil fuels and carbon intensive materials such as cement and steel which reduces the amount of CO_2 in the atmosphere.

In the past decades, the world forests have absorbed as much as 30% of CO_2 per year and this is contributed much unharvested forests (Luyssaert., 2008).

Jacobson and Delucchi (2009), suggested that the cost to generate and transmit power in 2020 will be less than 4 cent per Kilowatt hour (Kwh) for wind, about 4 cents for wave and hydroelectricity, from 4-7 cents per Kwh for geothermal and 8 cents per Kwh solar, fossil and nuclear power. These subsidies will greatly contribute to climate change mitigation.

Energy efficiency and conservation which aims at reducing amount of energy required to provide products and services for example insulating a home allows a building to use less heating and cooling energy to achieve and maintain comfortable temperature for example the use of compact fluorescent lights that use $^2/_3$ less energy and may cost 6-10 time longer than incandescent lights (Diesendorf, 2007 and Levine *et al.*, 2007). Other methods like setting up of mitigation policies can substantially reduce the risks associated with human induced

global warming (Oppenheimer *et al.*, 2014), global dimming (Boden and Marlandi 2007) to mention but a few.

2.4 Measures used in increasing crop productivity.

The special attempts have been made by the European state government to implement the land reforms legislation forcefully so that the slogan to the tiller's is translated into practice. This is done to enable a tiller have incentive to invest in land and adopt new agricultural techniques.

In west Bengal, land reforms improved agricultural productivity by 28% (Ghatak, Maitreesh and Roy, 2007). Similarly, Mookherjee and Bardhan (2007) used village level land reforms to conclude appositive impact on agricultural productivity.

According to Food and Agricultural Organization (FAO, 2011), integrated management of land and water resources methods enable an integrated and efficient management policy directed towards better utilization of land and water resource. For example, the emergence of herbicide-resistant (HR) genetically engineered crops in 1996 made it possible for the farmers to use a broad-spectrum herbicides (BR), glyphosate in ways that were previously impossible 1996through 2011 for example 0.55 Billion hectares of corn, Soybeans and cotton were grown in U.S.A resulting in an estimate of 94% of soybean, 72% of corn and 96% of cotton harvest after using HR varieties.

According to NAAC (2014), agro forestry contributes to increased crop productivity by restoring the soil fertility for food crops, cleaner water through reduced nutrient and soil runoff countering global warming and the risk of hunger by increasing the number of drought resistant trees and subsequent production of fruits, nuts and edible oils. It also reduces the rate at which crops are hit by sun's rays by shading them (Wojtkowski, 2002).

In the field of Conservation Agriculture (CA), there are many benefits that producers/farmers obtain. For example less erosion possibilities and better water conservation, increase in organic matter, improvement of soil structure and the rooting zone (Kirchmann and Thorvaldsson, 2000).

According to Theodor Friedrich, farmers like CA because it gives them a means of conserving, improving and making more efficient use of their natural resources (FAO, 2006).It also turns the products from the wastes to valuable plant nutrients for plant growth thus improving yields (Kirchmann and Thorvaldsson, 2000).

Walter at el., (2005) stated that rain harvesting in agriculture has demonstrated the potential of doubling food production by 100% compared to 10% increase from irrigation. Rain fed agriculture is practiced on 80% of the world's agricultural land area and generates 65-70% of the world's staple foods for instance in Africa, more than 95% of the farm land is rain fed, almost 90% in Latin America (GEO4, 2007) because retaining landscape water flows, increased rainfall infiltration, decreased soil erosion, surface runoffs and incidence of flooding thus high chances of increased crop productivity.

CHAPTER THREE
MATERIALS AND METHODS

3.0 Introduction

This chapter elaborates the materials and methods that were used to collect data, research design, sampling methods among others. It also gives the description of the study area in terms of location, economic activity, population and others.

