ADAPTIVE CAPACITY TO CLIMATE CHANGE AND FOOD SECURITY AMONG ARTISANAL FISHER FOLK IN RORYA DISTRICT, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

This research was carried out in the inshore of Lake Victoria, Rorya District in particular, to examine determinants of gendered adaptive capacity to climate change and its role in enhancing food security among artisanal fisher folk. The specific objectives were: to examine fishers perception on climate change by gender; to determine the adaptive capacity of artisanal fishers by gender; and to determine factors affecting the adaptive capacity to climate change by gender. A total of 90 small scale fishers were sampled. The sample was drawn from three villages from three wards, and it comprised of 30 respondents per village. Data were collected using the following methods: questionnaire survey, Focus Group Discussion and key informants' interviews. Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS) software, version 16.0, whereby descriptive analysis was done Likert scale was applied to facilitate inferential analysis and adaptive capacity index (ACI) was developed. Qualitative data were analyzed through content analysis. The results showed that the majority (80%) of the respondents had a positive perception towards climate change, while one-tenth of the respondents had a negative perception. Moreover, artisanal fisher folk adaptive capacity index was at a lowest average as its overall ACI was 18.54. However, it plays a vital role in enhancing food security among artisanal fishers and the fishing community. The study concludes that, Artisanal fishers are aware of climate change and how it affects food security but have a low adaptive capacity to fight against climate change risks and crisis. The study recommends that there should be improved provision of training to enhance fishers' ability over climate change and the government should intervene in fishing communities to improve their adaptive capacity.

DECLARATION

I, LUCY SHALLIE SIDI, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been nor is it being concurrently submitted any other institution.

_____ _____

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(M. A. Candidate)

The above declaration is confirmed by

_____ _____

Dr. Christopher Mahonge **Date**

(Supervisor)

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DEDICATION

This research is dedicated to my beloved daughter Gloria Fredy, my beloved mother Cleotildah Kulola, my brothers Pascal, Morris and Charles and my sisters, Josephine, Maureen, Careen, Pauline and Regina for their patience, moral support and prayers.

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LIST OF ABBREVIATIONS AND SYMBOLS

AIDS	Acquired Immune Deficiency Syndrome
ACI	Adaptive Capacity Index
BMU	Beach Management Union
CARE	Cooperative for Assistance and Relief Everywhere
CC	Climate Change
DF	Department of Fishery
DFID	Department for International Development
EAC	East African Community
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FMP	Fisheries Master Plan
GHG	Green House Gas
HIV	Human Immune Virus
IPCC	Intergovernmental Panel on Climate Change
MDG	Millennium Development Goal
MNRT	Ministry of Natural Resources and Tourism
NIP	National Investment Policy
NSGRP	National Strategy for Growth and Poverty Reduction
NTP	National Trade Policy
PMO	Prime Minister's Office
SLA	Sustainable Livelihood Approach
SNAL	Sokoine National University Library
SPSS	Statistical Package for Social Science
UN	United Nations

UNFCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
URT	United Republic of Tanzania
USD	United State Dollar
VICOBA	Village and Community Banking
WPDS	World Population Data Sheet

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Global fishery production in 2008 was about 90 million tons, with an estimate of US$ 93.9 billion, which comprised about 80 million tons from marine waters and a record of 10 million tons from inland waters FAO (2010). Global inland capture fishery production was fairly stable between 2000 and 2004 at about 8.6 million tons, but in the following four years it showed an overall increase of 1.6 million tons, reaching 10.2 million tons in 2008 (FAO, 2010).

The fishery Industry is a crucial source of income and livelihood for millions of people around the world. According to FAO (2010), employment in fishery and aquaculture has grown substantially in the last three decades, with an average rate of increase of 3.6% per year since 1980. It is estimated that, in 2008, 14.9 million people were directly engaged, fully or more frequently in fishing activities such as fishery capture and at least 12% of these were women. Generally, employment in the fishery sector has grown faster than the world's population and employment opportunities in traditional agriculture (FAO, 2010).

Fishery industry in Tanzania plays a vital role in sustaining the livelihoods of thousands of people national wise, and fishery sector employs about 4.2 million people who undertake various fishery activities like fishing, selling fish and processing of fish (URT, 2008). In 2008, product exports in 2008 reached US$ 141.6 million (URT, 2008). However, fisheries sector like other sectors faces the challenge of climate change. Climate change is projected to have significant impacts on conditions affecting fishing with anticipated decrease in fish yield and ultimate food security. It is reported that fish production may

decrease by 15% in developing countries by 2020 as a result of climate change (Parry *et al.,* 2004; Misselhorn, 2005; IPCC, 2007; IFAD, 2008; Von Broun, 2007). This affects among others artisanal fishers whose livelihood largely depends on fishery industry. Adaptive capacity enhancement of these fishers is thus important to relieve them from the climate based challenge and enhance food security amongst them.

Generally, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences. This definition integrates availability of nutritionally adequate food, access to food, biological utilization of food, and stability (Lovendal *et al.,* 2006). Food security refers to as the availability of food to the reasonable proximity to the individuals of sufficient quantities of appropriate food coming from domestic production, commercial imports, or donors (FAO, 1996). Access refers to as adequate incomes after catching fish for sale or other resources to assure appropriate food consumption, biological. Utilization of food refers to as the ability of the individual to convert food commodities into Dietary Energy Commodities (DEC). Finally, stability means that these conditions have to be fulfilled at present but also in any future point of time for active healthy life with full of protein and nutrients from fish (FAO, 1996).

Adapting to climate change is on the international agenda, it is increasingly apparent that efforts have moved too slowly to prevent impacts which are already being felt in many parts of the world (ShaZukang, 2008). In Africa climate change affects people with low adaptive capacities and constrained by various factors including endemic poverty, inadequate governance and institutional structures and limited access to capital, markets, infrastructure and technology (Boko *et al.*, 2007; UNISDR, 2008) among others. These factors in turn have contributed to Africa's weak adaptive capacity, and increased

continent's vulnerability to projected climate change. These changes are having a dramatic impact on food and nutrition security and health in Africa, and in particular, sub-Saharan Africa (Boko *et al*., 2007; Oxfam International, 2010; NOAA, 2011).

Inland fishers catch less fish per individual and per year than do small-scale fishers employed or who engage themselves in fishing activities. This is because a large number of rural households especially in the proposed area depend much on fishing activities for improving their livelihoods as the soil is not fertile and does not allow farming activities. However despite living close to water bodies, households engage in fishing activities for only a few weeks or a few months in a year due to climate change that has led to disappearance of fish.

According to Lambrau and Piano (2003), the fundamental goal of adaptive capacity to climate change impacts is to reduce the vulnerability of the poor men, women, youth and other socio-economic groups in order to protect and enhance their livelihoods. This includes among others enhancing their ability to have access to information and resources. Knowledge on adaptive capacity already exists around the globe but there is insufficient knowledge on how men, women and youth perceive and are affected by, and as to their differential capacity to cope with climate change (Lambrau and Piana, 2003). Such the knowledge is important as it may provide inputs that can help vulnerable actors including artisanal fishers to improve their food security situations. Therefore, this study analyses the artisanal adaptive capacity to climate change and food security by focusing on fisheries/fishing sector and uses Rorya district as the case study.

1.2 Problem Statement

Easterling *et al.* (2007a) infer with high confidence that subsistence farmers, pastoralists, and artisanal fisher folk will suffer complex, localized impacts from climate change. Climate change affects the poor through changes or depletion of common property/natural resources, such as fisheries, rangelands, or forests on which they depend on for their livelihoods (DFID, 2004). Literature confirms that the impacts of climate change will be felt differently among regions, nations, communities, gender and age groups. Literature also reveals that little has been done in climate change and gender neutral, and therefore gender is an important determinant in climate change adaptations (Dankelman *et al.,* 2008). Men, women and youth are affected differently and often more severely by climate change and associated natural disasters such as floods, droughts, cyclones and storms (Laddey *et al.,* 2011). These differences intensify the existing gender inequalities in many communities because of the differential roles, relations, power, access to and control over resources. The distinct roles, relations, power, access to and control over resources give rise to differences in vulnerability and ability to cope with these climate change consequences.

It is now widely acknowledged that negative effects of climate change affect the poorer most because they depend on natural resources and the environment for all their activities and the basic needs of their families (Gueye, 2008). Consequently, vulnerable groups especially poorer men, women and youth are likely to be faced with problems such as food insecurity, loss of livelihood, and hardships due to environmental degradation that lead to displacement and a host of other potentially devastating economic and social consequences (Laddey *et al.,* 2011). Despite mentioning the groups as most affected by climate change previous, previous research did not consider the gender disparities in the adaptive capacity of climate change and their affects, among artisanal fisher folk in

particular. Thus, this study aimed at examining determinants of adaptive capacity in the light of climate change among gender groups in artisanal fisher folk community as well as the impact of climate change on food security and used Rorya District as the case study.

