ROLE OF NON-TIMBER FOREST PRODUCTS IN CLIMATE CHANGE ADAPTATION BY FOREST DEPENDENT COMMUNITIES IN KILOLO DISTRICT, IRINGA, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN FORESTRY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

A study to assess the role of Non-timber forest products (NTFPs) was conducted to forest dependent communities around New Dabaga -Ulongambi Forest Reserve (NDUFR) in Kilolo District as a strategy to cope with the impacts of climate change. Data were collected through household questionnaires, PRA techniques, transect walk and direct field observations. Climatic data mainly rainfall and temperature for the last 30 years were obtained from Nduli Airport weather station. Data collected through PRA tools were analysed with the help of communities and the results communicated back to local communities for rectification. The CRiSTAL 3.0 was used to synthesize information from focus group discussion on the link between climate change, NTFPs and livelihoods. Household interviews data were analysed using Statistical Package for Social Sciences (SPSS). Logistic regression model was used to ascertain the relationships existing between the local peoples' perception on the impacts of climate change and socio-economic factors. A total of 107 plant species were identified to be harvested by residents around NDUFR as NTFPs. The majority of the respondents (81%) perceived that there has been a change in the climate pattern due to increased temperatures and unpredictable rainfalls. The local peoples' perceptions on temperature and rainfall patterns were in line with the available climatic data records. Agriculture was found to be the most affected livelihood activity by climate change around NDUFR. Communities living around NDUFR were found to use more than one strategy to cope with the adverse effects of climate change. About 43% of the respondents admitted to use NTFPs for subsistence and source of income as a climate change coping strategy. The study concluded that NTFPs still play a safety net role to assist communities in adverse situation such as crop failure under the current change in climate. The need to emphasis sustainable harvesting, improve processing and access to NTFPs markets is crucial.

DECLARATION

I, Upendo Msalilwa, do declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted for a degree award at any other University.

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Date

The above declaration confirmed by

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DEDICATION

To my wonderful parents Mr. Lufingo Msalilwa and Mrs. Rehema Msalilwa who made a lot of efforts in laying down the foundation of my education.

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CCIAM	-	Climate change Impact, Adaptation and Mitigation
CRiSTAL	-	Community-based Risk Screening Tool for Adaptation and Livelihoods
DFID	-	Department for International Development
EAMCEF	-	The Eastern Arc Mountains Conservation Endowment Fund
FAO	-	Food Agriculture Organization of the United Nations
IPCC	-	Intergovernmental Panel on Climate Change
IPGRI	-	International Plant Genetic Resources Institute
IRI/HTIR	-	Nduli Airport Code
JFM	-	Joint Forest Management
MNRT	-	Ministry of Natural Resources and Tourism
NBS	-	National Bureau of Statistics
NDUFR	-	New Dabaga-Ulongambi Forest Reserve
NGOs	-	Non-governmental organizations
NTFPs	-	Non Timer Forest Products
PFM	-	Participatory Forest Management
PRA	-	Participatory Rural Appraisal
SACCOS	-	Savings and Credit Cooperative Societies
SADC	-	Southern African Development Community-
SPSS	-	Statistical Package for Social Sciences
URT	-	United Republic of Tanzania
USAID	-	United States Agency for International Development
VNRC	-	Village Natural Resource Committees

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Non-timber forest products (NTFPs) are all biological materials other than timber, which are extracted from the forest for the human use (Hamilton, 1998; Posey, 1999; Cocks and Wiersum, 2003). FAO (2001) defined NTFPs as goods of biological origin other than wood, derived from forests, other wooded lands and trees outside the forest. They may be gathered from the wild, or produced in forest plantations, agro-forestry schemes and from trees outside forests (FAO, 1995). Koziell and Saundres (2001) reported that NTFPs are mainly used for food and medicinal purposes and in both cases can be used for domestic consumption and traded commercially. In the context of this study, NTFPs are considered as both direct benefits e.g. food and healthcare as well as indirect benefits such as biodiversity values, ecotourism, cultural and other values. Millions of people throughout the world make extensive use of biological products from the wild (Koziell and Saundres, 2001). NTFPs as one of the wilds are harvested for both subsistence and commercial use, either regularly or as a fall-back during times of need (Shackleton and Shackleton, 2004). The most commonly used NTFPs are medicinal plants, wild vegetables, fuelwood, wooden utensils, grass hand-brushes, edible fruits, and twig hand-brushes (Stile, 1988; Wickens, 1991).

Climate change has been defined as a long-term change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (Parmesan and Yohe, 2003; Robledo and Forner, 2005). According to USAID (2007) climate variability is defined as the inherent characteristic of climate which manifests itself in changes of climate with time. Examples of climate variability include extended droughts, floods, and conditions that result from periodic El Niño and La Niña events (Grimm *et al.*, 2000; Conway, 2008). Vulnerability to the impacts of climate change is a function of exposure to climate variables, sensitivity to those variables, and the adaptive capacity of the affected community (Fussel and Klein, 2006). Often, the poor are dependent on economic activities that are sensitive to the climate. For example, agricultural and forestry activities depend on local weather and climate conditions; a change in those conditions could directly impact productivity levels and diminish livelihoods (USAID, 2007).

Both climate change and variability may alter the productivity of forests and thereby shift resource management, economic processes of adaptation and forest harvests (Alig *et al.*, 2002). It is widely recognized that climate change has caused substantial impacts on forested ecosystems (Kirilenko and Sedjo, 2007). The majority of the forest dependent people have reduced opportunity to cope effectively with the adversities of climate change due to low capabilities, poverty, weak institutional mechanisms (Shackleton and Shackleton, 2004) and lack of access to resources (Brooks 2003; Brooks *et al.,* 2005). According to Regmi *et al*. (2010) climate change adaptation consists of initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects.

1.2 Problem Statement and Justifications of the Study

Forests are home to the people who are entirely or partly dependent on them for their livelihood (FAO, 2001; Basu, 2009). According to the report by World Bank (2008) the majority of communities living adjacent to the forest reserves; about 60 million around the globe are estimated to be almost wholly dependent on forests. Climate change is currently one of the greatest environmental challenges facing humankind (Totten *et al.*, 2003).

Africa was predicted to suffer the most from the impacts of climate change according to the 2001 Intergovernmental Panel on Climate Change (IPCC). The changing climatic patterns in Tanzania, such as increased temperatures and changes in rainfall patterns, is predicted to have strong impacts on livelihood and biodiversity in the country (URT, 2003). For example, species migratory patterns will likely change, pests and diseases might increase, and strain for resources has become more prominent (Berg *et al.,* 2010). Decreasing availability of forest-produce such as food, fuel, medicinal and herbs seem to deprive the rural poor from a supplementary source of income, food and healthcare (Basu, 2009). There is growing evidence that climate change is impacting on forests and forest ecosystems (Mukhopadhyay, 2009); thus need for Tanzania to think of adaptation and mitigation measures and include them through mainstreaming the existing development policies.

Little is known about the impact of climate change on NTFPs and livelihood of the local communities living around the New Dabaga-Ulongambi Forest Reserve (NDUFR). Furthermore, the extent to which the NTFPs and forest dependent communities' livelihood are vulnerable to the changing climate including the coping and adaptation strategies is not well known and documented. However, because of the prevalence and intensity of poverty, forest dependent communities in Tanzania seem to be highly vulnerable to the negative impacts of climate change, particularly those who depend on natural forests that are already facing degradation (MNRT, 2009). The present study provides an understanding of the ability of forest dependent communities to respond to climate change impacts, reduce their vulnerability and enhance their adaptative capacity using potential NTFPs. Information generated from this study provides a timely scientific input to policy-makers during the current implementation of initiatives to combat climate change effects while assisting communities to cope/adapt and sustain their livelihoods.

1.3 Objectives

1.3.1 Main objective

The main objective of this study was to assess the role of NTFPs to forest dependent communities as a strategy to cope/adapt with the impacts of climate variability and change around the NDUFR in Kilolo District, Iringa Region, Tanzania.

1.3.2 Specific objectives

Specific objectives of this study were to:

i. identify different types of NTFPs available in the study area,
ii. investigate the local perceptions on climate variability and change impacts to NTFPs availability and livelihood of forest dependent communities living around NDUFR,
iii. investigate the vulnerability of NTFPs and forest dependent communities to perceived climate variability and change,
iv. examine supply, access and use of NTFPs by household as a strategy to cope and adapt to the effect of changing climate and variability in the study area.

1.3.3 Research questions

The study aimed to answer the following fundamental questions:

i. What are the NTFPs in the study area under the current climate change and variability?
ii. How do local communities perceive the impact of climate change on NTFPs availability and livelihood?
iii. Which NTFPs, social groups and livelihood assets are vulnerable to climate change and variability within the forest dependent communities?
iv. How is the current access to and supply of NTFPs by household in the study area?
v. How do communities use NTFPs as a strategy to cope and adapt with the effect of changing climate within a gender context?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Climate Change concept

Climate change is a long-term change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (Adger, 1999; Robledo and Forner, 2005). Global warming is caused by accumulations of green house gases in the atmosphere that tend to trap radiations (Adger, 1999). Also, the chemicals that result in depletion of ozone layer by reacting with the ozone layer and form other compounds (Robledo and Forner, 2005). The most common green house gases are water vapor, carbon dioxide, methane, nitrous oxide and chlorofluorocarbons (Adger, 1999). In many areas, agricultural and other land use activities have upset the natural balance in the soil carbon cycle, contributing to an alarming increase in carbon release (Batjes, 1996). Interest has increased in the possible impacts of various agricultural management practices on soil organic matter dynamics. Agricultural and other land use practices have a significant influence on how much carbon can be sequestered and how long it can be stored in the soil before it is returned to the atmosphere (Dick *et al.*, 1998). Carbon dioxide (CO_2) emissions from fossil-fuel use, and from other sources, can be offset by removal of CO_2 from the atmosphere via a net increase in the carbon stocks of the biosphere (West and Marland, 2002). The green house gases resulted from both natural and human causes. Natural causes include continental drift, volcanoes the earth's tilt and ocean currents (Adger, 1999). According to the IPCC report (2007) about 90% of the green house gases are caused by human activities including industrialization, deforestation and degradation of forests (IPCC, 2007).