3.1 Description of the study area

Location

Tisai Island is found in Ongino Sub-county, Kumi district which is located approximately 65Km by road Northwest of Mbale on the highway between Mbale and Soroti, 54Km from Soroti and about 305Km from Kampala and lies approximately between $1^0 10'$ North and $1^0 35'$ North and longitude $33^0 30'$ East and $34^0 20'$ East.

The district is bordered by Katakwi district on the North, Nakapiripirit to the Northeast, Bukedea to the East, Paliisa to the South and Ngora district to the West. The district covers a land area of about 414.9 square miles (sq mi) that is approximately 1,074.6Km^2 of land and the main language spoken is Ateso.

Climate and vegetation

The district is characterized by savannah grassland with poor tree cover mainly as a result of indiscriminate cutting of trees which makes biomass cover very low.

The district climate is the modified equatorial type. The rainfall pattern in the district is bi-modal with peaks in April-May and July-August. The annual mean temperature is 24^0C and rainfall is 800-1000mm.

Economic activity

Subsistence agriculture is the main economic activity in the district and the crops grown are millet, cassava, peas, groundnuts (g/nuts), maize, rice, beans, tomatoes, sweet potatoes, cotton sunflower citrus and mangoes. The produce is consumed locally and some are sold in Kumi town.

Water bodies

The main water bodies in the district include lakes, streams, rivers, wetlands and water sources underground.

Population

The National Census in 2002 estimated the population of the district at about 8,800persons constituting 1.1% of the total country population. UBOS (2010) estimated the population at about 12,500persons and in 2011, it was estimated at about 13,000persons.

Soils

More than a half (½) of the district soils are sandy posing a great risk of leaching and soil erosion especially when poor cultivation methods are used. The sandy soils also have a low water retention capacity than clay soils which makes the nutrients to be easily lost thus making it infertile.

3.2 Research Design

The study used both quantitative and qualitative research designs. Qualitative design was used through asking questions and getting feedback which was recorded and presented in a narrative form.

Quantitative design was used to reveal the numerical form of data such as statistics, percentages and so forth. It was used to quantify the size, distribution and association of variables.

3.3 Target population

The target populations was basically local farmers, NGOs and the concerned authorities like National Agricultural Advisory Services (NAADs), environmental officers, local authorities for example local council chairpersons (1, 2 and 3) and elderly persons or opinion leaders.

3.4 Sampling design

Sample size

The total sample size of the study was 50 respondents. It comprised of 45 farmers who carried out agriculture in the area and three local chairpersons and two opinion leaders, who

gave information on the past crop productivity and the rate at which climate change was affecting crop productivity in the area.

Sampling method

I used simple random sampling method and this gave each farmer an equal chance of being chosen in the sample whereby small papers were shuffled and given identification inform of codes or letters hence those who picked them were included in the study.

Judgmental sampling which is a non-random sampling method was used to select a few individuals like local leaders, environmental officers and agricultural officers in the area and elders who gave data in relation to the past conditions and the present. This provided the necessary information from various persons about climate change in Tisai Island.

3.5 Sources of Data

The source of data of this study was both primary and secondary data through observation, questionnaires and interviewing.

3.5.1 Primary data

This involved collection of first hand data from respondents living in the designated research area through questionnaires and interview guide.

3.5.2 Secondary Data

The secondary data was acquired from reports, which had been compiled by field researchers, internet, text books, magazines and newspapers that concerns effects of climate change on crop productivity.

3.6 Data Collection Methods

In order to address the objectives of this research, the researcher used the following instruments which assisted in gathering and collection of data.

Questionnaires

Questionnaires were issued to the selected respondents, which were made up of open and closed ended questions. The questionnaires were self-administered amongst the respondents in order to collect all the complete responses including confidential information within a

short time since clarity to questions was given on the spot. For those who could not read and write, I administered the questionnaires personally by asking them questions as I recorded their responses.

Interviews

This was used on different lead farmers, environmental officer, local leaders and opinion leaders of the area who did not need questionnaires but just an interaction with the researcher through interviews. The researcher conducted personal interviews by asking them questions as I recorded their responses with the help of community leaders who administered to the key informants. They involved leaders themselves, environmental officers and other responsible people as far as climate change is concerned, to get the different views from a variety of personalities.