1.3 Justification of the Study

The study has generated knowledge on the determinants of adaptive capacity and has thus increased the understanding of the adaptive capacity based on gender disparities among artisanal fishers. This is due to the fact that gender disparity is a topical issue in the development agenda including climate change. The data on determinants of adaptive capacity to climate change are available but there is scant information on gender segregated data especially, concerning the artisanal fishers. Findings from this study may serve as raw materials that can be used by policy makers and implementers of strategies towards attainment of goals of macro-policy frameworks such as MDG number one: eradicate extreme poverty and hunger; number three: promote gender equality and empower women; and MDG number seven: ensure environmental sustainability. The findings are also relevant for Tanzania National Adaptation Programme of Action (NAPA) and for the fisheries and other communities in the study area and elsewhere by enhancing their awareness of changes in climate so that they can devise appropriate strategies for enhancing adaptation to climate change and improving food security.

1.4 Objectives of the Study

1.4.1 Overall objective

The overall objective of the study was to examine determinants of adaptive capacity to climate change among artisanal fisher folk in Rorya District, Tanzania.

1.4.2 Specific objectives

Specifically, the study intended;

(i) to examine fishers perception to climate change;

(ii) to determine the adaptive capacity of artisanal fishers;

(iii) to examine challenges affect artisanal fishers' adaptive capacity to climate change;

(iv) to determine factors affecting the adaptive capacity to climate change.

1.5 Research Questions

(i) How do artisanal fishers' perceive change in climate? and how do they relate these changes to fisheries?

(ii) What do artisanal fishers do when they observe changes in fish catch?

(iii) What adaptation practices have been developed by artisanal fishers?

(iv) What factors enhance or constrain the ability of artisanal fishers to adapt with effects of climate change in fishing?

(v) What aspects make artisanal fishers aware to climate change?

(vi) How do artisanal fisher folk cope with climate change?

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter reviews the literature relevant for artisanal adaptive capacity of the smallholder producers due to the impacts of climate change. However, before going to that stage, it is worthy to define the key concepts. This aims at making a reader understand the meaning of these concepts as provided in the literature and their contextualization for the purpose of this study. The main concepts are adaptation, adaptive capacity, climate change, artisanal fishers, and food security.

2.1Definition of Key Concepts

2.1.1 Adaptation

Adaptation refers to as adjustments in management strategies due to actual or expected changes in climatic conditions or their effects, in order to reduce risks or realize opportunities (Smit and Pilifisova, 2003). Adaptation takes different forms; it can occur at different scales and is undertaken by different people (for example, in the case of fisheries, these would be fishing net mending, fishing vessel repair, fish trading, fish processing or any other related activity at artisan level) (Bryant *et al.,* 2000).

2.1.2 Adaptive capacity

According to Nelson *et al.* (2007), preconditions that enable actions and adjustments in response to current and future external changes depend on social, political, economical and biophysical elements. Adaptive capacity is the ability of a system to adjust to climate change including climate variability and extremes to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (Chamber, 2009). Adaptive capacity is context-specific and varies from country to country, from community to

community, among social groups and individuals, and over time. Adaptive capacity is thus the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change (Levine *et al*., 2011).The ability to adapt is a fundamental determinant of how vulnerable a specific system is to external or internal stresses (Keskitalo, 2004; McCarthy *et al.,* 2001). Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development (Munasinghe, 2000; Smit *et al.*, 2000).

2.1.3 Climate change

Climate change refers to a change in the state of the climate that can be identified by changes in variability of its properties and that persists for extended periods, typically decades or longer (IPCC, 2007). It is a long-term shift in the climate of a specific location, region or planet that is measured by changes in features associated with average weather, such variables are temperature, wind patterns, floods, droughts and precipitation. The causes of climate change are either natural or human-induced causes. UNFCCC (1992) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which in addition to natural climate that is observed over comparable time periods and thus affects food security.

2.1.4 Food security

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO World Food Summit, 1996;RomeEAC, 2011; FAO 1996 Cited by Kayunze, 2009). Food security is the availability at all times of

adequate world supplies of basic foodstuffs at stable prices to sustain a steady expansion of food consumption and to offset fluctuations in production and prices (United Nations, 1975, cited by Pottier, 1999). The indicators of food security are stability of food prices and supply; degree to access to utilities, services; percentage food expenditure to household expenditure; household food production and diversity with sufficient quantity of food available on a consistent basis food access; having sufficient resources to obtain appropriate food for nutritious diet and food use; appropriate use based on knowledge of basic nutrition and care as well as adequate water (URT, 2012). People enjoy food security when they have access to sufficient, nutritious food for an active and healthy life (Drimieand *et al*., 2006).

2.1.5 Artisanal fisher folk

Artisanal Fisher folk mean a person or a group of people involved in fishing, net mending, fishing vessel repair, fish trading, fish processing or any other related activity at artisan level. Fishing activity in Tanzania Mainland covers the harvested fish from both marine and fresh waters including rivers, lakes and dams. However, According to the Food and Agriculture Organization of the world (FAO), a fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and purpose of the activities or a combination of the foregoing activities". These artisanal fishers have different ways in perceiving climate change and ability to adapt to climate change (FAO, 2007).

2.2 Fishing in Tanzania

2.2.1 Fishery management

There are several national policies governing and relevant for the fishery sector in Tanzania. These include National Fisheries Policy of 1997, the Fisheries Master Plan of

2002 (FMP), The National Trade Policy (NTP) of 2003 and the National Strategy for Growth and Poverty Reduction (NSGRP) of 2005. The National Investment Policy (NIP), through the Tanzania Investment Centre, has acted to lure investment both foreign and domestic industries. The FMP aims at developing a feasible integrated development strategy that will stimulate sustainable economic growth in the fisheries sector. The benefits of the FMP are directed at artisanal fisheries groups, small-scale trader, fish processors and their communities.

However, the Management of fisheries resources in Tanzania mainland is the responsibility of the Department of Fisheries under the Ministry of Natural Resources and Tourism (MNRT), currently under Ministry of livestock Development and fisheries. The main duty of the Department of Fisheries (DF) is to implement the Fisheries Act of 2003 and the Fisheries Policy of 1997; and the general development of the fisheries sector. These departments, in collaboration with Local Government Authorities, are responsible for the efficient and effective collection and allocation of revenue. Wilson (2004) noted that more than 50% of the total revenue collected is directed back to the fisheries via the retention scheme. While the Fishery department collects fish, the Local Government (under Prime Minister's Office – PMO) collects boat and fishing license fees.

2.2.2 Effects of climate change on fish

Fish are often largely affected by climate change as increasing temperature tends to affect every stage of their life cycle from their physiological, morphological, reproductive, migratory and behavioural responses (Daw *et al.,* 2009). Alterations in their food-web processes and interactions, species invasion and spread of vector-borne diseases could also result from the effects of climate change. Climate change in Africa is mainly as a result of increasing gas emissions. Since fish are cold blooded, they are very sensitive to

temperature changes. Any increase in temperature above the tolerance limit in their habitat will surely have serious negative effects on fish physiology especially in the supply of oxygen to their tissues.

Climate change will impact on the spawning success of fishes spatially and temporally (Mustapha, 2012). This is because time and locations of spawning of several species of fish are linked to physical conditions such as temperature, currents, as well as biological factors like food. Changes in these conditions on account of climate change would therefore impact negatively on the spawning of fishes in these habitats. Likewise, food and feeding of fish would be affected as plankton production in aquatic ecosystem is linked to physicochemical variables of the ecosystem which could be seriously affected by change in the climate (Ayub, 2010).

2.2.4 Effects of climate change on artisanal fisheries

Any effect of climate change produced on fish and its habitat will affect the fisheries and the fishermen, since fisheries is the interaction of the fish, habitat and the fisher folks. According to Daw *et al.* (2009), climate change will affect fisheries in the context of scale, environment, species, technology, markets, fishers, management arrangement and political contexts. Global warming on account of increasing higher temperature will lead to deep lakes stratification and non-mixing with attendant problems of anoxia at the hypolimnion and fish kills.

Low flow of water often leads to fish killing and migration, the synergistic effects produced by climate change on food webs, stratification, runoff, flow, flooding, and anoxia, will affect fish assemblages in the lake or river ecosystems bringing changes in the distribution of pelagic fisheries (Mustapha, 2009). Thus, low productivity of the water

body, low fish production, less number of adult fishes in the system, abundance of juvenile fish, reduced productivity of commercially important species and allowable catch per unit efforts by the fishermen are some of the possible consequences of climate change scenarios on artisanal fisheries (Mustapha, 2012).

2.3 Theoretical Framework

2.3.1 Behavioural theory of decision making under uncertainty

Uncertainty is a defining characteristic of fisheries. Fishermen make decisions affecting their livelihood and their lives daily and even hourly, often with scant information on which to evaluate alternatives. In modelling decisions of fishermen, economists typically assume that fishermen behave rationally, using what information is available to them to construct estimates of the expected utility and selecting the choice with the highest expected utility (Wilen *et al.,* 2002). Cognitive psychologists and behavioural economists have demonstrated that actual decision making under uncertainty often diverges substantially from normative behavioural models based on expected utility theory (Camerer, 2000). People have been shown to exhibit a number of decision-making behaviours that they do not involve gender in decision, and the resulting choices of individuals, and on aggregate, can depart substantially from what they can share and decide on the ability to adapt climate change for enhancing food security.

