GENDER SPECIFIC ADAPTATION PRACTICES TO THE EFFECTS OF CLIMATE CHANGE IN BAHI AND KONDOA DISTRICTS, DODOMA REGION, TANZANIA

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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EXTENDED ABSTRACT

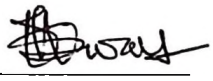
Climate change has differentiated effects between men and women, but there is scarce information on how men and women are adapting to the effects in Tanzania. The main objective of this study was to establish gender specific adaptation practices to the effects of climate change in Bahi and Kondoa districts, Dodoma Region, Tanzania. The study adopted a cross-sectional research design whereby both quantitative and qualitative data were collected from a sample of 360 respondents, 12 focus groups and 78 key informants. Focus group discussions, key informant interviews and a questionnaire survey were used to collect data. The analysis of quantitative data involved descriptive and inferential statistics using Statistical Package for Social Sciences (SPSS, Version 12.0) computer software programme. Qualitative data were summarized by using content analysis. Inferential analysis involved Chi-square test at $p < 0.05$ level of significance to determine relationships between study variables; F-test was used to determine the significance of the trends of anomalies of rainfall, temperature and wind speed; and a multinomial logit regression model was used to determine factors influencing choice of climate change adaptation options between men and women, using Nlogit 3.0. The indices of four climate change indicators (increase in rainfall variation, temperature, strong wind and drought) were formed to measure perception on climate change. This thesis was developed in papers format. It presents three published papers by the *Journal of African Studies and Development* (JASD), *Research on Humanities and Social Science* (RHSS) and *Sustainable Development* (JSD). The first paper, Swai *et al.* (2012a) determined the perception on climate change by sex and investigated the evidence of climate change from meteorological data. The results in this paper revealed that the majority of men and women perceived climate change. There was significant association between perception on climate change and sex of respondents. The trends of anomalies of meteorological data showed a significant decrease in rainfall amount for Bahi Districts, an increase in mean

minimum and maximum temperature and mean wind speed for Dodoma Region, proving that climate had changed. The second paper, Swai *et al.* (2012b) examined the effects of climate change on agricultural production by sex and found that, men and women perceived and were affected differently by climate change. Women were more likely to perceive the severity of the effects of climate change during food shortage or hunger, water and firewood shortages and when they were subjected to bad food debts whereas, men were more likely to perceive the severely of the effects of climate change when they wasted resources including productive land, seeds and labour due to floods or drought and when they out-migrated to search for casual labour or food grains away from home. There was a significant association between perceived effects of climate change and sex of respondents. The third paper, Swai *et al.* (2012c) investigated adaptation practices undertaken by men and women to adapt to climate change. The results indicated that women were more devoted to adaptation practices that enabled them to adapt to or reduce effects of climate change during food shortage or hunger, water and firewood shortages; and men were more devoted to adaptation practices that enabled them to adapt to or reduce effects of climate change on crops, livestock and land and/or environment. There was a significant association between adaptation practices undertaken by respondents and sex of respondents. The results of a manuscript that evaluated determinants of climate change adaptation, which was also a gendered analysis revealed that socio-economic, cultural and demographic factors had significant effects on the choice of climate change adaption options between men and women. The factors determining the choice of climate change adaptation options between men and women were not the same. Generally, the study concludes that men and women perceived climate change differently, were affected differently, and thus adapted differently to the effects of climate change, emphasizing the need for gender differentiated interventions to promote climate change adaptation. The study recommends planners and policy makers in Agriculture, Livestock and Environment sectors, Tanzania NAPA, NGOs and other development practitioners to use gender

sensitive interventions to manage climate change effects; and suggests a study of this kind (systematic collection of in-depth information at the community level) to be undertaken in other semi-arid areas and regions of Tanzania in order to gather more information that can justify generalization of the findings on gender and climate change. This is because climate change effects are location specific, and adaptive capacities of individuals vary across the country.

DECLARATION

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



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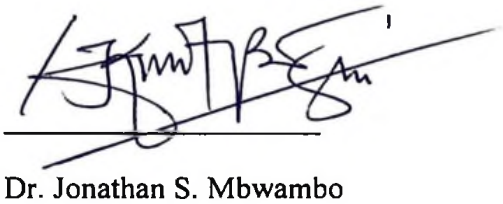

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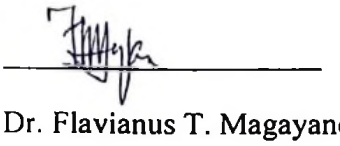

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DEDICATION

This work is dedicated to my Lord Jesus Christ.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
CARE	Co-operative for Assistance and Relief Everywhere
CBOs	Community Based Organizations
CO_2	Carbon dioxide
COP	Conference of the Parties
DADPs	District Agricultural Development Plans
DCT	Diocese of Central Tanganyika
ECE	Enhanced Greenhouse Effect
FAO	Food and Agriculture Organization
FBOs	Faith Based Organizations
GAD	Gender and Development
GHGs	Greenhouse Gases
HIV	Human Immunodeficiency Virus
IBP	International Biological Programme
INC	Inter-governmental Negotiating Committee
IPCC	Inter-governmental Panel on Climate Change
JASD	Journal of African Studies and Development
LDCs	Least Developed Countries
LGAs	Local Government Authorities
MDGs	Millennium Development Goals
NAPA	National Adaptation Programme of Action
NGOs	Non-Governmental Organizations
SACCOS	Savings and Credit Co-operative Societies

SGR	Strategic Grain Reserve
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
TMA	Tanzania Meteorological Agency
UDSM	University of Dar es Salaam
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
URT	United Republic of Tanzania
USGCRP	United States Global Change Research Programme
WAD	Women and Development
WFP	World Food Programme
WID	Women in Development

CHAPTER ONE

1.0 INTRODUCTION

This thesis was developed in papers format. The main objective of the study was to assess gender specific adaptation practices to the effects of climate change in Bahi and Kondoa Districts, Dodoma Region, Tanzania. To work out issues, the thesis was split into four major areas of study that facilitated development of three papers all written by Swai *et al.* (2012) and published by the *Journals of African Studies and Development* (JASD), *Research on Humanities and Social Science* (RHSS) and *Sustainable Development* (JSD); and a manuscript. The main agenda for the entire thesis was around the problem described in sections 1.1 and 1.2.

1.1 Background Information

Climate change is one of the global problems and an additional burden for developing countries still striving to reduce poverty and encourage sustainable development (IPCC, 2007a; Bambaige, 2007). Its effects, including variations in temperature and rainfall, droughts, floods, heat waves and the intensity of hurricanes and typhoons are already experienced across the world. Climate change effects are disproportionately distributed among different regions, income groups, occupations and between men and women. The poor (of whom 70% are women), primarily in developing countries, are more vulnerable and thus more affected by climate change (IPCC, 2007a).

In Africa, climate change is already having serious negative effects where much of the population is suffering from direct results of increased temperatures, changed rainfall patterns and rise in sea levels (UNFPA, 2009). Decreased precipitation has resulted into

water stress, reduced ground and surface water; loss of human lives and livestock; and shrinkage of lakes, such as Lake Haubi in Tanzania. The negative effects of climate change are more severe in sub-Saharan Africa where agriculture is the most important economic activity and source of food and income (Mkandla, 2009; Boko *et al.*, 2007).

Climate change has been the major constraint to agriculture productivity in Tanzania. Rainfall shortage has become an outstanding cause of crop failure and livestock deaths especially in semi-arid areas (Bambaige, 2007). For example, between 2004 and 2005, about two million people suffered from food scarcity due to extreme drought that occurred to three quarters of Tanzania (URT, 2007; Yanda *et al.*, 2006). Moreover, Dodoma Region in Tanzania is among the regions severely affected by failing agriculture due to climate change, as the region is situated in a semi-arid area (FAO, 2008).

Although all smallholder farmers in Dodoma Region are affected by climate change, women are more vulnerable because in addition to extreme poverty and low adaptive capacity, they make up a large number (63% in Tanzania) of individuals working in agricultural production, which is rain-fed and, therefore, more sensitive to climate change (Brody *et al.*, 2008; IPCC, 2007; URT, 2007). In addition, inequalities existing between men and women that often restrict women's property and land rights, constrain women from accessing important resources such as land and credit, thus undermining further their adaptive capacity (Osman-Elasha, 2008; Brody *et al.*, 2008). The fact that women are likely to be more affected by climate change is also supported by climate change literature including UNFPA (2009) and UNDP (2009), which insist that gender and climate change studies have to be undertaken from the grassroots in order to gather disaggregated information.

Gender refers to the differences in socially constructed roles and opportunities associated with being a man or a woman and the interactions and social relations between men and women (UNFPA, 2009). It extends beyond women and girls and includes men and boys and the relationship between the sexes. CARE's gender policy defines gender as "social differences between females and males throughout the life cycle that are learned, and though deeply rooted in every culture, are changeable over time, and have wide variations both within and between cultures" (CARE, 2010). Though gender is not a synonym for women, gender studies often focus on women because gender is a social construct and the position of women in society is unfavourable to that of men from every aspect - politically, economically and culturally (Parikh, 2007). Inequality between the sexes is not due to biological factors, but is determined by the learnt, unequal and inequitable treatment socially accorded to women. With regard to climate change, gender becomes even more critical because climate change adds another layer of inequality between women and men that is, men and women been affected differently by climate change (Kapoor, 2011; UNDP, 2010; UNFPA, 2009).

According to the IPCC (2007b), climate change refers to a change in the state of climate that can be identified, for example, by using statistical tests, by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It is a long-term continuous change (increase or decrease) to average weather conditions (for example, average temperature) or the range of weather, for example, more frequent and severe extreme storms (Dinse, 2011). Climate change may be due to natural internal processes or external forces or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2007b). Adaptation to climate change is defined as any "adjustment in natural or human systems in response to actual or

expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities". It is an action that minimizes the consequences of actual and expected changes in climate. Adaptation seeks to reduce vulnerability, increase resilience, moderate the risk of climate impacts on lives and livelihoods, and takes advantage of opportunities posed by actual or expected climate change (Nyanga *et al.*, 2011; Klein *et al.*, 2007; IPCC, 2007a).

Effective implementation of adaptation strategies that is, adaptation strategies that consider needs of men and women can reduce potential loss in agricultural production. It can minimize both natural disasters and potential conflicts over natural resources; and reduce unequal gender relations (Brody *et al.*, 2008; Hilpert *et al.* 2007; Adger *et al.*, 2003). In order to have effective adaptation practices, adaptation needs of men and women should be integrated into interventions planned to reduce negative effects of climate change (Bapna *et al.*, 2009; Lambrou and Piana, 2006). However, little is known on how men and women may be affected differently by climate change and may adapt differently considering their roles and responsibilities in the society.

1.2 Problem Statement and Justification

1.2.1 Problem statement

Climate change has differentiated effects between men and women, but there is a scarcity of information on the adaptation practices implemented specifically by men and women in Tanzania including Dodoma region (UNFPA, 2009). Men and women play different roles, and those living in harsh environmental conditions have different local knowledge that has enabled them to protect their families, assets and secure food security during floods or severe drought (Adger *et al.*, 2009; Agrawal *et al.*, 2008; Brody *et al.*, 2008). Moreover,

previous studies by various scholars, including Lema and Majule (2009), Paavola (2008) and Maddison (2006) have reported farmer observations of climate change and existing adaptation strategies for managing climate risks such as proper timing of agricultural operations and use of drought tolerant crop varieties. But reported adaptation practices are not differentiated to realize specific adaptation practices undertaken by men and women. There is no attention given to specific needs of men and women in adaptation to the effects of climate change, considering the fact that, men and women are affected differently (UNFPA, 2009; Brody *et al.,* 2008; Lambrou and Piana, 2006).

Lack of disaggregated data on gender implies that climate change policy makers in Tanzania including implementation of the National Adaptation Programme of Action (NAPA) cannot come up with gender specific policies, which will realize the adaptation needs of men and women (URT, 2007). Gender blind interventions will be less effective in addressing aspects of climate change as they may exacerbate the problems associated with climate change by widening inequalities existing between men and women (UNFPA, 2009). Such interventions will also be short of experience and knowledge of women in dealing with harsh environment, which is among the important knowledge base in formulating effective climate change policies. For example, it is argued in Lambrou and Piana (2006) that t*he argument favouring implementation of Kyoto Protocol would be strengthened if it included recognition of gender economics,* indicating that failure to recognize gender economics in Kyoto protocol could weaken implementation of that policy. Therefore, this study was done in Bahi and Kondoa Districts, Dodoma Region to collect disaggregated data on gender and climate change perception, effects of climate change, adaptation to climate change effects and factors determining the choice of adaptation options between men and women in order to fill part of this information gap.

1.2.2 Justification of the study

This study presents a critical view of gender dimensions of climate change and provides gender disaggregated information on the way men and women perceive, are affected, are adapting to climate change effects and factors determining the choice of adaptation options between men and women. The gender disaggregated information provided is important in designing and implementing policies, programmes and projects that can lead to greater equality and that may contribute to building more capacity to adapt to climate change (UNDP, 2009). The knowledge on gender specific adaptation practices implemented in specific locations is important in interventions, policies or adaptation options as this knowledge would be used as a base to formulate effective adaptation practices, which would take into account the differences between men and women.

Identification of factors influencing the choice of climate change adaptation options between men and women would uncover important factors, which facilitate implementation of adaptation practices between the two groups; and areas that need improvement in order to increase their adaptation efforts. This information is essential for policy makers and planners dealing with climate change in Tanzania including the Tanzania NAPA, planners in agriculture, livestock and environment sectors; Local Government Authorities (LGAs) and other institutions dealing with climate change including Non-Governmental Organizations (NGOs). The findings also provide important knowledge that can be used as a base by the Tanzania NAPA to improve adaptation practices in Dodoma Region. The study is in line with some Millennium Development Goals (MDGs) including eradicating extreme poverty and hunger, achieving gender equality, combating diseases and ensuring environmental sustainability (Leary *et al.*, 2008).

1.3 Objectives and Research Questions

1.3.1 General objective

The general objective of this study was: To establish gender specific adaptation practices to the effects of climate change in Kondoa and Bahi Districts, Dodoma Region, Tanzania

1.3.2 Specific objectives

1. To examine the perception on climate change by men and women
2. To examine the effects of climate change on agricultural production by sex
3. To investigate the adaptation practices undertaken by men and women in the study area
4. To evaluate factors determining the choice of climate change adaptation options between men and women.

1.3.3 Research questions

1. How do women and men describe climate change? In a long term perspective, does the data of climate properties such as rainfall, temperature and wind show any variations that can confirm that climate has changed in the study area?
2. How do crops, livestock and non-farm production activities affected by climate change? What are the socio-economic effects of climate change on men and women?
3. What measures are undertaken by men and women to reduce effects of climate change? What are the constraints to adaptation to the effects of climate change between men and women? What elements facilitate men and women adaptation to climate change effects?
4. What are the determinants of adaptation to climate change between men and women?

1.4 Limitations of the Study

This study employed a cross-sectional research design, which enables a researcher to study a situation, taking place at a particular moment in time and thus, managing to collect current information (Kothari, 2004). However, some of the information gathered for example, changes in climate between 1970 and 1990 reflected some years back whereby responses of respondents depended on their ability to recall. Recall methods are prone to bias or response errors. Therefore, to minimise errors so as to collect the required and reliable information the same questions were answered by different methods for example, during focus group discussion, key informant interviews and questionnaire survey; and secondary information was also consulted.

This study focussed on gender, a variable that constitutes various social groups including men, women, boys and girls. But the study population required experienced farmers in crop farming and livestock keeping who could recall events that had occurred between 1970 and 2010 regardless of whether they were disabled or old. The study population, therefore, resulted into a sample that denied participation of respondents below 38 years of age in the study. The minimum age for women was 38 years, the age category that involved only two women; and the minimum age for men was 40 years, while the maximum age for both men and women was 75 years. Thus, the majority of respondents were 40 years and above whereas, the mean years of age for men was 54.13 and for women 49.7.

1.5 General Conceptual Framework

The relationship between dependent and independent variables is shown in Fig. 1. The general conceptual framework presented in this study adopted a number of theories as

discussed in section 1.6, of which the concept of *stressors* and *human responses* according to Galvin (2005) were used in the conceptual frame work. *Stressors* in this study were climate change that is, increased rainfall variation, temperature, drought and strong wind that caused stresses that is, physical effects on crops, livestock and non–farm production activities and socio-economic effects on men and women. *Human responses* were actions undertaken to alleviate the stresses that were various adaptation practices implemented by men and women to adapt to the effects of climate change. In addition, gender was considered throughout the study in order to generate disaggregated information. According to Fig. 1, perceiving climate change as a problem depended on the severity of the stresses perceived by men and women due to climate change and its effects on production activities and on their lives. As climate change increased, its physical effects on farm (crops and livestock) and non-farm production activities, together with socio-economic effects on men and women also increased. Men and women were then responding to the effects of climate change by undertaking various adaptation practices to adapt to climate change, depending on different factors that determined choices of climate change adaptation options between them. The response of men and women to stresses resulted into the diverse gender specific adaptation practices implemented by men and women to adapt to climate change.

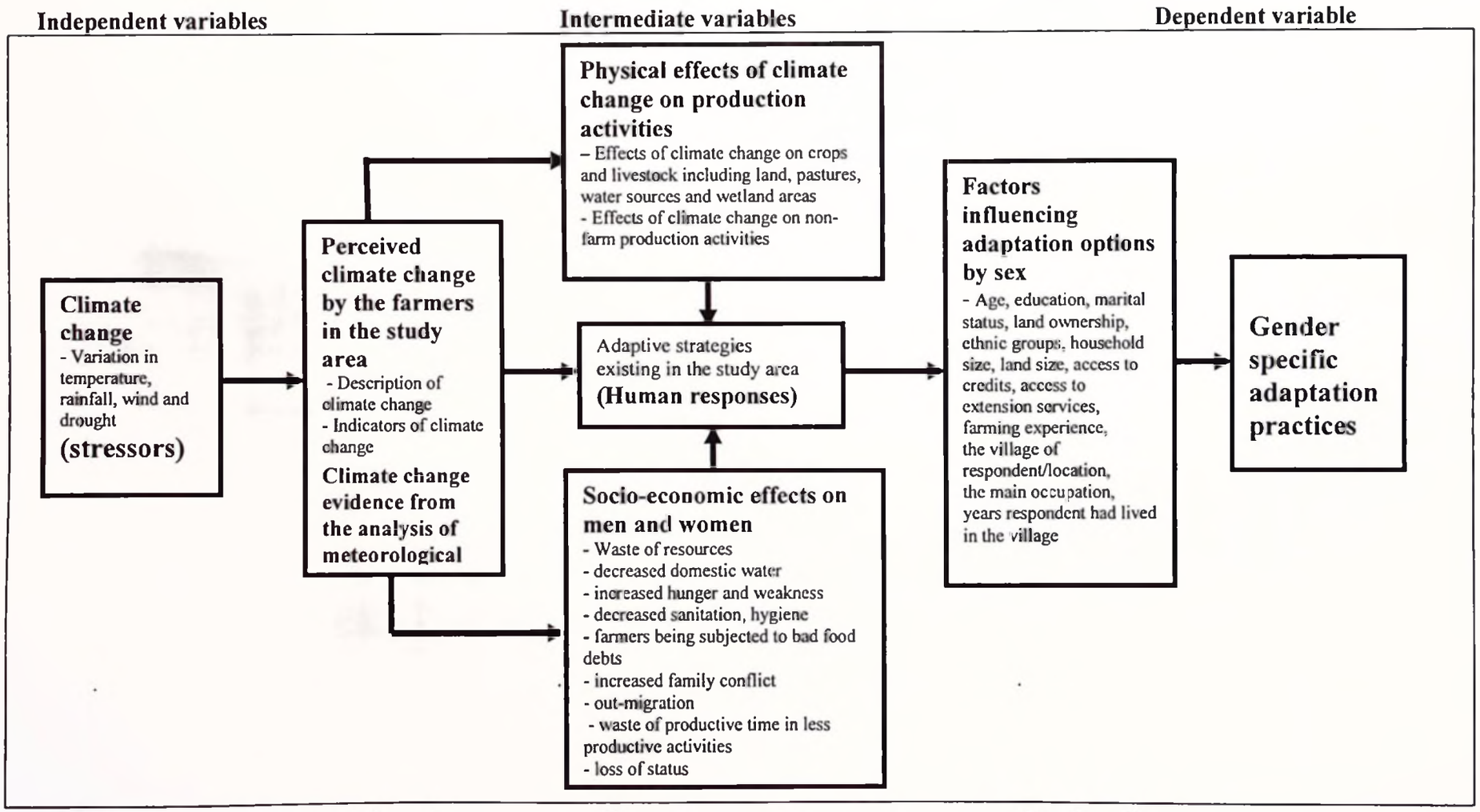

Figure 1: Conceptual frame work (adapted the concept of *stressors* and *human responses* from Galvin (2005))

1.6 Theoretical Framework

This section covers adaptation theory derived from biology of which the concept of *stressors* and *human responses* were used in the conceptual frame work of this study. It shows the evolution of the word adaptation, indicating that the concept of adaptation derived initially from biology, can still be used to address adaptation to climate change. The section also provides an overview of the importance of integrating gender in climate change adaptation and reveals efforts that have been undertaken to incorporate women and ultimately gender in development and environment issues, the efforts that are in line with this study.

1.6.1 Adaptation theory

The word adaptation is rooted in the natural science namely population biology and evolutionary ecology, and it refers to changes in genetic characteristics, which allow individual organisms to survive and reproduce in a particular environment (Lisa *et al.*, 2009; Smit and Wandel, 2006; Kitano, 2002). Ecological concepts such as tolerance, stability and resilience have been used to describe the propensity of biological systems to adapt to changed conditions, and the process by which these changes occur (Galvin, 2005; Davidson-Hunt and Berkes, 2003). Although adaptation to change has a long history both in ecosystems and human societies, it is only in the last two decades that scientists and a growing number of policymakers have begun to struggle with how humanity can actually adapt in a planned and a strategic way as the climate changes (Lisa *et al.*, 2009). Before 1992 the word adaptation was infrequently used in relation to climate change or other environmental risks. Instead, words like human adjustment, coping, risk management; vulnerability reduction and resilience were used (Lisa *et al.*, 2009; Folke, 2006; Gunderson and Holling, 2002).

Beginning in the mid-twentieth century, biological anthropologists focused on human adaptation to climatic environment (that is light, heat, cold, and humidity) through body morphology and body composition, whereby in the 1960s this interest broadened to include the physiological coping mechanisms of adaptation to climate and to other aspects of the environment (Galvin, 2005; Gunderson and Holling, 2002; Holling, 2001). The International Biological Programme (IBP) was a series of studies initiated to build ecological understanding on a global scale by studying undisturbed ecosystems and systems subjected to human interventions (Galvin, 2005). The Human Adaptability segment of the IBP included studies of adaptive mechanisms of populations living under some form of environmental stress, for example, the Eskimo in the Arctic, the Yanomano in the tropics and the Quechua living at high altitudes in the Andes (Galvin, 2005; Hagen, 1992; Smith, 1968).

According to the view of biological anthropologists, the spread of humans throughout the world exposed people of diverse populations to a variety of climatic, floral, faunal (vegetation and animals) and social environments. Adjustments or adaptations were made in response to these new and multiple selective pressures or stressors producing both biological and cultural variations. According to Galvin (2005), a stressor is something that produces a deviation from 'normal' dynamics and a response is something that is done to alleviate the stress. Responses may include moving away from the stress, accommodating the deviation, or compensating for the problem or failure. For instance, a household may respond to a nutritional stress of seasonal food shortages by directing most of the available food to children, a response, which is costly for the adults within the household, but beneficial for children.

Environmental stresses $\Longrightarrow$ human response $\Longrightarrow$ consequences (costs and benefits)

The human adaptability approach addressed specific stressors or limiting factors and the processes by which humans and their systems attempted to cope with stress (Reser and Swim, 2010; Galvin, 2005; Smit and Pilifosova, 2001; Little *et al.,* 2001). This concept of adaptation, derived initially from biology can still be used to address adaptation to climate change, as people, societies and cultures still make adjustments, and the adjustments are intended to reduce vulnerability (Galvin, 2005). According to Reser and Swim (2010), stressors are events or circumstances that tax normal environmental transactions and relationships; and initiate and motivate adaptation responses and stress and coping processes. In the climate change context stressors encompass direct, indirect, and mediated experiences with global climatic patterns and region-specific weather conditions (Reser and Swim, 2010; Wheaton, 1999). The physical environmental impacts and stressors are divided into: discrete stressors as explained by sudden, extreme, environmental phenomena or life changing events, including natural disaster events such as hurricanes or tornados; and continuous stressors for example, prolonged and adverse environmental conditions such as drought (Reser and Swim, 2010; Kasperson *et al.,* 2003). While biological adaptation to stress involves body adjustments, climate change adaptation involves actions that minimize the consequences of actual and expected changes in climate (IPCC, 2007a).

Thus, basing on literature and theoretical aspects reviewed in adaptation theory (section 1.6.1) the ideas of 'stressors and human responses to climatic stresses were adopted in the conceptual framework of this study. Stressors were climate change that is, increased rainfall variation, temperature, drought and strong wind and stresses were the effects of climate change that is, physical effects on crops, livestock and non-farm production activities; and socio-economic effects on men and women. Human responses were actions

undertaken to alleviate stresses that were various adaptation practices undertaken by men and women to adapt to climate change.