Observation

This involved seeing different climate change concerns in relation to the problem of study. The researcher was much interested in what was exactly happening on the ground in terms of climate change and crop productivity.

3.7 Validity and Reliability

The interview instrument and questionnaire were cross examined for approval by the research expert, to ensure that the information they generated was appropriate and consistent.

3.8 Ethical Consideration

I got an introduction letter from the School of Engineering and Applied Sciences (SEAS) from Kampala International University to introduce me to the area authorities like local council leaders. This involved seeking permission by the researcher from the senior leaders of the study area. This was important for protection from the respondents' harm or harassment and to gain the confidentiality in the sensitive information given by the respondents and their superiors.

3.9 Data Analysis and Presentation

Data was analyzed and presented with the use of tables, and percentage scores basically showing Potential themes, categories and patterns that were closely examined to see how they actually emerged from the data in relation to the objectives of the study.

3.10 Limitations in the Study

In the course of carrying out this study, the researcher faced several constraints, which in one way or the other limited the findings of the research and they included;

Time limitations and scheduling problems which affected the researcher's ability to gather information since all respondents had responsibilities like cultivation. So it was hard to make appropriate schedules for proper information gathering.

Limited financial resources were also a challenge in terms of accommodation and food. Some people expected some money before releasing any information because some of them were used to receiving money from other organizations before releasing the required information.

Sabotage was experienced from the people who had encroached on different environmental resources like wetlands and forests. Most of the people deliberately refused to give reliable information because of fear of being prosecuted due to carrying out environmental degrading activities.

CHAPTER FOUR

PRESENTATION OF FINDINGS AND DISCUSSION

4.0 Introduction

This chapter comprises the research findings which include among others; the demographic characteristics of the respondents, causes of climate change in Tisai Island, the effects of climate change on crop productivity, methods that are being practiced to mitigate the effects, measures of increasing crop productivity and the relationship between the two variables.

4.1 Demographic characteristics of respondents

Table 1: Demographic characteristics of respondents (N=50)

Demographic characteristics	Frequency	Percentage
Sex		
Male	20	40
Female	30	60
Total	**50**	**100**
Marital status		
Single	32	64
Married	12	24
widowed	3	6
divorced	3	6
Total	**50**	**100**
Age in years		
<15	15	30
16-35	18	36
36-50	12	24
>50	5	10
Total	**50**	**100**
Occupation		
Peasants	21	48
Civil Servants	5	10
Students	24	42
Total	**50**	**100**

Source: primary data, 2015

Table 1 shows that females (60%) were the majority of the population in Tisai Island while males (40%) were the least, an indication that climate change must have increased rapidly

due to high fertility rate among women which has increased the population of the area hence environmental degradation .

The singles were (64%) as the majority working for their own interests but not for their families. This is very dangerous in environmental management in that such people have short term plans for themselves and could carry out activities like charcoal burning and bricklaying to earn them a living. However, some of those who are single had families in need back in their villages that forced them to work in order to provide for basic needs of their families since they are believed to be energetic than the rest of the family members.

The married were 24% who are the long term planners. These people are also forced to work tirelessly without control for their families which degrades the environment.

The divorced (6%) and widowed (6%) were the smallest percentage in the area due to polygamous marriages where the men have more than one wife, women were left because of inadequate support from men who were not able to provide basic needs hence making women to sneak out to other men leading to easy spread of diseases like Human Immune Deficiency Virus (HIV), Sexually Transmitted Infections (STIs) which killed many and some were divorced on noticing or realizing that one of the partner is infected. Polygamous families require extra land for constructing houses and carrying out agriculture leading to deforestation

In terms of age, the youth (66%) were the majority of the population, who are energetic enough because they are still young to do heavy activities like cutting down trees while the adults were (24%) between 36-50 years who have families in need and are forced to work extensively by spending a lot of time deforesting and burning charcoal that they would sell to maintain their families. The elders (10%) who in most cases stay at home are not strong enough were the least indicating that the life expectancy has reduced because environmental degradation has detrimental effects to human health like respiratory diseases as a result of pollution since the carbon sinks have been reduced leading to loss of lives thus very few people now reach to the elderly stage.