Given the prevalence of decision making under uncertainty in fisheries, it is likely that these “non-rational” behaviours may have significant impacts on fishing behaviour and should be given consideration when group fishing decisions such as location choice, targeting, exit and entry, and compliance with regulations. Group level decisions, such as support for increases or decreases in the total allowable catch, may also be affected by decision behaviours. This theory influence adaptive capacity intangible determinants apart

from the tangible determinants, most of fisheries if only they change their behaviour of rejecting to cooperate with different gender that is involving men, women and youth by forming cooperatives that can assist them when there is climate hazards or disaster.

2.3.2 Sustainable livelihoods approach

This research is governed by or guided by Sustainable Livelihoods Approach which dates back to the work of Robert Chambers in the mid-1980s. Chambers developed the idea of "Sustainable Livelihoods" with the intention to enhance the efficiency of development cooperation.

The Sustainable Livelihoods Approach (SLA) perceived as a way of looking at how an individual, a household or a community secures its well-being over time (Serrat, 2008; Carney, 2002). Livelihood in the context of the SLA is made up of the abilities, the assets (stores, resources, claims and access) and activities required for day-to-day living. It doesn't only take account of monetary income but also the other forms of capital that people have access to, including social assets, physical assets, natural assets and human capital that can help in adapting climate change for enhancing food security. A study conducted by Wall and Marzall (2004), has designed assets types to assess adaptive capacity for meeting challenges posed by climate change. In their research they interpreted that adaptive capacity depends in part on the available social, human, natural and economic resources.

2.3.3 Conceptual framework

In this study adaptive capacity is defined as the capacity of a system to adapt if the environment where the system exists is changing. It is applied to ecological and social

systems that take advantage of opportunities or cope with the consequences of shocks or stress or due to climate change (IPCC, 2001).

The conceptual framework for this study is developed as to determine the link between the dependent variable that is adaptive capacity which includes ability to and equity in accessing resources, services, and network to learn and store knowledge and problem solving and disaster preparedness and awareness on climate change by gender as determinants of adaptive capacity; independent variables that is social economic variables such as financial, physical, human, natural and social; background variables which are age, sex, occupation, education level and marital status which at the end leads to the outcome of food security.

The framework views livelihood assets as the causes of or limits to the adaptive capacity of men, women, youth and marginalized groups to enhance food security in light of climate change. It is based on the assumption that; the poor, men, women, youth and marginalized groups among the fisheries community will suffer disproportionately from climate change due to gender disparity as a result among others, of their comparatively weaker set of livelihood assets (IPCC, 2007; UNFPA, 2009). It is assumed that the information about adaptive capacity context and climate change is received and perceived differently among men, women, youth and other marginalized groups among artisanal fishers' communities. As a result of differential access to and control over resources that enables them to adapt to climate change through enhancing their food security. The conceptual framework is presented in Fig. 1.

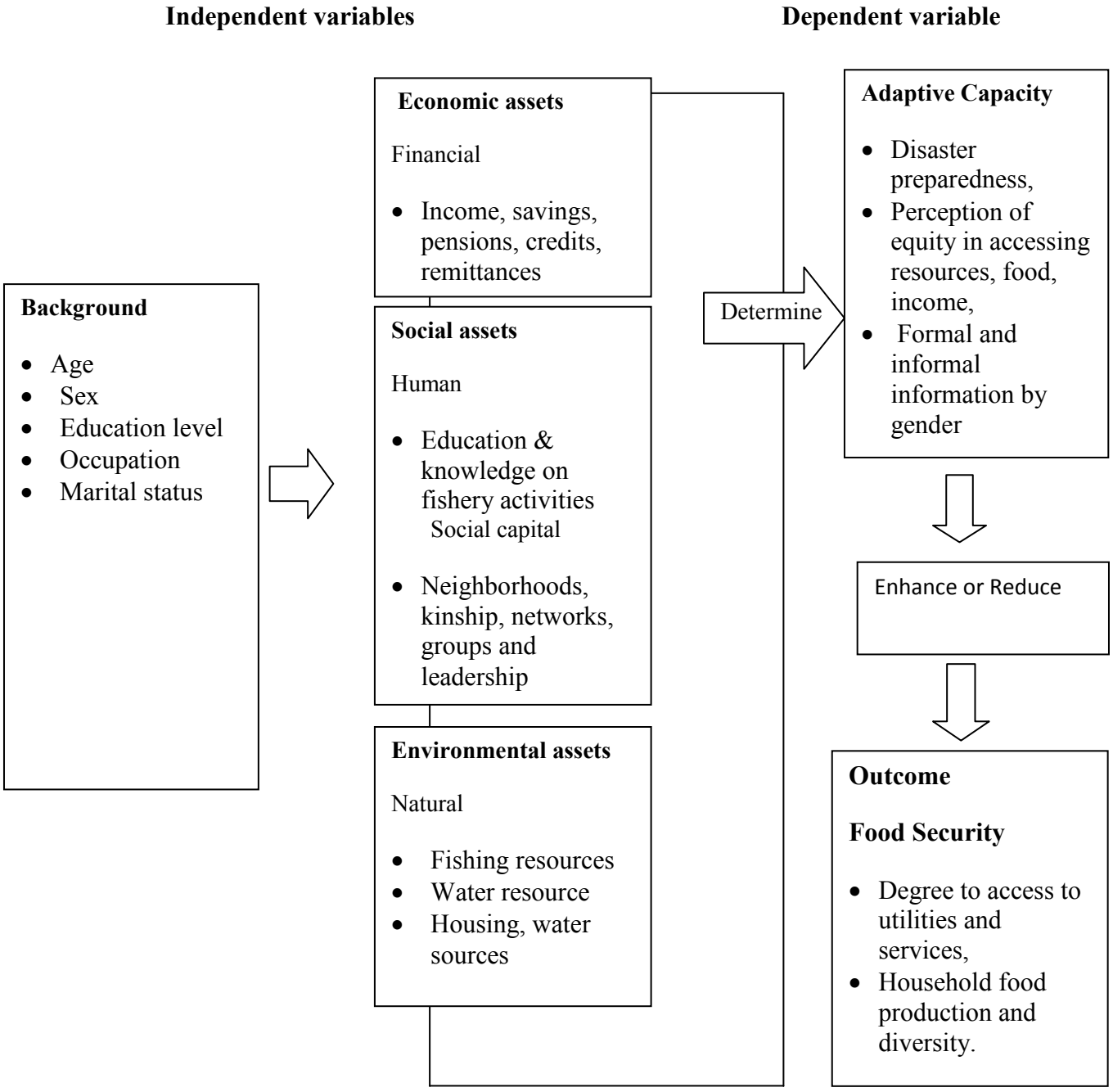

Figure 1: Conceptual framework showing relationship among variables relating adaptive capacity, climate change and food security.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of Study Area

The study was conducted in Rorya District in Mara Region. Rorya District has a total land area of 548 square kilometers (548 Km^2). Rorya District has a tropical type of climate, with clearly distinguished rain season. The average temperature for the District is about 28 degree centigrade, Rorya District lie at an altitude of 1 500 to 1 800 meters above sea level. In East the District bordered with Tarime District, while in Western side, it bordered with Butiama District and Lake Victoria, the Lake occupies two thirds of its total land. The District is also bordered by Kenya in the North, and Uganda in the North West. Based on 2012 Tanzania National Population Census, the population of Rorya District was 265 241 whereby 138 994 were females. The economy of the District depends mainly on fishing activities which is dominated by artisanal fishers who practice fishing in Lake Victoria.

3.2 Research Design

A cross-sectional research design was used. It was used on the basis that it allows collection of data from different groups of respondents at one point in time, which is recommended by Kothari. It determines the relationship between variables (Kothari, 2004).

3.3 Sampling Procedure and Size

The study involved small scale fishers (artisanal fisher folks) from three villages where fishing activities were carried out. The study was conducted in three villages from three wards selected randomly. Random sampling technique was used to select respondents

from each village (Babbie, 1990). Sample size of 90 artisanal fisher folk respondents was randomly selected.

According to Barley (1994), 30 cases sample is the minimum allowed sample size and appropriate for statistical data analysis to be done in a research. Sunder *et al.* (2007) argued that, a sample size intensity of 30 household is considered, the sample size selected for the study was 30 respondents in each of three village that make a total of 90 respondents in the whole study.

3.4 Sampling Procedure

Sampling procedure for Focus Group Discussion (FGD)

Stratified sampling was adopted; key informant and FGD were chosen so as to have participants who are known to have opinion and experience on the topics for discussion. A total of six focus group were selected which included groups of 6 – 8 participants depending on their group. However; the selection of group's considered segregation of female, male and youth of different sex to reduce domination of single gender during group discussion which would make others not free to give opinion.