1.6.2 The importance of considering gender in climate change adaptation

Discussion on gender dimensions of climate change is a very recent development that started with the Conference of the Parties (COP) 8, held in New Delhi in October 2002. The COP 13 led towards the promotion of gender equality as concerted efforts were made by the Network of Women Ministers and Leaders for Environment to incorporate the gender theme in the negotiations that took place (Agwu and Okhimamhe, 2009). Climate change literature shows that there are important gender perspectives in all aspects of climate change and that women are still underrepresented in decision-making about climate change and greenhouse gas emissions (Brody *et al.*, 2008; IPCC, 2007a; Lambrou and Piana, 2006). In addition, women in many contexts are disproportionately affected by climate change and natural disasters because of their social roles, discrimination, unequal access to resources, poverty, low adaptive capacity and limited mobility (Brody *et al.*, 2008; Parikh, 2007). Understanding and integrating gender-specific vulnerabilities help to ensure that the implementation of gendered adaptation practices relieves some of the disproportionately high burden of the adverse effects of climate change that women bear (UNDP, 2010).

Women should be included in climate change issues not only because they are most vulnerable and victims of climate change, but because they also have different perspectives and expertise to contribute to climate change adaptation (UNFPA, 2009; Parikh, 2007). Women's responsibilities in households and communities as stewards of natural resources has positioned them well suited for livelihood strategies adapted to

changing environmental realities. Including them in decision-making on climate change and other sustainable development issues will facilitate ability of women to contribute their unique and valuable perspectives and expertise on climate change (UNDP, 2009; UNFPA, 2009; Brody *et al.*, 2008). Thus, a gender approach will shed more light on the adaptation mechanisms of different social groups and the levels of vulnerability (UNDP, 2009). It will facilitate designing and implementing policies and climate change interventions that lead to greater equality (Agwu and Okhimamhe, 2009; UNDP, 2009). Gender equality assumes that the different behaviours, aspirations and needs of women and men are equally valued and favoured (UNDP, 2009; UNFPA, 2005).

The findings should feed into negotiations on climate change as well as national debates to enable decision makers to have a better understanding of how different groups of people perceive and are affected by climate change and what kind of capacity and support is needed (Brody *et al.*, 2008; Parikh, 2007). This is a vital element in reducing vulnerability to climate change while protecting and enhancing livelihoods of the poor, both women and men (Soussain *et al.*, 2003). The knowledge thus gained would help improve actions taken to reduce vulnerability and combat climate change in the developing world and in this case agricultural, livestock and environmental sectors. Thus, a critical view of gender dimensions of climate change using case studies across the globe will provide critical gender-disaggregated data on climate change perceptions, effects of climate change and adaptation practices implemented to adapt and or reduce climate change effects for climate change policy makers (Haque *et al.* 2012; UNFPA, 2009; Lambrou and Piana, 2006). Basing on the importance of gender approach, various efforts have been exerted to integrate gender in development and environmental issues, some of which are discussed in section 1.6.3.

1.6.3 Effort undertaken to integrate women and gender in development and environment issues

1.6.3.1 Climate change as a development issue

Considering climate change as a development issue (Huq *et al.*, 2006), the effort to include women in development or empower women started with the emergency of Women in Development (WID) approach in the early 1970s, in reaction to the perceived exclusion of women from development interventions (Risby, 2011). WID approach was a liberal approach that emphasized a focus on poverty (Podems, 2010). The force behind WID came from the emergence of the feminist movement and the publication of Boserup's influential work on women and economic development (Risby, 2011; Tinker, 1990).

During WID, development planners were encouraged to include women in the development field, particularly in development projects whereby women were facilitated to access credit, education, training and better employment to improve their position in the society (Farnworth *et al.*, 2013; Risby, 2011; Norad, 2009; Boserup, 2007). However, the WID approach was criticized by failing to change existed socio-cultural gender biases, as it concentrated on women and also treated them as a homogenous group (Vincent *et al.*, 2010; Sarapura and Mahone, 2009; Brown, 2006). As a result of such criticism another approach that recognized special responsibility of women in the development process, Women and Development (WAD), was formulated. The WAD accepted women as economic actors, advocating their inclusion in development. It also recognized that there were marginalized men in the society, but they failed to propose the way in which such men could be integrated in the process of eliminating gender inequality (Vincent *et al.*, 2010).

Thus, in the 1980s, both the WID and the WAD approaches were challenged for failing to address the basic issues exacerbating gender inequality. This gave rise to the development of another approach of Gender and Development (GAD), which donor organizations adopted as a central element of their approach to development (Risby, 2011; Razavi and Miller, 1995). GAD, in contrast to WID and WAD, does not concentrate its attention exclusively on women, but examines the social construction of gender and the assignment of specific roles, responsibilities, and expectations to women and to men (Podems, 2010; Vincent *et al.*, 2010; Razavi na Miller, 1995). The GAD approach aims to understand the power dynamics between men and women in different contexts arguing that it is only by understanding gender power relations that development can empower women and thereby create positive and sustainable socio-economic change (Podems, 2010; Vincent *et al.*, 2010; Bamberger and Podems, 2002). It recognizes the differential impact of the development policies and practices on women and sees women as agents, not simply as recipients of development. GAD places critical importance on the use of gender analysis to gather and analyse information on social roles based on gender, in order to understand and redress gender-based inequities through development interventions (Risby, 2011; Vincent *et al.*, 2010; Podems, 2010; UNDP, 2009).

1.6.3.2 Climate change as an environmental issue

Regarding climate change as an environmental issue, the effort to integrate gender in environment is revealed in the "gender, environment and sustainable development" theory that ties in with the GAD approach (Rico, 1998). This theory consolidated its position during the 1990s, maintaining that: (i) the discrimination that affects women is expressed in societies mainly through the division of labour by sex, with the result that responsibility for household work and bringing up children devolves almost exclusively upon women;

(ii) inequality between men and women in terms of access to productive resources and the benefits of these; and (iii) limitations on participation in decision-making processes and access to the various forms of public power (Lwanga, 2001; Schultz *et al.*, 2001; Salazar, 2000; Rico, 1998).

From this standpoint, the gender structure is regarded as one of the agents that intermediate in the relations that women and men have with the environment; and the discussion focuses on the social relationships that they establish and the system of power into which women and men are incorporated (Warren, 2000; Mies and Shiva, 1993). Previous efforts to integrate gender in environmental issues include eco-feminism approach that conceptualizes the relationship of women with nature, maintaining that there is a strong link between the two (Mies and Shiva, 1993; Plumwood, 1992; Shiva, 1988); and women and environment approach that forms part of the strand of thought and action - the WID. Women and environment approach stresses the potential of women's role as "day-to-day administrators" of natural resources. The main aim of eco-feminism and women and environment approaches was to empower women (Rico, 1998; Collins, 1991; Linggard and Moberg, 1990; Dankelman and Davidson, 1989).

Thus, as section 1.6.2 on the importance of considering gender in climate change adaptation and 1.6.3 on the effort undertaken to integrate women and gender in development and environmental issues show, this study is in line with the effort that has been exerted to integrate gender in development and in environmental issues. However, it examined the way men and women perceived, were affected and adapting to climate change and factors that determined their choices of adaptation options, so that policy makers or planners concerning with climate change could integrate the differences

identified between men and women in the interventions planned to reduce climate change effects. The study has demonstrated such efforts by integrating gender into climate change, as it considered gender throughout the process that is, during data collection, analysis of data and presentation of results in order to gather disaggregated information.

1.7 General Methodology

General methodology section covered the description of the study area; type of research design employed in the study; study population, sampling frame and sampling unit of the study; sampling procedures, sample selection and sample size; and reasons for selection of the study area. Other information presented in the general methodology section were information on data collection that includes types of data collected and methods employed to collect data; preliminary survey and questionnaire pre-testing; description of methods of data collection including key informant interviews; focus group discussions; questionnaire survey; and information on secondary data; and methods employed to analyze data.

1.7.1 Study area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively, Bahi District has four divisions, 21 wards and 56 villages whereas; Kondoa District has eight divisions, 35 wards and 160 villages. Both districts are situated in semi-arid areas and have a dry savannah type of climate, which is characterized by long dry season, unimodal and erratic rainfall that falls between November or December and April. Bahi District has an annual average rainfall of about 500 to 700 mm p.a and an annual average temperature of about 22.6^{0}C. Kondoa District has an annual average rainfall of about 500 to 800 mm p.a and an annual temperature of

about 21^0C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

1.7.2 Research design

The study adopted a cross-sectional research design whereby the data were collected at a single point in time (Walliman, 2006; Kothari, 2004). The cross-sectional research design is useful for descriptive purposes, as well as determination of relationships between and among variables and allows the use of other methods of data collection such as observations. From the six villages of study, information from key informants and focus group members were gathered prior to questionnaire survey during questionnaire pre-testing. Then questionnaire survey was carried out to collect data from men and women crop and livestock producers, using a structured questionnaire.

1.7.3 Study population, sampling frame and sampling unit

The population of the study was the farmers dealing with crop farming and livestock keeping in the study area. The sampling frame was a list of all men and women dealing with crops and livestock production from which the two sub-samples (strata), one for men and the other one for women were drawn (Kothari, 2004). A sampling unit was a man or a woman farmer.

1.7.4 Sampling procedures, sample selection and sample size

Sampling is the procedure of selecting a group of people, events, behaviours, or other elements with which to conduct a study. It involves taking a portion of a population as

representative of that population (Kothari, 2004; Kazerooni, 2001). This study employed various sampling methods including purposive, stratified and simple random sampling. A procedure to select sample started by selecting the study area whereby purposive sampling technique was employed to select two districts (Bahi and Kondoa), three divisions from each district, one ward from each division and one village from each ward. The reasons for selection of the study area were that the selected area is in a semi-arid, the area more vulnerable to climate change impacts due to prominent and persistent variation in rainfall, temperature and drought; it is the area where climate change evidence is expected to be more apparent (FAO, 2008; IPCC, 2007); also the researcher required to capture local knowledge about climate change from diverse cultural perspectives (that is from *Warangi, Wagogo, Wanyambwa* and *Wasandawe)*. The selection of wards and villages was based on the areas that were far from the ward centre/town where crop farmers and livestock keepers resided and where limited (or no) research, especially on climate change, having been conducted in the area to avoid duplication of efforts.

Then Yamane (1967) formula was used to get sample of 360 respondents from the population of the study. Yamane (1967) provides a simplified formula to calculate sample size (Israel, 2008), that is:

$n = N/1 + N(e)^2$.....(1)

Where: n = the sample size

N = the population size

e = the level of precision (an error of five percent)

Since the study was focused on gender, the sampling frame was put into two strata of men and women. In order to get sub sample size from the two strata, this formula was used:

$n_h/n = N_h/N$ .....(2)

$n_h = n(N_h/N) = nW_h$

Where:

n_h = sub-sample

n = desired sample

N_h = sub-sampling frame/population

N = Sampling frame (population)

W_h = sample proportion

That is, sub-sample 1 (men) = $n_h/360 = 2139/4498$

$n_h = 360(2139/4498) = 360(0.4755) = 171.2$

n_h per village $171.2/6 = 29$

Sub-sample 2 (women) = $n_h/360 = 2359/4498$

$n_h = 360(2359/4498) = 360(0.52445) = 188.8$

n_h per village $188.8/6 = 31$

The two sub-samples were 29 men and 31 women per village (Ahmed, 2009; Kothari, 2004). However, from the two strata, a simple random sampling technique was employed to select 30 men and 30 women per village in order to facilitate a fair discussion where comparison between men and women per village was necessary (Kothari, 2004).

1.7.5 Data collection

Types of data collected in this study were both primary and secondary data, whereby primary data involved qualitative and quantitative data. Methods to collect qualitative data were key informant interviews and focus group discussions; and questionnaire survey was employed to collect quantitative data. Prior to the main survey a preliminary survey was conducted in order to explore some basic information from the local people. During preliminary survey, key informant interviews and focus group discussions were held in the

six villages of the study to collect qualitative data. Questionnaire pre-testing was done in two villages of Bahisokoni and Uhelela, Bahi District. The questionnaire was pre-tested in order to ensure clarity, reliability and validity of the questions. After pre-testing, corrections were made to improve the instrument.

The key informant interviews method was held using a checklist of items for in-depth interviews to gather information from 78 key informants (that is 13 key informants from each village). The key informants selected were: a ward leader, village leader and crops and/of livestock extension agent. Others were one member from private institution or religious leader, a head teacher, four members from village environmental committees and four elderly farmers (two men and two women). The main information collected were: history of the village, main changes that had occurred in the village since village establishment (1970), changes associated with climate change and things that had changed. Other information collected were: major production activities in the village, changes that had occurred in production activities due to climate change and the way farmers were dealing with the changes (Appendix 4).

Besides key informant interviews, focus group discussion method was used to collect qualitative data by using an interview guide, whereby probe questions were used in order to get more information from group members. The discussion involved 12 groups of discussants. That is, two focus groups (one for men and another for women) from each village for the six villages. The optimal number of discussants ranged from six to eight members. The main aim of conducting focus group discussions was to gain knowledge about climate change. Prior to the discussions, the topic to be discussed and the aim of discussions were introduced to participants for them to be aware of the topic and be free to

participate. A moderator led discussions by asking questions in an interactive group setting whereby discussants were free to talk, and an assistant moderator was taking comprehensive notes. Information concerning the evolution of farmers' livelihood activities, effects of climate change on their livelihood activities, responses to such effects and elements hindering their effort to adapt to climate change effects were discussed (Appendix 5).

In addition, a structured questionnaire translated into *Kiswahili* with both closed and open ended questions (Appendix 6) was used to collect data from respondents. Open ended questions were used to probe deeper for additional insights into the information collected. The information on personal characteristics of respondents such as sex, age, marital status; level of education attained, ethnic groups, main production activities of respondents and size of household were collected. Other information collected was: the way men and women perceived climate change, using a Likert scale with five alternative responses (strongly agree, agree, undecided, disagree and strongly disagree) prepared for four climate change indicators – increase in rainfall variation, temperature, strong wind and drought. In addition, the data on effects of climate change and adaptation practices undertaken by men and women to adapt to climate change were also collected by using a questionnaire.

Secondary data collection involved reviews of published and unpublished documents including government and research reports, village records from village offices, libraries including the Sokoine National Agriculture Library (SNAL) and University of Dar es Salaam (UDSM); and online web resources. Other secondary data collected were the data of seasonal rainfall, mean minimum and maximum temperature and mean wind speed

from Tanzania Meteorological Agency (TMA), Dar es Salaam. The data of rainfall from TMA were recorded at Bahi and Kondoa meteorological stations that records only rainfall data and the data of temperature and wind speed were recorded at Dodoma station.

The data collected were analyzed by both qualitative and quantitative methods. Analysis of qualitative data involved content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data were analyzed using Statistical Package for Social Sciences (SPSS, Version 12.0) computer software programme, which involved descriptive and inferential statistics. In the descriptive statistics frequencies, percentages and means were computed while in the inferential statistics, Pearson chi-square (χ^2) test and corrected Rao-Scott chi-square (χ_c^2) (for multiple response answers) at $p < 0.05$ level of significant were used to determine association between dependent and independent variables (Lavassani *et al.*, 2009). F-test was used to test significance of R^2 in order to determine significance of the trends of anomalies of seasonal rainfall, mean minimum and maximum temperature and mean wind speed. The multinomial logit model was used to analyse factors influencing choice of climate change adaptation options between men and women using Nlogit 3.0.

The multinomial logit model and multinomial probit model are commonly used in adoption decision studies involving multiple choices. The models are important in analyzing adaptation decision of farmers and they are appropriate for evaluating alternative combinations of adaptation options. However, multinomial logit model was used in this study because it is widely used in adoption decision studies involving multiple choices and is easier to compute (Mbwambo *et al.*, 2011; Hassan and Nhemachena, 2008).

It is assumed from the study that each respondent faces a set of discrete, mutually exclusive choices of adaptation options, which are assumed to depend on socio-economic, cultural and demographic factors X. The Multinomial Logit regression model for the choice of adaptation specifies the following relationship between the probability of choosing adaptation option A_i and the set of independent variables X as (Greene, 2003):

$$Prob(Ai = j) = \frac{e^{\beta' j x_i}}{\sum_{k=0}^{j} e^{\beta' j x_i}}, j = 0,1 \ldots j \quad \ldots\ldots(3)$$

Where βj is a vector of a coefficient on each of the dependent variables X. Equation (3) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$Prob(A = j|x_i) = \frac{e^{\beta' j x_i}}{1+\sum_{k=0}^{j} e^{\beta' j x_i}}, j = 0,1 \ldots j \quad \ldots\ldots(4)$$

Estimating equation (4) yields the J log odds ratios

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x'_i(\beta_i - \beta_k) = x'_i\beta_j, \text{ if } k = 0 \quad \ldots\ldots(5)$$

The dependent variable is, therefore, the log of one alternative relative to the base alternative. The multinomial logit model coefficients are difficult to interpret, and associating β_j with the j^{th}outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003):

$$\delta_j = \frac{\delta P_j}{\delta x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k\beta_k\right] = P_j(\beta_j - \bar{\beta}) \quad \ldots\ldots(6)$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2003). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

1.8 Organization of the Thesis

This thesis is organized in three chapters, whereby chapter one presents the introduction including background to the problem, problem statement and study justification; research objectives and questions; limitations of the study, a general conceptual framework of which the details are discussed in separate published papers, adaptation theory, the importance of considering gender in climate change and effort that have been evolved to integrate gender in development and environmental issues; and the general methodology of the study. Chapter two includes three published papers and a manuscript; while chapter three presents the general conclusion that consist of a summary and implication of results from separate papers; theoretical implication of findings; recommendations and policy implications; then areas for further research; and appendices.

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CHAPTER TWO

2.0 PAPERS PUBLISHED AND A MANUSCRIPT

This chapter presents the three published papers and a manuscript chronologically, starting with paper one. Each paper presents its own introduction, methodology, results and discussions, conclusion and recommendations; and references. Paper one examined the perception on climate change by men and women and investigated the evidence of climate change in the study area through meteorological data; paper two examined effects of climate change on agricultural production by sex; paper three investigated the adaptation practices undertaken by men and women; and the manuscript evaluated determinants of adaptation to climate change which was a gendered analysis.

2.1 Paper One

Gender and perception on climate change in Bahi and Kondoa Districts, Dodoma Region, Tanzania.

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Full Length Research Paper

Gender and perception on climate change in Bahi and Kondoa Districts, Dodoma Region, Tanzania

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Perception precedes measures to adapt to climate change effects. However, little is known on how men and women dealing with agriculture in rural Tanzania perceive climate change. The study to analyze perception on climate change by gender was done in Bahi and Kondoa Districts Dodoma Region, Tanzania. Meteorological data were also used. Primary data obtained from 78 key informants, 12 focus groups and a sample of 360 respondents. Analysis involved descriptive statistics for quantitative data and content analysis for qualitative data. Findings revealed that 82.7% of men and 76.7% of women perceived the change in rainfall; 98.3% of men and 97.2% of women the change in temperature; 97.2% of men and 95.6% of women the change in strong wind; and all men and 99.4% of women the change in drought; acknowledging that rainfall variation, temperature, strong wind and drought had increased. It is concluded that majority of men and women perceived the changes in climate. The information obtained can be used as a base in formulating appropriate interventions to manage climate change problems in agriculture sector. The study recommends people of Dodoma, Tanzania and the LDCs to use available knowledge systems to develop appropriate interventions to manage climate change problems.

Key words: Climate change, perception, men and women, agriculture.

INTRODUCTION

Climate change is apparent and its effects including variation in temperature and rainfall, drought, floods, heat waves, hurricanes and typhoons are already felt across the world affecting countries differently. The effects of climate change are unevenly distributed among different income groups, occupations and between men and women. The poor (of whom 70% are women), primarily in developing countries, are more vulnerable and thus more affected by climate change. The adverse effects of climate are stronger in Africa where prolonged floods and severe drought are common; and more severe in Sub-Saharan Africa especially in semi-arid areas (Cline, 2007; Inter-governmental Panel on Climate Change (IPCC), 2007; United Nation Population Fund (UNFPA), 2009; Haque et al., 2012). East African countries including Tanzania are already among the most food insecure in the world and climate change is expected to aggravate falling harvests (Devereux and Edward, 2004).

Tanzania is experiencing greater weather extremes including increases in temperature and changes in rainfall patterns. Such effects have increased drought, floods, land resources degradation as well as health problems. The intensity of droughts, floods and changes to growing seasons have significant effects on agricultural productivity, water supply, food security and human welfare (Yanda et al., 2006; United Republic of Tanzania (URT), 2007). For example, the drought that occurred in 2005/06 and the El Niño in 1997/98, highlight the country's vulnerability to current climatic hazards (Ehrhart and Twena, 2006). Although every individual will be affected by climate change in Tanzania, small-holder

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farmers in rural areas especially women are likely to be more affected by climate change because of their low adaptive capacity, extreme poverty and dependence on rain-fed agriculture, activity more sensitive to climate change. Moreover, inequalities existing between men and women partly due to statutory and/or customary laws that often restrict women's property and land rights; constrain women from accessing important resources for example, land and credit, undermining further their adaptive capacity (International Fund for Agricultural Development (IFAD), 2008; Osman-Elasha, 2008; Brody et al., 2008). The fact that women are likely to be more affected by climate change is also supported by climate change literature (Lambrou and Piana, 2006; UNFPA, 2009; United Nations Development Programme (UNDP), 2009). The literature insist studies focusing on gender and climate change to be conducted at community level in various sectors including agriculture, in order to gather disaggregated data that will show the way men and women perceive, are affected and thus responding to climate change effects.

Perception is a process by which individuals receive information or stimuli from the environment and transform it into psychological awareness, in order to learn about the environment and respond to what is perceived (Bridgeman and Tseng, 2011). How individuals perceive risk is influenced in part by the type of hazard to which they are exposed and the perceived severity and frequency of that exposure (Slegers, 2008; Frank et al., 2011). Perception is important in climate change because it is one of the elements that influence adaptation process. It is after perceiving the changes in climate that individuals can undertake required measures to adapt to or reduce climate change effects (Maddison, 2006). Knowing the importance of perception, climate change perception studies have been conducted in developed countries mainly to explore mitigation options (Semenza et al., 2008; Mertz et al., 2009; Debono et al., 2010; Hansen et al., 2012). In developing countries studies on perception have been conducted in relation to adaptation options (Gbetibouo, 2009; Dhaka et al., 2010; Mengistu, 2010; Nzeadibe et al., 2011; Maharjan et al., 2011). Moreover, most of the studies on climate change conducted in Tanzania have focused on vulnerability, impact and adaptation strategies (Paavola, 2008; Lema and Majule, 2009; Mongi et al., 2010). The findings from these studies revealed that climate had changed and was the source of various adverse effects. However, the findings were not disaggregated by gender to indicate the way men and women perceived/were affected and thus responding to the negative effects of climate change. Studies on climate change perceptions and gender at the community level that could make disaggregated data available in Tanzania are scarce. Lack of disaggregated data has meant that climate change policy makers dealing with climate change in Tanzania for example, the National Adaptation Program of Action (NAPA), cannot come up with effective policies or adaptation options (URT, 2007). According to UNFPA (2009) and UNDP (2009), for the policy that is intended to address any aspect of climate change to be effective, the differences between men, women, boys and girls must be taken into account during policy formulation. Gender blind policies may exacerbate the problems associated with climate change by widening inequalities between the sexes. Thus, to attain effective and successful adaptation, the needs of men and women should be integrated in climate change policies including adaptation plans. This can be achieved if disaggregated information on the way men and women perceive climate change will be gathered.

Using Dodoma Region as a case study, the region is located in a semi-arid area, an area prone to drought. But the nature of drought felt in the region in the 1990s is not only due to its location. The situation has been exaggerated by climate change. However, it was not clear if men and women had perceived and related experienced drought in the 1990s with climate change. Information on how men and women perceived and described the concept of climate change was lacking. This paper therefore, presents results of the study on perception of respondents on climate change done in Bahi and Kondoa Districts of Dodoma Region in order to fill part of the information gap. The rest of the paper is structured as follows: the next section covers methodology including study area, research design and the way data were collected and analyzed; results and discussions; and finally conclusion and recommendations.

METHODOLOGY

Study area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6°C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21°C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003) (Appendix 1).

Research design and methods of data collection

A cross-sectional research design was used in this study. Sampling techniques involve purposive sampling, stratified random sampling and simple random sampling. Purposive sampling was used to select two districts, three divisions from each district, one ward from

each division and one village from each ward; basing on the availability of the evidence of climate change, accessibility and limited or no research especially on climate change had been conducted in the particular area. A sampling unit was a household from which a man or a woman was chosen; and a sampling frame was the farmers dealing with agriculture (crop farming and livestock keeping).

To obtain a representative sample according to Bailey (1994), the sampling frame was stratified into two strata of men and women and from each stratum simple random sampling was used to select 30 men and 30 women. The sampling frame was 4498 farmers, the two strata 2139 men and 2359 women; the sample proportions were 48% of men and 52% of women that resulted into a sub-sample of 173 men and 187 women respectively. Dividing each sub-sample by six villages the results were 29 men and 31 women respectively. However, from the two strata a simple random sampling technique was employed to select 30 men and 30 women per village in order to facilitate statistical analysis especially where comparison between men and women per village was necessary during discussion. This is based on Bailey (1994) that a sample or sub-sample of 30 respondents is a bare minimum for a study in which statistical data analysis is to be done, regardless of the population size. Besides, the key informants including ward and village leaders, crops and livestock extension workers, religious leaders, members of village government committees, head teachers and elderly farmers (two men and two women) were selected purposively. The selection was based on the position, knowledge and opinions/views of the individuals on climate change, history of the study area and other important required information.