Climate change and climate variability are likely to cause disruptions in the climate system, such as modifications to the precipitation regimes and to the frequency and intensity of extreme events (Forner, 2006) which results to changes in the structure and function of ecosystems. Whether these changes lead to positive or negative consequences will depend on the geographical, environmental, social and economic conditions of the affected area (Adger, 1999). For example, a rainfall increase could be beneficial in areas where water is scarce, but not in areas affected by floods. As Easterling *et al.* (2007) point out that 'climate change will substantially impact other services, such as seeds, nuts, hunting, resins, plants used in pharmaceutical and botanical medicine, and in the cosmetics industry; these impacts will also be highly diverse and regionalized'.

Climate change is expected to result, in many regions, in increased frequency and severity of extreme climate events such as heat stress, droughts and flooding in the coming decades (Irland *et al.*, 2001). In particular, it will modify the risks of fires and pest and pathogen outbreaks, with negative consequences for food, fibre and forest production including NTFPs (Easterling *et al.*, 2007). In regions with large forest-dependent populations, particularly in Africa, expected decreases in rainfall, and increased severity and frequency of drought, can be expected to exacerbate current exploitation pressures on forest and expansion of agriculture into forest lands (Arnold and Perez, 2001). In these regions, this can be expected to impose additional stresses on people who depend on fuelwood for their domestic energy needs and NTFPs for their livelihoods (Arnold and Perez, 2001). Also, climate change may result to shift of forest boundaries. The change in weather may be higher compared to the adaptability capacity of plants and may result to the loss of some of tree species (Scholes and Linder, 1998). Undoubtedly, human influences have implications for the present role of agricultural lands and forests in global carbon cycles and in future carbon sequestration. In order to mitigate climate change, more carbon should be sequestered in forest ecosystems and strategies for an adapted forest management are sought (Dixon *et al.,* 1994).

2.2 Importance of NTFPs to livelihoods

NTFPs are increasingly becoming important in terms of rural and urban livelihoods, as there is an established cause-and-effect relationship between poverty and forest degradation in the cause of deriving subsistence households' needs (Shackleton and Shackleton, 2004). The role of forests and trees in food security, contribution to water supply, provision of economic alternatives and support to other sectors has been recognized (Shackleton and Shackleton, 2004). There has been increased recognition of the value of non-timber forest products to people's livelihoods. For example, wild foods greatly improve nutrition and increase food security particularly for rural poor (Shackleton and Shackleton, 2004). A study by Hamza *et al.* (2004) found that 80% of local communities living adjacent to Mgori Forest Reserve obtained wild fruits, vegetables and honey from the forest that help in improving their nutritional needs. Wild vegetables save the lives of thousands of poor people residing in rural areas in Tanzania (Mvungi, 2001). The common vegetables include *Zanthoxylum chalybeum, Adansonia digitata, Bidens pilosa, Bidens spp.,* Sesamum *spp.* and many others. Roots and tubers provide carbohydrates and some minerals. In Tanzania, natural mushrooms are used mainly for household consumption and very small portions are being sold along the roads. Some species of mushrooms function as medicinal plants (Cunningham, 1993). Records indicate that, there are about 34 species of edible mushrooms spread all over Tanzania from forests to bushlands (Harkonen *et al.,* 2003). NTFPs provide livelihood benefits by assisting households to cope with sudden changes in the economic, social or bio-physical environments in which households exist and function (Shackleton, 2001). Collection and use of NTFPs to meet daily needs for energy, shelter, food and medicine allows scarce cash resources to be used to secure other household needs (Shackleton and Shackleton, 2004).

2.3 Classification of NTFPs

Usually there is no single classification used for NTFPs but classification depends on a particular purpose. According to FAO (1992), NTFPs are classified based on the type of products and the end uses as follows: Forest food, Medicinal plants, fuelwood and charcoal. Also they provide indirect benefits.

2.3.1 Forest food

Forest foods can assist in coping with seasonal food shortages and shortages due to extreme weather events, natural disasters, human-made conflicts and other shocks (Arnold *et al.*, 2011). These foods range from wild leaves, fruits, roots, tubers, seeds, nuts, mushrooms, saps, gums, and wild animals and their products, such as eggs and honey, altogether supplement the foods produced by agriculture and those obtained from other sources.

Fruits

Fruits are major source of proteins, vitamins, minerals, fats and roughages (FAO, 1992). Fruits are the main source of vitimin A and C. They contain vital nutrients and essential vitamins, which are important, especially for growing children who are prone to malnutrition and related diseases. Vitamin C is essential for protecting cells and keeping the body healthy and also absorbing iron from food.

According to the FAO (1992) some of the wild fruits have higher vitamins contents compared to farm fruits. The vitamin C content of an orange is 57 mg/100g and the fruit of the baobab tree (*Adansonia digitata*) is 360mg/100g. Ruffo *et al*. (2002) reported that fruits of *Adansonia digitata* and *Ximenia caffra* contain higher vitamin C content than mango (*Mangifera indica*) or orange (*Citrus sinensis*). The variations in vitamin C content between the wild and cultivated fruits does not imply the later to be abandoned but rather stressing the importance of wild resources, since the two occur in different environment.

Mushrooms

Mushrooms depend on other plant nutrients where they form symbiotic relationship with most of the trees (Torrey, 1992). Most of the mushroom found in the miombo woodlands are mainly available during rain seasons. Mushrooms provide valuable source of certain food protein and vitamins. Mushrooms are important sources of medicines and nutritive proteins and minerals (Bahl, 1994). The average protein content of 30 edible mushroom species from Upper Shaba, Zaire was reported to be 22.7 g/100 g dry weight (Parent, 1977). The mean calcium content was 349 mg /100g and average iron content was 1552 mg /100g of mushrooms (Parent, 1977).

In Tanzania, almost every ethnic group has a traditional knowledge of mushrooms growing in the wild and members of each group harvest consume and sell them. Over 60 edible mushroom species have been identified in Tanzania (Harkonen *et al.*, 2003). Mushrooms are frequently collected in southern Tanzania by the local population, mainly for domestic consumption. They can be used as fresh or dried mushrooms depending on the preference of the user. Some of the mushrooms are cooked fresh, while some are preserved by sun dying or smoking for use in dry season (Harkonen *et al*., 2003).

Wild vegetables

Leaves of wild plants like trees, shrubs and herbs, are a good source of food in the semi-arid areas. The wild vegetables serve as buffer food supplies during periods of food shortage. African indigenous vegetables play a highly significant role in food security of the underprivileged in both urban and rural settings (Schippers, 1997). Although semi arid areas are common, leaves and vegetables have a very important function especially where extreme drought occurs usually from November to February. These vegetables are good sources of micronutrients including iron and calcium as well as vitamins A, B complex, C and E. Some of these wild vegetables contain more nutrients values compared to cultivated vegetables for example; Wild Amaranth contains a multiple of these nutrients compared to green cabbage (IPGRI, 2003). A study by Ruffo *et al.* (2002) found that wild vegetables such as *Bidens pilosa, Corchorus olitorius* and *Solanum nigrum* have higher protein, fat, minerals (Calcium and Iron) and carotene contents than some exotic vegetables such as *Brassica chinensis* and many other vegetables of cabbage family.

These wild vegetables save the lives of thousands of poor people residing in rural areas such as Iringa, Dodoma, Singida and Morogoro (Mvungi, 2001). The common vegetables during the period include *Zanthoxylum chalybeum, Adansonia digitata, Bidens pilosa, Bidens spp.*, Sesamum *spp* and many others. Interestingly, *Z. chalybeum* and *Sesamum spp*. is preserved and sold for about three US dollars per kilogram in local markets (Mvungi, 2001). It has to be noted that most of the above mentioned wild vegetables have been domesticated and now cultivated in farms. Therefore, could sometimes be considered not wild.

Roots, tubers and gums

Roots and tubers provide carbohydrates and some minerals. Tubers are very small in size and are too few to constitute a complete meal. In Tanzania, roots of *Comminphora spp*., tuber of *Eriosema spp* and gums of *Acacia spp.* are chewed as food (FAO, 1997). The herdsmen and hunters as refreshment (water supply) eat these raw in most cases. In Mozambique the edible roots and tubers include *Negleta canensis* and *Oxalis semicobata*.

Insects and bush meat

These are the sources of proteins that can assist in reducing protein-energy malnutrition: due to inadequate food consumption causing reduced growth, susceptibility to infection, changes in skin hair and mental facility. The common known insects include bees, flying higher termite species (*Macro termes*) and grasshoppers (*Caelifera sp*). Tanzania is among countries in the world with a high production of bee products especially honey and beeswax. Based on statistics of 1998, the annual capacity of Tanzania for honey and beeswax production is 138,000 and 9,200 tones respectively (MNRT, 1998). Honey is believed to have medicinal properties, it helps against infections, promote tissue regeneration, and reduce scarring (Hutton, 1996).The animals hunted include wild pigs, Antelopes, Dike, Hares and Moles. Birds are also hunted but more especially fowls like Guinea fowls and wild ducks.