3.5 Data Collection Methods

The study involved qualitative and quantitative data collection methods. Quantitative data were obtained through structured interviews, while qualitative data were collected through key informant interviews and FGD. Checklist for key informants interview and questionnaire for questionnaire survey were used in data collection. Before the actual data collection, pre-testing of the tools to be used in the study was conducted. The application of more than one instrument in data collection was useful in the sense to provide checks

and balances as regards shortfalls inherent in each of the data gathering instruments (Hughes and Hopper, 2000). Individual artisanal fishers were the unit of measurement

3.5.1 Primary data

Quantitative primary data were obtained through structured interview to determine the knowledge of men and women towards climate change. A questionnaire formulated with open and closed ended questions was administered the selected individual fishers. Quantitative Primary data were collected through key informant interview and FGD.

3.5.2 Secondary data

Secondary data sources included the existing information, published and unpublished documents from BMU, fisheries officer. It includes different reports from the government and research which had information on climate change, gender among small scale fishers and food security. Other data were obtained from Rorya District office, village government office, ward government office, journals, books and dissertation from various institutions, such as Sokoine National Agriculture Library (SNAL) and non-governmental organizations dealing with issues pertaining to climate change, gender and food security.

3.6 Data Analysis

3.6.1 Analysis of qualitative and quantitative data

Quantitative data were processed and analyzed using the Statistical Package for Social Science (SPSS) computer software version 16.0 in order to get the frequency and percentages. Descriptive analysis was also used for analyzing verbal discussion and observation qualitative data (Bryman, 2008). Qualitative data were analyzed using content analytical technique (content analysis), where meaningful information was summarized.

3.6.2 Computation of adaptive capacity index

Before computing the adaptive capacity index (ACI), the study established a scale for assessing the level of adaptive capacity among the fishers. The scale was as follows: 100 was rated the highest, 50 medium and 1 lowest. Respectively, the scores were made as per level of scale. Overall mean was computed based on respective variables as indicated below:

ACI = AVERAGE (MA+MHHs+MAS+MCs+MF+MVS+MC+MT+MAk)

MA	=	Mean age
MHHs	=	Mean household size
MAS	=	Mean association
MCs	=	Mean cooperatives
MF	=	Mean farming
MVS	=	Mean vegetable selling
MC	=	Mean carpentry
MT	=	Mean tailoring
MAK	=	Mean animal keeping

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Demographic Characteristics of Fishers

This presents the demographic characteristics of respondents that were involved in the study which include: sex, age, education level, marital status and occupation.

4.1.1 Sex of respondents

The finding shows that majority of the respondents (74.4%) who depended on fishing activities for their livelihood were males, while 25.6% were females. Most of the fishing activities, especially, direct fishing in the lake was done by men whereas women did other fishing activities like drying fish, salting fish and selling the dried and fried fish (Table 1). Men were found performing fishing activities especially direct fishing. Women were doing other fishing activities such as cooking for the fishers, drying, chilling and salting fish. The study is in line with that reported by Asowe-Okwe, (1989) whereby the fishing sector was dominated by men because fishing is generally regarded as a demanding activity (Asowe-Okwe, 1989).

Table 1: Demographic characteristics

Variables	Categories	Frequency	Percentage
Sex	Male	67	74.4
	Female	23	25.6
Age	Under 18 years	3	3.3
	19-44 years	44	48.9
	45-54 years	21	23.3
	65 years and above	22	24.4
Household size	1-5	42	46.7
	6-10	45	50.0
	11-15	2	2.2
	21-25	1	1.1
Education level	No formal education	5	5.6
	Primary education	75	83.3
	Secondary education	10	11.1
Marital status	Single	11	12.2
	Married	75	83.3
	Divorced	2	2.2
	Widow/Widower	2	2.2
Source of income	Fishing	90	100

4.1.2 Age of respondents

Age of the respondents was recorded according to the relationship between the age of respondents and adaptive capacity to climate change in terms of food security among artisanal fisher folk. Age was divided into four categories for analytical purpose, under 18 years who were children: 19-44 years, youth; 45-64 years adult and above 65 years, elderly. Youth and adult ages are the active age group in a work force. From Table 1, it shows that below18 years were 3 respondents who accounted for 3.3% of the respondents doing fishing activities, 48.9% of the respondents involved in fishing activities were at the age ranging from19 to 44years, whereas 23.3% of fishing respondents were at 45 to 54 years and 24.4% of the respondents were fishers who were at the elderly age. Thus the majority of the respondents were youth at 19 to 44 years old; these are energetic and hence can actively involve into production activities (Table 1). The finding on active age group of 19-44years as mainly fishing group was similar to the age range reported by Mukasa and Raynolds; these observed that the main age group of fishers was mainly ranging from

20 to 40 years (Mukasa and Raynolds, 1991). The implication of the results was that the most age group performing fishing activity was youth (19-44years old).

4.1.3 Household size

Household size is defined as a number or group of persons who usually eat and share some common living arrangements (Cannon, 2008). The results in Table 1 indicate that majority of households (50%) had a household size of 6 to10 members, about half of the respondents (46.7%) had size of 1 to 5 members, and fewer of households had household sizes of 11 to 15 members (2.2%) and of 21 to 25 members 1.1% (Table 1). Moreover, 1.1% of the respondents were men who had 20 children. The study shows that majority of the fishers were respondents with family which made them easy to provide food for them even during non fishing season.

4.1.4 Marital Status of the Fishers

Fishing activities in this study area were performed by married respondents (83.3%) single were (12.2%), divorced (2.2%) and widow/widower (2.2%) (Table1). The research findings are in line with those reported by SEDAWOGA work, that the majority of fishers were at active age and were largely married (SEDAWOGA, 1999).

4.1.5 Educational Status of the Fishers

The majority of the interviewed fishers (83.3%) had attained primary education level. Whereas some of them (11.1%) had secondary education and fewer of the respondents (5.6%) were illiterates (Table 1). Since majority of the respondents (83%) had attained primary education; this implies that participants have some understanding and knowledge on matters pertaining to climate change, and its implication on gender and food security. They also have knowledge on coping strategies for climate change. However, primary

education within adaptive capacity scored 84.1% of the respondents who do not adapt to climate change and food security still have low knowledge to climate change (Table 2). According to Sampei and Aoyagi (2009), lack of knowledge and low level of education hinder a person to have access to climate change information.

Table 2: Adaptive Capacity in relation to educational level

Educational level		**Adaptive Capacity**	
		Not adapt (%)	Adapt (%)
No formal education	Count	0	5
	% within adaptive capacity	0.0	10.9
Primary education	Cont	37	38
	% within adaptive capacity	84.1	82.6
Secondary	Count	7	3
	% within adaptive capacity	15.9	6.5

4.1.6 Source of income of respondents

All of the respondents in the study area depend on fishing activities as a source of income to improve their livelihood: they all carried out fisheries activities. This is because the soil around Lake Victoria is infertile that cannot support crop farm. All the people around Lake Victoria at Rorya District depended on fishing activities to generate their income. According to those respondents fishing enabled them to educate their children, and to afford treatment bills and purchase food (Table 1). This implies that fishing is the priority livelihood source in keeping with the assertion by FAO that: Fishery Industry is a crucial source of income and livelihood for millions of people around the world (FAO, 2010).

4.2 Fishers Perception on Climate Change

The first objective of the study was to assess the fisher's perception on adaptive capacity to climate change among fishers. In order to capture respondents' attitude, a likert scale was used. It comprised of 1 to 3 scores, whereby 1= disagree, 2= Undecided and 3= agree (Mogey, 1999). The findings in Table 3 revealed that the average scores for attitude were

80% who was negative that had little knowledge concerning climate change. This was measured by mean 18 for the undecided who were neutral, below 18 for the disagreed respondents and above 18 for the agreed respondents. The responses were as follows: disagree (19.5%), Undecided (7.3%) and Agreed (73.1%). Based on this study, the mean score was below 7.3% meaning that it did not contribute significantly to the perceived changes on climate. In view of the results, agreed average scores accounted for 73.1%, meaning that it had significant influence on perceived changes on climate (Table 3). This shows that most of the respondents were aware of climate change.

Table 3: Fishers' perception on climate change

Statement	Disagree (%)	Undecided (%)	Agree (%)
Traditional perception of climate change as a curse from God lead to food insecurity	70.0	3.3	26.7
Climate change lead to disappearance of fish species	7.8	6.7	85.6
Rainfall fluctuation occurring in recent years is the affect of climate change	3.3	5.6	91.1
Climate change have a big impact in fish production	10.0	12.2	77.2
Artisanal fishers are locality pertaining climate change information	12.2	13.3	74.4
Artisanal fishers play a great role in climate change perception	21.1	4.4	74.4
Artisanal fisher folk low adaptive capacity to climate change	12.2	12.2	75.6
Climate change affects artisanal fishers differently depending on their ability	12.2	6.7	81.1
No relationship between climate change and rain pattern	26.7	1.1	72.2
Average scores	**19.5**	**7.3**	**73.1**

The results show that majority (80%) of the respondents had negative perception towards climate change, while one-tenth of respondents were undecided and disagreed. The disagreed respondents had a positive perception towards climate change and food security, while undecided was neutral. This showed that majority of the respondents were aware about climate change but lacked resources and interventions to enable them have adaptive

capacity to climate change and hence increase their food security (Table 4). The finding is on line with what reported by Sampei and Aoyagi (2009), people from far most in interior or remote area lack information on climate change thus led to negative perception towards climate change.