Both primary and secondary data were collected. Primary data involved qualitative and quantitative data. Methods to collect qualitative data involved key informant interviews and focus group discussions; and a structured questionnaire was used to collect quantitative data. To collect qualitative data, a checklist of items for in-depth interviews with key informants was used to gather information from 78 key informants; and a focus group interview guide was used in discussion to gather information from 12 focus groups (one group of men and one of women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents (30 men and 30 women from each village) to verify and quantify some of the findings from qualitative data. Among the questions administered were Likert items of five responses (strongly agree, agree, undecided, disagree and strongly disagree) prepared for four climate change indicators – an increase in rainfall variation, temperature, strong wind and drought (Appendix 2 and 3). The sources of secondary data were various reports relevant to the study, the web and Tanzania Meteorological Agency (TMA) Dar es salaam where data of seasonal rainfall, mean minimum and maximum temperature and mean wind speed were obtained.

Data analysis

Analysis of qualitative data involved content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means, percentages and cross-tabulations. An inferential analysis was done using the chi-square test at $p < 0.05$ level of significant to determine the association between perception of climate change and demographic/socio-economic variables. Perception on climate change was measured through indices of four climate change indicators. In order to form indices: (i) Likert statements were reverse-coded to obtain dimensionality. (ii) Reliability analysis was performed for each climate change indicator; and statements that counted Cronbach's alpha value of 0.7 and above were the only ones included in further analysis to develop indices. The reliability analysis is based on a calculation of the correlation among statements using Cronbach's alpha. The value of alpha of 0.7 and above is accepted in social science as indicating a reliable scale (Marshall and Marshall, 2007; Swai, 2006). (iii) Strongly agree and agree responses were transformed into 1; strongly disagree and disagree into **0** to form scale of the index of 0 – 1; and undecided responses were regarded as missing. (iv) Scores for each respondent were then summed and divided by the number of statements for each climate change indicator. (v) The scale was further transformed into two categories of 'not perceiving' for respondents that scored 0.5 and below and 'perceiving' for respondent that score 0.6 and above. This procedure of forming index was also used by Magayane (1995) when studying adaptive effort of farmers to soil erosion and land productivity decline in Uluguru Mountain Tanzania.

To analyze meteorological data, MS Excel was used to perform simple regression analysis for rainfall, temperature and wind data. The dependent variable [Y(j)] was the physical factor (rainfall, mean minimum temperature, mean maximum temperature and mean wind speed) and independent variables (x) were the number of seasons/years (for example, 1970/71 to 2009/10 for rainfall). From the analysis the XY scatter plot with regression line, regression equations together with the R–square (R^2) values were established. To determine significance of the trends, f-test was used to test significance of R^2.

RESULTS

Description of the concept of climate change by sex

The first question requested respondents to give one description on climate change in order to understand the way climate change was described in the study area. The findings revealed that 23.3% of men described the concept of climate change as a situation occurred when crops and livestock were in a good condition, while about 23% of women described climate change as a situation which occurred when the food was available or not available in the household. Besides, more men (16.7%) described the concept of climate change as the variation in temperature (coolness/hotness), while more women (17.8%) described the concept of climate change as the change in the amount of rainfall (Table 1). Results revealed that men and women described the concept of climate change differently. Men were more concerned with the condition of crops while in the field and the good condition for livestock, but women were more concerned with the availability of food in the household. Although the good condition for crops mentioned by men was an indicator of harvesting enough food, most of the crop yield could be sold after harvesting; an action that could reduce the available amount of food and subject the household to hunger or food shortage.

Major changes in climate between 1970s and 1990s

Respondents were also required to identify/choose one major change in climate that had occurred between 1970s and 1990s in the study area. The findings revealed

Table 1. Description of the concept of climate change by sex.

Description	Men (n = 180)		Women (n = 180)	
	n	%	n	%
Men and women description of the concept of climate change				
Good condition for crops and livestock	42	23.3	14	7.8
Food availability/food shortage/hunger	40	22.2	42	23.3
Variation in temperature (coolness and hotness)	30	16.7	22	12.2
Whirlwind and strong wind that blows away rainfall clouds	24	13.3	25	13.9
Changes in rainfall amount	20	11.1	32	17.8
Drought/dry spell	17	9.5	20	11.1
Presence/absence of diseases and deaths for people	6	3.3	23	12.8
I do not know	1	0.6	2	1.1
Total	180	100.0	180	100.0

Source: Survey data (2011).

Table 2. Major changes in climate between 1970s and 1990s.

Description	Men (n = 180)		Women (n = 180)	
	n	%	n	%
Major changes in climate between 1970s and 1990s				
Drought has increased	51	28.4	47	26.1
Temperature has increased	34	18.9	39	21.7
Rainfall variation has increased	30	16.6	31	17.2
Rainfall amount has decreased	20	11.1	19	10.5
Strong wind has increased during rainy season and whirl	19	10.5	21	11.7
Others.....	26	14.4	23	12.8
Total	180	100.0	180	100.0

Source: Survey data (2011).

that: drought, temperature, rainfall variation and strong wind had increased and rainfall decreased in the 1990s compared to the 1970s. The change in drought was ranked high by both men and women (that is 28.4% of men and 26.1% of women) (Table 2).

It was also revealed during key informant interviews and focus group discussions that in the study area bad years had increased and good years (years in which there were sufficient and well distributed rainfall) decreased in the 1990s compared to the 1970s. The discussants (both men and women) described a bad year as the year when rainfall, water and pastures were inadequate; when crops failed or when they got very low crop yield and when drought/dry spell and insect pests damaged crops. Men discussants described a bad year as the year when there was floods and strong wind in December blowing away rainfall clouds; and when improved seeds and honey were inadequate. Conversely, the ratio of bad and good years was 3:2, meaning three women described a bad year as the year when there was food shortage/hunger, when market for crops was inadequate, when crops fetched very low price; when they had no money to buy food; and when they were forced to spend most of their time selling labour in order to buy food. Women further explained a bad year as the year when they were forced to replant more than twice; when rainfall was irregularly distributed; and when there was inadequate green vegetables in the study area. According to the discussants, in the 1970s the ratio between good and bad years was 1:5 that is, one bad year followed by five consecutively good years. But in the 1990s in all surveyed villages good years were few and difficult to remember. The ratio between good and bad years for the most surveyed villages was 1:3 and in other villages 1:5, that is one good year followed by three or five consecutively bad years, except in Puhi village where relatively good years followed by two consecutively bad years. The discussants argued that there was no good year hundred percent but the years regarded as good had deficiencies; and that, in most seasons farmers were forced to buy food in November throughout March, hopping to start harvesting in April. It was also revealed that the ratio of bad years started to increase in 1984 for Bahi District and in 1990 for Kondoa District.

Table 3. The main causes of climate change by sex.

Description	Men (n = 180)		Women (n = 180)	
	n	%	n	%
Main reasons for the changes of climate				
Deforestation	89	49.5	92	51.1
Increase in population	47	26.1	59	32.8
Keeping large number of cattle per area	33	18.3	10	5.6
God's plan	4	2.2	11	6.1
Increase of carbon dioxide in the atmosphere	4	2.2	0	0.0
I do not know	3	1.7	8	4.4
Total	180	100.0	180	100.0

Source: Survey data (2011).

The main causes of climate change by sex

When respondents were asked to give one main reason for the changes in climate, deforestation was ranked high by both men and women (49.5% of men and 51.1% of women) (Table 3). Other causes mentioned were increased population and livestock keepers keeping large number of cattle per unit area.

The causes were interconnected because, as the village population increased demand for farms, building material including poles, firewood and grazing area also increased. Deforestation was aggravated by the demand of farmers to increase income, the situation that caused more of them to be engaged in charcoal and firewood businesses due to climate change. Furthermore, only four men associated the changes in climate with an increase in carbon dioxide in the atmosphere.

Perception on climate change by sex

After the reliability testing, Likert items for climate change indicators – the change in rainfall had eight items and Cronbach's alpha value of 0.845; the change in drought 20 items and alpha value of 0.738; the change in temperature eight items and alpha value of 0.726 and the change in strong wind eight items and alpha value of 0.734 (Appendix 2 and 3). Those items were used to form indices to measure perception. It is depicted in Table 4 that 87.2% of men and 76.7% of women perceived the change in rainfall; 98.3% of men and 97.2% of women perceived the change in temperature; 97.2% of men and 95.6% of women perceived the change in strong wind; and all men and 99.4% of women perceived the change in drought.

Respondents who perceived the change in rainfall accepted that the amount of rainfall had decreased; rainfall was less predictable and more unevenly distributed. Respondents who perceived the change in temperature accepted that the temperature had increased and was the main cause of increased hotness especially during dry season, the number of warm days to increase during cold season and uncomfortable nights especially during dry season. Similarly, respondents who perceived the change in strong wind accepted that strong wind during rain season and whirl wind during dry season had increased; and respondents who perceived the change in drought accepted that drought (including the number of days of dry spell) had increased and was the main cause of water sources and water amount to decrease; wetland areas to shrink; crop yield, food amount and pastures to decrease; and frequencies of occurrence of crop pests and livestock diseases to increase in the 1990s compared to the 1970s.

The chi-square test showed significant association between perception of respondents on the change in rainfall and sex ($\chi2 = 11.588$; $p \leq 0.05$); perception of respondents on the change in strong wind and their villages/location ($\chi2 = 42.792$; $p \leq 0.01$); and perception of respondents on the change in drought and marital status ($\chi2 = 73.536$; $p \leq 0.001$) and ethnic groups ($\chi2 = 193.098$; $p \leq 0.001$); indicating that perception of respondents on climate change varied by sex, location/village of respondent, ethnic groups and marital status. However, the chi-square test showed no significant association between perception of respondents on the change in temperature and sex (or other socio-economic/demographic variables); the result that suggests an equal chance for respondents from Bahi and Kondoa districts to perceive the change in temperature.

The evidence of climate change from meteorological data

The trend of rainfall anomaly of Bahi District for the growing season of November to April for the past 39 seasons (1970/71 to 2009/10) revealed that rainfall was decreasing gradually but the change was insignificant, that is $R^2 = 0.0461$, ($p = 0.1831$). However, from 1980/81 season rainfall started to decrease significantly, that is $R^2 = 0.205$, ($p \leq 0.05$) (Figure 1a).

Table 4. Perception of respondents on climate change by sex.

Scale categories for perception	Men (n = 180)		Women (n = 180)	
	n	%	n	%
Perception on the change in rainfall				
Perceiving	157	87.2	138	76.7
Not perceiving	23	12.8	42	23.3
Perception on the change in temperature				
Perceiving	177	98.3	175	97.2
Not perceiving	3	1.7	5	2.8
Perception on the change in strong wind				
Perceiving	175	97.2	172	95.6
Not perceiving	5	2.8	8	4.4
Perception on the change in drought				
Perceiving	180	100.0	178	98.9
Not perceiving	0	0.0	2	1.1

Source: Survey data (2011).

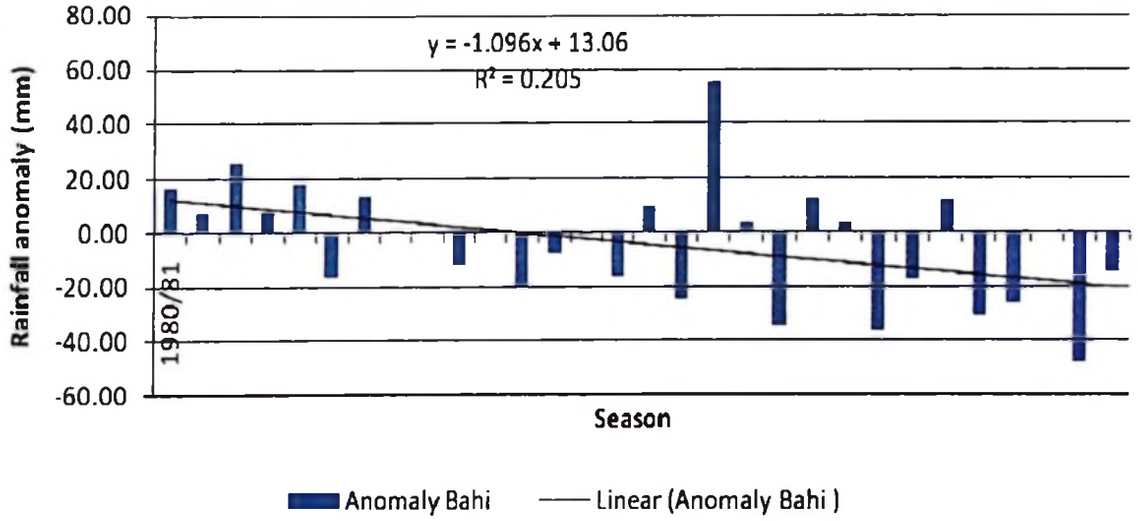

Figure 1a. The trend of rainfall anomaly for Bahi district 1980/81 – 2009/10 seasons. Source: TMA data (2011).

Likewise, the trend of rainfall anomaly of Kondoa District for the growing season of November to April for the past 39 seasons (1970/71 to 2009/10) revealed that rainfall was increasing with a decreasing rate but insignificantly from 1970/71, that is R^2 = 0.0107, (p = 0.5255). But, from 1984/85 rainfall started to decrease although the change was statistically insignificant, that is R^2 = 0.022, (p = 0.4628) (Figure 1b).

It is shown in Figure 2a that, trends of the mean minimum and mean maximum temperature anomalies for Dodoma region for the past 40 years (1970 to 2010) showed significant increase in both mean minimum and mean maximum temperature, that is R^2 = 0.404, ($p \leq 0.001$) (Figure 2a) and R^2 = 0.125, ($p \leq 0.05$) (Figure 2b) respectively. The observation also revealed that the mean minimum temperature was increasing more rapidly compared to the mean maximum temperature.

Equally, the trend of the mean wind speed anomaly of Dodoma region for the past 32 years (1977 to 2009) showed a significant increase in wind speed, that is R^2 = 0.276, ($p \leq 0.01$) (Figure 3).

It is evident from the analysis of meteorological data that rainfall had decreased in Bahi District. However, in Kondoa District the change in rainfall was not statistically

tion they were experiencing in the 1990s from the situation they had experienced in the 1970s. In the 1970s the bad years were few and one bad year could be followed by more than four consecutively good years, before experiencing another bad year (Mwanga, 2002). The farmers used coping strategies (short term adaptation practices) to cope with the harsh environment conditions, hoping the situation would improve after a year or two. But in the 1990s bad years have increased because of climate change; the situation that requires farmers to be motivated to implement long term adaptation practices (Chaudhary and Aryal, 2009; Hartter et al., 2012; Haque et al., 2012).

Likewise, respondents perceived and described climate change differently depending on sex, location/village, ethnic groups and marital status. Perception of respondents on the change in rainfall varied by sex, the difference that could probably be explained by the existing different socially constructed roles and responsibilities between men and women (Brody et al., 2008; Agwu and Okhimamhe, 2009; UNFPA, 2009; UNDP, 2009). For example, women were subjected to various hardships including starving during food shortage or hunger; and collected water from far sources to fulfil their roles. Equally, men especially livestock keepers were forced to move livestock far away during dry season, sometime when it was very hot, to search for water and pastures. The challenges that both men and women experienced when struggling to fulfil their roles were among the causes of variation in perceiving the change in rainfall (Slegers, 2008; Speranza, 2010).

In addition, perception of respondents on the change in strong wind varied by location/village of respondents. The differences in perception could be explained by the diversity of topography and other features existing in the specific location including type of vegetation, as climate change literature indicates that effects of climate change are location specific (IPCC, 2007). For example, the Bahi District is in low altitude, it is dry and has experienced extensive deforestation compared to Kondoa District which is in high altitude, wet and is observing environmental management practices including tree planting and other measures to control soil erosion (Chamshama and Nduwayezu, 2002; Mongi et al., 2010).

Moreover, perception of respondents on the change in drought varied by ethnic groups and also marital status of respondents. Ethnic groups situate in specific location. For example, the Rangi reside mainly in Kondoa District which is wet compared to the Bahi District where the Gogo reside. Likewise, perception of respondents on the change in drought was reported to vary by marital status, a variable that has diverse groups including the married some of who are polygamists; and the single including separated, divorced, widows and widowers. Differences in the level of wealth/adaptive capacity and family size can be among the main sources of variation in perceiving drought among the married and single groups (Meena and Sharif, 2008). In the study area for example, most married men and women especially the polygamists had big family sizes, big farms and a big number of livestock. When severe drought occurred most of their crops were damaged and livestock died, events that caused them to experience big losses compared to the single groups (Slegers, 2008; Speranza, 2010). While perception of respondents on climate change in the study area varied by sex, location, ethnic groups and marital status, other studies have shown that farmer's experience, availability of free extension advice, formal education, social interactions and access to information had also influence on perception (Maddison, 2006; Gbetibouo, 2009; Hartter et al., 2012). This indicates how elements influencing perception on climate change can vary from one location to another.

The study focused on gender and obtained disaggregated data, the information required in order to formulate effective climate change interventions/adaptation options (Lambrou and Piana, 2006; UNFPA, 2009). The disaggregated data obtained from this study are useful information for the researchers/scientists, agriculture and livestock sectors and Tanzania NAPA. The information can be used as a base by the NAPA when formulating adaptation options. Moreover, since the main actors in rural areas are the individuals dealing with agriculture, adaptation options developed by the NAPA can be incorporated in districts' one year rolling plans or in the recent instituted five year plan instead of the NAPA to work alone. Equally, feedback meetings with stalk-holders (District Agricultural and Livestock Officers and District Development Officers) and sensitization and/or awareness creation seminars on the causes and threats associated with climate change to the grass-roots can give climate change appropriate weight during participatory development problems identification. This will enable climate change adaptation needs to appear in District Agricultural Development Plans (DADPs) in order to be considered for funding.

CONCLUSION AND RECOMMENDATIONS

Both men and women have perceived climate change and have clear perception on the change in rainfall, temperature, strong wind and drought. They managed to anticipate future threats of climate change arguing that climate change will continue to worsen. As rainfall amount will decline, crop and livestock yield/productivity will continue to decrease and family bond/relations will deteriorate. The field based findings corresponded well with trends of anomalies of meteorological data that showed a decrease in rainfall amount for the Bahi and Kondoa districts; an increase in minimum and maximum mean temperature; and mean wind speed for Dodoma Region. Findings also agreed with climate change literature and findings of other scientists that showed/

tion they were experiencing in the 1990s from the situation they had experienced in the 1970s. In the 1970s the bad years were few and one bad year could be followed by more than four consecutively good years, before experiencing another bad year (Mwanga, 2002). The farmers used coping strategies (short term adaptation practices) to cope with the harsh environment conditions, hoping the situation would improve after a year or two. But in the 1990s bad years have increased because of climate change; the situation that requires farmers to be motivated to implement long term adaptation practices (Chaudhary and Aryal, 2009; Hartter et al., 2012; Haque et al., 2012).

Likewise, respondents perceived and described climate change differently depending on sex, location/village, ethnic groups and marital status. Perception of respondents on the change in rainfall varied by sex, the difference that could probably be explained by the existing different socially constructed roles and responsibilities between men and women (Brody et al., 2008; Agwu and Okhimamhe, 2009; UNFPA, 2009; UNDP, 2009). For example, women were subjected to various hardships including starving during food shortage or hunger; and collected water from far sources to fulfil their roles. Equally, men especially livestock keepers were forced to move livestock far away during dry season, sometime when it was very hot, to search for water and pastures. The challenges that both men and women experienced when struggling to fulfil their roles were among the causes of variation in perceiving the change in rainfall (Slegers, 2008; Speranza, 2010).

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CONCLUSION AND RECOMMENDATIONS

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predicted an increase in temperature, drought (especially in semi-arid areas) and a decrease in precipitation in parts of Tanzania and other areas of Africa. The findings have addressed an important knowledge gap and provided significant information to policy makers. The information obtained can be used as a base when formulating interventions/adaptation options to manage climate change problems in agriculture and livestock sectors. In addition, the trends of anomalies of meteorological data can be used to learn and/or monitor climate change. The study recommends the Least Developed Countries (LDCs) to use available knowledge systems to develop appropriate interventions to manage climate change problems; and use trends of anomalies of meteorological data to learn and/or monitor climate change.

Respondents perceived climate change differently depending on sex, location/village, ethnic groups and marital status. The underlying causes of the variation could probably be due to the existing differences in roles and responsibility between men and women; diversity of topography and other features existing in specific locations; and differences in the level of wealth/adaptive capacity and family size. This implies that location/ethnic groups and marital status are also important variables in understanding climate change perception. This suggests more location specific studies on climate change and gender, married and single individuals; and youths at the community level in agriculture and other important sectors in Tanzania in order to gather more areas of specific information.

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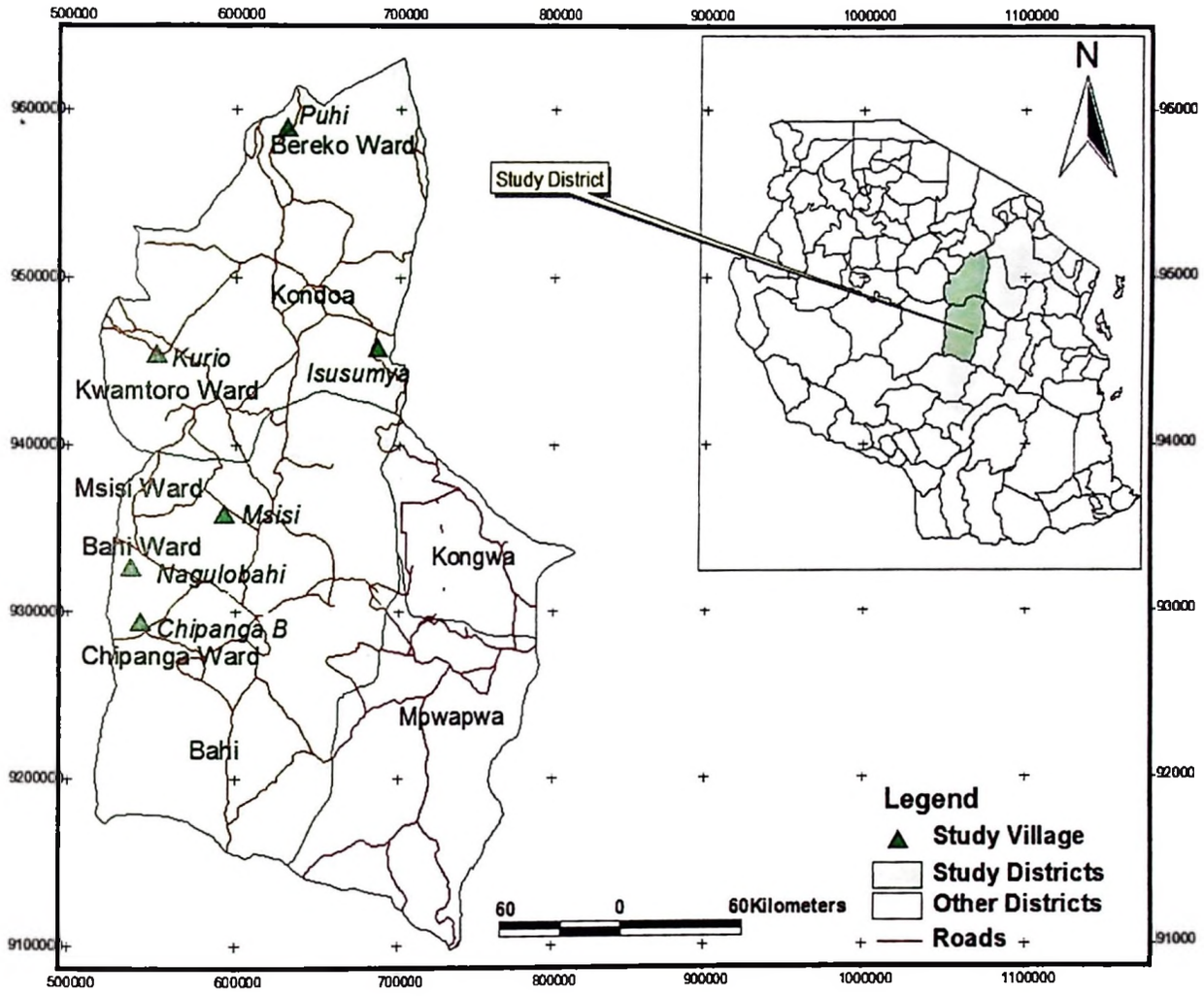
APPENDIX



Appendix 1. A map of Dodoma Region Tanzania showing study area.

Appendix 2. Item-total statistics of a change in rainfall, temperature and wind.