2.3.2 Medicinal plants

Medicinal plants are widely and successfully used on every continent. They are important to the health and income to the community. Most of the rural communities in developing countries continue to rely heavily on the use of traditional medicines as their source of healthcare (Mann *et al.*, 2008). Ethnobotanical studies carried out throughout Africa confirm that indigenous plants are the main constituents of traditional African medicines

(Hedberg *et al.,* 1983; Mann *et al.,* 2008). Over 80% of rural people in Tanzania depend on traditional healers and herbs for their primary health care needs and reliance on medicinal plants creates the need to maintain and conserve biodiversity (Dery *et al.,* 1999). Medicinal plants function well to a good number of people (Acharya, 2003; 2004). For examples, the numerous herbalists in the Muhimbili National Hospital indicate the importance of medicinal plants in the society (FAO, 2002). The Maasai women on the other hand are found in towns nationwide selling traditional medicines (FAO, 2001). Several studies have been carried out and a number of medicinal plant species have been recorded in Tanzania. For example, Abdallah (2007) documented a total of 45 medicinal plant species in the NDUFR. Similarly, Minja (1994) listed 20 plant species found in the Udzungwa Mountain Forests which are used as medicine to treat various diseases.

2.3.3 Firewood and charcoal

Many communities and families in the developing countries use woodfuel as their major source of energy (Bruce *et al*., 2000). A study by Mogaka et al. (2001) estimated that about 85% of the sub-Saharah population relies on wood based energy. MNRT (2005) estimated that about 97.9% of total wood consumed in Tanzania was on wood biomass (charcoal and firewood). Total wood fuel consumption in Tanzania was estimated to be 46.2 million cubic metres of solid round wood (Magessa, 2008). On the other hand, fuelwood is the second major cause of deforestation throughout the developing world (UN, 1994). Firewood and charcoal supply the energy needs of numerous industries and small business in the third world. In Tanzania for example, the industries using fuelwood include tobacco curing, salt mining (drying), tea curing, brick kilning and fish smoking.

It has been estimated that the average woodfuel use per capita per year in Tanzania ranges from 0.6 m^3 to 1.86 m^3 (Ishengoma and Ngaga, 2000). Partly due to scarcity, much of the fuelwood has entered the market economy. Ishengoma and Ngaga (2000) reported that most of the rural areas, fuelwood is becoming a commercial good. This has attracted farmers near urban areas to quit farming in order to trade in charcoal. Populations have been growing much faster than those in rural areas as the result urban households require many products from the woodlands including demand for fuelwood which probably has the most widespread negative impact on the woodlands (Campbell *et al.,* 1997). Leach (1990) reported that urbanization rate in most African countries is about 5% annually in the SADC countries in which Tanzania is a member.

2.3.4 Indirect benefits of NTFPs

According to Sunderlin *et al.* (2005) indirect benefits of NTFPs include watershed protection, protection of species and genetic diversity, climate regulations and carbon sequestration, soil protection, recreation and religious values. Among the key forest ecosystem services which are expected to be affected by climate change are those related to hydrological regulation and water quality. These include, among others: the regulation of run-off and river discharge; the maintenance or improvement of water quality through forest filtering and retention of freshwater for consumptive use.

2.3.5 Environmental importance of NTFPs

NTFPs represent a way to meet environmental objectives such as conservation of forests, watersheds, and biological diversity. Many scientific studies and development workers suggest that NTFPs can help communities meet their needs without jeopardizing forest ecosystems (Wilkinson and Elevitch, 2000; Oduro, 2002; Shackleton and Shackleton, 2004). Conservation efforts seek to encourage low-intensity management systems and see livelihood improvement as an important instrument to achieve nature conservation (Belcher, 2003). It is often assumed that harvests of NTFPs have less impact on a forest than logging. However, forest ecosystems have complex interrelationships that harvests of some NTFPs can affect plant (and wildlife) populations negatively (Wilkinson and Elevitch, 2000). Without a sound knowledge of the resource and regular monitoring, harvests of certain NTFP resources can have a large impact.

2.4 NTFPs and climate change impacts

The impact of climate change on NTFPs is an area that requires greater attention from the research community (Easterling *et al.,* 2007). According to Irland *et al*. (2001) the site specific nature of both climate change and the provision of NTFPs services complicate the understanding of climate change impacts on these resources. In general, the influences of climate change on NTFPs resources are more difficult to assess because of high uncertainty regarding ecological effects of climate change, and also because data on the current and projected future demand for these products is incomplete at the global as well as regional and national levels (FAO, 2005; Easterling *et al.,* 2007).

Climate change has increased frequency and severity of extreme climate events such as heat stress, droughts and flooding in the coming decades (Irland *et al.,* 2001). In particular, it will modify the risks of fires and pest and pathogen outbreaks, with negative consequences for food, fibre and forest production including NTFPs (Easterling *et al.,* 2007). In regions with large forest-dependent populations, particularly in Africa, expected decreases in rainfall, and increased severity and frequency of drought, can be expected to exacerbate current exploitation pressures on forest and expansion of agriculture into forest lands (Arnold and Perez, 2001). In these regions, this can be expected to impose additional stresses on people who depend on fuelwood for their domestic energy needs and other NTFPs for their livelihoods (Arnold and Perez, 2001).

2.5 Climate Change, Vulnerability and Adaptations

Vulnerability is an indication of people's exposure to external risks, shocks and stresses and their ability to cope with, and recover from, the resulting impacts (IPCC, 2007). Vulnerability may differ seasonally or at different times within people's lives (Chia *et al*., 2013). It also differs across groups within communities or individuals within a household, owing to their livelihood activities or social standing. The sustainable management of forests and trees outside forests for NTFPs and benefits presents a range of potential adaptation options, particularly for rural people in developing countries (Arnold and Perez, 2001). Current climate shocks and stresses already have a devastating impact on the vulnerability of the poor (Chia *et al*., 2013). Increasing frequency and intensity of weather-related extremes, and gradual changes in the average temperature will exacerbate these impacts (Basu, 2009). This has implications for the vulnerability of the poor to shocks of all kinds. The poor are often the most exposed to climate variability because of where they live or their livelihood activities (Rosenzweig and Parry, 1994; Parry *et al.*, 1999). Recently, there has been a risk of unprecedented shocks, such as the flooding experienced in East Africa following extended drought (DFID, 2004; Conway, 2008).

According to FAO (2005) smallholder and subsistence farmers and pastoralists in developing countries may not be able to cope with climate change effectively due to their reduced adaptive capacity and higher climate vulnerability. Eastaugh (2008) found that climate change is expected to impact heavily on forest-dwelling communities in developing world with no other source of sustenance. The lack of supportive infrastructure and effective governance system can further increase vulnerability (Adger, 1999; Adger *et al.,* 2003; Brockington, 2007; Chia *et al*., 2013).

2.6 Impacts of Climate Change on Forest Conservation and Genetic Resources

Global climate change may have a serious impact on genetic resources in tropical forest trees which play a critical role in the survival of populations in rapidly changing environments (Bawa and Dayanandan, 1998). Furthermore, most tropical plant species are known to have unique ecological niches, and therefore changes in climate may directly affect the distribution of biomes, ecosystems, and constituent species (Bawa and Dayanandan, 1998). Climate change may also indirectly affect plant genetic resources through effects on phenology, breeding systems, and plant-pollinator and plant seed disperser interactions, and may reduce genetic diversity and reproductive output (Jarvis *et al.,* 2011; Loo *et al.,* 2011). As a consequence, population densities may be reduced leading to reduction in genetic diversity through genetic drift and inbreeding. (Loo *et al.,* 2011). Predictions regarding impacts on forest genetic resources in natural forests, forest plantations and on farms vary. Mátyás (2007) and Rehfeldt *et al*. (2001) predicted that climate change will have severe impacts on forest genetic resources. Climate change impacts are expected to be severe in dry, high-temperature regions where trees are at their adaptive limit (Lindner *et al*., 2010) and in confined islands of moist forest that are surrounded by drier land (Williams *et al*., 2003). Whereas the ranges of some tree species are expected to expand, others will diminish. Thuiller *et al*. (2006) have also shown that tree species richness and functional diversity will be impacted more at low than at high latitudes. In other regions such as the tropics, changes in precipitation rather than temperature may be of key importance (Dawson *et al*., 2011).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Site

3.1.1 Geographical location

The study was conducted in the selected Participatory Forest Management (PFM) forest dependent communities around NDUFR in Kilolo District, Iringa region (Figure 1). The forest reserve is located between latitudes $35^0$54' E and $35^0$57' E and longitudes $8^0$01' S and $8^0$06' S. It covers an area of 3728 ha and is surrounded by six villages namely; Kidabaga, Magome, Isele, Lulanzi, Lusinga and Ilamba. The selected site is within the Eastern Arc Mountains. The choice of the study site was based on the very high levels of species diversity (Lovett and Wasser, 1993) and the high reliance of adjacent communities for livelihood security. Furthermore, the Eastern Arc is currently facing threats due to high pressure from human activities such as fire, illegal logging as well as slash and encroachment which might be obstacles towards the efforts to mitigate climate change impacts in Tanzania (Katoomba Group, 2009).