Table 4: Evaluation Fishers' perception on climate change

Perception	Frequency	Perception
Disagree	9	10.0
Undecided	9	10.0
Agree	72	80.0
Total	**90**	**100.0**

FGD in Kanga village showed that the fishers lacked source of information concerning climate change and food security. Though their perception on climate change appeared to be influenced by different external sources such as mass media, magazines, government intervention and own observation. Most of elderly and disabled respondents lack network to enable them to access information on climate change as they found it difficult to move from one place to another Akter and Bannet (2009). The study shows that most of the youth and adult were too cosmopolite as they received climate change information very quick as they have friends from a far distance and can move from one place to another. A member from Kanga FGD said:

> *"...youth and the other active age have more information about climate change as they have many friends in town compared to dependant group who lag behind in getting information pertaining climate change"*.

Magazines were not found or sold in fishing area, but people bought them when they came from town. It was also found that there was no electricity in the study area thus makes it difficult for the respondents to use television. Only few of them had solar energy hence

artisanal fishers had no access to or had little information pertaining climate change. Sampei and Aoyagi (2009), Usui (2009) and Akter and Bannet (2009) revealed that the exposure to mass media increases the awareness and concern associated with climate change which is not the same as observation from the study as respondents used traditional way (events) such as long rain when it is not its season, a flock of birds flying and *kakakuona* pangolin of knowing the change in climate as there was little mass media used.

4.3 Adaptive Capacity of Artisanal Fishers

The second objective focuses on adaptive capacity to climate change by considering the ability artisanal fishers have to overcome climate change challenges. This capacity is measured in terms of fish catch per season, ownership of fishing gears, organization of fishing activity and methods used in fishing.

4.3.1 Fish Catch per a season/years

From the interviewed respondents, it was noted that the catch was measured in terms of tones of fish-catch per a season and not in kg (Table 5). The majority of the respondents (75.6%) practiced fishing every day, whereas some of them (6.7%) practiced fishing for 6 days in a week, and other respondents(17.8%), practiced fishing for 5 days in a week. The findings in this regard are contrary to those reported by Easterling *et al.* (2007a) whereby other researchers measures the adaptation in fish catch size and effort. Adaptation in the fisheries sector need not be restricted to altering catch size and effort. Numerous options are available, many focus on building adaptive capacity and resilience, and many also contributing to additional goals of improved fisheries management and poverty reduction, and on improving the livelihoods of poor rural people who are at risk from the effects of climate change (Easterling *et al.,* 2007b).

There was no big difference based on the food security improvement for the artisanal fishers and the years spent in fishing since the average years of respondents in fishing were 1-20 years (72.2%), 21-40 years (24.4%) and 41-60 years (3.3%) (Table 5). Decrease of the fish catch was the major change expressed by the respondents. Majority (93.3%) of the respondents described a big change in catch per tones in recent years. According to focus group discussants, the catch has decreased much due to change of climate and increased number of fishers in the Rorya Distrct. Most fishers were not the native; they immigrated from other places such as Nkome in Geita Rural District, Ukara in Ukerewe, Musoma and Bunda. Migratory tendencies were caused by the ban, which was passed by the government to rescue fish habitats in their respective fishing areas. The fishers shifted to the Rorya District since the ban was not seriously followed. This was said during focus group discussion in Nyang'ombe village.

Table 5: Fishing period

Variable (years)	Frequency	Percent
1-20	65	72.2
21-40	24	24.4
41-60	3	3.3
Total	**90**	**100**

4.3.2 Ownership of fishing gears, organization of fishing activity and methods used in fishing

Most fishers (70%) in Rorya District practiced fishing in crew, while 20% practiced fishing alone. Gill netting was the commonly used fishing method in Rorya. About 47% of the artisanal fishers used gillnet, some of artisanal fishers used hooks (14.4%) and others (23.3%) used small nets. Although there was a new traditional fishing method locally called (*dema)* a wickerwork trap only few (15.6%) preferred this method. About 70% of fishers had their own fishing gears; while 20% didn't have any of the fishing gears, but

used to rent (Table 6). Fishing was the main source of income of the respondents; it was practiced by the entire respondent due to the fact that the soil at the lake zone is infertile that does not support crop farming activities.

About half (51%) of the fishers practiced agriculture activity but they grew only bitter cassava and sweet potatoes as they were the only food crop that could grow under the sand soil. Few (7.8%) of the fishers practiced vegetable faming along the lake banks, there were also18.9% of fishers who were carpenters and tailors, most of these tailors and carpenters were disabled persons. Few fishers (3.3%) in the study area practiced livestock keeping. However, there were 18.9% of fishers who did not practice any activity apart from fishing, during non- fishing season they stayed idle (Table 6).

Majority (83%) of fishers used to change fishing grounds depending on the availability of catch in the area; this means that they didn't catch fish in the same area daily, whereas 1.1% of fishers caught fish in the same ground and 6.7% of the fishers used Tsh.180 000 to hire the fishing gear and majority (72.2%) of fishers were given gears by the fish agents, on the condition that they had to sell the captured fish to the same agent (Table 6). Other minor activities were carried out on temporal basis (vegetable selling, carpentry and tailoring) during non fishing season. Nevertheless, all artisanal fisher folk depended on fishing for their livelihood.

Table 6: Cost for renting fishing gears and organization of fishing

Amount Tshs/= per month	No. of Fishers	Percent (%)
150 000	12	13.3
180 000	6	6.7
300 000	7	7.8
Sold fish to the agents	65	72.2
Total	**90**	**100.0**
Organizing fishing		
A lone	20	22.2
In a crew	70	77.8
Total	**90**	**100.0**

4.4 Major Livelihood Challenges of the Fishing to Artisanal Fishers

4.4.1 Introduction of Nile perch in Lake Victoria

The findings show that majority (56.7%) of the respondents argued that the introduction of Nile perch in Lake Victoria in 1980s brought a big challenge to them (Table 7). That was due to the fact that Nile perch *lates niloticus* feed on other fish species thus led to the disappearance of many species in Lake Victoria especially Nile tilapia *Oreochromis niloticus*, (dagaa) *Sardines* and the native fish species, such, as (ngege) *Oreochromis esculentus*, (gogogo) *Synodontis victoriae* and furu *Haplochromine (*Harris *et al.,* 1995). Nile perch species dominate the fish community in Lake Victoria. It is believed that Nile perch is responsible for the extinction or severe decline of several hundred Cichlid species in Lake Victoria. Nile perch is type of fish mainly for generating income as were sold to the factory for exportation thus decreased the availability of other types of fish species.

Nile perch were deliberately introduced to Lake Victoria due to attempt to augment the indigenous fishery for tilapia without knowing its side effect. Some respondents (8.9%) said that the challenge they faced in fishing activity was deforestation, 28.9% of the respondents complained of climate change as the challenge to fishing activity, some (3.3%) mentioned environmental pollution also as a challenge to the artisanal fishers and

2.2% of the respondents complained over increase of artisanal fisheries. Findings from this study are in line with what was reported by (Scully (1975) that Inshore (Furu) *Haplochromine* fish is the heavier fished thus have been declining rapidly in heavily fished area and Harris *et al.* (1995) argues that the introduction of Nile perch *lates niloticus* in Lake Victoria was due to introduction of international trade which increased demand on lake fish thus led to disappearance of other species.

Table 7: Challenges fishers face in fishing activities

Variables	Frequency	Percent
Climate change	26	28.9
Deforestation	8	8.9
Introduction of Nile perch in Lake Victoria	51	56.7
Environmental pollution	3	3.3
Increase of artisanal fisheries	2	2.2
Total	**90**	**100.0**

4.4.2 Deforestation

Deforestation means cutting down trees without replacing them. Deforestation affects climate change because it releases the carbon stores in the plants and soils alters the physical properties of the surface (Bala, 2007). It is obviously known that trees are used as the source of rain catchment thus people were ought not to cut trees anyhow. However, deforestation was reported by some respondents (8.9%) as a challenge during non fishing season people engage themselves into different activities that would make them put a hand into a mouth to sustain their lives. Trees were cut to make charcoal for sale so that fishers would get money to buy food (Table 7). It was also revealed that deforestation is one of the challenges encountered in fishing activities as tree cutting makes fishing area bare and thus causes evaporation of lake water which led to fish migrating to areas with water as they cannot survive in very little water Oldrup, *et al.* (2009). This also affects the

availability of food in the fisher's community and decreased income making the communities not afford social services such as education and health.

4.4.3 Climate change and artisanal fishers

Climate change is the most serious problem facing human society all around the world especially artisanal fishers as climate change affects water sources. That was seen in a study area where 28.9% of the respondents complained about climate change being the major challenge in their fishing activities (Mustapha, 2012). According to FGD climate change affects water surface temperature which damages the water hyacinth *magugu maji* which serves as breeding habitat and may help protect the shore wave action, the exposure to which affect lake level. This implies that climate change is the priority challenge in the study area (Table 7).