Climate change domain	Scale mean if Item deleted	Scale variance if Item deleted	Corrected Item-total correlation	Cronbach's Alpha if Item deleted
The change in rainfall				
Rainfall amount in 1990s has decreased compared to 1970s	12.2528	19.532	0.593	0.825
Rainfall amount in 1990s has increased compared to 1970s	12.2500	19.074	0.643	0.819
Compared to 1970s in 1990s it has been difficult to predict rainfall onset	12.4083	20.632	0.534	0.832
Compared to 1970s in 1990s it is easy to predict rainfall onset	12.3667	20.606	0.524	0.834
Rainfall shortage is insignificant in 1990s	12.2333	19.104	0.642	0.819
Rainfall shortage is significant in 1990s	12.2500	19.074	0.643	0.819
Rainfall amount in 1990s is more irregular distributed	12.4083	20.632	0.534	0.832
Rainfall amount in 1990s is less irregular distributed	12.3556	20.642	0.519	0.834
The change in temperature				
Compared to the 1970s temperature in the 1990s has increased	11.6722	9.530	0.416	0.699
Compared to the 1970s temperature in the 1990s has decreased	11.6778	9.422	0.453	0.692
Compared to the 1970s the number of warm days during cold season in 1990s has increased	11.6833	9.181	0.479	0.686
Compared to the 1970s the number of warm days during cold season in 1990s has decreased	11.6806	8.953	0.510	0.679
It has been too hot during dry season in the 1990s compared to 1970s	11.7056	9.885	0.356	0.711
It has been too cool during dry season in the 1990s compared to 1970s	11.6722	9.341	0.479	0.687
Increase in temperature in the 1990s has caused uncomfortable nights in the 1990s compared to the 1970s	11.7000	9.837	0.309	0.721
Increase in temperature in the 1990s has caused comfortable nights compared to the 1970s	11.6778	9.589	0.352	0.713
The change in wind				
Frequency of heavy winds during rain season in 1990s has increased compared to 1970s	11.8333	12.947	0.371	0.718
Frequency of heavy winds during rain season in 1990s has decreased compared to 1970s	11.8194	12.867	0.389	0.715
Compared to the 1970s frequency of whirlwind in 1990s has increased	11.8111	12.672	0.375	0.718
Compared to the 1970s frequency of whirlwind in 1990s has decreased	11.8139	12.670	0.375	0.718
Whirlwind is the major cause of environment and water pollution in the 1990s when compared to the 1970s	11.8250	11.811	0.536	0.684
Whirlwind is the minor cause of environment and water pollution in the 1990s when compared to the 1970s	11.8167	11.844	0.529	0.686
Strong wind destroys crops regularly in the 1990s when compared to the 1970s	11.9056	12.855	0.433	0.707
Strong wind destroys crops rarely in the 1990s when compared to the 1970s	11.8889	12.879	0.412	0.710

Appendix 3. Item-total statistics of the change in drought.

Climate change domain	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's Alpha if item deleted
Compared to the 1970s frequency of drought in 1990s has increased	31.6250	29.522	0.301	0.728
Compared to the 1970s frequency of drought in 1990s has decreased	31.6083	29.481	0.304	0.728
The number of days of dry spell in 1990s has increased compared to 1970s	31.8222	30.637	0.206	0.735
The number of days of dry spell in 1990s has decreased compared to 1970s	31.8194	30.549	0.219	0.734
Drought is significant in the 1990s	31.7417	29.752	0.350	0.725
Drought is insignificant in the 1990s	31.7417	29.802	0.332	0.726
Compared to the 1970s in the 1990s water amount has decreased due to drought	31.7556	29.962	0.282	0.729
Compared to the 1970s in the 1990s water amount has increased regardless of drought	31.7611	29.820	0.301	0.728
Compared to the 1970s wetland area in 1990s has decreased due to drought	31.7722	30.020	0.303	0.728
Compared to the 1970s wetland area in 1990s has increased regardless of drought	31.7694	30.183	0.287	0.729
Compared to the 1970s water sources in 1990s have decreased due to drought	31.7222	29.789	0.250	0.733
Compared to the 1970s water sources in 1990s have increased regardless of drought	31.7194	29.812	0.247	0.733
Compared to the 1970s insect pest attack to crops in 1990s has increased	31.7833	30.410	0.231	0.733
Compared to the 1970s insect pest attack to crops in 1990s has decreased	31.7917	30.310	0.244	0.732
Frequency of diseases attack to livestock in the 1990s has increased compared to 1970s	31.7556	29.132	0.322	0.726
Frequency of diseases attack to livestock in the 1990s has decreased compared to 1970s	31.7639	29.139	0.320	0.726
The amount of crop yield in 1990s has decreased compared to 1970s due to drought	31.8139	29.461	0.347	0.724
The amount of crop yield in 1990s has increased compared to 1970s regardless of drought	31.8056	29.516	0.337	0.725
Compared to the 1970s the amount of pastures in 1990s has decreased due to drought	31.7833	28.660	0.412	0.718
Compared to the 1970s the amount of pastures in 1990s has increased regardless of drought	31.7722	28.683	0.411	0.718

2.2 Paper Two

Perceived Effects of Climate Change on Agricultural Production: A Gendered Analysis Done in Bahi and Kondoa Districts, Dodoma Region, Tanzania.

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Perceived Effects of Climate Change on Agricultural Production: A Gendered Analysis Done in Bahi and Kondoa Districts, Dodoma Region, Tanzania

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Abstract

Climate change literature has revealed that the effects of climate change on women and men are not the same and that women are more likely to be severely affected by climate change. However, data to indicate the way men and women are affected by climate change are missing. A study to examine effects of climate change on agricultural production by sex was done in Bahi and Kondoa Districts, Dodoma region, Tanzania. Specifically the study analyzed perception of climate change and effects of climate change on agricultural production. A sample of 360 respondents, 12 focus groups of discussants and 78 key informants were consulted. Analysis of quantitative data involved descriptive statistics and qualitative data were analyzed by content analysis. Results showed that men and women perceived and were affected differently by climate change. Women were severely affect by effect of climate change that caused hunger/food shortage, that caused them to be subjected to bad food debts and effects that caused them to waste productive time in less productive activities; whereas men were severely affected by the effects of climate change that involved wasting of resources; that associated with out-migration and effects that reduced status of respondents. Using their knowledge, respondents managed to perceive and identify climate change effects. The study recommends Tanzania and other Less Developed Countries to use available knowledge system to learn and manage climate change effects.

Key words: Effects of climate change, Men and women, Perception, Agricultural production

1.0 Introduction

Climate change effects are location specific and disproportionately distributed among different countries, income groups, occupations and between gender (IPCC, 2007). In Africa, climate change is already having serious negative effects where much of the population is suffering from direct result of increased temperatures, changed rainfall patterns and rise in sea level. The impacts of climate change are more severe in sub-Saharan Africa where agriculture is the most important economic activity and source of food and income (Boko *et al.* 2007). Climate change has been the major constraint to agriculture productivity (crop and livestock production) in Tanzania because in addition to other deficiencies that exist in the sector, the nature of agriculture practiced depends solely on rainfall. In Tanzania, Dodoma Region is among the regions severely affected by failing agriculture due to climate change (FAO, 2008), as the region is situated in semi-arid areas. Various studies including Ribeiro and Chaúque (2010), UNFPA (2009) and Osman-Elasha (2008) have revealed that the effects of climate change on women and men is not the same and that women are more likely to be severely affected by climate change. However, data to indicate the way men and women are affected by climate change are missing. Most of documented information on climate change effects including Mark (2010), Levira (2009) and Morton (2007) are not disaggregated by gender.

Lack of disaggregated data has meant that climate change policy makers in Tanzania such as the National Adaptation Programme of Action (NAPA) cannot come up with gender specific policies (URT, 2007). According to UNFPA (2009), gender blind interventions will be less effective in addressing aspects of climate change, as they may exacerbate the problems associated with climate change by widening inequalities between the sexes. Therefore, this

paper, examines the effect of climate change by gender in Bahi and Kondoa Districts of Dodoma Region, in order to contribute relevant data that can be used to develop efficient interventions to adapt to or reduce climate change effects. The rest of the paper is structured as follows: the next section covers methodology including study area, research design and the way data were collected and analyzed; results and discussions; and finally conclusion and recommendations.

2.0 Methodology

2.1 Study area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^{0}C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21^{0}C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

2.2 Research design and methods of data collection

A cross-sectional research design was used in this study. Both primary and secondary data were collected and analyzed. Primary data involved qualitative and quantitative data. The study sample was obtained by using simple random sampling technique, from a sampling frame of farmers who were dealing with crop production and livestock keeping. Moreover, key informants including ward and village leaders, crops and livestock extension workers, religious leaders, members of village government committees, head teachers and elderly farmers (two men and two women) were selected purposively. Qualitative data were collected through key informant interviews and focus group discussions; and quantitative data were collected by using a structured questionnaire. To collect qualitative data, a checklist of items for in-depth interviews with key informants was used to gather information from 78 key informants (13 individuals from each village); and a focus group interview guide was used in discussion to gather information from 12 focus groups of discussants (one group of men and one of women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents (30 men and 30 women from each village) to verify and quantify some of the findings from qualitative data. Secondary data were gathered from various reports relevant to the study and the web.

2.3 Data analysis

Analysis of qualitative data was done by using content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means, percentages and cross-tabulations. Perception on climate change was measured through indices of four climate change indicators (increase in rainfall variation, temperature, strong wind and drought. Inferential analysis was done by using chi-square test at $p < 0.05$ level of significance to determine association between the variables; and corrected Rao-Scott chi-square (χ_c^2) was used to determine association between variables for the multiple response answers (Lavassani *et al.* 2009).

3.0 Results and discussions

3.1 Perception of climate change by sex

Using indices from Likert scale statements, it is revealed in Table 1 that 87.2% of men perceived changes in rainfall variation compared to 76.7% of women. The findings further showed that more than 95.0% of the respondents

perceived increase in temperature, strong wind and drought; and that drought was highly perceived by both men and women. The findings attest that the majority of men and women perceived changes in climate. Using the chi-square test, the findings showed that there was significant association between perception of respondents on increase in rainfall variation and sex ($\chi2 = 11.588$; $p \leq 0.05$); increase in strong wind and location (village) of respondents ($\chi2 = 42.792$; $p \leq 0.01$); increase in drought and marital status ($\chi2 = 73.536$; $p \leq 0.001$) and also increase in drought and ethnic group ($\chi2 = 193.098$; $p \leq 0.001$). This indicates that perception of climate change in the study area varied by sex, village of respondent, marital status and ethnic group of respondents.

Table 1: Perception of respondents on climate change by sex

Scale for perception	Men (n=180)		Women (n=180)	
	n	%	n	%
Perception on increase in rainfall variation				
Perceiving	157	87.2	138	76.7
Not perceiving	23	12.8	42	23.3
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in temperature				
Perceiving	177	98.3	175	97.2
Not perceiving	3	1.7	5	2.8
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in strong wind				
Perceiving	175	97.2	172	95.6
Not perceiving	5	2.8	8	4.4
Total	**180**	**100.0**	**180**	**100.0**
Perception on increase in drought				
Perceiving	180	100.0	178	98.9
Not perceiving	0	0.0	2	1.1
Total	**180**	**100.0**	**180**	**100.0**

Source: Survey data (2011)

It was revealed during the key informant interviews and focus group discussions that rainfall used to begin in November or December and end in late May in the 1970s, but in the 1990s variation in rainfall onset and also distribution of rainfall had increased. Rainfall could start in December or January and end in March or early April, causing rain season to be short. It could fall too heavy for example, during El Niño in 1997/98; or too heavy and very little within the same season. Moreover, rainfall could fall in one side of the village and leave another side of the same village dry; and sometimes could fall for one or two weeks and stop for a month and start to fall again after crops have been damaged by drought.

In addition, high temperature was felt much in November and cooled down when rainfall started; and it was an indicator that rainfall was about to fall. But, according to discussants, in the 1990s temperature had notably increased and in some seasons increased temperature extended from August to February. The cold season that used to be experienced mainly from late May to September in the1970s was experienced only in mid June throughout July in the 1990s, and the rest of the cold season becomes warm and sometimes very hot during the day. Furthermore, in the 1970s the dry spell used to take one to two weeks in late January or February and it was an important period required during crops establishment. Nevertheless, in the 1990s dry spell takes four to six weeks between January and March, causing strong sunshine that damages crops. For example, during the survey, in the study area rainfall had stopped in December and started to fall again at the end of March. Crops, especially maize were badly damaged by drought such that farmers in Kurio village ploughed maize plots to plant sweet potatoes and cassava. Traditional indicators that were used to indicate rainfall onset (for example, when baobab trees sprout) could indicate signs for rainfall

onset but rainfall delays. Other changes mentioned during focus group discussions were increase in human diseases such as malaria, cholera and typhoid; crop pests; and livestock diseases. It was also revealed that bad years had increased and good years decreased in the 1990s compared to the 1970s. Rainfall variation including erratic distribution and amount together with variation in rainfall onset; increased temperature; and also strong wind were the main causes of increase in drought. Strong wind blew away rainfall clouds causing rainfall to delay or fall in patches. Climate change had caused various physical effects on agricultural production activities of men and women in the study area as it is shown in section 3.2.

3.2 Perceived physical effects of climate change on production activities by sex

Table 2 depicts perceived physical effects of climate change on production activities of respondents in the study area. It is shown from the Table that climate change was the cause of crops to be damaged and also the cause of persistent low yields, the effect which was perceived equally by men and women. Moreover, more women were likely to perceive effects of climate on reduction of water sources and shrinkage of wetland areas; reduction in crop varieties; non-farm production activities; and increased crops insect pests and vermin compared to men. Likewise, men were more likely to perceive effect of climate change on reduction in pastures, number of livestock and milk yield; and increased livestock diseases compared to women. This indicates that men and women perceived physical effects of climate change on their production activities differently. The corrected Rao-Scott chi-square (χ_c^2) test showed significant association between the perceived physical effects of climate change on production activities and sex (χ_c^2 = 250.171; $p \leq 0.001$) indicating that perception of the physical effects of climate change on production activities depend on the sex of respondents.

Table 2: Perceived physical effects of climate change on production activities by sex

Description	Men (n=180)		Women (n=180)	
	n	% of responses	n	% of responses
Physical effects of climate change on production activities				
Damaging crops and persistent low yield	180	16.1	180	15.8
Reduction in pastures, number of livestock and milk yield	179	16.0	165	14.5
Increased livestock diseases	177	15.8	118	10.4
Reduction in water sources and shrinkage of wetland areas	175	15.7	180	15.8
Increased crops insect pest and vermin	160	14.3	177	15.5
Reduction in crop varieties	127	11.4	163	14.3
Reduction in non-farm production activities	120	10.7	157	13.8
Total	**1118**	**100.0**	**1140**	**100.0**

NB: Multiple responses
Source: Survey data (2011)

In the study area, drought was the cause of frequent wilting and in severe case most of crops to dry, the effect that resulted into persistent low crop yields. Droughts reduced pastures, causing high mortality rates in livestock and reduction in milk yield due to inadequate feeding and increased incidence of diseases. Drought had also encouraged emergency and increase of insect pests and vermin including stalk borers and birds that attacked maize, sorghum, paddy and pearl millet. It was revealed during focus group discussions and key informant interviews that birds especially quelea quelea occurred often in the study area and for the past five consecutive years (2005 – 2010) quelea quelea was a threat to sorghum and pearl millet grains in villages of Nagulobahi, Puhi and Kurio. In addition, elegant grasshoppers had been a threat to cassava, sunflower and pigeon peas crops, attacking leaves and cutting seedlings in Isusumya village. Those insect pests had discouraged sorghum, pearl millet and cassava farming such that 6.7% of men and 5.8% of women (responses) had abandoned sorghum farming; 7.7% of men and 3.2% of women

(responses) pearl millet farming and 9.6% of men and 7.4% of women (responses) had abandoned cassava farming. The merit of sorghum, pearl millet and cassava is that they are hunger buffering crops, grown purposively for food security and are produced more by women. Abandoning or reducing production of these crops, will have great effect on food security within the household and income of women.

Table 2 show also that drought had caused decline in water sources and shrinkage of wetland areas in the study area. This reduced the amount of domestic water and lessened non-farm production activities by reducing garden crops, fishes; salt production and basket making materials (*milala*). Additionally, crops like beans and sweet potatoes that were grown in late February to early March had been very much reduced and were no longer grown every season because of rainfall variation that had caused growing season to be shortened, especially in Bahi District. Similar findings were reported by various studies including Maharjan *et al.* (2011), Mengistu (2011) and Mongi *et al.* (2010). The consequences of perceived physical effects of climate change were the socio-economic effects discussed in section 3.3.

3.3 Perceived socio-economic effects of climate change by sex

The main reported socio-economic effects of climate change were waste of resources; increased hunger and weakness; farmers being subjected to bad food debts; increased family conflict; out-migration; decreased sanitation, hygiene and domestic water; waste of productive time in less productive activities; and loss of status and failure of respondents to improve family well-being (Figure 1).

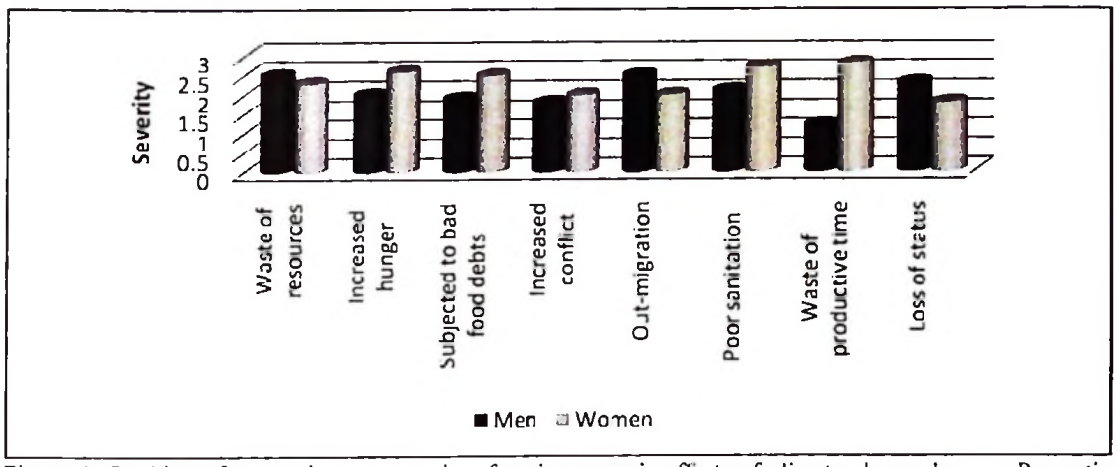

Figure 1: Ranking of perceptions on severity of socio-economic effects of climate change by sex. Perception of severity of the effect of climate change increases as scale increases from
0 – 1 = Low/moderately affected; 1.1 - 2 = Highly affected; 2.1 - 3 = Severely affected.
Source: Survey data (2011)

3.3.1 Waste of resources

It is shown in Figure 1 that men were more likely to perceive severity in wasting resources compared to women. In the study area wasting of resources occurred when farmers were forced to replant several times because of crop failure or when crops were destroyed by drought such that they were forced to plough again the same plot to plant other crops. In addition, waste of resources occurred when floods carried away top fertile soils including manure hence destroying farms. It was revealed during focus group discussions that replanting has become a common exercise from the 1990s due to climate change. For example, in 2006/07 farmers from Isusumya village replanted

four times. Similarly, in Kurio village farmers were forced to plough maize plots to plant other crops including sweet potatoes and cassava after maize crop had been damaged by dry spell. Moreover, floods carried away fertile top soil including manure from the farms in Chipanga B village; and some plots in Isusumya village were no longer used for production because of erosion that had caused deep gullies and water ways. These effects had wasted resources including seeds, land, labour, money and time and also increased cost of production. Men were more likely to perceive severity in wasting resources compared to women probably because of the variation in cost of production between them, which is more felt when money is involved. Women use more of their labour or family labour and are good at keeping seeds.

3.3.2 Increased hunger and food shortage

It is also depicted in Figure 1 that women were more likely to perceive severity of hunger compared to men, probably because it was their role to assure food security in the household. Climate change was the main cause of increased hunger and food shortage due to persistent low yield. Hunger caused weakness and reduced work performance of respondents. For example, it was found during focus group discussions that a number of women had gone without food for three days in Kurio village, but they were continuing with field operations including weeding. With such hunger situation, it was not easy for the respondents to be efficient in production activities. In addition, hunger had also reduced school attendance and class participation of pupils and students. It was impossible for children to go to school when there was nothing to eat at home or hope to get food after classes. Related findings are also reported by Shepherd *et al.* (2011) from a study done to analyze hidden hunger in rural Tanzania.

3.3.3 Respondents being subjected to bad food debts

The results in Figure 1 show further that women were more likely to perceive effects of being subjected to bad food debts compared to men. In the study area persistent low yield for both cash and food crops due to climate change caused demand of food to increase and price of crops including food items to be inflated. During such periods one of the measures undertaken by the respondents to protect the family from hunger was to borrow from traditional food credit (*songoleda*[2]) but during such period the interest rate of food was very high (150 to 300%). This is because the rich compared price of a particular food item during transaction and its price during harvesting period. Moreover, borrowing food from traditional credit was a risk practice in the 1990s compared to the 1970s because yield was unpredictable and persistent low yield reduced the possibility of the respondents to repay loan in time. However, more women opted for borrowing from traditional food credit in order to save their families from food shortage. This action subjected more of them to bad food debts as they failed to repay the food loan in time. Food debts were bad because even if borrowers got food next season, most of it was taken by lenders because of the high interest rate which they were required to pay. This practice locked borrowers in the cycle of food shortage and bad food debts.

3.3.4 Increased family conflict

It is also revealed in Figure 1 that women were likely to perceive severity in increased family conflict compared to men. Although there were various sources of family conflict in the study area, conflict associated with climate change occurred when after the family was stricken by hunger, men became devastated. Instead of accepting the reality and cooperate with their spouses to confront the situation, they opted for gathering with other men to eat and drink and left the struggle to search for food to their wives. Such actions caused conflict in the family and women and children were more affected by the conflicts.

3.3.5 Out-migration

Increase in food shortage and hunger due to climate change encouraged out-migration in the study area. Although

[2] *Songoleda* is a Gogo word for a traditional food credit system operating in the study area which involves the rich - livestock keepers and crop producers (*tajiri ng'ombe/chakula*) and the poor (*mochiwa*). The main commodity for transaction is cereals (food), but they are also lending money nowadays.

out-migration is one of the measures of adaptation, it had negative effects to the family. The findings in Figure 1 show that men were likely to perceive severity on the effect of out-migration compared to women. Out-migration was not a pleasure, but respondents emigrated to search for casual labour or exchange various possessions with food away from home whenever opportunities to secure survival of their families in the village were inadequate due to drought. Whether emigrants succeeded to get casual labour or food depended on the situation which they encountered in the new areas where they emigrated to. Some of the emigrants returned home after getting food while others came back after the food shortage was over with nothing in their hands; and others forsook their families and decided to establish new ones. Such actions destroyed family bond and marriage ties; caused children to be discouraged and decided to emigrate to roam in towns (for example, in Kondoa and Dodoma towns) to become street beggars, increasing number of street children and childhood pregnancies for girls. Moreover, emigration had increased chances of spreading or being infected by HIV/AIDs and other sexually transmitted diseases. This is for both emigrated respondents including children; and also women who remained at home.

Emigration was also one of the causes of increased burden of women because in addition to their reproduction and production roles they were required to undertake part of the responsibilities which were to be done by men. The challenge of women was also increased when the family moved to a new place or when they were forced to stay away from home or from their children for a week or more days. It is argued in UNFPA (2009) that population movement is likely to intensify as changing climate leads to the abandonment of flooded or arid and harsh environments including areas with persistent food shortage or hunger, a situation which is happening in the study area.

3.3.6 Decreased sanitation, hygiene and domestic water

It is also shown in Figure 1 that climate change was the cause of poor sanitation, hygiene and had increased domestic water shortage; and that women were likely to perceive severity of decreased sanitation, hygiene and domestic water compared to men. In the study area drought reduced water sources and ground water causing shortages in domestic water in the 1990s compared to the 1970s. In the 1990s most of water sources which had enough water throughout the year, dried just after rain season. For example, Kurio village water source had enough water throughout the year in the 1970s but during El Niño of 1997/98 the source was eroded by floods such that when rain falls, the rain water flowed straight to the low land areas of Bahi District through River Bubu. Furthermore, in the 1970s women drilled shallow wells that kept water throughout the year, but in the 1990s it was difficult for them to drill such shallow wells after rains. For the areas where women managed to drill the wells, for example, Nagulobahi village, the wells dried in July. Decrease in domestic water was the main cause of poor hygiene.

Furthermore, in the study area floods had destroyed buildings including houses and latrines. For example, in 2009/10 season floods destroyed more than 100 houses in Msisi village and more than 15 houses and 20 latrines in Isusumya village. When houses are destroyed some of the families are forced to take sanctuary in school or office buildings which are not affected, places where toilet facilities are inadequate. This increases the possibility of environment to be polluted. Equally, pollution from destroyed latrines and heavy dust in the atmosphere due to whirlwind (especially during dry season) polluted and contaminated environment including water sources, reducing the amount of clean water that could be available for domestic use. Water and environment contamination due to climate change widened chances of farmers to be infected by various diseases including typhoid, diarrhoea and cholera. For example, from 1994 typhoid was a common problem in Isusumya village. Whirlwind was also one of the causes of cough and eye diseases. In addition, domestic water shortage exposed famers especially children to skin diseases due to poor sanitation and hygiene. Women were more affected by poor sanitation and hygiene because they were forced to sacrifice water use for their spouses and children. Improved sanitation, hygiene and safe water are important measures for the community to improve health status and it is among the Millennium Development Goals targets (Target 7C: By 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitation) (WHO, 2011). However, climate change had undermined the efforts of Tanzania to attain this target in the study area.