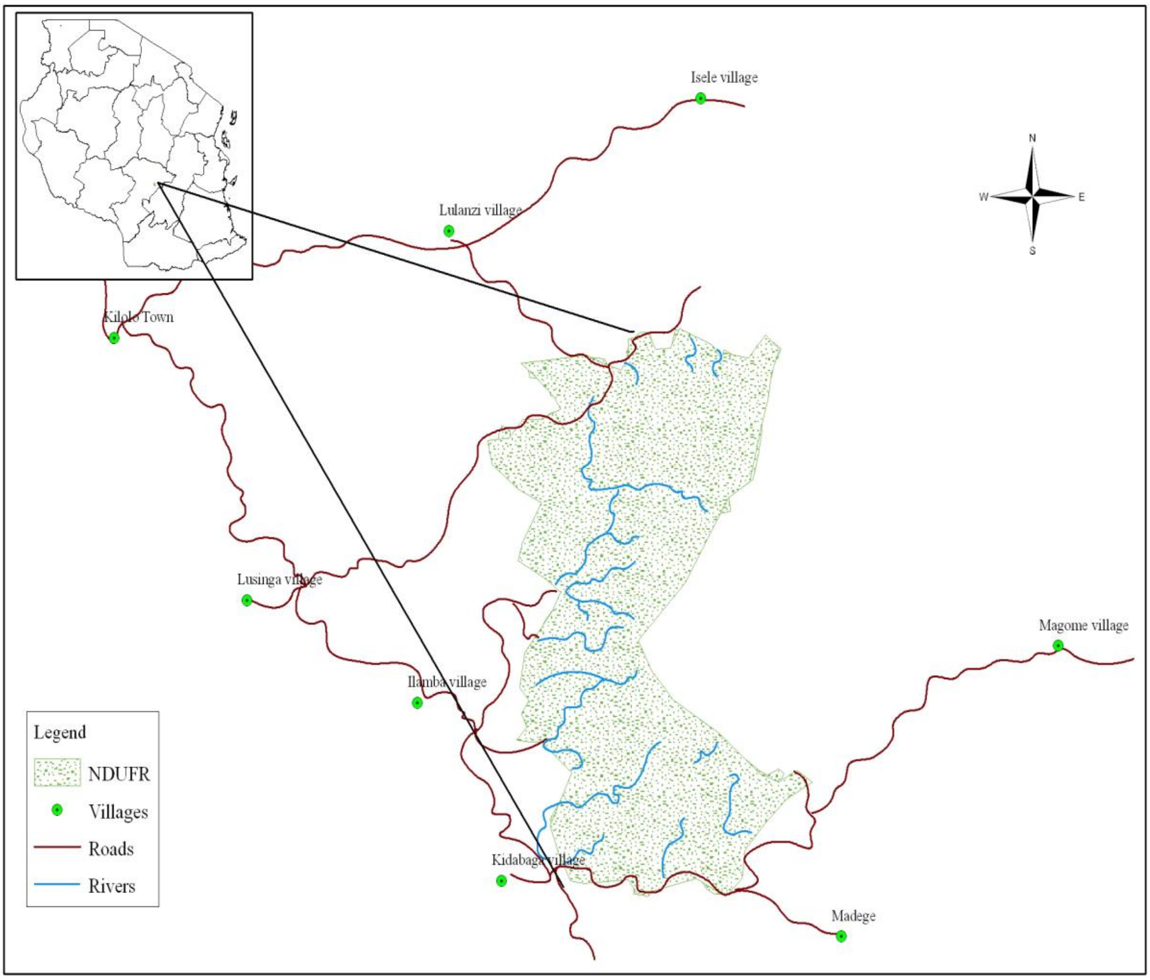

Figure 1: Map of the NDUFR showing surrounding villages

Source: Frontier Tanzania, (2001a)

3.1.2 Climate and vegetation

The area is characterized by oceanic rainfall and temperature. The elevation of NDUFR is between 1740 - 2100 m a.s.l. Estimated rainfall is between 1500-2000 mm/year. The maximum temperature is ~20°C (December) and a minimum is ~15°C (July). The dry season is between June and November. The forests are a mosaic of upper montane and montane forests, with patches of bamboo. Species typical of montane forests occur in the valleys with upper montane species occurring on upper slopes (Lovett *et al.,* 1997; Lovett

1998). The forest is surrounded by grassland fields, small patches of *A. mearnsii*, *Parinari excelsa* as well as *P. patula* and tea plantations (Malimbwi *et al*., 2002).

3.1.4 Soil and topography

Soils of the area like other Eastern Arc Mountain forests are brown sandy loams over crystalline genesis with areas of clay and stones (Lovett *et al.,* 1997). The soils are fertile due to the build-up of nutrients from litter decomposition and protection from erosion and excessive leaching (Malimbwi *et al.,* 2002). Extensive areas of bare rocks covered with lithophytes also occur in the area. There are about eight small streams with their origins in the reserve. These streams are used locally for crop irrigation and general water supply to households.

3.1.5 Socio-economic activities

The main socio-economic activities of local communities adjacent to forest reserve include agriculture, livestock keeping, hunting (outside and inside the forest), and trade in traditional medicine, timber, firewood, building poles, charcoal, ropes and other forest products (Sumbi, 2004). The agricultural crops cultivated include maize, sugar cane, potatoes, tomatoes, legumes, soya, sunflowers, groundnuts and a range of green vegetables. These crops are grown as a monocrop and sometimes intercropped. Common domestic animals in this area include; cattle, goats, poutry, sheep and pigs. In addition, people in this area interact with the NDUFR by collecting various NTFPs like firewood, poles, medicinal plants, wild mushrooms, wild fruits and wild vegetables to supplement their daily livelihoods.

3.2 Data Collection

The study involved both collection of primary and secondary data. Primary data were collected from November 2011 to March 2012 through household interviews, Participatory Rural Appraisal (PRA) techniques and direct field observation. A reconnaissance survey was carried out prior to actual data collection to provide a general picture of the research area, including identifying and meeting various stakeholders around the NDUFR. Reconnaissance survey enabled the researcher to obtain basic information on population size, ethnicity and socio-economic activities of the study area. Ward and village officers were the main sources of general information related to the study area.

Secondary data involved collection of information from different sources like reviewing relevant documents like publications, journals, reports and books. Some information was obtained from Kilolo District Natural Resources Office. The electronic databases such as CD-ROM and website were also explored. Secondary data aimed at reviewing what has been done in relation to the interest of the study, and identify gaps in the information. Climatic data mainly rainfall, temperature, and other natural calamities for 30 years that occurred in the study site was obtained from Nduli Airport (IRI/HTIR) weather station, Iringa Region. Information regarding the study site was also solicited from the Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) that operates in Kilolo District.

3.2.1 Sampling procedure

The actual data collection was preceded by a preliminary survey to determine the total number of sample villages and households required based on the variability of the area. Four villages namely Luhindo, Isele, Ilamba and Kidabaga surrounding the NDUFR were purposively selected. Luhindo and Isele villages are located in the north and Ilamba and Kidabaga villages are located in the south of the NDUFR. This was done in order to gather information from both northern and southern parts of the NDUFR. The selection criterion of the study village was based on its closeness to the forest. A village list of households was established in collaboration with the village leaders. A total of 30 households (15 male and 15 female household heads) in each village were selected for interview based on gender. According to Bailey (1994) regardless of the population size, a sample of 30 cases is the bare minimum for studies in which statistical data analysis is to be performed. The head of household or his/her representative was interviewed using a structured questionnaire (Appendix 1). A household in this case was defined as a group of people who eat from a common pot, sharing the same dwelling and may cultivate the same land (Katani, 1999). Household heads were the key respondents during household survey as they are the decision makers for the households in the utilization of NTFPs (Kajembe, 1994).

3.2.2 Household survey

A household was a sampling unit for this survey. The structured questionnaire with both closed and open-ended questions was used to collect household data (Appendix 1). The questionnaire was designed to permit acquisition of both quantitative and qualitative information. The questions were designed to focus on key issues on socio-economic, variables such as gender, household size, occupation, household income, age, and education level of household head and agricultural production. Also collected data included information on main types of NTFPs collected and utilised in the study area under the current climate change and variability, percerved effects of climate change on local community’s livelihoods and NTFPs, vulnerability and coping strategies/aspects. A pilot study of 10 households was conducted prior to the questionnaire survey to check reliability and validity of the information. This was essential in order to take into account ambiguity of some of the questionnaire items (Mettrick, 1993).

3.2.3 Participatory Rural Appraisal (PRA) techniques

PRA is an exploratory method that aims at having a dialogue with stakeholders and getting information from them through participatory communication and analytical method (Duangsa, 1996). The participatory tools and techniques for assessing climate change impacts and exploring adaptation options by Regmi *et al*. (2010) were modified and adopted for use during the exercise. The tools used in the study were resource mapping to map local climatic hazards; free listing of NTFPs; matrix scoring; climatic hazard trend analysis to gain insight into past hazards; climatic hazard ranking to compare and contrast the impact of major climatic hazards on the social group; vulnerability assessment; coping and adaptation strategies to assess the effectiveness of the current coping strategies (Appendix 2).

3.2.4 Transect walk

Transect walks was conducted to verify the identification of NTFPs in the area (Appendix 3). In each village, two transects of 3km each from the edge of the forest towards the center were carried out. Distance from one transect to the next was 2 km. The first plot was established randomly, followed by systematic sampling where the distance from one plot to another was 500m. The square sample plots of 15 m x 15 m were adopted because they are easy to layout. The study by Hamza *et al.* (2004) used similar sample plots design in Mgori Forest Reserve in Singida Rural District, Tanzania. The square plot design is also recommended in the guideline for Participatory Forest Resource Assessment and Management Planning (MNRT, 2005). A total of 48 sample plots were established and existing NTFPs assessed and recorded. People with long experience in utilization of particular NTFPs were asked to identify plant species and provide information on the use and quantity which can be harvested from each plant. Identification of plant and animal species were in vernacular names and later were translated into botanical names.