Climate change contributes to food shortage as artisanal fishers depended on fish for their livelihood. Table 8 shows that 93.3% of the respondents agreed with the statement that climate change was the cause of the disappearing and appearing of fish in Lake Victoria. According to the respondents, when the temperature is high the fish species migrate to the deep water to cool their bodies. Other respondents (6.7%) opposed the statement that climate change was the cause of disappearing and appearing of Tilapia fish from Lake Victoria (Marten, 1979). Table 8 also shows types of fish species disappearing in the shore of Lake Victoria, 66.7% of the respondents argued that *Sardines* (*dagaa)*, Nile perch, Tilapia and *Synodontis victoriae* (gogogo) were type of fish species disappearing from Lake Victoria. Climatic change has caused in the disappearance of local community preferred species which were found from Lake Victoria and the demand for fish increases while fish resource decreases, was reported by Rwang'enyi FGD.

The findings from this study agree with those reported by Marten (1979) who studied the impact of fishing on the inshore fishery of Lake Victoria (East Africa). The author found that some fish species were declining especially *Tilapia esculenta,* previously the fish of greatest commercial importance, has virtually disappeared much from the lake. Numerous fish have declined drastically during the past decade. During FGD argues that climatic change has resulted in the disappearance of some preferred species which were found in Lake Victoria and the demand increase with the decrease of resources. During FGD in Nyang'ombe, it was revealed that climate change also led to change in the location and size of suitable range for particular species like tilapia. The findings from this study are also supported by Mustapha who reported about reduced productivity of commercially important species and that allowable catch per unit efforts by the fishermen are some of the possible consequences of climate change scenarios on artisanal fisheries (Mustapha, 2012).

Table 8: Type of fish species disappearing and Climate change as cause of fish disappearing

Fish species	**Frequency**	**Percentage**
Sardines Dagaa and Nile Tilapia *Oreochromis niloticus*	14	15.6
Nile perch *lates niloticus* and Nile Tilapia *Oreochromis niloticus*	8	8.9
Sardines Dagaa, Nile perch *lates niloticus*, Nile Tilapia *Oreochromis niloticus* and gogogo *Synodontis victoriae*	60	66.7
Sardines Dagaa, Nile Tilapia *Oreochromis niloticus* and Nile perch *lates niloticus*	7	7.8
Nile Tilapia *Oreochromis niloticus*, gogogo *Synodontis victoriae* and *Haplochromine* Furu	1	1.1
Total	**90**	**100**
Climate change as the cause of appearing and disappearing of fish		
Yes	84	93.3
No	6	6.7
Total	**90**	**100**

4.4.4 Environmental pollution

Environmental pollution as a challenge to artisanal fishers in fishing activities was reported by few 3.3% respondents who argued that environmental pollution was a challenge in their fishing activities (Table 8). Human activities such as industrial processes, energy generation from fossil fuels, deforestation and intensive land use practices are said to be the major causes of global Green House Gas (GHG). Currently emissions are rising by more than 3% per annum (Hamilton, 2009). The Nyamongo Barrick Gold Mining in Tarime District deposits its waste product that contained chemicals into River Mara which pours its water into Lake Victoria. The discharged waste becomes toxic to fish which kills several fish and causes harm to fishing community as they feed on poisoned fish. Environmental pollution causes fish migrating from their habitant area and fish kill.

4.4.5 Increase of artisanal fishers

Findings show the increase of artisanal fishers as one of the challenges for fishing activities as reported by 2.2% of the respondents. The increased artisanal fishers in the fishing area led to overfishing that caused over-exploitation and the decline of fish species (Sharma, 2007). This is because Nile perch became a popular fish species after the disappearance of native species and used for economic purpose for generating income, currently being severely over fished in Lake Victoria. Over fishing leads to the decline of fish especially due to increased number of fishers from other parts of Tanzania and, along with this fishers' increase, there is an increased use of illegal fishing gears. This has resulted in decreases in the size and number of fish species in Lake Victoria inshore.

The results from this study are supported by those of Sharma (2007) who reported that, increase in artisanal fishers led to an increase in human population which had impacts on

the environment. Use of natural resources and production of wastes associated with environmental stresses like loss of biodiversity, air and water pollution increases pressure on the resources. Growing population poses some serious environmental threats. More people means less forest, water, soil and other natural resource (WPDS, 2007).

4.4.6 Health challenge in fishing area

Based on focus group discussions in the study area, women complained on sexual transmitted diseases and HIV/AIDS as a major challenge in their fishing activities. One woman said

> '' *most of our young (youth) are dying out of HIV/AIDS, the old ones are taking care of the orphans instead the old people are to be taken care of, it was a burden to women and old ones''.*

The findings observed in this study partly contrasts those reported by Bello (2012) who noted that 98% of fishers were affected by malaria, typhoid and water borne diseases; he did not mention about HIV/AIDS. In the study area during high season of long rains locally termed as *masika* there were high fish yields due to the fact that fish come near to the inshore of the lake for food searching, thus made fishers migrate and leave their partners (wives) behind at home, and while away fishers sometimes practiced unsafe sex, leading to the spread of HIV/AIDS (Bamett and Grellier, 2003). The disease destroys the working age/active age hence contributes to food shortage and starvation when the active labour is affected with HIV/AIDS; other households members (dependants) are unable to adapt to climate change.

Based on FGD at Rwang'enyi village, malaria was the leading health challenge among the fishers followed by typhoid and other water borne diseases like cholera which affected artisanal fishers. This was due to lack of clean and safe water in fishing areas since fishers

use water from the Lake. Based on this, women suffered a lot, playing different duties in fishing activities as they depended much on natural resources and have to take care of the sick fishers and children. This result is in line with that of Oldrup and Breengaad (2009) whose research found that women depended much on natural resources and agriculture activities than men.

4.4.7 Disabilities as a challenge in fishing activities

The disabled respondents also, complained as they said during FGD that,

> *''our disability makes us unable to participate well in fishing activities as we cannot go fishing directly in the Lake''*.

However, majority (85.6%) of the respondents complained that they did not get any assistance, thus made their life to be very difficult ending up facing food shortage (Table 9). The cripples could not walk to the lake inshore while the albino faced difficulties with sun rays during hot season. Because of the disadvantaged position of women and the disabilities, their ability to cope with climate change is lower than that of men, and, hence, climate policies are not gender-neutral (Lambrou & Piana, 2006).

Moreover, disabled fishers lack fish drying machines which led to use traditional means such as sun drying, salted the fish, and smoked and chilled the fish. During long rain season the fish get spoiled due to lack of sun leading to decreased income and food shortage. A participant during FGD in Kanga village said that;

> *....We disabled face a lot of challenges different from other gender, as we cannot get into a boat and do direct fishing yet we have to hire youth to do the work but sometimes they are not sincere in terms of money after fishing. So we need support*

to enable us to get into fishing grounds. If we could be provided with fish drying machines, we could perform our work easily.

Table 9: Kind of assistance and Food accessibility

Kind of assistance and Food security	Frequency	Percentage
No assistance	77	85.6
Environment management	2	2.2
Fishing strategies	3	3.3
Fisher's organization knowledge	2	2.2
Climate change awareness	6	6.7
Food accessibility		
Yes	31	34.4
No	59	65.4

4.4.8 Food security/insecurity among artisanal fisher folk

Food insecurity in the study area was probably due to the existence of infertile land that could not favour farming activity. It was observed by 65.4% of the respondents that their fishing community was food insecure by observing the food production and diversity with sufficient quantity of food availability on consistent basis food access and degree to access to utilities and services (URT, 2012). However, 34.4% of the respondents accepted to have adequate food which was the minority. These were capable of having resources for fishing such as fishing gears and were able to pay for more workers (Table 10). Food insecurity was due to climate change that led to decline of fish whereby there were some seasons, catches became almost zero such situation led to food insecurity especially for majority who did not practice diversification of economic activities as they depend on one activity (fishing), thus cannot generate income to buy food as they only depended on fish for food and generating income for buying other type of food. The report is in line with what was reported by URT, (2012) that food security is having sufficient resources to obtain appropriate food for nutritious diet and food use.

The findings from this study are in line with argument of Lovenda (2006) that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food. Food security has been used as a vital component in this study to analyze artisanal fisher's livelihood at the Rorya District as it has been widely identified by different scholars (e.g. Maxwell and Smith, 1992 and Davies, 1993) to be one of the elements of livelihood security. Likewise, Tefera contends that ensuring food security at household level is the primary goal of the livelihood strategies of rural households (Tefera, 2003). However, food insecurity on the other direction does not always mean going completely without food the whole day. More often, it means going without *sufficient* food in a day (FAO, 2006). The findings from this study imply that there was a shortage of food in the study area due to climate change and to the challenges fishers encounter.