3.3.7 Wasting productive time in non-productive activities

The results in Figure 1 reveal also that severity of effect of wasting productive time in non-productive activities was perceived more by women compared to men, probably because it was the role of women to collect water and firewood. In the study area respondents wasted productive time mainly when fetching water and also collecting firewood. Decline in water sources including ground water and increased domestic water shortages forced women to travel a mean distance of 2.0 km to fetch water and also 4.0 km to collect firewood in the 1990s, compared to 0.7 km travelled in the 1970s (for water and also firewood). It was revealed during key informant interviews and focus group discussions that women wasted more time (two to six hours depending on location) because of the long queue and the fact that they had to wait for water to ooze from the ground. In addition, drought encouraged farmers to be engaged more in charcoal and firewood business to earn income. This practice (together with other causes including increased demand for land and material for housing because of increased population) reduced forest and firewood and increased the distance that respondents had to travel to collect firewood.

3.3.8 Loss of status and failure of respondents to improve family well-being

It is also depicted in Figure 1 that men were likely to perceive severity of the effect of loss of status and failure of respondents to improve family well-being compared to women. In the study area respondents varied in status depending on the level of their wealth. According to the findings from key informant interviews livestock ownership was among the criteria used to determine wealth status of respondents. Rich farmers had 20 and above heads of cattle, 10 and above hectares of land, produced enough food and surplus and could pay school fees of children. Additionally, in the 1990s livestock were mainly kept for security purposes, to be sold or exchanged for food during food shortage or hunger. However, climate change had reduced livestock, income and all privileges accrued from production activities, reducing the ability of respondents to meet family development targets and ability to improve their well-being. Although climate change had great negative effects to all farmers, livestock owners who were among 78.9% of men and 50.0% of women were more affected by loss of status. The same observation was reported by Jotoafrica (2011) in a study done in Northern Kenya that loss of animals due to climate change had threatened the pastoralists such that they were forced to shift to low paid jobs like security guards in towns.

It is shown throughout the discussion that men and women were affected differently by climate change. Men were more affected by the effects of climate change that involved wasting of resources; that associated with out-migration and effects that reduced status of respondents. Similarly, women were more affected by the effects of climate change that increased hunger (food insecurity) causing them to be subjected to bad food debts and family conflict; effects that reduced domestic water and forest (trees) causing them to be subjected to poor sanitation and hygiene, and forcing them to waste their productive time that could be allocated in more productive alternatives. The chi-square test revealed that there was significant association between perceived socio-economic effects and sex ($\chi2 = 77.474$; $p \leq 0.001$); location (village) of respondent ($\chi2 = 175.418$; $p \leq 0.001$); ethnic group ($\chi2 = 266.030$; $p \leq 0.001$); main occupation ($\chi2 = 72.839$; $p \leq 0.001$); and size of land of respondent ($\chi2 = 85.\ 254$; $p \leq 0.001$). The findings indicate that perceived socio-economic effects of climate change varied by sex, village, ethnic group, main occupation and land size of respondents.

It is evident from the discussion that although men and women were continuing to work on their farms, crop production and livestock keeping are becoming more risky production activities as climate change intensifies, the observation reported also in Maharjan *et al.* (2011). Climate change has increased poverty level of the farmers, obstructing their effort to meet family development targets; and had undermined effort of Tanzania to reduce poverty and attain Millennium Development Goals, the argument which was also foreseen by UNFPA (2009). However, it was encouraging to realize that respondents were not passive victims of climate change but they were fighting back to assure their survival by undertaking various adaptation practices.

4.0 Conclusion and recommendations

This study analyzed perception of respondents on climate change, and examined effects of climate change by sex. Using available knowledge system majority of men and women managed to perceive climate change (that is increased rainfall variation, temperature, drought and strong winds); identify negative effects associated with climate change; and severity of those effects on their livelihoods. This means that the available knowledge system in the study area can be used to identify climate change and its effects; and use appropriate adaptation practices to adapt to or reduce the effects in Tanzania. The study suggests Tanzania and other Less Developed Countries to build on available knowledge system to learn and manage climate change problems.

Moreover, climate change and its effects were perceived differently by respondents depending on sex, location (village), marital status, ethnic group, main occupation and land size of respondents. This implies that climate change perception varied between men and women; one village and another; among the single and married individuals; and also among various ethnic groups. The study calls for follow up studies to analyze perception of climate change among and between various gender groups.

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2.3 Paper Three

Gender and Adaptation Practices to the Effects of Climate Change in Bahi and Kondoa Districts Dodoma Region, Tanzania.

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Gender and Adaptation Practices to the Effects of Climate Change in Bahi and Kondoa Districts Dodoma Region, Tanzania

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Abstract

Climate change has different effects between men and women, but disaggregated data by gender to realize specific adaptation practices undertaken by men and women in Tanzania are scarce. To fill part of the information gap, this study analyzed adaptation practices to the effects of climate change by gender in Bahi and Kondoa Districts Dodoma region, Tanzania. The study also analyzed perception of climate change and identified elements influencing adaptation practices. A sample of 360 respondents, 12 focus groups of discussants and 78 key informants were consulted. Analysis involved descriptive statistics for quantitative data and content analysis for qualitative data. Results showed that women were more devoted to adaptation practices that enabled them to adapt to or reduce hunger/food, water and firewood shortages while men were more devoted to adaptation practices that enabled them to adapt to or reduce effects of climate change on crops, livestock and environment. The corrected Rao-Scott chi-square (χ_c^2) test showed significant association between adaptation practices implemented by respondents and sex, revealing that undertaken adaptation practices varied by sex. Respondents perceived climate change and managed to identify adaptation practices undertaken to manage climate change effects. The findings can be used to improve/formulate appropriate adaptation practices to manage climate change problems in agriculture sector. The study recommends systematic collection of in-depth information of this kind at the community level in other areas of Dodoma Region, Tanzania and the LDCs in order for the policy makers to design and implement appropriate interventions to manage climate change problems.

Keywords: climate change, gender, agricultural production, adaptation practices

1. Introduction

Despite the fact that climate change has different effects between men and women, disaggregated data by gender to realize specific adaptation practices undertaken by men and women are scarce. Climate change literature indicates that effects of climate change including variation in temperature and rainfall, drought, floods, heat waves, hurricanes and typhoons have already occurred across the world; affecting countries, income groups and occupations differently (Chaudhary & Aryal, 2009; Intergovernmental Panel on Climate Change [IPCC], 2007). The negative effects of climate change are more severe in sub-Saharan Africa, including Tanzania (Cline, 2007; Haque, Yamamoto, & Sauerborn, 2012). Tanzania is experiencing greater weather extremes including increases in temperature and changes in rainfall patterns. Such effects have increased drought, floods, land resources degradation as well as health problems. The intensity of droughts, floods and changes to growing seasons have significant effects on agricultural productivity, water supply, food security and human welfare (Yanda, Kangalawe, & Sigalla, 2006; United Republic of Tanzania [URT], 2007). For example, the drought that occurred in 2005/06 and the El Niño in 1997/98, highlight the country's vulnerability to current climatic hazards (Ehrhart & Twena, 2006). Moreover, Dodoma region in Tanzania is among the regions severely affected by failing agriculture due to climate change, as the region is situated in semi-arid areas (Food and Agricultural Organization [FAO], 2008).

Although all small-holder farmers in Dodoma region will be affected by climate change, women are expected to be severely affected because in addition to extreme poverty and low adaptive capacity, they make up a large

number of individuals working in agricultural production. In addition, inequalities existing between men and women partly due to statutory and/or customary laws that often restrict women's property and land rights; constrain women from accessing important resources for example, land and credit, undermining further their adaptive capacity (Osman-Elasha, 2008; Brody, Demetriades, & Esplen, 2008). The fact that women are likely to be more affected by climate change is also supported by climate change literature insisting studies focusing on gender and climate change to be conducted at community level in order to gather disaggregated data (Lambrou & Piana, 2006; United Nations Population Fund [UNFPA], 2009; United Nation Development Programme [UNDP], 2009).

It is obvious that people in drought and flood-affected communities have evolved their own adaptation strategies to protect their families, assets and secure food security (Agrawal, McSweeney, & Perrin, 2008; Odjugo, 2010). Moreover, previous studies by various scholars, including Maddison (2006), Ishaya and Abaje (2008), Paavola (2008), Mutekwa (2009) and Lema and Majule (2009) have reported farmer observations of climate change and existing adaptation strategies for managing climate risks, for example, proper timing of agricultural operations and use of different crop varieties. Nevertheless, the findings are not disaggregated by gender to realize specific adaptation practices undertaken by men and women. Moreover, studies focusing on gender and adaptation to the effects of climate change have been conducted in developing countries for example, Agwu and Okhimamhe (2009), Ribeiro and Chaúque (2010) and Kapoor (2011) but in Tanzania studies focusing on gender and climate change are scarce.

Lack of disaggregated data has meant that policy makers dealing with climate change in Tanzania including the National Adaptation Program of Action (NAPA) cannot come up with effective policies or adaptation options. According to UNFPA (2009) and UNDP (2009), for the policy that is intended to address any aspect of climate change to be effective, the differences between men, women, boys and girls must be taken into account during policy formulation. Gender blind policies may exacerbate the problems associated with climate change by widening inequalities between the sexes. Thus, to attain effective and successful adaptation, the needs of men and women should be integrated in adaptation plans and policies. This can only be achieved if information on how men and women are adapting to climate change effects will be gathered. This paper intends to fill part of this gap of information by analyzing adaptation practices to the effects of climate change by gender in Bahi and Kondoa Districts of Dodoma Region. The rest of the paper is structured as follows: it starts with methodology section which includes the study area, methods of data collection and data analysis; then the results and discussions section; and finally recommendations and the conclusion section.

2. Methodology

2.1 Study Area

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate, which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6°C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21°C. The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

2.2 Research Design and Methods of Data Collection

The study employed a cross-sectional research design and both primary and secondary data were collected. Primary data involved qualitative and quantitative data. The study sample was obtained by using simple random sampling technique from a sampling frame of farmers who were dealing with crop production and livestock keeping. Moreover, key informants involved purposive selected ward and village leaders, crops and livestock extension workers, religious leaders, members of village government committees, head teachers and elderly farmers (two men and two women). Methods to collect qualitative data involved key informant interviews and focus group discussions; and a structured questionnaire was used to collect quantitative data. To collect qualitative data, a checklist of items for an in-depth interview with key informants was used to gather information from 78 key informants; and a focus group interview guide was used in discussion to gather information from 12 focus groups (one group of men and one of women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents (30 men and 30

women from each village) to verify and quantify some of the findings from qualitative data. Secondary data were gathered from various reports relevant to the study and the web.

2.3 Data Analysis

Analysis of qualitative data was done by using content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means, percentages and cross-tabulations. Perception on climate change was measured by using indices of four climate change indicators (increased rainfall variation i.e. increased rainfall unpredictability and irregularity; increased temperature; strong wind; and drought) formed from Likert items (Marshall & Marshall, 2007). Inferential analysis involved chi-square test at $p < 0.05$ level of significance, employed to determine association between the variables; and corrected Rao-Scott chi-square (χ_c^2) that was used to determine association between variables for the multiple response answers (Lavassani, Movahedi, & Kumar, 2009).

3. Results and Discussions

3.1 Demographic and Socio-economic Characteristics of Respondents

3.1.1 Mean Age and Family Size

Results in Table 1 show that the average age of respondents was 54.0 years for men and 50.0 years for women. The average number of years of engagement in crop production was 35.0 for men and 32.0 for women while for the case of livestock keeping was 19.0 years for men and 16.0 years for women. It is further shown in Table 1 that the family size of respondents was 7.0 members for men and 6.0 for women. Family sizes in both cases were large and above the rural average household size of 5.1 (URT, 2002). Large family sizes are an important asset in working together to reduce vulnerability to the effects of climate change. This occurs when almost all of the household members take part in production and/or service provision to contribute to the economy of the household (Kayunze, 2000). Conversely, having big families is said to be one of the causes of poverty in Tanzania (URT, 2002).

Table 1. Mean age, years in crops and livestock production and family size

Respondent characteristic	Mean	
	Men (n=180)	Women (n=180)
Respondent age	54.4	50.0
Years in crop production	35.0	32.0
Years in livestock keeping	19.0	16.0
Family size	7.0	6.0

Source: Survey data (2011).

3.1.2 Education Level

Among the interviewed respondents 83.3% of men and 69.4% of women had attained primary school education level (Table 2). The number of women with primary school education level was half that of men, indicating that more men had attained primary education level compared to women. Although the Tanzania Human Development Report (2000) shows that the gap of education between men and women for primary level has been corrected, the changes may hold for the coming generation, but that gap still exists between men and women farmers for the earlier generation. Education is the source of knowledge which is very essential for respondents to perceive and interpret day to day changes experienced when interacting with climate. According to Prahalad (2009), education has a key role to play in promoting understanding and helping individuals and community to make informed choices to respond to challenges posed by climate change.

Table 2. Distribution of respondents by education level

Respondent characteristic	Men (n=180)		Women (n=180)	
	n	%	n	%
Education level of respondents				
Primary school level	150	83.3	125	69.4
Adult education	5	2.8	5	2.8
Secondary school level	1	0.6	0	0.0
None (had not gone to school)	24	3.3	50	27.8
Total	**180**	**100.0**	**180**	**100.0**

Source: Survey data (2011).

3.1.3 Land Acquisition

The findings in Table 3 show that to acquire land 36.0% of men and 31.3% of women responses cleared the forest during village establishment; 29.4% of men and 33.5% of women responses inherited land from their parents; and 18.1% of men and 23.3% of women responses purchased the land. During village establishment in the 1970s, the land was abundant and farmers practiced shifting cultivation. However, as the population increased demand for land also increased such that, it was impossible for the farmers to expand the land freely within villages. To expand their farms farmers were forced to purchase land from their fellow farmers within the village or nearby villages. The mean hectares of land owned by respondents were 3.8 for men and 1.9 for women, indicating that the land size of women was only half of that owned by men. Having small farms was among the major obstacles that constrained respondents from planting on different dates; livestock keepers to spare a plot for livestock to graze during dry season; harvesting enough food; and was one of the causes of increased vulnerability for women to climate change. The same observation was also reported by Deressa, Hassan, Alemu, Yesuf and Ringler (2008).

Table 3. Distribution of respondents by land acquisition

Respondent characteristic	Men (n=180)		Women (n=180)	
	Count	% of responses	Count	% of responses
Land acquisition				
Cleared the forest/bush	131	36.0	100	31.3
Inherited	107	29.4	107	33.5
Purchased	66	18.1	42	23.3
Others	60	16.5	70	22.0
Total	**364**	**100.0**	**319**	**100.0**

NB: Multiple responses.

Source: Survey data (2011).

3.1.4 Production Activities Undertaken by Respondents

It is seen in Table 4 that the main production activities undertaken by respondents were crop and livestock production (78.9% of men and 50.0% of women). The findings further revealed that many men were agro-pastoralists compared to women, half of whom were crop producers; production activities that need enough rainfall in a changing climate.

Table 4. Production activities undertaken by respondents

Production activities	Men (n=180)		Women (n=180)	
	n	%	n	%
The main production activities of men and women				
Agro-pastoralists	142	78.9	90	50.0
Crop production	38	21.1	90	50.0
Total	**180**	**100.0**	**180**	**100.0**

Source: Survey data (2011).

3.1.5 Ownership, access and control of household assets

Assets owned by households were hand hoes, houses, land, local chickens, goats, cattle and ox-ploughs (Table 5). Spouses had access to household assets but men were the owners and they controlled all household assets; except for 32.8% of women, the majority of whom were widows (16.7%), separated (5.6%), divorced (4.4%) and single (3.3%). Limited control of the household assets is one of the causes of increased vulnerability for women to climate change (Brody et al., 2008; UNFPA, 2009).

Table 5. Access, Ownership and Control of Household Assets

Access and control of assets	Men (n=180)		Women (n=180)	
	n	%	n	%
Assets owned by respondent*				
Hand hoes	180	17.6	180	21.8
House	180	17.6	176	21.3
Land	179	17.5	164	19.8
Local chicken	134	13.0	119	14.4
Goats	104	10.2	59	7.1
Cattle	75	7.3	34	4.1
Ox-ploughs	68	6.6	33	4.0
Others	104	10.2	62	7.5
Total	**1024**	**100.0**	**827**	**100.0**
Respondent's level of control of household assets				
Control all household assets	180	100.0	59	32.8
Control hand hoe, axe and machetes	0	0.0	40	22.2
All assets are controlled by my husband	0	0.0	81	45.0
Total	**180**	**100.0**	**180**	**100.0**

NB: *Multiple responses.

Source: Survey data (2011).

3.2 Perception of Climate Change by Sex

Using the indices of Likert items based on the four climate change indicators (increased rainfall variation, temperature, strong wind and drought) it was revealed that 87.2% of men and 76.7% of women perceived the change in rainfall; 98.3% of men and 97.2% of women perceived the change in temperature; 97.2% of men and 95.6% of women perceived the change in strong wind; and all interviewed men and 98.9% of women perceived the change in drought. The results indicate that majority of men and women perceived changes in climate (Table 6). The chi-square test showed significant association between perception of respondents on the change in rainfall and sex (χ^2=11.588; $p \leq 0.05$); the change in strong wind and village of respondent (χ^2=42.792; $p \leq 0.01$);

the change in drought and marital status (χ^2=73.536; $p \leq 0.001$) and the change in drought and ethnic groups of respondents (χ^2=193.098; $p \leq 0.001$). The findings show that perception of climate change in the study area varied by sex, village of respondent, marital status and ethnic groups of respondents.

Table 6. Perception of respondents on climate change by sex

Scale for perception	Men (n=180)		Women (n=180)	
	n	%	n	%
Perception on increased rainfall variation				
Perceiving	157	87.2	138	76.7
Not perceiving	23	12.8	42	23.3
Perception on increased temperature				
Perceiving	177	98.3	175	97.2
Not perceiving	3	1.7	5	2.8
Perception on increased strong wind				
Perceiving	175	97.2	172	95.6
Not perceiving	5	2.8	8	4.4
Perception on increased drought				
Perceiving	180	100.0	178	98.9
Not perceiving	0	0.0	2	1.1

Source: Survey data (2011).

During focus group discussions and key informant interviews it was also revealed that bad years had increased and good years decreased in Bahi District since 1984 and 1990 in Kondoa District. The findings from the field related to the trend of anomalies of meteorological data from the Tanzania Meteorological Agency Dar es salaam for 1970 to 2010 period, which showed a significantly decrease in rainfall amount for the Bahi District from 1980/81 (that is $R^2 = 0.205$, $p \leq 0.05$), a significantly increase in mean minimum and maximum temperatures (that is R^2=0.404, $p \leq 0.001$ and $R^2 = 0.125$, $p \leq 0.05$ respectively); and mean wind speed (that is $R^2 = 0.276$, $p \leq 0.01$) for Dodoma Region. However, for Kondoa District rainfall amount had decreased insignificantly from 1984/85 (that is $R^2 = 0.022$, $p = 0.4628$), indicating that the area might be more affected by variations in rainfall onset and rainfall distribution than the change in rainfall amount. The findings also agreed with climate change literature and the findings of other scientists that showed/predicted increased temperature, drought (especially in semi-arid areas) and decreased precipitation in Tanzania and other areas of Africa (World Wide Fund for Nature [WWF], 2006; United Nations Framework for Conversion on Climate Change [UNFCCC], 2007; IPCC, 2007; Ishaya & Abaje, 2008; Mongi, Majule, & Lyimo, 2010; Nature, 2011; Haque et al., 2012).

3.3 Perceived Effects of Climate Change in the Study Area

In the study area climate change had damaged crops due to drought; reduced pastures, water and firewood; caused livestock deaths; reduced non-farm production activities; and was the main cause of persistent low yield. The consequences of perceived physical effects of climate change were increased food shortage/hunger and body weakness due to low food intake; persistent low income; waste of resources including money, labour, time and productive land; farmers being subjected to bad food debts; increased family conflict; out-migration; decreased sanitation and hygiene; waste of productive time in less productive activities; and reduced status. Similar findings were reported by various studies including Nelson and Stathers (2009), Mengistu (2011), Jotoafrica (2011), Swai, Mbwambo and Magayane (2012).

3.4 Practices Undertaken to Adapt to or Reduce Effects of Climate Change

3.4.1 Practices Undertaken to Adapt to or Reduce Effects of Food Shortage or Hunger by Sex

Findings in Table 7 show that in short term women were leading in reducing number of meals per day including quantity and quality of food (meal) for example, taking porridge instead of stiff porridge (*ugali*); feeding on wild fruits; and starving for a day or two. Women were also in the front line to embark on casual labour; non-farm

production activities including petty trade and local brew; borrow food from traditional credit; and were assisted by relatives and friends. Conversely, men were in the front line to sell livestock, local chickens and other belongings including bicycles and radio; and to emigrate to various villages including Mpwayungu, Matui and Endasaki and also to Kondoa, Dodoma and Dar es Salaam towns to sell labour or exchange labour and various commodities for food (Swai et al., 2012). Emigration was opted when opportunities to get money or food were fading in the village. Men emigrated in groups and after obtaining food one of the group members brought food back home.

Table 7. Adaptation practices undertaken to adapt to or reduce effects of climate change

Adaptation practices	Men (n=180)		Women (n=180)	
	Count	% of responses	Count	% of responses
Practices undertaken to adapt to or reduce effects of food shortage or hunger				
Reduce number of meals, wild fruits, starve	165	13	172	11.3
Sell labour, assisted by relatives/friends	155	12.2	176	11.6
Sell livestock and/or local chicken	152	12	93	6.1
Engage in non-farm production activities	128	10.1	149	9.8
Plant hunger buffering crops e.g. sweet potatoes	120	9.5	145	9.6
Emigrated	108	8.5	33	2.2
Borrowing food from traditional food credit	98	7.7	129	8.5
Practices undertaken to adapt to or reduce effects of water and firewood shortages				
Drill deep water wells	143	11.3	2	0.1
Fetch water/firewood from far sources; control/boil water	93	7.3	180	11.9
Sell food crops to buy water	40	3.2	65	4.3
Drill shallow water wells for domestic use	3	0.2	165	10.9
Use cobs, stalks, bricks stoves	2	0.2	123	8.1
Others	60	4.7	86	5.7
Total	**1267**	**100**	**1518**	**100**

NB: Multiple responses.

Source: Survey data (2011).

While men were away women, the majority (81.7%) of who remained within the village, continued to search for casual labour and others undertake petty trade to save the family from hunger. Women sacrificed more of their time, energy and whatever they had, including their food share for the family members. Although it was their responsibility to keep enough seeds for the next season, women allowed family members to consume seeds during severe food shortage/hunger. To avoid wasting food they used rosella flowers, sugar and bicarbonate to make local brew instead of using cereals.

3.4.2 Practices Undertaken to Adapt to or Reduce Effects of Water and Firewood Shortages by Sex

It is also depicted in Table 7 that to adapt to or reduce effects of water shortage, women drilled shallow water wells which were mainly for domestic purpose; and men drilled deep water wells. When water shortage increased, especially after August, women were forced to awake early in the morning to fetch water from far water sources either within their village or at nearby villages. In the 1990s, men had joined women in fetching water and using bicycles or wheel barrows they could fetch up to six buckets of water per trip. Equally, respondents sold food crop products to buy water, especially in Isusumya village where the price per bucket of water ranged between TZS 500.00 and 700.00. Moreover, women were leading in boiling water especially

during rain season to reduce contamination and water borne infectious diseases. They also controlled water use by reducing frequencies of bathing and washing, measures that reduced frequencies of fetching water.

To adapt to or reduce effects of firewood shortage, women used maize cobs and stalks of sorghum, pearl millet and maize for cooking; and in Puhi village potters were using energy serving stoves made of bricks which enabled them to use little quantities of firewood during pot processing (Table 7). Moreover, men had joined women in collecting firewood where they hired power tillers, ox-carts or tractors and went far in the forest to fell trees in order to collect firewood in greater quantities. For example, respondents from Nagulobahi village were collecting firewood from Uhelela village, a distance of seven kilometers. The firewood was then dried at home and could be used for more than three months. During week-ends and after classes women were accompanied by boys rarely and girls often to collect water and firewood. Agwu and Okhimamhe (2009) indicate the same findings. Firewood and water collection were the role of women in the 1970s, but it is shown in Table 7 that men were also collecting water and firewood in the 1990s; probably due to the long distance that women travelled and time spent in those activities in the 1990s.

Men engaging in collecting water and firewood show that their roles are changing, indicating further that the cultural division of labour demarcating gender constructed roles can no longer hold as climate change increases; as not only the role of men that had changed but, women were also engaged in emigration regardless of their marital status in the 1990s. The same observation was reported in Jotoafrika (2011). Measures undertaken by women to control water use, together with the assistance they were getting from men reduced frequencies of women to fetch water and firewood and enabled them to save time that could otherwise be wasted. It is evident from the findings in Table 7 that women were leading in most of practices to adapt to or reduce effects of food shortage/hunger, water and firewood shortages. The corrected Rao-Scott chi-square (χ_c^2) test showed significant association between the adaptation practices undertaken by respondents and sex (χ_c^2= 1219.799; $p \leq 0.001$) revealing that undertaken adaptation practices varied by sex.