3.2.5 Key informants interviews

While the group meetings can provide details on the broad context for local circumstances and practices, there are frequently particular individuals who for whatever reason have acquired significant knowledge about specific issues (Katani, 1999). These individuals come from a variety of segments of society, including farmers, elders and priests. What sets them apart as key informants is that they are recognized by others in their community as being particularly knowledgeable about the area. For the purposes of the study, Forest Officers, Village Natural Resource Committees (VNRC), village leaders and knowledgeable elders in the villages were interviewed (Appendix 4).

3.2.6 Focused group discussions

Focused group discussions (Appendix 5) were employed to encourage collective response of the link between climate change and variability and the livelihood. The focused group discussions were comprised of 10-15 men and women with knowledge and experience on the climate change issues dominantly those with more than 30 years. This assisted to gather information on the link between NTFPs and livelihood, the impact of climate change, current hazards and coping strategies. Also, livelihood context information especially how resources are affected by hazard and coping strategies was obtained by focus group discussions. This social science tool helped to triangulate the information collected through semi-structured questionnaires.

3.3 Data Analysis

Data were analysed qualitatively and quantitatively to ensure their consistence and a better understanding of the existing NTFPs under current climate change and variability. Statistical Package for Social Sciences (SPSS) and Excel spreadsheet computer packages tools were used for statistical analysis.

3.3.1 Qualitative data analysis

Data collected through PRA were analysed with the help of communities in the study area and the results communicated back to them for verification. Content and structural functional analyses were used to analyse qualitative data and information. The components of verbal discussion were analysed in details with the help of content analysis method. The recorded conversations with respondents were broken down into smallest meaningful units of information to ascertain values and attitudes of the respondents. Kajembe (1994) stated that structural functional analysis seeks to explain social facts, related to each other within the social system and by manner in which they are related to the physical surrounding. The Community-based Risk Screening Tool for Adaptation and Livelihoods (CRiSTAL 3.0) was used to synthesize information from focus group discussion on the link between climate change, NTFPs and livelihoods. This provides a holistic picture of the current climate hazards and impacts on local livelihoods and ascertains values and attitude of respondents.

3.3.2 Quantitative data analysis

Data collected through questionnaire were coded to facilitate data entry in the computer. Systematic organization of data into categories and in this case numerical codes are assigned to responses (Babbie, 1995). Data collected through structured and semi structured questionnaire were analysed using Statistical Package for Social Sciences (SPSS) to obtain descriptive statistics such as percentages of responses, frequencies, and means, and the results were used for construction of tables. Moreover inferential analysis were carried out to find relationships between some variables and to provide an idea about whether the patterns described in the samples were likely to apply in the population from which the samples were drawn (Kajembe, 1994). In this regard, cross tabulation was applied to show the relationship between local peoples' perception on the impacts of climate change/variability and socio-economic factors. Chi-square test was used for the significant in dependency on local peoples' perception on the impacts of climate change/variability and socio economic factors. Microsoft Excel software tool was used to analyze quantitative data from questionnaires and meteorological data to generate the climatic change trend (annual means of temperature, and total annual rainfalls) of the study site from 1980 to 2010. Also, the relative frequency of the existing NTFPs recorded during transect were calculated using Microsoft Excel software tool (Appendix 5). Logistic regression models were developed and used to explain the relationships between dependent and independent variables. In this study, a number of explanatory variables were used in explaining the response of local peoples' perception on the impacts of climate change/variability and socio economic factors in the study area. Most vernacular names of all species recorded in the NDUFR were originated from Hehe and Bena tribes. Identification of plant and animal species were in vernacular names and later were translated into botanical names at the Tanzania Forestry Research Institute herbarium in Morogoro.

The following logistic regression model by Obua *et al.* (1998) was adopted:

$Yi = ß_0 + ßX_1 + ßX_2 + \ldots\ldots\ldots\ldots + ß_kX_k + e$ ....Equetion (i)

Yi = dependent variable (Perceptions on climate change and variability)

X_1 to X_k = independent variables (Gender, marital status, age, residence, education and occupation)

i = 1, 2, 3, …………. k, where k is a total number of variables

$ß_0$ = the constant term of the model without the independent variable

$ß_0 + ß_k$ = Independent variables coefficients estimates from data showing marginal effect (whether negative or positive) of the unit change in the independent variables on the dependent variable

e = a natural logarithm base approximately 2.718

The assessment of goodness of fit of the regression model to variables tested was done by using the model chi-square at 5% probability level of significance. The chi-square indicates how good independent variables influenced the outcome of dependent variable while the -2log likelihood shows whether the model fits reasonably good and at the same time the higher overall percentage of correct predictions imply the better the model. The said parameters above were observed in testing and concluding on the goodness of fit of the model to tested variables.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characteristics of the Respondents

The respondents' sex, tribe, education level, residence, marital status, household size, age and occupation were used as parameters to describe respondents' characteristics as discussed below. A total of 120 respondents were interviewed in four villages namely Lulanzi, Isele, Ilamba and Kidabaga. About 52.5% of the respondents were males and 47.5% were females. Chi-square tests showed no significant difference in sex at 5% level of probability (Chi square value = 0.30, df = 1, p = 0.584). This suggests that males and females were equally represented during the surveys. This was done purposively in order to get different views about climate change and variability adaptations based on the use of NTFPs by gender. Women formed about 61.5% of all people who were actively engaged in NTFPs activities. The results were in agreement with the findings of Katani (1999) that women were extensively involved in several forest based gathering and processing enterprises contrary to the assumption that they are greatly involved in subsistence activities.

It was also noted that women were more active in forest-based activities undertaken near homesteads such as firewood, food and medicine collection. This is because the activities can be combined with domestic responsibilities. In general, differences in gender roles in the use of NTFPs were based on the way a particular product contributes to household food security. Women were actively engaged in NTFPs contributing directly to food security. For example, women were more active in mushroom, vegetable, and fuelwood collection while men were more active in poles, honey and beeswax collections from the forest. Makonda (1997) reported similar observations in roles distribution for NTFPs activities according to gender in Geita District, Mwanza Region.

The results revealed that 76% of the respondents had primary school education, 11% had no formal education, 9% had adult education, and 4% had secondary education. The chi-square test indicated significant difference in education level in four villages (chi-square value = 166.53, df = 3, p = 0.001). Education is necessary to enable someone to easily adopt and transform with new technologies in coping with climate change. According to Abdallah (2001), educated people stand a good chance of adopting new technologies in coping with climate change. Education increases working efficiency and productivity, making households with more educated individuals benefit more from generation of income (Mhinte, 2000). It was revealed that 51% of the respondents had lived in the area between 30 and 55 years. About 26% and 23% of them had lived in the area for more than 55 years and less than 30 years respectively. The chi-square test indicated significant difference in residence duration around the NDUFR (chi-square value = 16.65, df = 2, p = 0.001). This implies that the respondents have accumulated a lot of experience and knowledge on availability, values and sources of different NTFPs, climate change and variability in the study area. It was clear that increase in years of staying in the village increased knowledge on NTFPs.

Respondents were categorized into three age groups namely 18 - 30, 30 - 60 and greater than 60. It was done in order to obtain different views on climate change and variability in different age groups. Majority (73%) of the respondents were aged between 30 and 60 years old. Only 5.8% of the respondents were less than 30 years while 22% were older than 60 years old (Figure 2). The chi-square test indicated significant difference in age groups of the respondents (chi-square value = 87.35, df = 2, p = 0.001). This implies that older people have accumulated experience compared to young people living around NDUFR.

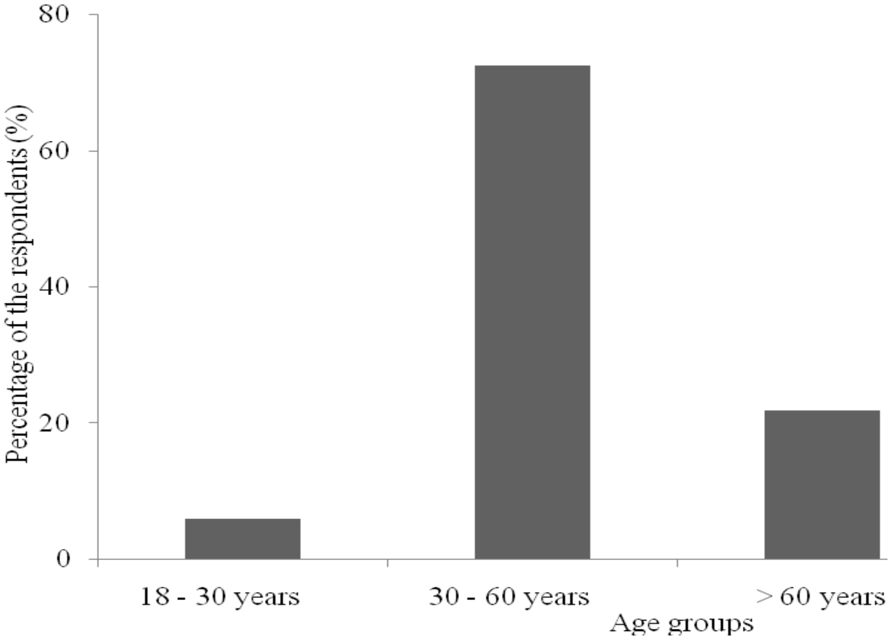

Figure 2: Age distribution of the respondents living around the NDUFR

The majority of the respondents interviewed (82%) were married, 13.3% were widowed, 3% were single and only 2% were divorced. The chi-square test indicated significant ($p<0.05$) difference in marital status (chi-square value = 209.33, df = 3, p = 0.001). Marital status influences decision making at the household level, including the use of NTFPs (Ongugo *et al.,* 1996). Understanding the distribution of marital status of respondent is important for assessing management and utilization of forest resources (Sherbinin *et al.,* 2008).