The highest population in Tisai Island was peasants (48%), an indicator that most people are involved in exploiting and selling of environmental resources like timber, clay products like bricks and over utilization and pollution of water bodies like Lake Bisina.

Students in schools were 42% who generate wastes but do not mind about managing them because they take it as some other people's concern. Students in this case are regarded as one of the most environmental enemies through the great human wastes generated; air pollution through cooking for them that claims much firewood and also construction of shanty structures.

The civil servants (10%) who have other sources of income (salary) are indirectly involved in environmental degradation since they are the one who buy the charcoal from the local people hence encouraging deforestation even through purchasing poles for house construction and fencing.

4.2 Causes of climate change in Tisai Island

4.2.1 Residence of respondents

Table 2: Area of residence of respondents

Status	Frequency	Frequency
Within Tisai Island	40	80
Outside Tisai Island	10	20
Total	**50**	**100**

Source: primary data, 2015

Most of the respondents (80%) are permanent residents in Tisai Island where as only 20% are temporal in that they leave for their homes outside the Island at night. The permanent residents that have the right of occupancy of the land and they feel that they have the entire mandate to degrade the environment especially by cutting down trees hence promoting climate change in the area to a greater extent as compared to the temporal residents who do not own land and therefore first have to seek permission to carry any activity in the area/ land from the land owners.

4.2.2 The major economic activities in the area.

Table 3: The major economic activities in the area.

Activity	Frequency	Percentage
Crop production	20	40
Charcoal burning	25	50
Fishing	3	6
Business	2	4
Total	**50**	**100**

Source: primary data, 2015

Table 3 shows that in Tisai Island, charcoal burning (50%) is most practiced by jobless youths, family heads and less educated people which is sold to the nearby towns to cater for their family's basic needs such as education, food, health care and clothes. Some people (40%) do crop production during the wet seasons in their land for subsistence use while fishing (6%) is practiced in Lake Bisina by unemployed youths for food and some for sale in order to get other basic necessities like clothing and medical care and (4%) do business that is operating retail shops and other small scale businesses such as selling fire wood, fish and others.

4.3 Causes of Climate Change

Table 4: Causes of Climate Change

Cause	Frequency	Percentage
Deforestation	25	50
Bush burning	16	32
Fossil fuels	09	18
Total	50	100

Source: primary data, 2015

Table 4 Shows that bush burning (32 %) is the major cause of climate change in Tisai Island and this is because most residents clear their fields on the onset of rains by burning the vegetation and also as a means to regenerate fresh pastures during the dry season for their livestock.

Deforestation (50%) has caused the number of trees available to absorb carbon dioxide through photosynthesis to be greatly reduced because these trees are demanded for charcoal burning, lumbering and need to create land for agriculture.

Fossil fuels (18%) combustion mostly at homes where kerosene is used for lighting and a few for cooking and also from vehicles is another cause of climate change in the area since it is relatively a cheaper source of energy as compared to other sources like solar energy and electricity.

4.3.1 Sources of energy.

Table 5. Sources of energy.

Source	Frequency	Percentage
Fire wood	25	50
charcoal	15	30
Biogas	6	12
Electricity	4	8
total	50	100

Table 5 shows that most of the residence in the area use fire wood (50%) because it is the cheapest source of energy and it is readily available.

Charcoal (30%) is also used by most of the respondents since they are the ones involved in the production of charcoal making relatively cheap and available for them.

Biogas (12%) is less used because most of the respondents cannot afford the installation costs and maintenance costs.

Only (8%) of the respondents use electricity because the bills are too high.