3.3.3 Practices Undertaken to Adapt to or Reduce Effects of Climate Change on Production Activities by Sex

Results in Table 8 show that to adapt to or reduce effects of climate change on livestock, men were in the front line to feed livestock tree leaves for example, miyombo and sausage tree *(mwegea)* every season; and banana stems especially in Puhi village. As pasture and water decreased herders moved livestock to areas that were less affected by drought. For example, herders from Isusumya village moved livestock to Zajirwa and Izava villages, a journey which took 20 hours. This was a long journey that herders could not travel every day. Instead they travelled after every three days forcing livestock to go without water for three days, as one of the adaptation measures. In addition, respondents spared a plot during cropping season for livestock to graze on during dry season; preserved grasses and crop residues for livestock to feed during pasture shortages; sold livestock to reduce them to a manageable number; and loaned livestock to relatives or friends (livestock *songoleda* in Gogo) (Swai et al., 2012; Notenbaert, Mude, Steeg & Kinyangi, 2010).

The practice of loaning livestock to relatives or friends was undertaken as a risk aversion practice and a measure to improve livestock management for the lender; and a measure to improve life standard for the borrowers. For example, a livestock keeper from Nagulobahi village could lend a number of cattle to relatives or friends from Msisi village such that when a fatal livestock disease or rustling occurred in Nagulobahi a number of his cattle at Msisi could be safe. Conversely, individuals keeping livestock of the rich benefited from milk, manure and draught power; these advantages contributed to their effort to fight against climate change. To control diseases against livestock, men used traditional medicine for example, *Azadractaindica* leaves (*majaniyamwarobaini*) to treat livestock against ticks. In addition, they used their experience to identify livestock diseases or parasites and buy agro-chemicals from primary markets at a ward centre or from Kondoa and Dodoma towns, to treat sick animals. For the villages that had Livestock Extension Workers, for example Chipanga B, respondents consulted them for treatment when livestock were sick.

To adapt to or reduce effects of climate change on crops, women were in the front line to clear the land early in order to match with rainfall onset and reduce resources loss. Moreover, women selected and kept enough seeds for the next season, every season (Table 8). Preservation of seeds was a traditional practice that women were not required to continue observing because most of crops that were grown in the 1970s including long maturing sorghum, groundnuts and maize varieties were replaced by improved short maturing varieties. However, women continued to select and keep seeds probably because they could not afford buying improved seeds every season. Instead, women bought the amount of improved seed they could afford (for instance, one kilogram) and multiplied the seeds in the first season and then continued selecting and keeping the seeds for even five

consecutive seasons. In addition, women used traditional substances including ashes of maize cobs and sunflower remains; and *Azadractaindica* leaves to treat and preserve crops including seeds every season.

Table 8. Adaptation practices undertaken to adapt or reduce climate change

Adaptation practices	Men (n=180)		Women (n=180)	
	Count	% of responses	Count	% of responses
Practices undertaken to adapt or reduce effects of climate change on production activities				
Feed livestock tree leaves (e.g. miyombo)/banana stems	111	5.5	39	2.2
Livestock go without water for three days	92	4.5	58	3.2
Move livestock to other places/divide to friends/reduce/ fed crop residues	78	3.8	18	1.0
Use traditional herbs/experience/consult livestock officer	69	3.4	37	2.0
Use of improved seeds/drought tolerant/short term	176	8.6	168	9.3
Use of deep cultivation/early planting	176	8.6	159	8.8
Use of manure	174	8.5	115	6.4
Ask rainfall from God	173	8.5	174	9.6
Select and keep enough seeds /replant	166	8.2	180	10.0
Change of crop varieties/plant different dates	154	7.6	83	4.6
Use of traditional medicine/herbs	116	5.7	120	6.6
Early land clearing	80	3.9	180	10.0
Practices undertaken to adapt or reduce effects of climate change on environment				
Plant trees (shade/firewood)	176	8.6	167	9.2
Contours/plant reeds (*matete*)	110	5.4	94	5.2
Use of ridge farming	113	5.6	132	7.3
Others	72	3.5	83	4.6
Total	**2036**	**100**	**1807**	**100**

NB: Multiple responses.

Source: Survey data (2011).

Likewise, men were leading in using improved seeds of short maturity and drought tolerant crop varieties; undertaking deep cultivation during land preparation and planting early; using manure; and were changing crop varieties and planting crops in different dates (staggered planting). Besides, both men and women asked rainfall from God. Other adaptation practices implemented by 3.5% of men and 4.6% of women responses (Table 8) were intercropping; changing from food crops to cash crops; and using deep cultivation after crop emergence during first weeding, a practice that was mostly undertaken often by women. That is, instead of using deep cultivation during land preparation, women planted in the dust in order to time/match with rainfall onset and then used deep cultivation after crop emergence during first weeding to enhance water percolation. Possession of livestock and ability of men to hire tractors, power tillers or ox-carts enabled more men to secure and ferry manure to their farms compared to women. Further analysis revealed that the farms of some of men and women were located more than three kilometer away from home (64.0% of men and 63.3% of women responses). It was not easy then for women to carry manure for such a long distance even if they were given manure by livestock keepers. Most of adaptation practices to the effects of climate change on livestock were also done by boys and girls after classes and during week-ends. The same adaptation practices were reported by Nhemachena and Hassan (2007), Ribeiro and Chauque (2010) and Acquah and Onumah (2011).

3.4.4 Practices Undertaken to Adapt to or Reduce Effects of Climate Change on Environment by Sex

Other important adaptation practices undertaken in the study area were tree planting and management; contour making and reeds planting; and ridge farming (Table 8). Those practices enabled respondents to adapt to or reduce effects of floods, strong wind and whirlwind on the environment. Respondents also planted trees around

home stead for shade, established plots of trees for firewood and other purposes; and were required to leave at least 10 trees in the field during bush clearing or plant at least 10 trees in the field to reduce wind speed (wind breaker). Tree planting and management were important practices for environmental conservation. The practices reduced possibility of wasting resources including time wasted by women to collect firewood. Moreover, contours, reeds planting and ridge farming were used to reduce water run-off and control erosion, especially in Puhi and Isusumya villages. Ridges were also used in the 1990s to trap water for crops in Kurio village because of rainfall shortage. Farmers made very big ridges which kept water in between for considerable time for crops.

It is obvious from Table 8 that men were leading in most of adaptation practices to the effects of climate change on livestock and crops production and on environment compared to women. The findings reveal that men and women responded differently to the effects of climate change on production activities and environment. The corrected Rao-Scott chi-square (χ_c^2) test showed significant association between the adaptation practices to the effects of climate change on production activities and on environment and sex (χ_c^2= 461.323; $p \leq 0.001$), indicating that undertaken adaptation practices varied by sex of respondent. The difference could probably be explained by the variation in roles; unequal access to assets and benefits accrued from production; unequal control of household assets; and other opportunities. For example, it was revealed during focus group discussions that other men trained oxen of the rich farmers in order to use the animals for land preparation; and a number of men assisted oxen owners during land preparation in order to secure oxen service. These were among the opportunities that women could not access. Adaptation practices to the effects of climate change on production activities and environment were important for respondents to increase yield, number of livestock including an increase in milk production; reduce food shortage or hunger and an increase in income. If the income of respondents is increased, their status and ability to meet household development targets will subsequently improve.

3.5 Elements Influencing Adaptation Practices

Findings in Table 9 reveal that the effort of women to adapt to or reduce effects of climate change was mainly obstructed by various elements including inadequate capital and limited access to credit, use of poor production tools and having small farms. Conversely, the effort of men to adapt to or reduce effects of climate change was mainly obstructed by inadequate input and veterinary services including cattle dip facility in the study area; inadequate manpower, sickness and old age; inadequate formal markets; and inadequate knowledge of improved crops and livestock production (Nhemachena & Hassan, 2007; Deressa et al., 2008).

Table 9. Elements influencing adaptation practices

Description	Men (n=180)		Women (n=180)	
	n	%	n	%
Elements impeding adaptation				
Inadequate capital including credit	36	20.0	47	26.1
Inadequate input and veterinary services	35	19.4	28	15.6
Inadequate production tools	32	17.8	37	20.6
Inadequate manpower, sickness and old age	24	13.3	13	7.2
Inadequate formal market	20	11.1	8	4.4
Inadequate improved production knowledge	19	10.6	16	8.9
Small farms	14	7.8	31	17.2
Total	**180**	**100.0**	**180**	**100.0**
Elements facilitating adaptation				
Improved transport, communication and business	53	29.4	40	22.2
Patience and ability to work hard	46	25.6	47	26.1
Observation of government bye-laws and directives	40	22.2	28	15.6
Mutual support spirit and ability to learn from others	24	13.3	43	23.9
Involvement in non-farm production activities	17	9.4	22	12.2
Total	**180**	**100.0**	**180**	**100.0**

Source: Survey data (2011).

Besides, practices of women to adapt or reduce effects of climate change were facilitated by the ability of women to work together and to learn from other farmers; and their ability to be involved in non-farm production activities. For the men, improved transport, communication and increased business; together with the ability to observe government by-laws and directives facilitated their adaptation practices. Moreover, both men and women were patient and hard working.

In the study area, men and women had ability to work together under mutual support where one household prepared food and invited friends or neighbours *(kualikana in Swahili* or *kularika in Kirangi)* to assist them during land tillage, weeding or harvesting operations. This practice reduced the problem of inadequate manpower and shortage of cash for paying hired labour. In addition, in the 1990s in all surveyed villages, transport, transport means including buses, motorcycles and bicycles; and communication had improved in comparison to the 1970s. These enabled business men from Kondoa or Dodoma towns to transport various food items to the study area during food shortage; and also the situation facilitated exchange of various commodities either for money or food. For example, in Nagulobahi village respondents exchanged paddy for sorghum or pearl millet and businessmen came straight to the village to buy paddy. That action reduced cost of transporting food items to the ward centre or Dodoma Town. Likewise, villages had established various by-laws and regulations that farmers were required to observe. For example, every farmer was required to use farm yard manure; and farmers were not allowed to cut trees even if they were the owners of those particular trees, without seeking permission from the village government.

4. Recommendations

The study recommends systematic collection of in-depth information on climate change and gender at the community level in other areas of Dodoma Region, Tanzania and the Least Developed Countries (LDCs), in order to obtain enough disaggregated information. This will avail more and diverse location specific climate change indicators from the study areas and enable the policy makers on climate change to design and implement appropriate interventions to manage climate change problems. More studies on climate change and various locations/villages; ethnic groups and married and single individuals are important in order to generate more generalized conclusions. The study also suggests that, adaptation practices undertaken by respondents can be learned through their roles in the household and/or community. Moreover, the study calls for appropriate stakeholders including the Local Government Authorities (LGAs); Agriculture and Livestock sectors; the Central Government of Tanzania, Non-governmental Organizations (NGOs) and other development practitioners to provide farmers with necessary inputs and credit services in order to improve their adaptive capacity.

5. Conclusion

The majority of men and women perceived climate change (increased rainfall variation, temperature, strong wind and drought) and managed to identify adaptation practices undertaken to manage climate change effects; and elements impeding/facilitating adaptation practices. The information obtained can be used to improve/formulate appropriate adaptation practices to manage climate change problems in the Agriculture and Livestock sectors. However, respondents perceived and adapted differently to the effects of climate change depending on sex, location/village, marital status and ethnic groups. This implies that location/village, marital status and ethnic groups are also important variables in climate change studies, especially when characteristic of the effects of climate change of being location specific is taken into account. Adaptation practices undertaken by respondents were biased towards their roles. Women were more devoted to the measures of adaptation that enabled them to adapt to or reduce effects of climate change during hunger/food, water and firewood shortages and men were more devoted to the adaptation measures that enabled them to adapt to or reduce effects of climate change on crops, livestock and environment. This implies that adaptation practices undertaken by respondents to adapt to or reduce effects of climate change can be learned through their roles. However, the effort of respondents to adapt to or reduce effects of climate change was obstructed by various elements including inadequate production tools, inputs, capital, knowledge on improved production, formal markets, veterinary and credit services. If the identified obstacles to production will be corrected the adaptive capacity of respondents will improved and both men and women will be in a better position to manage climate change problems.

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2.4 A Manuscript

Determinants of adaptation to climate change: A Gendered analysis from Bahi and Kondoa Districts, Dodoma Region, Tanzania.

2.4.1 Introduction

Climate is changing and has affected many natural environments in all continents, most of the oceans, income groups and men and women differently (IPCC, 2007; Pielke *et al.*, 2007). The poor, especially in developing countries, are among groups that are more vulnerable to climate change because of their low adaptive capacities, wide spread poverty and dependence on agricultural activities, which are more sensitive to climate change (Reser and Swim, 2010; IPCC, 2007). Climate change is affecting food and water resources, which are critical for livelihoods in Africa.

In Tanzania drought, floods, soil erosion and health problems have increased and are affecting agricultural productivity, food security, water supply and human wellbeing (Fosu-Mensah *et al.*, 2010; Hassan and Nhemachena, 2008; IPCC, 2007; Yanda *et al.*, 2006). Dodoma Region, which is located in a semi-arid area of Tanzania, is among the regions severely affected by failing agriculture due to climate change (URT, 2007). Although all smallholder farmers in Dodoma Region will be affected by climate change, women are expected to be severely affected because, in addition to extreme poverty and low adaptive capacity, they make up a large number of individuals (63% in Tanzania) working in agricultural production (Swai *et al.*, 2012a; URT, 2007).

It is shown in literature that men and women have survived and coped with a degree of uncertainty in relation to local weather in various ways over time (UNDP, 2009; Odjugo,

2010). However, most of the measures used were the short term adaptation practices, which are no longer efficient measures to rely on as climate change increases. Thus, climate change literature have shown that various long term adaptation measures are currently implemented by farmers to adapt to the effects of climate change in most African countries including Tanzania. Some of those measures include use of improved seeds, staggered planting and use of drought tolerant crop varieties (Mutekwa, 2009; Ishaya and Abaje, 2008).

Although various long term adaptation measures are currently implemented by farmers to adapt to the effects of climate change, effort of farmers to adapt to climate change is determined by diverse factors that vary among regions and individuals including men and women; because of significant differences that exist in traditions, resources and climates (Mbwambo *et al.*, 2011; Leary *et al.*, 2008). It is thus important to understand factors determining choice of climate change adaptation options among various groups including men and women in order for policy makers to consider such variations when developing interventions or climate change adaptation options. Studies for example by Enujeke and Ofuoku (2012), Nabikolo *et al.* (2012), Mbwambo *et al.* (2011) and Hassan and Nhemachena (2008), have reported factors determining farmers' choice of climate change adaptation options including land size, access to extension, credit and market services. Nevertheless, reported factors are not disaggregated by gender to realize factors influencing choice of climate change adaptation options between men and women.

Failure to consider gender and/or disaggregate factors influencing the choice of climate change adaptation options between men and women is among the main constraints for the policy makers dealing with climate change to develop effective policies relevant to

manage climate change (UNFPA, 2009; Deressa *et al.*, 2009; Lambrou and Piana, 2006). According to UNFPA (2009) and UNDP (2009), for a policy that is intended to address any aspect of climate change to be effective, the differences between men and women must be taken into account during policy formulation. Gender blind policies may aggravate the problems associated with climate change by widening inequalities between the sexes. This paper, therefore, presents some of the findings intended to fill part of this information gap from a field study done to analyze factors influencing adaptation decisions between men and women in Bahi and Kondoa districts, Dodoma Region Tanzania. The rest of the paper is structured as follows: the next section covers the study methodology including study area, research design, study population, sampling frame and sampling unit; sampling techniques and sample size, types of data collected and methods of data collection, data analysis; the data and empirical specifications of the model variables, results and discussions, conclusion, recommendations and policy implications; and areas for further research.

2.4.2 Methodology

The study was conducted in three villages of Bahi District, Dodoma Region, namely Nagulobahi, Chipanga B and Msisi; and three villages of Kondoa District that is Puhi, Isusumya and Kurio. Administratively Bahi District has four divisions, 21 wards and 56 villages whereas Kondoa District has eight divisions, 35 wards and 160 villages. Both Districts are situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. Bahi District has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^0C. Kondoa District has an annual average rainfall of about 500 to 800 mm and an annual temperature of about 21^0C.

The economies of Bahi and Kondoa Districts depend on agriculture (crops and livestock production). The main crops grown in Bahi District are pearl millet, sorghum, paddy and ground nuts; and for Kondoa District the main crops are maize, finger millet, oil seeds, pearl millet and sorghum (URT, 2003).

A cross-sectional research design was used in this study. The design is useful for descriptive purposes, as well as determination of relationships between and among variables and allows the use of other methods of data collection such as observations (Kothari, 2004). The population of the study was farmers dealing with crop farming and livestock keeping in the study area; and the list of all farmers dealing with crops and livestock production formed a sampling frame from which two strata, one of men and the other of women were chosen. A sampling unit was a man or a woman farmer.

Sampling techniques involved purposive sampling, stratified and simple random sampling. Purposive sampling was used to select the two districts, three divisions from each district, one ward from each division and one village from each ward. Reasons for the selection of the two districts were that the selected area is in a semi-arid, the area more vulnerable to climate change due to prominent and persistent variation in rainfall, temperature and drought; it is the area where climate change evidence is expected to be more apparent (FAO, 2008; IPCC, 2007); also another reason that prompted the researcher to select the study area was a need to capture local knowledge about climate change from diverse cultural perspectives (that is from *Warangi, Wagogo, Wanyambwa* and *Wasandawe*). The selection of wards and villages was based on the areas that were far from the ward centre/town where crop farmers and livestock keepers resided and where limited (or no)

research, especially on climate change, having been conducted in the area to avoid duplication of efforts.

After selecting the villages, Yamane (1967) formula was used to get sample of 360 respondents from the population of the study. Yamane (1967) provides a simplified formula to calculate sample size (Israel, 2008), that is:

$n = N/1 + N(e)^2$.....(1)

Where: n = the sample size

N = the population size

e = the level of precision (an error of five percent)

Since the study was focused on gender, the sampling frame was put into two strata of men and women using this formula:

$n_h/n = N_h/N$ .....(2)

$n_h = n(N_h/N) = nW_h$

Where:

n_h = sub-sample

n = desired sample

N_h = sub-sampling frame/population

N = Sampling frame (population)

W_h = sample proportion

That is, sub-sample 1 (men) = $n_h/360$ = 2139/4498

n_h = 360(2139/4498) = 360(0.4755) = 171.2

n_h per village 171.2/6 = 29

Sub-sample 2 (women) = $n_h/360$ = 2359/4498

n_h = 360(2359/4498) = 360(0.52445) = 188.8

n_h per village 188.8/6 = 31

The two sub-samples were 29 men and 31 women per village (Ahmed, 2009; Kothari, 2004). However, from the two strata, a simple random sampling technique was employed to select 30 men and 30 women per village in order to facilitate a fair discussion where comparison between men and women per village was necessary (Kothari, 2004).

Both primary and secondary data were collected. Primary data involved qualitative and quantitative data. Methods to collect qualitative data were key informant interviews and focus group discussions; and a structured questionnaire was used to collect quantitative data. To collect qualitative data, a checklist of items for in-depth interviews with key informants was used to gather information from 78 key informants; and a focus group interview guide was used in discussion to gather information from 12 focus groups (one for men and another for women from each village). To collect quantitative data, a structured questionnaire was administered to a sample of 360 respondents to verify and quantify some of the findings from qualitative data.

Analysis of qualitative data involved content analysis in which the data were broken down into smallest meaningful units of information and/or themes and summarized to supplement important information with respect to the objectives of the study. Quantitative data analysis was based mainly on descriptive statistics including frequencies, means and percentages. A multinomial logit model was used to analyze factors determining choice of climate change adaptation options between men and women using Nlogit 3.0. Multinomial logit model and multinomial probit model are commonly used in adoption decision studies involving multiple choices. The models are important in analyzing adaptation decision of farmers and they are appropriate for evaluating alternative combinations of adaptation options (Mbwambo *et al.*, 2011; Hassan and Nhemachena, 2008). However, this study

used a multinomial logit model to investigate factors determining choice of climate change adaptation options between men and women because the model is easier to compute (Mbwambo *et al.*, 2011; Hassan and Nhemachena, 2008). It is assumed from the study that each respondent faces a set of discrete, mutually exclusive choices of adaptation options, which are assumed to depend on socio-economic, cultural and demographic factors $\boldsymbol{X}$. The multinomial logit model for the choice of adaptation option specifies the following relationship between the probability of choosing adaptation option A_i and the set of independent variables X as (Greene, 2003):

$$Prob(Ai = j) = \frac{e^{\beta' j x_i}}{\sum_{k=0}^{j} e^{\beta' j x_i}}, j = 0,1 \ldots j \quad \ldots\ldots(3)$$

Where βj is a vector of a coefficient on each of the dependent variables X. Equation (3) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$Prob(A = j|x_i) = \frac{e^{\beta' j x_i}}{1+\sum_{k=0}^{j} e^{\beta' j x_i}}, j = 0,1 \ldots . j \quad \ldots\ldots(4)$$

Estimating equation (4) yields the J log odds ratios

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x'_i(\beta_i - \beta_k) = x'_i\beta_j, \text{ if } k = 0 \quad \ldots\ldots(5)$$

The dependent variable is, therefore, the log of one alternative relative to the base alternative. The Multinomial Logistic regression coefficients are difficult to interpret, and associating β_j with the j^{th}outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003):

$$\delta_j = \frac{\delta P_j}{\delta x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k\beta_k\right] = P_j(\beta_j - \bar{\beta}) \quad \ldots\ldots(6)$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2003). The signs of the marginal effects and respective coefficients may be different as the former depend on the sign and magnitude of all other coefficients.

2.4.3 The data and empirical specifications of the model variables

The dependent variable used in the model was gender specific adaptation practices to climate change. The variable consisted of various adaptation options practiced by the majority of respondents in the study area, which fell into three groups: (i) adaptation options implemented to reduce food shortage or hunger, (ii) adaptation options implemented to reduce effects of climate change on crops, and (iii) adaptation options implemented to reduce effects of climate change on land and/or environment (Table 1).

Table 1: Adaptation options practiced by the majority of respondents by sex

Adaptation practices	Men (n=180)		Women (n=180)	
	n	%	n	%
Adaptation practices to food shortage or hunger				
Reduce number of meals per day	37	20.6	48	26.7
Sell labour	35	19.4	44	24.4
Sell livestock and/or local chicken	49	27.2	24	13.3
Engage in non-farm production activities	29	16.1	38	21.1
Plant hunger buffering crops	30	16.7	26	14.4
Adaptation practices to climate change for crops				
Select and keep enough seeds for the next season	41	22.8	76	42.2
Use of deep cultivation	39	21.7	29	16.1
Use of improved seeds	37	20.6	25	13.9
Use of manure	34	18.9	29	16.1
Change of crop varieties	29	16.1	21	11.7
Adaptation practices to climate change for land and/or environment				
Avoid cultivating along steep slopes	50	27.8	55	30.6
Plant trees	48	26.7	40	22.2
Contours/plant reeds	44	24.4	35	19.4
Use of ridge farming	38	21.1	50	27.8

The independent variables used in the empirical analysis were: village of respondents/location, access to agricultural knowledge, access to credit, land ownership, access to education, main occupation undertaken by respondent, ethnic group and marital status (Table 2).

Table 2: Independent variables used in the empirical analysis

Variables	Men (n=180)		Women (n=180)	
	n	%	n	%
The village of respondents or location				
Nagulobahi	30	16.7	30	16.7
Chipanga B	30	16.7	30	16.7
Msisi	30	16.7	30	16.7
Puhi	30	16.7	30	16.7
Isusumya	30	16.7	30	16.7
Kurio	30	16.7	30	16.7
Access to agricultural knowledge				
Crop/livestock extension agent	136	75.6	42	23.3
Fellow farmers/neighbours	26	14.4	102	56.7
None	18	10.0	36	20.0
Access to credit				
No	157	87.2	160	88.9
Yes	23	12.8	20	11.1
Credit institutions from which respondents borrowed				
Traditional credits	11	47.8	1	5.0
SACCOs	9	39.1	18	90.0
Others	3	13.1	1	5.0
Land ownership				
No	1	0.6	14	7.8
Yes	179	99.4	166	92.2
Access to education				
No	24	13.3	50	27.8
Yes	156	86.7	130	72.2
The main occupation undertaken by respondents				
Agro-pastoralists	142	78.9	90	50.0
Crop production	38	21.1	90	50.0
Ethnic group of respondents				
Gogo	66	36.7	63	35.0
Rangi	52	28.9	57	31.7
Sandawe	30	16.7	30	16.7
Nyambwa	20	11.1	21	11.7
Others	12	6.8	9	5.2
Marital status of respondents				
Married	177	98.3	122	67.8
Singles including divorced, widows, separated and widowers	3	1.7	58	32.2

Other independent variables that were used in the empirical analysis were household size, experience of respondents in crops production and land size owned by respondents (Table 3).

Table 3: Other independent variables used in the empirical analysis

Respondent characteristics	Mean	
	Men (n=180)	Women (n= 180)
	%	%
Household size	7.22	5.56
Experience in crops production (years)	34.51	31.63
Land size (hectares) owned by respondents	3.8	1.9

2.4.4 Results and Discussions

2.4.4.1 Factors determining choice of adaptation options to reduce food shortage or hunger by sex

Table 4 shows marginal effects and ρ-levels for choice of adaptation options between men and women during food shortage or hunger from the multinomial logit model. The reference category regarded as a base (Y = 0) from which men and women were expected to move to other adaptation options in this analysis was adaptation option 'reduce number of meals per day'. Other adaptation options were sell labour (Y = 1), sell livestock and/or local chicken (Y = 2), engage in non-farm production activities (Y = 3) and plant hunger buffering crops (Y = 4).