4.4.9 Fishing Trend

The decrease of fish production in Nyancha Division, Rorya District had been a major problem in recent years as the fishing community primarily relied on fishing activity for their livelihood. Fish were often hit by climate change as increasing temperature tends to affect fishing trend and every stage of fish life cycle from their physiological, morphological, reproductive, migratory and behavioral responses (Daw *et al.*, 2009). Fishers have two trends of fish catch that was long rain season locally termed as *masika* and short rain season locally termed as *vuli*. Appearance and disappearance of fish species affected fishers' livelihood. It was reported by Rwang'enyi Beach Management Union (BMU) official.

4.4.10 Adaptation practices among artisanal fishers

One third of the respondents (30.0%) had chosen diversification of activities as one of the ways to adapt to climate changes and enhance food security among the artisanal fishers (Table 10). That is due to the fact that fishing activities are carried out during long rain season '*masika'* and short rain season '*vuli'*. So during short rain season, the fish catch decrease which led to fishers opts to other activities that would provide them with food for household. This results imply that fishers should not only rely on fishing activity, but also should think of alternative activities to be done in non-fishing season and during fishing season; that means after fishing time they ought to do something instead of remaining idle (Quarantelli, 1998).

Few respondents (28.9%) suggested use of modern fishing gears to enhance food security in the fishing community. Most of fishers used illegal fishing gears like *kokoro* small nets and illegal practice like poisoning the water thus led to climate change after evaporation took place and affect ozone layer. The chemical water turns into chemical gas water through precipitation thus affect ozone layer and cause climate change (Quarantelli, 1998). Fishers suggested that using large gillnets of 10-12cm would catch only adult fish and not small fish. However, 22.2% of the respondents suggest on environmental conservation that is afforestation (planting of trees) to preserve water catchment; reduce evaporation of water through sun rays. This was also revealed during FGD at Rwang'enyi village.

Table 10: Adaptive/ability to climate change among artisanal fishers

Adaptive practices	Frequency	Percentage
Environmental conservation	20	22.2
Use modern fishing gears	26	28.9
Diversification of activity	27	30.0
Organize fishers' association	17	18.9
Total	**90**	**100.0**

4.5 Adaptive Capacity Index for Fishers against Climate Change Impact

Adaptive strategies are important measures that enable people to absorb the impact of shock (for any emergence). Communities have different levels of coping strategies that allow them either respond to hazards or to prevent potential hazard. Communities with greater adaptive capacity face a lower risk of disaster. From the research, it was found that in Rorya District, people have a wide range of coping options that seek to reduce hazard. According to Quarantelli, (1998), the used coping mechanism will differ depending on individual perspective and location.

4.5.1 Cooperatives and association

Coping strategies artisanal fishers adopted to cope with climate change included formation of or joining into cooperatives and associations. However, 72.2% of the respondents argued that they did not have registered cooperatives but the unregistered cooperatives namely village community banking (VICOBA) which helped the members to save and get credit with little interest in return ((FAO, 2002). Majority (83.3%) of the respondents argued that through the VICOBA they saved very little and ended up receiving little in return. On the other hand, though (BMU) was fishers' association, according to artisanal fishers it did not assist them.

The findings from this research are similar to those reported by DFID study in Ghana, whereby fishing communities were exposed to poverty due to poor government support, remote location, poor services, low literacy and innumeracy and weak organizational capacity (DFID, 2001). According to FAO, sustainable exploitation and alternative employment opportunities are important and widely supported for poverty reduction in the small-scale fishery (FAO, 2002). However, in the study area there is little Government support in terms of resource planning, service provision, protection of life and property

and the provision of alternative employment opportunities seemed to be weak thus making the fishing community vulnerable. The government support to the fishers associations would add value. For example, cooperatives in Thannermukkom village in South India were reported to be stronger (Florence, 2010).

4.5.2 Farming

From the interviews it was noted that 51% of the respondents were practicing farming during non-fishing season (Table 11). Though the land was not fertile to grow maize they used to grow bitter cassava and sweet potatoes that could sustain their life. This is due to the fact that they could not go to fishing during that period. One member who participated in FGD in Kanga village said:

> *''...Our soil is infertile, it is a sand type of soil that does not allow maize growing only we try to plant bitter cassava and little of sweet potatoes but farming is not the activity that is dependable for our livelihood, and we only depend on fishing for everything''.*

Fishing is the main source of protein and income with some small subsistence farming also practiced as an alternative during non fishing season. Fishing is important as a means of generating cash and therefore capital for recycling into fishing (inputs and labour) Kirema-Mukasa and Reynolds (1991).

4.5.3 Vegetable selling

A small percent of the respondents (8%) sold vegetables as a coping strategy to adapt to climate change (Table 11). The vegetable selling was practiced by women as they were mostly affected by climate change due to the responsibility of taking care of elderly and

children while men migrated to other area searching for jobs. However, vegetable selling was not done by all women but only those who were capable in financial capital to conduct the business. Fishing, as already mentioned, is the main source of protein and income with some small subsistence farming also practiced. The finding is in line with Kirema-Mukasa and Reynolds (1991) survey on Lake Victoria fisher- folk communities also indicated that 76 percent of adults were engaged in fish-related activities as their principal occupation. Only 17 percent were engaged in farming and 6 percent in the food and refreshment services. This again confirms the importance of fishing as a source of livelihood. Fishing, which entails production, processing and marketing is therefore the most important economic activity for the fishers and is almost continuous throughout the year though seasonal.

4.5.4 Carpentry and Tailoring

Apart from main economic activity, farming and vegetable selling as coping strategies other artisanal fishers were carpenters. The result shows that 11.1% of the respondents did carpentry activity as the coping strategy. The carpentry activity was done by disabled artisanal fishers who found it easy for them. However, few of the disabled artisanal fishers (7.8%) also practiced tailoring (Table 11). Carpentry and tailoring seemed to be a light work for these disabled artisanal fishers. However, artisanal fishers had to diversify themselves with other activities as fishing is a seasonal and thus make their survival become easy. Finding is in line with what reported by Boko *et al.*, (2007) and UNISDR, (2008), climate change affects people with low adaptive capacities and constrained by various factors including endemic poverty, inadequate governance and institutional structures and limited access to capital, markets, infrastructure and technology (Boko *et al.*, 2007; UNISDR, 2008)

4.5.5 Animal keeping

The results show that few (3.3%) respondents practiced animal keeping (cows) as one of the coping strategies (Table 11). This is a small number indeed, it seems most of artisanal fishers depended almost solely on fishing activity for their livelihood. This was proved by 18.9% of the respondents who were observed in the study area as having no any other activity to do apart from fishing activity even during non fishing season they just survived by what they had preserved from fishing. According to Munasinghe, reveals that enhancement to different activities to cope with climate change can improve sustainable development (Munasinghe, 2000).

Table 11: Adaptive capacity to climate change

Adaptive capacity	Frequency	Percent
Cooperatives	65	72.2
Association	75	83.3
Other coping strategies		
Farming	46	51.1
Vegetable selling	7	7.8
Carpentry	10	11.1
No other activity	17	18.9
Tailors	7	7.8
Livestock keeping	3	3.3

4.5.6 Food storage

From this study, it was found that women used to store dried and salted fish for future use. Fish were dried and stored for shortage months. Food shortage months included February through March (lean season) while adequate fish catch periods occurred from July to September. As far as climate change is concerned, people have to store food for future use. One FGD member at Nyang'ombe village said that:

"We normally store dried and salted fish during rainy season and when it's dry season we consume them. This way it becomes easy to cope with climate change impacts''.

According to Mortimore., *et al* (2008) 'If assets are protected through climate change, investments can be cumulative, if not, then investment in food emergencies frustrates growth.

4.5.7 Adaptive capacity index

An adaptive capacity index for fishers against climate change was 18.54, which indicates the lowest as the scale established was 100 highest, 50 medium and 1 lowest (Table 12). Adaptive capacity index for farming was at the medium level as compared to others. The lowest adaptive capacity index for the fishers was observed for their involvement in tailoring.

Table 12: Adaptive capacity index for fishers against climate change

Variables	ACI
Score for age	35.62
Score for household size	5.69
Score for association	16.67
score for cooperatives	27.78
Score for Farming	51.10
Score for vegetable selling	7.80
Score for carpentry	11.10
Score for tailor	7.80
Score for animal keeping	3.30
Overall ACI	**18.54**

Through measuring the adaptive capacity among artisanal fishers' community, it was observed that the mean score was 51.10 indicating that the adaptive capacity for farming was at medium level which was above the average mean score of 18.54. Climate change

and fishing had bad impact to artisanal fishers particularly women and elderly, these were obliged to practice farming as an alternative source of livelihood to cope to climate change impact. Moreover, livestock keeping scored 3.30 adaptive capacity indexes; this is below the mean. As such, artisanal fishers' community had suffered a lot following the impact from climate change. Artisanal fishers had 1-3 cattle. For that matter the artisanal adaptive capacity was low since they were not well economically as they depended much on fishing as their source of income while adaptation requires significant level of fund and resources. Adger (2003) argued that for individuals, their capacity to adapt to climate change "is a function of their access to resources". Household size in measuring adaptive capacity mean score index was 5.69 that means the adaptive capacity of the household was very low because there is no enough labour that can assist in adaption process for example engaging in fishing activities as the household size had few members.