4.3.2 Effects of climate change on environment.

Table 6: Effects of climate change on environment

Effects	Frequency	Percentage
Increased pests and diseases	3	6
Extreme temperatures	25	50
Unreliable rainfall	15	30
Floods	5	10
Reduced yields	2	4
Total	**50**	**100**

Source: primary data, 2015

According table 6 above, 50% of the respondents said that extreme weather is the major effect of climate change. This concurs with Esele (1995); Wasswa and Odelle (1995) who stated that prolonged drought and unreliable rainfall received alter the planting season for crops especially millet by harming the crops and reducing the yields in terms of quality and quantity. Extreme temperatures in Tisai Island are mainly due to deforestation to acquire land for settlement, timber and fuel wood. This has also caused dryness of soils since high temperatures lead to high evaporation rates due to exposure of the soils to direct sun's rays.

Unreliable rainfall (30%) occurs because of reduced number of trees that help in rainfall formation as a result of reduced transpiration. As a result this has shifted the planting season of the crops from early March to late April and this in turn delays planting and this leads to little or no yields harvested. Such conditions have resulted to problems like poverty, hunger and malnutrition in the area.

Floods (10%) have also been evidenced in Tisai Island as a result of climate change especially in 2007 where the fields were flooded after heavy rains received and this is in

relation to Thembo (2013) who noted that heavy rains received in 2013 in Kasese led to heavy floods and this destroyed 700 acres of crops like maize, cassava, groundnuts among others leading to food shortage in affected areas.

Increased pests and diseases (6%) is a clear effect of climate change in Tisai Island due to their high multiplication rates and spread which is due to low or moderate temperatures that provide good breeding conditions or high spread for example the caterpillars that destroyed cereal crops such as millet, rice among others in 1997 (FAO) thus leaving people with nothing to eat.

Reduced yields (4%) in Tisai Island has not been left out as one of the evident effects of climate change due to floods after receiving heavy rain fall at times that wash away the nutrients leaving the soil infertile.

4.3.4 Problems encountered by human beings due to climate change.

Table 7: Problems encountered human beings due to climate change.

Problems	Frequency	Percentage
Famine	06	12
Malnutrition	05	10
Poverty	10	20
School drop out	3	6
Floods	09	18
Drought	10	20
Pests and Diseases	07	14
Total	**50**	**100**

Source: primary data, 2015

Table 7 above shows that poverty (20%) and drought (20% respectively) are the highest problems evidenced in Tisai Island. According to the LC III chair person of Ongino Sub County, Mr. Okello Charles, the people of Tisai Island used to have plenty in the past when

they had minimal droughts and this gave them plenty that they could sell and get money as compared to the present where they even hardly harvest what they can eat leaving them in high levels of poverty. He also said that drought experienced especially in the months of November to March leave the crops dry in the gardens thus contributing to high poverty levels in the area.

Floods (18%) pointed out by some residents is another problem faced. These floods are experienced during the short and heavy rain periods which leave the gardens water logged thus causing leaching of the nutrients hence affecting crop growth.

Pests and diseases (14%) is another problem due to the moist and warm favourable conditions for the pests and disease causing organisms promoting their multiplication and spread thus affecting crop yields.

Famine (12%) due to the fact that there is less harvest got at the end of the season to feed the increasing population making them prone to diseases like kwashiorkor.

Malnutrition (24%) has also become a common challenge in Tisai Island due to low crop production. People themselves also spend a lot of money buying food and those who cannot afford are forced to starve or feed on foods with low quantities of nutrients regularly thus no balanced diet.

Some few respondents (6%) pointed out that the number school dropout has started increasing in Tisai Island due to hunger. These children are forced to stay home to offer labor as a way of getting what to eat in exchange and this is encouraged by their parents who expect them to work for what there are going to eat before going to school.

4.4 Measures used to mitigate climate change.

4.4.1 Measures used to mitigate climate change.

Table 8: Measures practiced to mitigate climate change.

Measures	Frequency	Percentage
Afforestation and reafforestation	27	54
Awareness	11	22
Law and policy	8	16
Public participation	4	8
Total	**50**	**100**

Source: primary data, 2015

Although there are many environmental challenges in Tisai Island due to climate change, some measures have been put and encouraged by the government, Non Governmental Organizations, institutions and individuals to reduce on the effects.