It is revealed in Table 4 that some of explanatory variables were statistically significant at 5% level and the chi-square result shows that the likelihood ratio statistic was significant at $\rho \leq 0.01$ for both men and women. (The estimated coefficients are given in Appendix 1). The second column in Table 4 compares the choice of adaptation option 'sell labour' with 'reduce the number of meals per day'. Marginal effects and their signs reflect the expected change in the probability of choosing to sell labour as opposed to reducing the number of

meals per day per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 4.

Table 4: Factors determining choice of adaptation options to reduce food shortage or hunger by sex (Marginal effects)

Variable	Marginal effect							
	Men (n=180)				Women (n=180)			
	Y = 1	Y = 2	Y = 3	Y = 4	Y = 1	Y = 2	Y = 3	Y = 4
Ethnic groups	- 0.002	- 0.005	0.0232	- 0.012	0.014	0.027	- 0.06**	0.03
Marital status	- 0.210	- 0.115	0.0113	- 0.057	0.141**	0.013	0.001	- 0.13**
Main occupation	0.18**	- 0.082	- 0.0029	- 0.001	0.057	-0.039	- 0.002	- 0.04
Household size	- 0.02	0.012	- 0.0002	- 0.19**	-	-	-	-
Education	0.002	0.067	0.1392	- 0.057	-	-	-	-
Land size	0.005	- 0.008	0.0006	0.008**	0.01	- 0.003	0.005	- 0.02**
Experience in crop production	- 0.003	0.004	- 0.011**	0.006**	- 0.01**	0.0003	0.001	0.01**
Log likelihood function				- 265.4093				-270.949
Restricted log likelihood				- 286.3044				-283.198
Chi squared				41.79020				24.49875
Prob[ChiSqd > value]				0.1362045E-01				0.7916311E-01
Pseudo R-squared				0.07298				0.04325

It is depicted in Table 4 that a unit change in the main production activities undertaken by respondents significantly (5%) increased the decision of men to sell labour; a unit change in the land size and experience in crop production, significantly (5% each) increased their decision to plant hunger buffering crops, but experience in crop production, significantly (5%) reduced the decision of men to engage in non-farm production activities; while a unit change in the household size significantly (5%) reduced the decision of men to plant hunger buffering crops, instead of reducing the number of meals per day. Thus, from the findings it is revealed that the main occupation, land size and experience in crop

production were the main factors that positively and significantly determined the choice of adaptation options of men during food shortage or hunger, encouraging them to sell labour and plant hunger buffering crops (that is cassava and sweet potatoes) instead of reducing the number of meals per day.

Although experience in crop production encouraged men to plant hunger buffering crops to adapt to food shortage, the same variable discouraged them from engaging in non-farm production activities, while household size discouraged men from planting hunger buffering crops thus, causing the majority of men with larger households to remain with only one adaptation option (selling labour). This can be explained by the fact that food shortage or hunger occurred when production especially of crops failed mainly due to drought or floods. During such periods farmers were forced to search for other alternatives for them to survive. In the study area the main production activities were agro-pastoral and crop production of which, men were mainly agro-pastorals (78.9% of men 50% of women).

Farmers were also engaged in non-farm production activities whereby men dealt mainly with fishing, charcoal and livestock businesses and women were undertaking local beer business, petty trade, salt and pottery businesses. Most of the non-farm production activities also failed during drought because they depended on rain. As the non-farm production activities failed, farmers were forced to engage in selling labour. Although majority of farmers planted hunger buffering crops, as drought persisted, all crops were damaged by drought. This indicates further that measures to increase production and maintain sustainability of production activities in the study area are vital for farmers to adapt to food shortage or hunger, as climate change increases.

In the case of women, it is shown in Table 4 that a unit change in marital status, significantly (5%) increased the decision of women to sell labour, but significantly (5%) discouraged them from planting hunger buffering crops. A unit change in experience of respondent in crop production, significantly (5%) increased decision of women to plant hunger buffering crops, but significantly (5%) reduced their decision to sell labour. A unit change in land size, significantly (5%) reduced the decision of women to plant hunger buffering crops, while a unit change in ethnic group of respondents significantly (5%) reduced decision of women to engage in non-farm production activities. This reveals that the main factors that determined the choice of adaptation options among women during food shortage or hunger were marital status and experience of respondents in crop production. Marital status and experience of respondents in crop production encouraged women to sell labour and plant hunger buffering crops respectively.

The ethnic group of respondents discouraging women from engaging in non-farm production activities could be due to the fact that Islamic women who were mainly based at Kondoa District (especially for Isusumya village) were not allowed to undertake non-farm production activities, as men were worried that they might be overlooked or neglected after women had became stronger economically. The creation of awareness in the study area on the importance of women to participate in non-farm production activities including various businesses, could change the attitude of men towards women participation in businesses or non-farm production activities and instead encourage women to engage in such activities to increase family income.

Furthermore, findings in Table 4 show that the land size encouraged men, but discouraged women from planting the hunger buffering crops to adapt to food shortage or hunger. It is

shown in Swai *et al.* (2012a) that the average land size owned by men in the study area was 3.8 hectares while on average women owned 1.9 hectares. Since the land size of women was small, they had to give priority to food crops, but the size of land of men enabled them to plant additional crops including the hunger buffering crops, meaning that small farms was among the factors that hindered adaptation effort, especially for women in the study area.

The experience of respondents in crop production also positively and significantly influenced the choice of adaptation options for men and women, suggesting that more experienced farmers were more likely to adapt to climate change than less experienced ones. The observation concurred with the findings of Hassan and Nhemachena (2008), who asserted that experienced farmers have better knowledge on agronomic practices that can be used to adapt to the changes in climate.

2.4.4.2 Factors determining choice of adaptation options to reduce effects of climate change to crops by sex

The marginal effects and ρ-levels for the choice of adaptation options for men and women to adapt crops to climate change from the multinomial logit model are shown in Table 5. A reference category regarded as a base (Y = 0) from which men and women were expected to move to other adaptation options was 'select and keep enough seeds for the next season'. Other adaptation options were: use of deep cultivation (Y = 1), use of improved seeds (Y = 2), use of manure (Y = 3) and change of crop varieties (Y = 4). The findings in Table 5 show that some of the explanatory variables were statistically significant at 5% level and the chi-square test results show that the likelihood ratio statistic was significant at $\rho \leq 0.01$ for both men and women. (The estimated coefficients are given in Appendix 2).

The second column in Table 5 compares the choice of adaptation option of 'use of deep cultivation' with 'select and keep enough seeds for the next season'. The marginal effects and their signs reflect the expected change in the probability of choosing to use deep cultivation as opposed to selecting and keeping enough seeds per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 5.

Table 5: Factors determining choice of adaptation options to reduce effects of climate change to crops by sex (Marginal effects)

Variable	Marginal effect							
	Men (n=180)				Women (n=180)			
	Y = 1	Y = 2	Y = 3	Y = 4	Y = 1	Y = 2	Y = 3	Y = 4
Village/location of respondents	0.029	0.049**	0.04**	- 0.04**	0.028	0.001	- 0.041**	0.03**
Access to agricultural knowledge	0.12**	0.0001	- 0.113	0.007	0.025	0.001	- 0.043	- 0.036
Access to credit	- 0 .03	- 0.04	- 0.07	0.016	0.115	- 0.051	0.074	0.054
Land size	- 0.001	- 0.005	0.003	0.0006	0.004	- 0.004	0.0001	- 0.002
Experience in crop production	- 0.005	0.001	0.001	0.0004	- 0.003	0.002	0.003	0.002
Education	- 0.061	0.069	- 0.03	0.006	-	-	-	-
Land ownership	0.063	- 0.109	0.051	0.025	- 0.185**	- 0.015	- 0.04	- 0.14**
Log likelihood function				- 268.1363				- 251.2854
Restricted log likelihood				- 288.4451				- 265.8865
Chi squared				40.61756				29.20207
Prob[ChiSqd > value]				0.1833942E-01				0. 8385619E-01
Pseudo R-squared				0.07041				0.05491

It is shown in Table 5 that a unit change in the village/location of respondents, significantly (5%) increased the decision of men to use improved seeds and manure respectively, but significantly (5%) reduced their decision to change crop varieties to adapt

crops to climate change, instead of selecting and keeping enough seeds for the next season. Moreover, a unit change in respondents' access to agricultural knowledge, significantly (5%) increased the decision of men to use deep cultivation instead of selecting and keeping enough seeds for the next season. Thus, the village/location of respondents and access to agricultural knowledge were the main factors that positively and significantly determined the choice of adaptation options for men to reduce effects of climate change on crops, encouraging them to use improved seeds, manure and deep cultivation, instead of selecting and keeping enough seeds for the next season. The observation concurred with the findings of other studies including Enujeke and Ofuoku (2012) and Hassan and Nhemachena (2008), who found that access to crop and livestock extension services, significantly increases the likelihood of adaptation.

However, access to agricultural knowledge had no significant influence on the choice of women to adapt crops to climate change. In the study area 75.6% of men acquired agricultural knowledge through crops and/or livestock extension agents and more women (56.7%) acquired agricultural knowledge through other sources including neighbours and/or fellow farmers. The findings indicate that the knowledge acquired by women from their fellow farmers could not influence the adaptation to climate change effects. Thus, provision of a reliable source of agricultural knowledge at the village level is important for both men and women to improve adaptation to climate change.

Table 5 further shows that a unit change in the village/location of respondents significantly (5%) increased the decision of women to change crop varieties, but significantly (5%) reduced their decision to use manure and a unit change in the land ownership, significantly (5%) reduced the decision of women to use deep cultivation and change crop varieties

respectively instead of selecting and keeping enough seeds for the next season. Thus, the village/location of respondents was the main factor that determined choice of climate change adaptation options for women to reduce effects of climate change to crops, encouraging them to change crop varieties. However, land ownership of respondent had no significant influence on the decision of men to reduce effects of climate change on crops. This observation could be justified by the fact that the majority of men owned land in the study area compared to women (that is, 99.6% of men and 92.2% of women), indicating that the choice of adaptation option for men depended on other factors rather than land. In the case of women those who had land were likely to adapt crops to climate change compared to those who had no land, meaning that promotion of land ownership for women in the study area would increase their adaptation efforts. The findings were in line with the study of Nabikolo *et al.* (2012), although they were opposite in that the land ownership had negative influence for men headed household but had no significant influence on women headed household.

The findings also revealed that the village/location of respondents discouraged women from using manure on their farms, but encouraged men to use manure and improved seeds. Revealed variation could be due to the fact that men were the main agro-pastoralists (78.9% of men 50% of women), keeping livestock, and they were in a better position to access manure compared to women. It was also revealed during focus group discussions that men managed to buy and/or hire other technologies including tractors, wheel barrows and power tillers to ferry manure to their farms. Moreover, using manure and improved seeds were among the by-laws in the study area. Village leaders distributed improved seeds especially sorghum, pearl millet, maize, sunflower and cowpeas crops to the farmers, but the seeds were inadequate and sometimes brought when the season was over.

Men, the majority of whom were mobile and liquid financially compared to women, travelled to Kondoa, Bahi and Dodoma towns to buy improved seeds instead of relying on the small amount of seeds brought in their respective villages. This means that locating input markets in the village where women could easily access would enable women to adapt crops to climate change well.

It is also indicated in Table 5 that access to credit had no significant influence on the choice of adaptation options for both men and women. The findings were contrary to the studies of Nabikolo *et al.* (2012), Derressa *et al.* (2009) and Gbetibouo (2009) which revealed that the availability of credits has positive and significant impact on adaptation to climate change, as access to credits increases financial resources of farmers, reduces cash constraints and allows farmers to purchase inputs including improved seeds. In the study area credit services were inadequate and only few respondents (12.8% of men and 11.1% of women) had access to credit. Men borrowed from the traditional credit (the rich men livestock keepers) and women from the Savings and Credit Co-operative Societies (SACCOS). The loans borrowed were small and could not influence the adaptation, indicating that the low access to credit discouraged adaptation to climate change. Thus, there is a need to facilitate farmers' access to credits in the study area in order to improve adaptation to climate change.

Furthermore, access to education had no significant influence on decision of men and women to adapt crops to climate change. The results were contrary to the studies of Enujeke and Ofuoku, (2012), Deressa *et al.* (2009) and Maddison (2006), which have shown that there is a positive relationship between the educational level of respondents and adaptation to climate change. However, in the study area 86.7% of men and 72.2% of

women had access to education of which 83.3% of men and 69.4% of women had attained primary school education level. The observation indicates that the kind of knowledge acquired by men and women from primary school education could not influence adaptation to climate change, suggesting the subject of climate change to be introduced in the curriculum of primary school education to improve climate change awareness.

2.4.4.3 Factors influencing choice of adaptation options to reduce climate change to land/environment by sex

The marginal effects and ρ-levels for the choice of adaption options for men and women to adapt land and/or environment to climate change from the multinomial logit model are shown in Table 6. In this analysis, adaptation option 'avoid cultivating along steep slopes' was a reference category considered to be a base (Y = 0) from which men and women were expected to move to other adaptation options including: 'plant trees' (Y = 1), 'make contours and/or plant reeds' (Y = 2) and use ridge farming (Y = 3). According to the findings in the Table, some of explanatory variables are statistically significant at the 5% and 1% levels and the chi-square result shows that likelihood ratio statistic was significant at $\rho \leq 0.001$ for both men and women. (The estimated coefficients are given in Appendix 3). The second column in Table 6 compares the choice of the adaptation option 'plant trees' with 'avoid cultivating along steep slopes'. The marginal effects and their signs reflect the expected change in the probability of choosing to plant trees as opposed to 'avoid cultivating along steep slopes' per unit change in the explanatory variable. This explanation applies to other remaining choices in Table 6.

It is depicted in Table 6 that a unit change in the access to agricultural knowledge significantly (5%) increased the decision of men to plant trees and for women to use

contours and/or plant reeds; the village/location of respondents positively and significantly (1%) determined choices of men and women to use contours and/or plant reeds to control soil erosion but significantly (1%) reduced their decisions to plant trees as opposed to avoid cultivating along steep slopes. In addition, a unit change in the level of education significantly (5%) reduced decisions of women to use contours and/or plant reeds but it had no significant influence on men; and a unit change in the experience of respondents in crop production significantly (1%) reduced decision of women to undertake ridge farming; while a unit change in the land ownership significantly (5%) increased decision of women to undertake ridge farming instead of avoiding to cultivate along steep slopes. Access to education significantly reduced decision of women to use contours and/or plant reeds but it had no significant influence on men, showing that the knowledge gained from primary school was lacking the component of land use and/or environmental conservation, the defect that could be corrected by providing farmers with land use and/or environmental conservation knowledge.

Table 6: Marginal effects – decision to adapt land/environment to climate change by sex

Variable	Marginal effect					
	Men (n=180)			Women (n=180)		
	Y = 1	Y = 2	Y = 3	Y = 1	Y = 2	Y = 3
Access to agricultural knowledge	0.141**	- 0. 072	- 0.006	- 0. 073	0. 117**	0.075
Village of respondents	- 0.07***	0.095***	0.016	- 0. 06***	0.071***	- 0.035
Education	0.086	- 0.126	0.045	0.057	- 0.121**	- 0.005
Land size	- 0. 002	0.003	- 0.004	0. 001	0. 005	0.001
Experience in crop production	- 0. 001	0.002	0.00003	0.003	- 0.004	- 0. 02***
Land ownership	- 0.014	- 0.063	- 0.059	0.053	- 0.102	0.299**
Log likelihood function			- 228.2684			- 216.1859
Restricted log likelihood			- 248.5808			- 246.7354
Chi squared			40.62490			61.09903
Prob[ChiSqd > value]			0.3647104E-03			0.000000
Pseudo R-squared			0.08171			0.12381

Table 6 also show that, a unit change in the experience of respondents in crop production significantly (1%) reduced decision of women to undertake ridge farming while a unit change in the land ownership significantly (5%) increased their decision to undertake ridge farming as opposed to avoid cultivating along steep slopes. Thus, access to agricultural knowledge and the village/location of respondents were the main factors that positively and significantly determined the choice of adaptation options for men to reduce effects of climate change on land/environment, encouraging them to plant trees and use contours and/or plant reeds to control soil erosion, while for women the land ownership, access to agricultural knowledge and village/location of respondents were the main factors that positively and significantly encouraged them to use contours and/or plant reeds and ridge farming to reduce effects of climate change on land and/or environment.

The village/location of respondents supporting adaptation to climate change effects could be explained by the fact that, the two districts of Bahi and Kondoa where the study villages were located that is Nagulobahi, Chipanga B and Msisi for Bahi District and Puhi, Isusumya and Kurio for Kondoa District, were not in the same altitude. The villages of Kondoa District were a bit in higher altitude compared to those of Bahi District and contours and/or reeds were practiced mainly in Kondoa District because of its location. In addition, Kurio and Puhi villages practiced ridge farming for the most of their crops but in other villages especially of Bahi District ridge farming was mainly applied in sweet potatoes and cassava farms. Moreover, the village by-laws and/or regulations and traditions/culture that encouraged farmers to protect traditional trees and forest encouraged adaptation to climate change. For example, during key informants interviews and focus group discussions it was revealed that, farmers were not allowed to cut down trees unless for a genuine reason and after seeking permission from the village environmental committee. There were regulations to protect traditional trees which farmers observed under their traditional leaders as well, for example, to pay a fine of a goat for the farmers who cut down traditional trees. All these contributed to adapting land/environment to climate change.

2.4.5 Conclusions and recommendations

2.4.5.1 Conclusions

This study has analyzed factors determining choice of climate change adaptation options between men and women by using a multinomial logit model. Dependent variables used in the model were: adaptation options implemented to adapt to food shortage or hunger, adaptation options implemented to adapt crops to climate change and adaptation options implemented to adapt land and/or environment to climate change. The dependent variable

was regressed on the following independent variables: village/location of respondents, access to agricultural knowledge, access to credit, education, the main occupations undertaken by respondents, ethnic groups of respondent, land ownership and marital status. Other independent variables were household size, experience of respondents in crops production and land size.

The study has shown that the main factors that positively and significantly determined choice of climate change adaptation options between men and women were the main occupation, land size, experience of respondents in crop production, the village/location of respondents, access to agricultural knowledge, marital status and land ownership. The main occupation, land size, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge were the main factors that determined choice of climate change adaptation options of men, whereas for women, the land ownership, marital status, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge were the main factors that determined their decision to adapt to climate change. Although experience of respondents in crop production and village of respondents had effects on the choice of climate change adaptation for both men and women, in some cases their influence was different. For example, the village of respondents encouraged men to use improved seeds and manure respectively, but discouraged women from using manure and encouraged them to sell labour to adapt crops to climate change. The differences revealed in the factors influencing choice of climate change adaptation options between men and women emphasized the importance of eliminating inequalities existing between men and women including inequalities in land ownership and production inputs and services in order to promote climate change adaptation.

Land size of respondents encouraged men, but discouraged women from planting the hunger buffering crops to adapt to food shortage or hunger, because women had small land size. In addition, women who owned land were likely to adapt crops to climate change compared to those who had no land meaning that, promoting land ownership for women and equal ownership and control of land between men and women in the study area would improve their adaptation efforts.

The village of respondents was an important factor for men and women to adapt to climate change, but failure of villages to provide farmers with necessary inputs and services such as, improved seeds and veterinary services; and weak enforcement of village by-laws were among the factors that retarded effort of men and women to adapt to climate change. Thus, the village of respondents could motivate farmers to adapt better to climate change by providing inputs including improved seeds in time and by observing village by-laws.

Access to agricultural knowledge, encouraged men to adapt to climate change, but it had no influence to women, because the majority of women acquired agricultural knowledge from their neighbours and/or fellow farmers, knowledge that could not influence adaptation to climate change. Allocating crops and/or livestock extension agents to the level of the village and creating awareness on the importance of acquiring agricultural knowledge from the extension agents to women could motivate them to access agricultural knowledge from a reliable source.

The low access to credit in the study area discouraged adaptation to climate change, as the amount of loans borrowed was small and could not influence adaptation to climate change. Thus, mobilizing men and women to form groups, gather together their resources and encourage saving and borrowing ability among the farmers to form SACCOS, could enable farmers to access credits.

2.4.5.2 Recommendations

The study showed that, factors determining the choice of climate change adaptation options between men and women were different. It is, therefore, recommended that LGAs, NGOs and other development practitioners dealing with climate change should use gender sensitive interventions to reduce climate change effects and should create awareness on the importance of women to own and control land to the farmers. In addition, the LGAs should provide inputs including improved seeds to the farmers on time and ensure that village by-laws are observed; they should allocate crops and/or livestock extension agents at the village level in order to increase interaction between farmers and extension agents and encourage women to seek agricultural information from the extension agents; and they should mobilize men and women to form SACCOS in order to facilitate them to access credits.

2.4.5.3 Policy implication

Findings indicate that it is important for the policymakers and planners including the Tanzania NAPA to introduce necessary measures to reduce gender inequalities in the study area including inequalities in ownership of land in order to encourage adaptation to climate change between men and women. It is also important for the policymakers and planners to develop mechanism which will promote production and ensure sustainability of production activities in the study area; and measures that will ensure that crops and/or livestock extension agents are allocated at the village level so that both men and women can access agricultural knowledge from a reliable source. Policymakers and planners would also do well if they could develop measures that could facilitate farmers' access to inputs on time; facilitate the availability of affordable credits; and develop measures to introduce the subject of climate change in the curriculum of primary school education to

improve climate change awareness in the study area. It is also vital for policymakers and planners to introduce measures that will facilitate farmers to access knowledge on land use and/or environmental conservation.

2.4.6 Area for further research

1. The study has revealed that more men acquired agricultural knowledge from crops and/or livestock extension agents while more women acquired agricultural knowledge from their neighbours and/or fellow farmers. Thus, it is important to investigate the factors that limit women from accessing agricultural knowledge from crops and/or livestock extension agents, and instead rely more on their neighbours and/or fellow farmers.

2. A study to investigate the effectiveness of adaptation practices which are implemented in the study area.

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Appendix 1: Factors influencing choice of adaptation options to food shortage or hunger by sex (estimated coefficients)

Variable	Coefficient							
	Men (n=180)				Women (n=180)			
	Y = 1	Y = 2	Y = 3	Y = 4	Y = 1	Y = 2	Y = 3	Y = 4
Factors influencing choice of adaptation options to adapt to food shortage or hunger by sex								
Ethnic group	0.004	- 0.021	0.097	- 0.066	0.10	0.16	- 0.44	0.27
Marital status	- 2.527	- 2.456	- 1.051	-1.824	0.66	0.16	0.11	- 0.89
Main occupation	1.354**	- 0.100	0.425	0.425	0.16	- 0.24	- 0.09	- 0.34
Household size	- 0.132	- 0.001	- 0.082	- 0.207**	-	-	-	-
Education	0.722	1.146	1.203**	0.339	-	-	-	-
Land size	0.049	- 0.031	0.026	0.075**	- 0.02	- 0.05	0.001	- 0.17**
Experience in crop production	- 0.024	0.016	- 0.045	0.031	- 0.04	- 0.01	0.003	0.04

Appendix 2: Factors influencing choice of adaptation options to adapt crops to climate change by sex (estimated coefficients)

Variable	Coefficient							
	Men (n=180)				Women (n=180)			
	Y = 1	Y = 2	Y = 3	Y = 4	Y = 1	Y = 2	Y = 3	Y = 4
Factors influencing choice of adaptation options to adapt crops to climate change by sex								
Village of respondents	0. 49***	0. 60***	0. 61***	0 .11	0. 223	0. 048	- 0.235	0. 323**
Access to agricultural knowledge	0. 60	0. 068	- 0. 55	0.108	0.042	- 0.118	- 0.406	- 0.45
Access to credit	- 0 .673	- 0.756	- 0. 953	- 0.47	1.182	0. 10	0. 933	0.291
Land size	- 0. 011	- 0. 034	0. 010	- 0.005	0. 018	- 0. 035	- 0. 028	- 0. 883
Experience in crop production	- 0. 036	- 0. 005	- 0. 006	- 0.009	- 0. 007	0. 026	0. 024	0. 028
Education	- 0.362	0. 237	- 0.276	- 0. 056	-	-	-	-
Land ownership	0.424	- 0.376	0.422	0.295	- 2.068**	- 1.045	- 1.134	- 2.164**

Appendix 3: Factors influencing choice of adaptation options to adapt land and/or environment to climate change by sex (estimated coefficients)

Variable	Coefficient					
	Men (n=180)			Women (n=180)		
	Y = 1	Y = 2	Y = 3	Y = 1	Y = 2	Y = 3
Factors influencing choice of adaptation options to adapt land/environment to climate change by sex						
Access to agricultural knowledge	0.737	- 0.144	0.181	0.065	1.097**	0.64
Village of respondents	- 0.111	0.608***	0.215	- 0.30**	0.373**	- 0.188
Education	0.344	- 0.602	0.211	0.027	- 0.96**	- 0.232
Land size	- 0.017	0.006	- 0.026	0.028	0.053	0.025
Experience in crop production	- 0.004	0.008	0.0008	- 0.046	- 0.08**	- 0.12***
Land ownership	- 0.510	- 0.764	- 0.711	1.009	0.152	1.84***

CHAPTER THREE

3.0 CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to establish gender specific adaptation practices to the effects of climate change. Since the thesis was developed in a published papers format, of which each paper presented its own findings, the general conclusion section is organized according to papers and a manuscript. Thus, the section presents a summary of the major findings, conclusion and implications of the major findings; theoretical implication of the findings; recommendations and policy implications; and areas for further research.