The main ethnic groups of the respondents were Hehe followed by Bena (Figure 3). The chi-square test indicated significant ($p<0.05$) difference in ethnic groups of the respondents (chi-square value = 134.15, df = 2, p = 0.001). About 73%, 21% and 6% of the respondents were from households of people between 3 and 5, more than 5 and less than 3 people respectively. The chi-square test indicated significant ($p<0.05$) difference in the household size of the respondents (chi-square value = 90.45, df = 2, p = 0.001).

The size of the family in the study area was between 1 to 9 people, with an average of 5 members per household. This is similar to the regional household size, which is estimated at an average of 5 people per household (NBS, 2004). Household size has an important socio - economic implication in household`s ability to improve its livelihood. A large household size implies more mouths to feed and share the household budget, but on the other hand it implies more availability of labour for collecting, processing and marketing of NTFPs. For example, Nyingili (2003) reported that increase in household size significantly increased collection of wild fruits in Mbozi District.

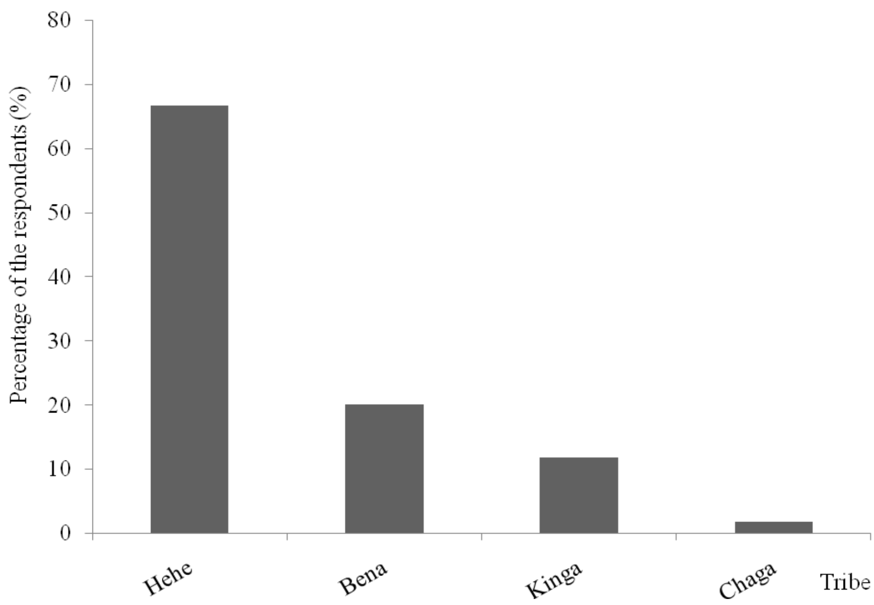

Figure 3: Ethnic groups of the respondents around NDUFR

4.2 Household Occupation

The results revealed that 88% of the respondents were farmers, 10% were employed and only 23% were involved in small business. The chi-square test indicated significant ($p<0.05$) difference in the main occupation of the respondents (chi-square value = 134.8, df = 2, p = 0.001). It was learnt that majority of the interviewees were engaged in the collection of NTFPs both from the forest (57%) and farmlands (43%). The respondents in the study villages were obseved to depend on farming, livestock keeping, selling forest products, employement in forest plantations or government offices and small enterprises. This implied that local people are being involved in NTFPs activities simply because they are of great value to them in terms of food, health as well as cash. The average distance from the house to the NDUFR was 4.6 km. It was observed that the respondents leaving closer to the forest (less than 3.5 km) depend much on forests for social and economic benefits. Lema (2003) reported that people leaving nearest to the forest will inevitably depend much on these forests for NTFPs for their daily use. The author pointed out that decrease in the distance from the forest results in the increase of extraction of NTFPs.

4.3 Identified and used NTFPs from the NDUFR

The results showed that local people extracted ten (10) different categories of NTFPs from the NDUFR. These included medicinal plants, wild vegetables, poles, woodfuel, ropes, shrubs and grasses, honey, bush meat, wild mushrooms and wild fruits. It was learned that most of the NTFPs were abundant during rainy season. Local people extracted NTFPs primarily for meeting household needs, as well as for earning additional income to support or supplement their livelihoods. NTFPs harvested from the NDUFR have been classified according to the benefits identified by the respondents including direct and indirect benefits. Direct benefits included human food, animal feed, medicinal plants, and grasses, building poles, woodfuel and ropes. It was learnt that local people are required to obtain permits from the village natural resources committees to collect different NTFPs from the forest. NDUFR has been providing regulated non-timber forest products and local communities have benefited from NTFPs (Sumbi, 2004). Indirect benefits include environmental conservation and watershed protection.

A total of 107 plant species and 16 wild animal species were identified to be harvested by residents around the NDUFR as NTFPs (Appendix 6). It was observed that *Albizia gummifera* was the most encountered NTFPs in the NDUFR with the relative frequency of 17.95. It was reported that extracts from the crushed pods of *A.gummifera* are taken for stomach pains and the bark decoction for malaria. *Parinari excelsa, Ocotea usambarensis* and *Teclea nobilis* had the relative frequencies of 6.45, 5.34 and 5.26 respectively. The least common NTFPs were *Syzigium cordatum, Rapanea melanophloeos, Prunus africana, Olinia rochetiana,* and *Myrica salicifolia* (Appendix 7). The results also showed that the NDUFR is very rich in diversity of NTFPs and local people living in the area are knowledgeable on different plant and animal species found in the forest. Similar results have been reported by different researchers in the country. Kilonzo (2009) identified a total of 60 plant species and 16 animal species in Nyanganye Forest Reserve. Shangali *et al.* (1998) recorded 489 plant species from 107 families in Udzungwa Scarp Forest Reserve. Msuya (1998) identified 242 wild plants used as NTFPs representing 73 plant families from West Usambara Mountain. A study conducted by Temu and Andrew (2008) identified 108 plant species used as NTFPs in the Uluguru Mountans.

4.4 Direct Benefits

4.4.1 Wild vegetables

The Majority of respondents (82%) around NDUFR admitted to harvest and use 8 types of wild vegetables. These included *Faurea saligna, Sonchus schweinfurthii, Solanum nigrum,* *Amaranthus spinosus, Caylusea abyssinica, Basella rubra, Oxygonum sinuatum* and *Cleomea hirta*. It was learnt that harvested wild vegetables were used either fresh or dried for future consumption. It was also observed that wild vegetables were mostly utilized during the rainy season (January to April) when plants sprout and produce tender leaves. Vainio-matilla (1999) identified 73 wild vegetables in West and East Usambara. Msuya *et al.* (2010) identified 34 and 25 wild vegetables in Uluguru North Mountains and West Usambara Mountains respectively. The authors reported that wild vegetables are consumed and preferred because they are easily obtainable and available all the year. Lema (2003) found that a total of 23 plant species in Morogoro Rural District were used as wild vegetables. Wild green leafy vegetables are an essential part of diet, which accounted for 81.2 % of all side dishes in West Usambara, Tanzania (Kajembe *et al.,* 2000). The probable explanation for the few species identified in the NDUFR could be the low knowledge on utilization of wild vegetables. Moreover, the collection of wild vegetables and other NTFPs from the NDUFR was through the permit from the village government and it was under restrictions.

4.4.2 Wild fruits

Fruits are major source of proteins, vitamins, minerals, fats and roughages (FAO, 1992). The majority of respondents (72%) admitted to harvest 11 different types of wild fruits from the NDUFR (Table 1). They reported that wild fruits are important food supplement in the village because they play an important role in human nutrition for the members of the family. The study revealed that local people mostly consume the wild fruits when walking through the forest while few fruits were harvested for sale. The study revealed wild fruits were consumed either fresh or dried for future consumption or for sale.

Table 1: List of identified wild fruits harvested from the NDUFR

	Vernacular name	Scientific name	Growth form	Availability
1	Mtowo	*Azanza garckeana*	Tree	Dry season
2	Mwitsa	*Bridelia micrantha*	Tree	Wet season
3	Muholo	*Canthium oligocarpum*	Tree	Wet season
4	Mfusta	*Myrianthus arborea*	Tree	Wet season
5	Msaula	*Parinari excels*	Tree	Dry season
6	Kitunumbi	*Rhus sp.*	Shrub	whole year
7	Muvengi	*Syzigium cordatum*	Tree	Dry season
8	Msambalawe	*Vangueria volensii*	Tree	Dry season
9	Lwizana	*Saba comorensis*	Tree	Dry season
10	Msada	*Vangueria infausta*	Tree	Dry season
11	Mfwifwi	*Psorospermum febrigugum*	Shrub	Wet season

A study by Sumbi (2004) found that about 25% of the respondents admitted to harvest wild fruits from Udzungwa Mountain Forest. Hamza and Msalilwa (2004) identified about 8 species of wild fruits in Mgori Forest Reserve, Singida Rural District while Nyingili (2003) identified 33 species of wild fruits in Mbozi District. The difference might be caused by low diversity of fruit species in the NDUFR and low knowledge on edibility of wild fruits of the people around the forest. Sumbi (2004) found that increased diversity of wild plants increases the supply of forest-based products including non-timber forest products such as wild fruits thereby increasing food security of the households. Increased food security means improved local livelihoods and hence sustainable development at the local level. Forest products collected for commercial purposes increase household income, which in turn increases diversification of economy and hence increase households' income (Cavendish, 1998).

4.4.3 Wild mushrooms

Mushrooms were identified as key and rare NTFPs in the study area. Majority of the respondents (83%) admitted to harvest and consume mushrooms during the wet season. A total of 10 mushroom species harvested from the forest were listed during PRA (Table 2). This implies the NDUFR is rich in wild mushroom species and people were knowledgeable on edible mushroom species found in the forest.