The results indicate that artisanal fishers' adaptive capacity and food security to climate change was at a lowest mean. Furthermore, diversification adaptive indicators help to highlight artisanal fishers' strengths in coping with changes as well as areas for improvement. Adaptive strategies varied between the artisanal fisher folk, which included farming, tailoring, carpentry, livestock keeping, vegetable selling, cooperatives and association. During the interviews, it was noted that: artisanal fishers were more inclined to adopt sustainable practices, managerial and behavioural changes such as involving in farming by planting the crops that can be sustained, for example, sweet potatoes and bitter cassava, in a sand soil as farming had an adaptive capacity index of 51.10 which was above average mean score of 18.54.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Diversification of activities is one of the presumptions of enhancing food security to artisanal fisher folk and to adapt with climate change. The research results shows that the sustainability of fishers' livelihoods of Lake Victoria at Rorya District are insecure due to poor management of resources, limited ability to adapt climate change as the fishers depend almost solely on fishing activity as their source of generating income.

Fishers' perception on climate change among artisanal fishers is still very low. It is due to lack of education and attainment, unequal resource access and control among gender such as women and disabled have access to resource but lack control over the resource. Majority of the artisanal fisher folk have attained primary school level of education that it become too difficult to adapt or have the ability to climate change and enhance food security.

Inefficient of fisher's cooperatives/associations seemed to be an obstacle for fishers to rescue their livelihood when there is a change in climate that fish disappear due to climate change, they could have solidarity to overcome that climate change or adapt to it and continue to have food. Savings and credits for fishers would be solved through cooperative since they will be able to stand as one and speak with one voice thus have ability to climate change. The absence of basic social services near fishing grounds like health centres, clean and safe water supplying systems, poor communication systems and remoteness of the area have led fishers using VIKOBA which displayed an unsustainable situation to the livelihood of fishers community in Rorya District. The BMU is there but

ineffective to give out services needed by the artisanal fisher folk to enable them to adapt climate change and food security.

Adaptive capacity index showed that; artisanal fishers adaptive to climate change were very low as their adaptive capacity average mean index was 18.54 at a lowest level. This shows that the artisanal fishers' ability to adapt climate change is still low.

5.2 Recommendations

From the study findings, the following are recommended ways to enhance the ability of fishers to adapt to climate change and in turn enhance food security among small scale fishers. The fishing communities of the Lake Victoria inshore at Rorya District found to be aware of climate change but have no adaptive capacity over it; there is a need to improve the sector based on the following recommendations:

(i) There is a need of education and training that should be given to fishers so as to diversify and employ themselves in other related activities. Education/training should be provided so as to increase fishers' awareness on climate change and sensitization of the rules, regulations on the importance of proper management of water resource.

(ii) The formation of Fishers' Cooperatives and Associations (i.e. Community Based Organizations) should be given a priority by the district administration so as to rescue fishers' livelihood which exist in an insecure environment. However, fishers should use appropriate fishing gears/methods so as not to over exploit the resources.

(iii) There is a need for interventions to be taken to fishing communities so that to improve artisanal ability to adapt to climate change in their fishing activity to sustain their livelihood.

5.3 Area for Further Research

HIV/AIDS as one of challenges that made artisanal fishers' not have ability to adapt to climate change and enhance food security in the study area. This challenge was found during women FGD at the study area. However, apart from climate change as a major challenge in enhancing food security also HIV/AIDS was among the constraints encountered artisanal fishers. It is suggested that, further study be conducted to find out the direct link between adaptive capacity to climate change and HIV/AIDS among artisanal fisher folk.

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APPENDICES

Appendix 1: Schedule Interview for the research

ADAPTIVE CAPACITY TO CLIMATE CHANGE AND FOOD SECURITY AMONG ARTISANAL FISHER FOLK-RORYA DISTRICT, TANZANIA

M.A. (Rural Development)

The purpose of this questionnaire is to collect your views concerning gendered adaptive capacity to climate change for enhancing food security to artisanal fisher folk in Rorya District.

I request your cooperation for filling this questionnaire to be interviewed and I assure you that the information will be treated with strict confidence.

Section A: Background characteristics'

1. Name of respondent.....Name of Division……
   Ward……..... Village...….....

Questionnaire number..... Date of interview.....

2. Sex of respondent
   (1) Male….....…….
   (2) Female…….....
3. Age of respondent ……
4. Gender of respondent
5. Men
6. Women
7. Youth
8. Elderly

9. disabled

10. Household size……...

11. Education level:

    (1) No formal education;

    (2) Partial-primary

    (3) Primary;

    (4) Secondary

    (5) Collage

    (6) Others (specify) ……

12. Marital status

    (1) Single

    (2) Married

    (3) Divorced

    (4) Widow/Widower

Section B: fishing and Socio-economic activities

13. Main source of income of the respondents……

14. How do you organize the fishing activity?

    (1) Alone

    (2) In crew

15. What means/methods of fishing are commonly used?

    (1) Hooks

    (2) Gillnets

    (3) Small nets

    (4) Others specify.....

16. If any set a reason for change? ……..

17. Do you have your own fishing gear and/or craft?

(1) Yes

(2) No

18. If No, do you rent them? And how much does it cost for renting.....……

19. Is fishing your main source of income?

(1) Yes

(2) No

20. If no, specify other activities apart from fishing

- …….....
- …….....
- …….....

21. Are you fishing in the same place every day or you change the ground according to the season, describe. .....…….....

22. How much do you catch per day? …….

23. What kind of species is mainly caught, specify type and seasonality of species

- …….....…
  …….....…
- …….....…
- …….....

24. Have you ever got training or assistance from the natural resource management department?

(1) Yes

(2) No

25. How many days do you get to go fishing during the season? ……

26. How long have you been fishing? Specify……

27. Have you noticed any changes over the years in terms of quantity and size of fish? Describe the difference per season. …….....

28. What are the main problems do you face in your daily fishery activities?……..…….....

29. What other activities do you look for during the non-fishing season? .....……

Section c: perception on climate change

30. Have you ever noticed any climate change occurred in your village in the past 10 years?

    - Yes
    - No

- Please tick a number from the scale to show how you agree or disagree with each of the following statement.

S/No	Statements	SA	A	U	SD	D
1	There is no relationship between climate change and rainfall pattern					
2	Climate changes have a very big impact in fish production					
3	Rainfall fluctuation occurring in recent years is the effect of climate change					
4	Climate change lead to disappearance of fish					
5	Traditional perception of climate change lead to food insecurity					
6	Artisanal fishers are highly affected by climate change					
7	Artisanal fishers play a great role in fishing activities and improving food security					
8	Artisanal fisher folk low adaptive capacity to climate change					

Key definition of likert scale

SD= Strong disagree
D = Disagree
U = Undecided
A = Agree
SA =Strong agree

In the past ten years is fishing yield increasing or decreasing?

- Increasing
- Decreasing
- Remain the same

Appendix 2: Questionnaires to key informants

A. To examine fisheries perception to climate change

1. How do women, men, youth and vulnerable groups perceive change in weather?
2. What do the artisanal fishers do when there is less number of fishes in the system?
3. Is climate change a curse from God after wrong doing?
4. What is traditional believe of climate change?

B. To identify their ability to access food, income, services, used by artisan fisher folk for food security

1. What adaptation practices have been developed by artisanal fishers for enhancing food security?
2. What are the major livelihood challenges of the fishing to artisanal fishers' in Rorya District?
3. Do artisanal fisher folks in the area depend only in fishing for enhancing food security?
4. Do men, women, youth and vulnerable groups involve in fishing activities?
5. Who are most affected by climate change? Is it men, women, youth, elderly, children or vulnerable groups?
6. What are the main fisher's problems?
7. What are the rules for fishing in the area?
8. Are there any illegal gears being used?
9. What are the measures used to prevent illegal gears?
10. What species do artisanal fishers catch in the area?

C. To determine factors for and major elements of adaptive capacity to climate change

1. What factors that make artisanal men, women, youth and vulnerable Groups aware to climate change?
2. How do artisanal fisher folks cope with climate change?
3. Are there any main changes you have noticed over years based on adaptation to climate change for enhancing food security?
4. Is there any fishers association or cooperatives in the area?
5. How does men, women, youth and vulnerable groups adapt to climate change for enhancing food security to artisanal fisher folk?
6. Do men, women, youth and vulnerable groups involve in fishing cooperatives or association?
7. How do women, men, youth, elderly and vulnerable groups manage to share their ability to fight against floods and drought?
8. What adaptation strategies to climate change do you offer to help in improving food security in the area?
    - What are the main challenges that you face on ensuring proper adaptation to climate change for improving food security to artisanal fisher folk in the area?

Appendix 3: Focus Group Discussion

A: Perception of climate change

1. What do you know of the climate change?
2. What is the local language associated with climate change?

B: Trend of climate change over the year

3. What has happened over years concerning climate change?
4. How serious was the problem?
5. What were the responses of the people, government and local institution?
6. What was the local language used to identify this situation?

C: Fishing strategies

What has been the practice used by the artisanal fisher folk

S/No	Practices used	How long	Local name

Thank you for your cooperation