Respondents said that afforestation and reafforestation (54%) is one of the methods being used in mitigating climate change. According to Mr. Okalang Emmanuel, the District Environmental Officer of Kumi, "afforestation and reafforestation is being promoted through schools, village associations, workshops among others which are being accompanied by district formulated policies to increase on the carbon sinks". Besides that National Forest Authority (NFA) together wither organizations provide free seedlings to the local people.

Some people revealed that public awareness (22%) has been done through adverts and environmental programs such as "wetland demarcation and restoration" on radio stations like Radio Continental on (94.7 FM) and through posters advising people to conserve the quality of their environment while (16%) said that laws and policies like no cutting down of mango trees including reforestation, imposing charges and fines to restrict degradation are being implemented some tools being used.

Public participation (8%) is one of the ways used in environmental conservation in Tisai Island. People are advised by the government to work together in tree planting and reaforestation practices, formulation of policies and local Environment Committees and Environmental monitoring.

4.5 Measures to increase crop production by the respondents

Table 9 Measures to increase crop production by the respondents

Measure	Frequency	Percentage
Fallowing	3	6
Mulching	4	8
Conservation Agriculture	18	36
Crop rotation	10	20
Fertilizers	15	30
Total	**50**	**100**

Source: primary data, 2015

Conservation agriculture (36%) which is agriculture with reduced mechanical tillage was the greatest measure recommended by the respondents to increase crop productivity. They said that it should be the role of the government to use the laws and policies available in implementing this strategy and if they are weak let them be strengthened.

Fertilizers (30%) were also suggested by the respondents in a view that it is one way of increasing soil fertility. They said that being famers should be taught how to make organic fertilizers for example compost and farm yard manure this will help boost the productivity of their soils.

It was said by the respondents that farmers need to practice crop rotation (20%) since it helps in breaking the life cycle of the pests and it also ensures maximum utilization of soil nutrients by plants from all levels of the soil profile.

Mulching (8%) should be practiced to reduce evaporation rates and increasing soil fertility as suggested some respondents.

Artificial Fallowing (6%) whereby land is left to rest for some time is pointed out as the least recommended method because people in Tisai Island have small pieces of land which cannot allow them practice natural fallowing.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5:0 Introduction

This chapter is comprised of general conclusions on the findings of the study and the recommendations.

5.1 Conclusions

Tisai Island has become one of the affected areas by climate change in Uganda with low crop productivity. Most residents were born in the area and have a clear trend of climate in Tisai Island. Climate change in Tisai Island is caused by many factors, most of them being human caused like deforestation and bush burning.

As a result of climate change temperatures in Tisai Island have increased and this has favored the growth of different weeds and the breeding of pests. Other effects that have resulted due to climate change include floods, droughts and unreliable rain fall.

However, the government, other organizations and institutions have tried to influence mitigation measures like awareness creation, public participation, laws and policies, afforestation and reafforestation to reduce the effects of climate change. They have also through the District Environment Officer and farmers associations put some measures like fallowing, mulching, conservation agriculture, crop rotation and fertilizer use to increase crop productivity in the area especially through training, workshops.

5.2 Recommendations

There is a need to extend development projects in the area like rural electrification programmes, modern agricultural programmes and schools to help in development of the area and this will help in regulating human activities like deforestation, bush burning and

charcoal burning since this will provide with alternative source of energy. Also the local processing industries should be established in rural area to create jobs for people to earn a living so that they may not depend solely on the environment.

The National Environmental Management Authority (NEMA) together with the government and other organizations should extend various projects like afforestation and reafforestation, irrigation among others in the area. Fines and charges should be emphasized under policy guidelines to reduce on the rate of environmental degradation. Public awareness should be increased through adverts on radios, posters and carrying out freely attended seminars is one way to involve the public in sustainable development to curb down the effects of climate change.