Table 2: List of identified mushrooms harvested from the NDUFR

	Vernacular name	**Scientific name**	**Availability**
1	Wisiga	*Lactarius kabansus*	Wet season
2	Winyamikwee	*Cantharellus isbellinus*	Wet season
3	Kichuguu	*Lactarius edulis*	Wet season
4	Wilelema	*Amanita loosii*	Wet season
5	Nguyugu	*Amanita masasiensis*	Dry season
6	Wisogoro	*Cantharellus platyhullus*	Wet season
7	Winyafigulu	*Termitomyces letestui*	Wet season
8	Wisogoro	*Cantharelus platyphyllus*	Wet season
9	Litelali	Unidentified	Wet season
10	Unyafigulu	Unidentified	Wet season

Mushrooms can be consumed either fresh or dried for future use. The results of this study suggested that only 24% of the respondents agreed to dry and preserve mushrooms for later use especially in the dry season. Frontier Tanzania (2001b) and Sumbi (2004) found that local people living around the NDUFR harvest mushrooms for household use and sale. Similar results have been reported where Harknen and Vainio-Mattila (1998) identified 28 different types of wild mushrooms in West and East Usambara. Paulo (2007) found that a total of 21 mushroom species were utilized by people in Kilwa District. The possible explanations for the differences in species could be due to lack of mushroom market in the villages bordering NDUFR and perhaps feeding habits which do not favour the use of mushrooms.

4.4.4 Bush meat

A total of 16 edible wild animals were mentioned to be harvested from in the NDUFR (Table 3). It was learnt that local people hunt game meat mainly for food and sale. Sumbi (2004) found that live animals were trapped for tourism and for medicinal purposes in the Udzungwa Mountains forests. Fresh dung and droppings encountered during transect walk confirmed the presence wild animals mainly Dik dik, African hare, Bush pig and Stone hyrax. Nielsen (2006) found that a total of 14 different animal species were commonly used by the local communities in the NDUFR. The author found that the most hunted wild animals were Blue duiker, Harvey's duiker, Abbot's duiker, Bush pig, Hyrax and Giant pouched rat. Similarly, Hamza (1997) reported that wild animals such as birds and their eggs, insects, rodents and large animals are important source of protein for people living close to the forest by providing animal protein.

Table 3: List of reported and identified wild animals commonly hunted for bush meat in the NDUFR

	Vernacular name	**English name**	**Scientific name**	**Family**
1	Nungunungu	Porcupine	*Atherurus africanus*	Hystricidae
2	Funo	Blue duiker	*Cephalophus monticla*	Bovidae
3	Vinde	Abbot duiker	*Cephalophus spadix*	Bovidae
4	Ndumbili	Velvet monkey	*Cercopithecus aethiops*	Cercopithecidae
5	Ngedele	Sykes monkey	*Chlorocebus pygerythrus*	Cercopithecidae
6	Kimuhili	Elephant shrew	*Elephantulus brachyrhynchus*	Macroscelididae
7	Ngukilo	Mongoose	*Helogale parvula*	Eupleridae
8	Kivangusele	Zorilla (polecat)	*Ictonyx striatus*	Mustelidae
9	Kisungura	African hare	*Lepus canensis*	Heporidae
10	Kiswagala	Sable	*Martes zibellina*	Mustelidae
11	Digidigi	Dik dik	*Modaqua kirkii*	Bovidae
12	Ngubi	Bush pig	*Patamochoerus africanus*	Suidae
13	Ngubi	Warthog	*Phacochoerus africanus*	Suidae
14	Ng'uluva	Iringa red colobus	*Procolobus sp.*	Cercopithecidae
15	Kipwege	Bush baby	*Galago sp.*	Galagidae
16	Mimbi	Stone hyrax	*Heterohyrax brucei*	Procaviidae

Even though majority of the respondents denied trapping wild animals, on average about 4 traps per km were recovered during transect walk (Plate 1). A study conducted by Frontier

Tanzania (2001a) recovered 5 traps per km in the NDUFR. The main hunters of wild animals were men and most of them were reluctant to respond on issues related to hunting because they knew hunting was illegal. However most of them admitted to use bush meat through purchasing from illegal hunters. This implies that illegal entry into the forest and harvest of NTFPs is still ongoing and total protection is not there. The low utilization of bush meat might be caused by restrictions in hunting.

Plate 1: A trap and the trapped Velvet monkey as encountered in the NDUFR

4.4.5 Honey

About 76% of the respondents reported to utilize honey either as food or as medicine. It was revealed that on average about 7.5 kg of honey was consumed per household per year. It was consumed as jam or as a side dish in order to increase palatability of the meal. These results are similar with those reported by Nyingili (2003) who observed 7 kg of honey consumed per household per year in Mbozi District. The study also revealed that honey harvest and beeswax processing was done by men, due to the fact that in most cases are involved in products that can bring cash while women were involved in harvesting NTFPs for direct consumption. Kagya (2002) reported similar findings that male were responsible for trapping of wild animals and honey while women were largely involved in collection of wild vegetables and mushrooms which were for direct consumption in Morogoro Rural District and Meatu District respectively. In Cameroon, Perez *et al*. (1999) found that male traders concentrated on the largest, most lucrative products, while women tend to deal with less attractive commodities. It was learnt that beekeeping was not a common practice in the study area because only 9% of the men interviewed were involved in beekeeping. However, about 8 tradition beehives were encountered hanged in trees during transect walk in the forest (Plate 2). Also, honey was harvested from natural holes in the forest. It was learnt that honey was harvested once per a year particularly at the end of flowering season.

Plate 2: Traditional beehive hanging in a tree as encounter during transect walk

4.4.6. Grass

A total of 10 grass species were recorded and identified to be used for different purposes in the NDUFR. The main uses included weaving basket and mattress, fodder and roofing. Fodder and thatching grasses are also some of the benefits received by local communities from the forest reserve. Sumbi (2004) reported that local people around the NDUFR collect shrubs and grasses for household use and sale. Veltheim and Kijazi (2002) reported similar findings that local people illegally graze animals inside the reserve as well as fodder and roofing grass from East Usambara Forest Reserve. About 67% of the respondents admitted to obtain shrubs/grasses from the forest reserve. It was observed that Sedge (*Cyperus papyrus*), *Sesamum calycinum*, *Hyphaene compressa* and *Mwinyi* were the four main plant species used for weaving. *Cyperus sp.*, *Dactyloctenium aegyptica, Aerva leucura* and *Lukegeta* were mainly used for roofing. *Dolichos trilobus* and *Lugoka* were mainly used as animal feeds. Kagya (2002) identified about 7 species of grasses in Meatu District. Similarly, Lema (2003) identified 5 species of grasses in Morogoro Rural District been used as NTFPs. The results are more than those reported by Kagya (2002) and Lema (2003) who identified 5 species of grass in Morogoro Rural District. This implies that the people in the study area might be more knowledgeable on the species of grass than those in Morogoro Rural District.

4.4.7 Ropes

About 34% of the respondents admitted to use ropes (climbers) for various purposes including hanging beehives, house construction, tying firewood, bed weaving and making baskets. Veltheim and Kijazi (2002) reported similar benefits to local communities in Eastern Usambara Catchment. This study identified that *Hibiscus diversifolius, Erythrococca kirkii*, *Heliotropium zeyleanicum*, *Plectranthus sp* and *Nyegeta* were the five main plants species used for making ropes around the NDUFR (Table 4). The number of species identified was less than those reported by Kilonzo (2009) who identified 10 plant species used as ropes in Nyanganye Forest Reserve. This implies that Nyanganye Forest Reserve is richer in plant species used as ropes compared to the NDUFR or that people in the study area might be less knowledgeable on the plant species used for ropes than those in Nyanganye Forest Reserve. However, the author found that extraction of ropes undermines ecosytem resilience because saplings are easily debarkable which scales down regenaration.

Table 4: List of NTFPs commonly used for making ropes in the NDUFR

	Vernacular name	**Scientific name**	**Growth form**	**Parts used**	**Availability**
2	Nyakibiki	*Erythrococca kirkii*	Climber	Stem bark	Wet season
1	Muhang'ana	*Hibiscus diversifolius*	Shrub	Stem bark	Whole year
4	Lwisenga	*Heliotropium zeyleanicum*	Climber	Stem bark	Whole year
3	Lufufugala	*Plectranthus sp*	Climber	Stem bark	Wet season
5	Nyegeta	Unidentified	Climber	Stem bark	Wet season

4.4.8 Medicinal plants

This study recorded and identified a total of 55 plant species including trees, shrubs and grasses that are used by local people for medicinal purposes (Appendix 8). A study conducted by Abdallah (2007) identified a total of 45 medicinal plant species in the NDUFR. Ruffo *et al.* (1989) documented about 185 species used for medicinal purposes in East Usambara. This suggests that people living in East Usambara probably have more knowledge about medicinal plants compared to people living around the NDUFR. About 78% of the respondents admitted that they prefer traditional medicine to manufactured medicines. The main reason cited was the availability, effectiveness and low cost of the traditional medicines. The main diseases cured included stomachache, chest ache, fever, colds, allergic reaction and various infections, swelling of breasts, and convulsions. The results further revealed that 86 % of respondents were able to mention more than 25 different plant medicinal species. This indicates that respondents around the NDUFR were knowledgeable about medicinal plants, which contribute to the primary health care of their families. The findings are similar to those reported by FAO (1995) that indigenous people have developed interesting and often sophisticated knowledge systems about the use of a vast variety of plants for medicinal purposes.