3.1 Summary of the Major Findings

The summary of major findings section starts with the first paper that examined gender and perception on climate change; and then second paper which was a gendered analysis on perceived effects of climate change on agricultural production. The third paper was on gender and adaptation practices to the effects of climate change and the last part of the summary is from a manuscript that investigated determinants of climate change adaptation, which is also a gendered analysis.

3.1.1 Paper one: Gender and perception on climate change

Paper one on Gender and perception on climate change was published in 2012 by the *Journal of African Studies and Development* (JASD). The paper sought to examine the perception on climate change by men and women. It examined the local description of climate change and identified major changes in climate that had occurred between 1970s and 1990s in the study area (that is climate change indicators); described the concept of

bad year, causes of climate change and the way men and women perceived climate change; and analyzed evidence of climate change through meteorological data, in order to compare results from meteorological data and findings obtained from the field.

The findings showed that the majority of men and women acknowledged the existence of climate change in the study area. Men and women described the concept of climate change differently. The main climate change indicators identified were changes in drought, temperature, rainfall and strong wind whereby drought, temperature, rainfall variation including rainfall shortage, unpredictability and rainfall irregularity; and strong wind had increased in the 1990s compared to the 1970s. The bad years for surveyed villages (that is the years which were accompanied by increased drought, low yield and food shortage) had also increased since 1984 for Bahi District and 1990 for Kondoa District; and men and women anticipated climate change to continue worsening, because of increased bad years in the 1990s compared to the 1970s.

The chi-square test statistic (χ^2) showed significant association ($p < 0.05$) between perception of respondents on the change in rainfall and sex, change in strong wind and village of respondents and change in drought and ethnic groups and marital status of respondents; indicating that perception of respondents on climate change in the study area varied by sex. The observation has an implication that it is important to integrate gender in the studies planned to determine perception on climate change. Respondents used the local knowledge available in the study area to perceive, describe and anticipate future climate change effects, implying that available local knowledge systems can be used to study and describe climate change. However, differences revealed by men and women in perceiving

climate change could be reduced by providing farmers with necessary information on climate change and its source through sensitization seminars.

The results of analysis of meteorological data, showed significant decrease in rainfall for Bahi District that is, $R^2 = 0.205$, ($p \leq 0.05$); significant increase in both mean minimum and mean maximum temperature that is, $R^2 = 0.404$, ($p \leq 0.001$) and $R^2 = 0.125$, ($p \leq 0.05$) respectively; and a significant increase in wind speed $R^2 = 0.276$, ($p \leq 0.01$), proving that climate had changed. The findings from the analysis of meteorological data matched well with responses of respondents who perceived changes in rainfall, temperature, wind and drought, admitting that rainfall variation, temperature, strong wind and drought had increased in the 1990s compared to the 1970s; and findings from the focus group discussions, which revealed that bad years had increased since 1984 for Bahi District and 1990 for Kondoa District. The findings imply that meteorological data can be used to study and monitor climate change.

3.1.2 Paper two: Perceived effects of climate change on agricultural production: A gendered analysis

Paper two on 'Perceived effects of climate change on agricultural production: A gendered analysis' was published in 2012 by the *Journal of Research on Humanities and Social Sciences* (RHSS). The paper aimed at examining effects of climate change on agricultural production by gender. It examined effects of climate change on crops and livestock production and the consequences of such effects (socio-economic effects) to men and women.

The findings revealed that climate change had reduced crop yield, pastures, crop varieties and had increased food shortage and insect pests including queleaquelea birds in the study area. Men and women perceived severity of the effects of climate change on crops and livestock differently. The corrected Rao-Scott chi-square statistic (χ_c^2) test showed significant association ($p < 0.05$) between perceived effects of climate change on production activities of respondents and sex, implying that perceived climate change effects varied by sex. The socio–economic effects of climate change were: waste of resources; increased hunger and weakness; farmers being subjected to bad food debts; increased family conflict; out-migration; decreased domestic water; waste of productive time in less productive activities; and loss of economic status. These socio-economic effects were also perceived differently by men and women. The chi-square statistic (χ^2) test showed significant association ($p < 0.05$) between perceived socio-economic effects and sex, the village, ethnic groups, the main occupation and land size of respondents, implying that socio-economic effects of climate change varied by sex. This insists the importance of considering gender in the studies intended to determine effects of climate change.

3.1.3 Paper three: Gender and adaptation practices to the effects of climate change

Paper three was on 'Gender and adaptation practices to the effects of climate change.' The paper was published by the *Journal of Sustainable Development* (JSD). It sought to investigate the adaptation practices implemented by men and women to reduce effects of climate change. The analysis was divided into adaptation practices undertaken to reduce food shortage or hunger, water and firewood shortages; and adaptation practices undertaken to reduce effects of climate change on crops, livestock and land and/or

environment. The paper also determined elements that hindered and elements that facilitated men and women adaptation to climate change.

The results revealed that women were leading in adapting to food shortage or hunger, water and firewood shortages. The corrected Rao-Scott chi-square (χ_c^2) statistic test showed significant association ($p < 0.05$) between adaptation practices undertaken by respondents and sex, implying that men and women adapted to food shortage or hunger, water and firewood shortages differently. Findings also showed that men were leading in adapting livestock, crops and land and/or environment to climate change. The corrected Rao-Scott chi-square (χ_c^2) statistic test showed significant association ($p < 0.05$) between adaptation practices undertaken by respondents and sex, indicating that men and women adapted crops and land and/or environment to the effects of climate change differently. The findings have revealed that men and women responded differently to effects of climate change. The disparity revealed between climate change adaptation practices implemented by men and women stress the importance of considering gender in the interventions planned to adapt to climate change in order to attain effective adaptation to climate change.

The findings have shown that men and women had started undertaking long term adaptation options such as: use of improved seeds of short maturity and drought tolerant crop varieties, deep cultivation, use of manure, change of crop varieties, planting crops in different dates, planting trees, using contours and planting reeds to control soil erosion and use of energy serving stoves to reduce firewood consumption. However, adaptation practices such as reducing the number of meals per day, feeding livestock tree leaves and selecting and keeping enough seeds for the next season, were of short term or coping

strategies which could not withstand the threat of climate change as it increases. In addition, production activities of men and women were constrained by various elements including inadequate production inputs and services such as improved seeds, credits and veterinary services. Those constraints reduced adaptive capacity and increased vulnerability of farmers to climate change. Thus, if men and women were provided with the knowledge on climate change to improve their understanding and be supplied with necessary inputs and services, they could be motivated to put more efforts on the long term adaptation practices.

3.1.4 Determinants of climate change adaptation: A Gendered analysis

A manuscript on 'Determinants of climate change adaptation: A Gendered analysis' sought to evaluate factors determining the choice of adaptation options between men and women by using multinomial logit model. Dependent variables used in the model were the short and long term adaptation options practised by the majority of respondents in the study area, which fell into three groups: adaptation options implemented to adapt to food shortage or hunger; adaptation options implemented to adapt crops to climate change; and adaptation options undertaken to adapt land and/or environment to climate change. The dependent variable was regressed on the following independent variables: village of respondents, access to agricultural knowledge, access to credits, access to education, main occupation undertaken by respondents, ethnic groups of respondents, land ownership and marital status. Other independent variables were household size, experience of respondents in crops production and land size.

The study showed that the main occupation, land size, experience of respondents in crop production, the village/location of respondents, access to agricultural knowledge, marital

status and land ownership positively and significantly determined the choice of climate change adaptation options between men and women. The main occupation, land size, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge were the main factors that determined choice of climate change adaptation options of men, whereas for women, the land ownership, marital status, experience of respondents in crop production, the village/location of respondents and access to agricultural knowledge were the main factors that determined their decision to adapt to climate change. Thus, the findings have shown that factors determining the choice of adaptation options between men and women were not the same. The differences revealed in the factors influencing choice of climate change adaptation options between men and women emphasize the importance of eliminating inequalities existing between men and women including inequalities in land ownership and production inputs and services in order to promote climate change adaptation.

In addition, the village/location of respondents was among the factors that retarded adaptation efforts for both men and women because of the deficiencies that existed in the respective villages including inadequate production inputs and services such as, improved seeds, credits and veterinary services; and weak enforcement of village by-laws. Thus, the village of respondents could contribute much to the effort of the farmers to adapt to climate change by providing inputs including improved seeds on time; observing village by-laws; and mobilizing men and women to form groups, gather together their resources and encourage the ability to save and borrow among the farmers to form SACCOS, the effort that could enable farmers to access credits.

3.2 Theoretical Implication of the Findings

According to the theory of adaptation derived from biology by biological anthropologists, which was adopted in this study, adaptations were made in response to new and multiple selective pressures or stressors, which produced both biological and cultural variations. A stress was something that produced a deviation from 'normal' dynamics and human response was something that was done to alleviate the stress. However, the biological adaptation to stress involves body adjustments while climate change adaptation involves actions that minimize the consequences of actual and expected changes in climate. Thus, this study found that stressors, that is climate change including increased and persistent drought, increased rainfall variation, temperature and strong wind had caused stresses, that is physical effects on plants, livestock, land and/or environment, water resources; and socio-economic effects on men and women. To alleviate the stresses, men and women were undertaking various adaptation measures to adapt to food shortage or hunger, water and firewood shortages; and to adapt crops, livestock, and the land and/or environment to climate change.

However, the literature and theory of adaptation have revealed that the adaptive capacity and factors determining decisions of men and women to adapt to climate change vary depending on flexibility and choices because individuals and communities who can be flexible in their responses and have a range of choices usually have greater capacity to deal with the change. The literature and theory also argue that the capacity varies among individuals, men and women, communities, socioeconomic groups and regions and that those with the least capacity to adapt are generally the most vulnerable to the negative impacts of change. Thus, the ability to adapt to climate change between men and women was not the same.

Although both men and women were affected by climate change, women were more affected, as they were deficient in ownership and control over household assets, had small farm and some owned no land, had inadequate agricultural knowledge and were constrained financially compared to men. Any effort to reduce inequalities in ownership and control over household assets between women and men would reduce vulnerability of women to climate change effects and improve their adaptive capacity.

The study focussed on gender, and gender was considered throughout the study during data collection, analysis of data and reporting of results. It has addressed an important knowledge gap and the findings are an important step in revealing the realities of gender differentiated perception, effects of climate change, adaptation practices implemented to adapt to climate change and factors determining choice of adaptation options between men and women, that is, the disaggregated data important for policy makers to formulate effective adaptation options. The analytical approach of this study has also demonstrated the value of gender disaggregated analysis as an approach to achieving a more in-depth and better understanding of climate change adaptation.

3.3 General Recommendations

Men and women perceived climate change and effects of climate change differently. Thus, the study recommends that LGAs, NGOs, researchers, the Tanzania NAPA and other development practitioners should integrate gender in climate change studies. They should build on the available local knowledge system to learn and manage climate change; also interpret and utilize meteorological data to learn and/or monitor climate change in their respective regions; and the farmers should be provided with necessary information on

climate change and its source through sensitization seminars in order to reduce differences revealed by men and women in perceiving climate change.

Men and women adapted differently to the effects of climate change depending on sex. Thus, in order to attain effective climate change adaptation, it is recommended that, policy makers and planners dealing with climate change including those from agricultural, livestock and environmental sectors should use gender sensitive interventions to manage climate change effects. Some of the adaptation practices implemented in the study area were of short term or coping strategies but men and women had started implementing long term adaptation options. It is recommended that LGAs, NGOs and other development practitioners should promote long term adaptation practices in the study area by providing farmers with important knowledge on climate change adaptation and supplying farmers with necessary production inputs and services; and promote equal ownership of land and access to other production inputs and services between men and women.

3.4 Policy Implication

Findings indicate that it is important for the policymakers and planners including the Tanzania NAPA to integrate gender in adaptation measures or interventions planned to reduce climate change effects; and introduce necessary measures to reduce gender inequalities in the study area including inequalities in ownership of land between men and women. It is also important for the policymakers and planners to develop mechanism which will promote production and ensure sustainability of production activities in the study area; and measures that will ensure that crops and/or livestock extension agents are allocated at the village level so that both men and women can access agricultural knowledge from a reliable source. Policymakers and planners would also do well if they

could develop measures that could facilitate farmers' access to input on time; facilitate the availability of affordable credits; and develop measures to introduce the subject of climate change in the curriculum of primary school education to improve climate change awareness in the study area. It is also vital for policymakers and planners to introduce measures that will facilitate farmers to access knowledge on land use and/or environmental conservation.

3.5 Areas for Further Research

1. A study of this kind (systematic collection of in-depth information at the community level) need to be undertaken in other semi-arid areas and regions of Tanzania in order to gather more information that can justify generalization of the findings on gender and climate change. This is because climate change effects are location specific, and adaptive capacities of individuals vary across the country.

2. It is important to investigate factors that limit women access to agricultural knowledge from crops and/or livestock extension agents and instead, rely more on their neighbours and/or fellow farmers.

3. A study to evaluate the effectiveness of adaptation practices which are implemented in the study area.

APPENDICES

Appendix 4: Checklist items for the key informant interviews

1. Village history
2. The main changes that have occurred in the village since village establishment
3. Changes related to climate and things that have changed
4. The major production activities in the village
5. Changes in production activities due to climate change
6. The way you are dealing with the changes

7 Your anticipation in the future (5 – 10 years) regarding climate change.

Appendix 5: Interview guide for focus group discussions

1. What are the key livelihood activities for the household in 1990s? What were the household activities in the 1970s?
2. Are there good and bad years in this village? Explain.
3. How do you describe the concept of climate change?
4. What effects climate changes had on your main livelihoods?
5. How do you respond to those effects?
6. What are the elements that affect your ability to adapt to or reduce those climate change effects?
7. What do you anticipate to happen in the future (5 – 10 years) with regard to changes in climate, crops, livestock production and family relation/bond?

Appendix 6: A structured questionnaire

Date of interview .....Questionnaire number.....Interviewer's name.....

A: Basic household characteristics

A1. Name of respondent.....

A2 District..... A3 Division.....

A4 Ward..... A5 Village.....

A6. Sex of respondent: 1) Male 2) Female ( )

A7. Age of respondent (years).....

A8. Marital status 1) Married 2) Single 3) Divorced 4) Widow

5) Widower 6) Separated ( )

A9. If married what is the number of spouse (wives)? .....

A10. Ethnic background

1) Gogo 2) Fyomi 3) Rangi 4) Sandawe 5) Burunge 6) Goroa

7) Others (specify)..... ( )

A11. Religion background

1) Christian 2) Muslim 3) Traditional 4) Others (specify)..... ( )

A12. Education level 1) None 2) Primary school education

3) Secondary school education ( )

4) Tertiary (college/university) 5) Adult education 6) Others (specify).....

A13. How many years have you lived in this village?.....

A14. What is your main occupation/production activity?

1) Crop production 2) Livestock keeping 3) Agro-pastoralist ( )

4) Others (specify).....

A15. Total family size

Name of the family member	Sex	Age	Education level	Main occupation	Relationship to respondent

A16. Show the number of plots of your farm, their size, crops grown; location, distance from home; and the way plot was obtained.

Plot name	Plot size (Acres)	Name of the crop grown	Location	Distance from home	How was plot obtained
			1) High land areas 2) River basin 3) Plateau flat 4) Low and wet land areas 5) Lowland areas 6) Others (specify...	1) Around homestead 2) Not very far from home 3) Far away from home 4) Others (specify).....	1) Purchased 2) Rented 3) Inherited 4) Given by village committee 5) Others (specify) .....

A17a. In addition to land what other assets do you own? .....

A17b. To what extent do you access and control the assets?.....

A18. How many years have you been involved in crop production?.....

A19. How many years have you been involved in livestock keeping?.....

B: Perception of climate change by men and women

B1. How do you describe the concept of climate change?

B2. Have you observed any change in climate in the 1990s compared to the 1970?

1) Yes 2) No ( )

B3. If the answer is YES, mention one major change in climate that you have observed

1) Rainfall has decreased 2) Drought has increased 3) Temperature has increased

4) Others (specify)..... ( )

B4. What is the main reason for the change?.....

Kindly use the options below to answer the following questions according to your level of agreement or disagreement: Strongly Agree, Agree, Undecided; Disagree, Strongly Disagree

S/N	Perception on climate change	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Increased rainfall variation						
B5	Rainfall amount in the 1990s has decreased compared to the 1970s					
B6	Rainfall amount in the 1990s has increased compared to the 1970s					
B7	Compared to the 1970s in the 1990s it has been difficult to predict rainfall onset					
B8	Compared to the 1970s in the 1990s it has been easy to predict rainfall onset					
B9	Rainfall shortage is insignificant in the 1990s					
B10	Rainfall shortage is significant in the 1990s					
B11	Rainfall amount in the 1990s is more irregularly distributed					
B12	Rainfall amount in the 1990s is less irregularly distributed					
B13	Compared to the 1970s the number of rain days in the 1990s has decreased					
B14	Compared to the 1970s the number of rain days in the 1990s has increased					

Increased temperature						
B15	Compared to the 1970s temperature in the 1990s has increased					
B16	Compared to the 1970s temperature in the 1990s has decreased					
B17	Compared to the 1970s the number of warm days during cold season in the 1990s has increased					
B18	Compared to the 1970s the number of warm days during cold season in the 1990s has decreased					
B19	It has been too hot during dry season in the 1990s compared to the 1970s					
B20	It has been too cool during dry season in the 1990s compared to the 1970s					
B21	Increase in temperature in the 1990s has caused uncomfortable nights compared to the 1970s					
B22	Increase in temperature in the 1990s has caused comfortable nights compared to the 1970s					
Increased frequency of wind						
B23	Frequency of heavy winds during rain season in the 1990s has increased compared to the 1970s					
B24	Frequency of heavy winds during rain season in the 1990s has decreased compared to the 1970s					
B25	Compared to the 1970s frequency of whirlwind in the 1990s has increased					
B26	Compared to the 1970s frequency of whirlwind in the 1990s has decreased					
B27	Whirlwind is the major cause of environment and water pollution in					

	the 1990s compared to the 1970s					
B28	Whirlwind is the minor cause of environment and water pollution in the 1990s compared to the 1970s					
B29	Strong wind destroys crops regularly in the 1990s compared to the 1970s					
B30	Strong wind destroys crops rarely in the 1990s compared to the 1970s					
Increased drought						
B31	Compared to the 1970s frequency of drought in the 1990s has increased					
B32	Compared to the 1970s frequency of drought in the 1990s has decreased					
B33	The number of days of dry spell in the 1990s has increased compared to the 1970s					
B34	The number of days of dry spell in the 1990s has decreased compared to the 1970s					
B35	Drought is significant in the 1990s					
B36	Drought is insignificant in the 1990s					
B37	Compared to the 1970s in the 1990s water amount has decreased due to drought					
B38	Compared to the 1970s in the 1990s water amount has increased regardless of drought					
B39	Compared to the 1970s wetland area in the 1990s has decreased due to drought					
B40	Compared to the 1970s wetland area in the 1990s has increased regardless of drought					

B41	Compared to the 1970s water sources in the 1990s have decreased due to drought					
B42	Compared to the 1970s water sources in the 1990s have increased regardless of drought					
B43	Compared to the 1970s insect pest attack to crops in the 1990s has increased					
B44	Compared to the 1970s insect pest attack to crops in the 1990s has decreased					
B45	Frequency of diseases attack to livestock in the 1990s has increased compared to the 1970s					
B46	Frequency of diseases attack to livestock in the 1990s has decreased compared to the 1970s					
B47	The amount of crop yield in the 1990s has decreased compared to the 1970s due to drought					
B48	The amount of crop yield in the 1990s has increased compared to the 1970s regardless of drought					
B49	Compared to the 1970s the amount of pastures in the 1990s has decreased due to drought					
B50	Compared to the 1970s the amount of pastures in the 1990s has increased regardless of drought					

B51. What do you anticipate to happen in the future (5 – 10 years) in terms of climate in general, crop production, livestock keeping and family relation/bond?

.....

C: Effects of climate change on agricultural production (crops and livestock production activities)

C1. What crops do you grow?

C2. Among the grown crops what new types of crops have been introduced since 1990s?

C3. What are the reasons for introducing the new types of crops?

C4. What types of crops were grown in 1970s but have been abandoned?

C5. What are the reasons for abandoning mentioned crops?

C6. What livestock do you keep?

C7. What new livestock have been introduced since 1990s?

C8. What are the reasons for introducing the new mentioned livestock?

C9. What livestock were kept in 1970s but have been abandoned?

C10. What are the reasons for abandoning mentioned livestock?

C11. Did you produce enough food in 2008/09 season?

1) Yes 2) No ( )

C12. Indicate the number of months of food shortage, the size of land owned and cultivated in 2009/10 season and in the past 20 years (explain if there is any change).

Description	**Duration/timeframe**		**Reason for change (if there is any change)**
	2009/10 season	**In the past 20 years**	
Number of months of food shortage experienced in …			
Hectares of land owned			
Hectares of land cultivated			

C13. What two diseases have frequently attack your family since 1990s?

C14. What do you think are the causes of such diseases?

C15. How far do you travel for water for domestic use in the dry season?

Distance/time.....

C16. What distance/time was used in 1970s?.....

C17. What have brought about these changes? (If there is change)

1) Deforestation 2) Drought 3) Increase in population

4) Others (specify)..... ( )

C18. How far do you travel to collect firewood? Distance/time.....

C19. What have brought about these changes? (If there is change)

1) Deforestation 2) Drought 3) Bush clearing to increase land size ( )

4) Others (specify).....

S/N	Question	Response options
C20	For the past 20 years what have been the effects of climate change on production activities (physical effects)	1) Damaging crops and persistent low yield 2) Reduction in pastures, number of livestock and milk yield 3) Increased livestock diseases 4) Reduction in water sources and shrinkage of wetland areas 5) Increased crops insect pest and vermin 6) Reduction in crop varieties 7) Reduction in non-farm production activities 8) Others (specify).....
C21	How are the farmers affected? (socio-economic effects)	1) Waste of resources 2) Increased hunger and general body weakness 3) Farmers are subjected to bad food debts 4) Family conflict has increased 5) Out-migration 6) Decreased domestic water, sanitation and hygiene 7) Waste of productive time in less productive activities 8) Others (specify).....

D: Adaptation to the effects of climate change

D1. Show the extent at which you have applied the following adaptation options to adapt to/reduce food shortage/hunger and its effects using the following options:

1) Always 2) Often 3) Rarely 4) Never

Adaptation option	Application level
Reduce number of meals	
Sell labour	
Sell livestock and/or local chicken	
Engage in non-farm production activities	
Plant hunger buffering crops e.g. sweet potatoes	
Eat wild fruits	
Starve/go without food for a day/more days	
Assisted by relatives/friends	
Emigrate	
Borrow food from traditional food credit	
Others (specify)....	

D2. Show the extent at which you have applied the following adaptation options to adapt to/reduce domestic water and firewood shortages and its effects using the following options:

1) Always 2) Often 3) Rarely 4) Never

Adaptation option	Application level
Drill deep water wells	
Fetch water/firewood from far sources	
Sell food crops to buy water	
Drill shallow water wells for domestic use	
Control/boil water	
Use cobs, stalks, bricks stoves	
Others (specify).....	

D3. Show the extent at which you have applied the following adaptation options to adapt to/reduce effects of climate change on your production activities and environment.

Adaptation option	Application level
Feed livestock tree leaves (e.g. miyombo)/banana stems	
Livestock go without water for three days	
Move livestock to other places	

Divide livestock to friends/reduce the number	
Feed livestock crop residues	
Use traditional herbs/experience	
Consult livestock officer	
Use of improved seeds/drought tolerant/short term varieties	
Use of deep cultivation	
Early planting	
Use of manure	
Prayed to God	
Select and keep enough seeds /replant	
Change of crop varieties	
Plant in different dates	
Use of traditional medicine/herbs	
Early land clearing	
Plant trees (shade/firewood)	
Make contours/plant reeds (*matete*)	
Use of ridge farming	
Others (specify).....	

D4. Choose one element that reduces or facilitates your effort to adapt to climate change?

D4a	Elements impeding adaptation	1) Inadequate capital including credit 2) Inadequate input and veterinary services 3) Inadequate production tools 4) Inadequate manpower 5) Others (specify).....	( )
D4b	Elements facilitating adaptation	1) Improved transport, communication and business 2) Patience and ability to work hard 3) Observation of government bye-laws and directives 4) Mutual support spirit and ability to learn from others 5) Others (specify).....	( )

E: Factors determining the choice of adaptation practices by sex

E1. Among the adaptation options listed below which one option does you implement more often?

E1a. Adaptation options implemented to adapt to food shortage or hunger

a) Reduce number of meals per day b) Sell labour

c) Sell livestock and/or local chicken d) Engage in non-farm production activities

e) Plant hunger buffering crops f) Others..... ( )

E1b. Adaptation options implemented to adapt crops to climate change

a) Select and keep enough seeds for the next season b) Use of deep cultivation

c) Use of improved seeds d) Use of manure e) Change of crop varieties

f) Others..... ( )

E1c. Adaptation options implemented to adapt land/ environment to climate change

a) Plant trees (shade/firewood) b) Contours/plant reeds

c) Use of ridge farming d) Others..... ( )

THANK YOU FOR YOUR COOPERATION