Also committees from village level to parish and district level should be established and well financed by the government and/or other organizations to ensure these projects reach up to grass root level.

Farmers should also be provided with fast maturing crop varieties that can mature within a short period when the rains are available and this comes along with changing their minds to leave the old varieties. There is a need to promote food security by encouraging people to drying and storing food in granaries for their families that will be used during the dry spells

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APPENDICES

APPENDIX 1: BUDGET

ITEM	QUANTITY	RATE (Ugx)	TOTAL COST (Ugx)
Transport		80,000/=	80,000/=
Pens	2	500/=	1,000/=
Proposal printing and binding	2	15,000/=	30,000/=
Ream of papers	1	17,000/=	17,000/=
Accommodation & food		70,000/=	70,000/=
Dissertation Printing	3	15,000/=	45,000/=
Binding	3	12,000/=	36,000/=
Questionnaires and interview guides	100 copies	5000/=	5000/=
Miscellaneous		50,000/=	50,000/=
TOTAL			**334,000/=**

APPENDIX II

WORK SCHEDULE

	2015							
Activity	**Feb**	**Mar**	**April**	**May**	**Jun**	**Jul**	**Aug**	**Nov**
Submission of research topics and approval								
Proposal writing								
Data collection								
Data presentation and analysis								
Final dissertation writing and submission								
Graduation								

APPENDIX III

QUESTIONNAIRE

I am **Akurut Marion** a student from Kampala International University pursuing a Bachelor of Science in Environmental Management and currently conducting research entitled **"Impacts of Climate Change on Crop Production in Tisai Island, Ongino sub County, Kumi District".** So I kindly request you to be part of this study by answering all the questions below.

This research is purely for academic purposes and the information you provide shall be treated with utmost confidentiality.

Date.....

Name of the village

.....

Tick ☑ **the right options**

Section A: Socio-Demographic data

1. Sex

a) Female ☐

b) Male ☐

2. Marital Status

a) Single ☐ b) Married ☐

c) Divorced ☐

Any other

.....

3. Age

a) Young (below 15 years) ☐

b) Youth (15-35 years) ☐

c) Adult (35-50 years) ☐

d) Elder (50 years above) ☐

4. Residence

a) Resident (within Tisai Island) ☐

b) Nonresident (outside Tisai Island) ☐

5. Occupation

a) Peasant ☐

b) Civil Servant ☐

c) Student ☐

Others (specify).....

Section B: Causes of climate change in Tisai Island.

6. Were you born in Ongino?

a) Yes ☐

b) No ☐

7. For how long have you been in Tisai?

a) A year (short period) ☐

b) 2-5 years (medium period) ☐

c) 6-15 years (long period) ☐

d) 16 and above years (very long period) ☐

8. Have you ever heard of climate change?

a) Yes ☐

b) No ☐

9. Do you know the meaning of climate change?

a) Yes ☐

b) No ☐

Give reasons for your answer.....

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If yes, through which means?

.....

.....

10. What are the major economic activities in this area?

a) Crop production ☐ c) Fishing ☐

b) Charcoal production ☐ d) business ☐

Any other, please mention.....

11. What source of energy do you use for cooking in this area?

a) Charcoal ☐ b) Biogas ☐

c) Electricity ☐ d) Firewood ☐

Others (specify).....

12. What do you use for clearing your fields on the onset of rains?

a) Machinery ☐ b) Bush burning ☐

c) Ploughing ☐ d) Digging ☐

Others (specify).....

13. What is the major transport means used in Tisai Island, Ongino Sub County?

a) Cars ☐ Foot ☐ c) Bicycle ☐ d) Boats ☐

Others specify).....

Section C: Effects of climate change on crop productivity.

14. What yields were you getting from your crop fields in the past?

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15. How are the yields in the present?

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.....

16. In what other ways has climate change affected crop production?

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17. After which duration did you notice a change?

a) 30 years ☐ b) 15 years ☐

c) 5 years ☐ d) 1 year ☐

18. What factors have caused a change in crop production?

a) Pests ☐ b) Diseases ☐

c) Land fragmentation ☐ d) Soil Infertility ☐

Any other, please mention.....

19. What are some of the noticeable weather changes in this area?

a) Unreliable rainfall ☐ b) High temperatures ☐

c) Floods ☐ d) Humidity ☐

Give reasons for your answer.....

20. How have the weather changes affected the crop yields?

a) Decreased soil fertility ☐ b) Increased pests ☐

c) Delayed planting ☐ d) Extreme temperatures ☐

Any other specify.....

21. What problems are encountered due to reduced crop production?

a) Famine ☐ c) Poverty ☐

b) Malnutrition ☐ d) School drop out ☐

Any other specify.....

Section D: Mitigation measures used to reduce CC effects.

21. Do you know any measures being used to reduce any of the above effects in question?

a) Yes ☐

b) No ☐

22. If yes, what measures are used in reducing the climate change effects?

a) Planting trees and flowers ☐ c) Law and policy ☐

b) Awareness ☐ d) Pubic participation ☐

Others (specify).....

23. Do you personally practice any of the measures being promoted as listed above?

a) Yes ☐

b) No ☐

24. Who is encouraging the practicing of the above mentioned measures in question 20?

a) Institutions and Universities ☐ c) Government ☐

b) Non-Governmental Organizations (NGOs) ☐ d) Local leaders ☐

Others.....

25. How successful are the prevention measures listed in question 22 above?

a) Increased awareness ☐ c) Trees and flowers being planted ☐

b) Reduced famine ☐ d) Increased crop yields ☐

Others specify).....

26. What are the failures or problems of the measures in question 22?

a) Lack of enough funds ☐ b) Weak laws and policies ☐

c) Corruption ☐ d) Lack of public participation ☐

Others specify).....

27. What other measures do you think should be implemented?

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Section E: Measures used in increasing crop productivity

28. Are there any measures used to increase crop production in Tisai?

a) Yes ☐

b) No ☐

29. What are some of the measures used?

a) Fertilizers ☐ b) fallows ☐

c) Irrigation ☐ d) others, please specify ☐

30. Which fertilizers are commonly used by farmers to increase the fertility of their soils?

a) Inorganic fertilizers ☐

b) Organic fertilizers ☐

31. Do farmers practice Agro forestry in their farms?

a) No ☐

b) Yes ☐

32. If yes, how has the practice increased crop production?

a) Restoring soil fertility ☐ c) Reduced effect of sun's rays ☐

b) Reduced nutrient and soil runoff ☐ d) Increased resistance to drought ☐

33. Apart from fertilizer use, which other method do farmers use to increase soil fertility?

a) Fallowing ☐ c) Mulching ☐

b) Conservation Agriculture ☐ d) Crop rotation ☐

34. Do farmers harvest rain water during the short rains?

a) Yes ☐

b) No ☐

35. If yes, which among these methods do they use?

a) Underground tanks ☐ b) Jerri cans ☐ c) Drums ☐

Others, please specify.....

36. If No, where do they get water for their fields during the dry season?

a) Open wells ☐ c) Lake ☐

b) Boreholes ☐ d) Wetlands ☐

Others (specify).....

APPENDIX IV
INTERVIEW GUIDE

1. Have you ever heard of climate change?.

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2. Do you know the meaning of climate change?

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3. What are the major economic activities in this area?

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4. Do you think these activities lead to climate change? If yes, give reasons for your answer.....

5. What are the noticeable weather changes?.

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6. How have these weather changes affected crop productivity?

.....

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7. What problems are encountered due to reduced crop production?

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8. Are there some measures being used to minimize climate change effects? If yes please mention.....

9. How effective is the implementation of these measures?

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10. What are the failures or problems faced in using these measures?

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11. Which measures do farmers use to restore soil fertility?

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12. Do you think these measures have increased the crop yields in the areas? If yes give reasons to your answer.

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13. How have the good yields improved on peoples' standards of living?

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