Tradition medicine was also reported to be practiced in witchcraft. A study by Frontier (2001b) found that some medicinal plants are only found inside the NDUFR. Minja (1994) listed 20 plant species found in the Udzungwa Mountain Forests which are used as medicine to treat various diseases. Similar results have been reported by different researchers. For example, Augustino and Gillah (2005) identified 72 and 52 medicinal plants in Morogoro Rural and Iringa Regions respectively. A study by Medius (1998) identified a total of 295 medicinal plants in Bwindi Forest, Uganda. The discrepancy in numbers of recorded medicinal plants in this study might be caused by low knowledge of collectors. For example, they might be knowledgeable in few medicinal plants they use more frequently in their villages but the forest might have more medicinal plants than the number reported in this study.

The results revealed that majority of the medicinal plants are readily available throughout the year because most of them are perennial plants. It was learnt that traditional healers are required to obtain a permit to harvest medicinal plants. The results revealed further that roots, bark and leaves were the most common plant parts used as medicine. During transect walk, it was observed that debarking of tree species mainly *Parinari excelsa,* *Ocotea usambarensis, Olinia rochetiana, Bersama abyssinica,* and *Bridelia micrantha* were the most common in the NDUFR (Plate 3). Roots, bark and leaves were most commonly used plant parts (Frontiers, 2001b). Roots and barks harvesting may result in death of plant which was also observed during transect walk. Similarly, Sumbi (2004) reported that harvesting of traditional medicine for treatment and trade had negative impact on the forest. Peters (1994) observed that bark and root collection almost always kills the plants.

Plate 3: Debarked trees used for medicinal purposes as encountered in the NDUFR during transect walk

4.4.9 Woodfuel

Woodfuel comprises of charcoal and firewood. This study revealed that about 98% of the respondents use firewood as the main source of energy. It was observed that dead woods or some tree parts were collected for fuelwood for supply of domestic energy. A total of

34 tree plant species were recorded to be used for woodfuel (Appendix 9). The number of tree species observed in this study was similar to that reported by Lema (2003) in Morogoro Rural District. Bahru *et al.* (2012) recorded a total of total of 102 plant species used for charcoal and/or firewood production in semi-arid Awash National Park, Ethiopia.

About 8% of the respondents admitted to have gathered firewood from the NDUFR. The low number of respondents admitted to obtain firewood from the forest was due to the fact that people in the study area rely on their own plantations as the main source of woodfuel. The majority of the respondents (92%) living around the NDUFR mentioned plantations to be their main source of firewood. It was learnt that the *Acacia mearnsii* (*Black wattle),* *Eucalyptus saligna* and *Pinus patula* were the three most preferred tree species used as the main source of woodfuel obtained from respondents' own plantations. It was clear that most of the forest tree species can be used as firewood. Majority of the respondents mentioned that the harder the wood the better the species. Hardwood tree species are however more likely to be extracted for this purpose. About 28% of the respondents admitted to be engaged in charcoal production that was sold in the area and *A. mearnsii* was the most preferred tree for charcoal production because it was easily availability.

4.4.10 Poles

Poles extraction was not common in the NDUFR because most of the poles used were obtained from *A. mearnsii*, *E. saligna* and *P. patula* plantations. The results revealed that about 36 tree species could be used as poles from the NDUFR (Appendix 10). Poles were mainly used for house construction, livestock house construction, business huts and making traditional beds and tool handles. Veltheim and Kijazi (2002) found that local people living around East Usambara Forest Reserve cut different sizes of construction poles for household use and sale. It was revealed that local people prefer to obtain poles from the forest because they are hardwood suitable for making tool handles. The most preferred plant species included *Teclea nobilis*, *Nuxia congesta*, *Prunus africana*, *Zanthoxylum gillettii*, *Albizia gummifera*, *Bridelia micrantha*, *Podocarpus latifolius* and Mtasamani. The results imply that people around NDUFR were more knowledgeable about plant species used for building poles. The results of this study differ from those reported by Lema (2003), in which only 18 plant species were identified in Morogoro Rural District. The difference might be caused the availability of other building materials and difference in availability of tree species used for poles.

4.5 Indirect Benefits

About 82% of the respondents admitted that the forest provides them with clean water and they believe that the forest was the main source of the rainfall. The NDUFR offers a number of environmental services such as species protection and watershed protection. According to Sunderlin *et al*. (2005) indirect benefits of NTFPs include watershed protection, protection of species and genetic diversity, climate regulations and carbon sequestration, soil protection, recreation and religious values. The forest moderates the water cycle and plays a major role in carbon sequestration. Among the key forest ecosystem services which are expected to be affected by climate change are those related to hydrological regulation and water quality. These include, among others: the regulation of run-off and river discharge; the maintenance or improvement of water quality through forest filtering and retention of freshwater for consumptive use. For example, focused group discussion with key informants revealed that local communities do benefit from improved clear water supply from the forest. In this study, the majority of the respondents revealed that they have free access to the forest for sacred activities such as customs and taboos. This was an important means through which biodiversity was maintained inside the forest.

Munishi *et al.* (2007) argued that traditional institutions are important in natural resources management and play a greater role in regulating access and utilization of various natural resources in a given forest; since they originate from local cultures, have roots in the past and reflect knowledge and experience of the local people. Identification of these institutions can serve as a point of entry in the search for local level and broad based approaches. They include norms, rituals and customs governing protection of resources. Ritual use of forests and trees tend in most cases to be disregarded in classical forest literature (Kajembe, 1994) but indigenous knowledge accompanying this ritual use of forests and trees if studied carefully can be valuable for biodiversity conservation.

4.6 Perceptions on Climate Change and Variability Impacts on NTFPs and Livelihoods

4.6.1 Local perceptions on climate change and variability

The majority of the respondents (81%) agreed that there have been changes in the climate patterns in the area. These findings are similar to the study conducted by Lyimo and Kangalawe (2010) where 90% of the farmers in Shinyanga Rural District acknowledged that there has been a change in climatic condition. Elsewhere in West Africa, Akponikpe *et al.* (2010) reported that about 98% of the respondents who believed that there had been a change in the overall climate pattern.

From this study, the main climatic changes identified by the local people were increase in temperatures and unpredictable rainfalls (71%), increase in temperatures (6%) and Unpredictable rainfall (23%). About 60% of the respondents agreed that climate change was caused by human activities. Others believed that climate change was caused by punishment from God (20%) and both human activities and punishment from God (12%). Only 8% of the respondents were uncertain about the causes of climate change and variability (Table 5). This suggests that local people around NDUFR are aware of the causes of climate change and their impacts on their livelihoods. PRA results found that local peoples' perception on the effects of climate change included increase in temperature, unpredicted rainfall, increased in climatic related diseases and increase in wildfire incidences. The study further revealed that over 50% of the respondents agreed that climate change started between 10 and 20 years ago while the other half believed that climate change started more than 20 years ago. These results are closely related to the findings by Akponikpe *et al*. (2010), where farmers believed that climate change started 15 years ago in Ghana.

Table 5: Local perceptions on the causes of climate change and variability

Cause	**% Response (n)**
Human activities (cutting trees)	60 (72)
Punishment from God	20 (24)
Uncertain	8 (9)
Human activities and punishment from God	12 (15)
Total	**100 (120)**

Note: Figure in the brackets present frequencies of responses and outside brackets present percentages of respondents.

4.6.2 Changes in temperature around the NDUFR

Majority of the respondents agreed that there have been changes in the temperature in the area. About 85% of them reported that there has been an increase in temperature for the more than 20 years ago around the NDUFR (Figure 4). However about 12% of the respondents noticed the contrary, a decrease in temperature. While only 3% believed that there has been no change in the temperature for the last 20 years. Trend analysis of the mean monthly temperature around NDUFR shows an increase in the temperature for the past 30 years (Figure 5). The climatic data records were in line with the people's perceptions.

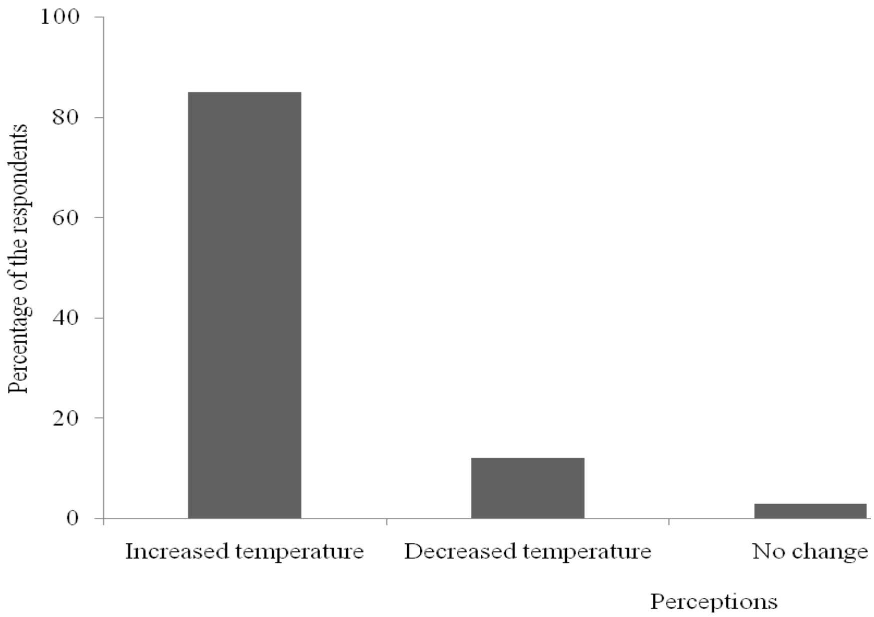

Figure 4: Local perceptions on changes in temperature around the NDUFR

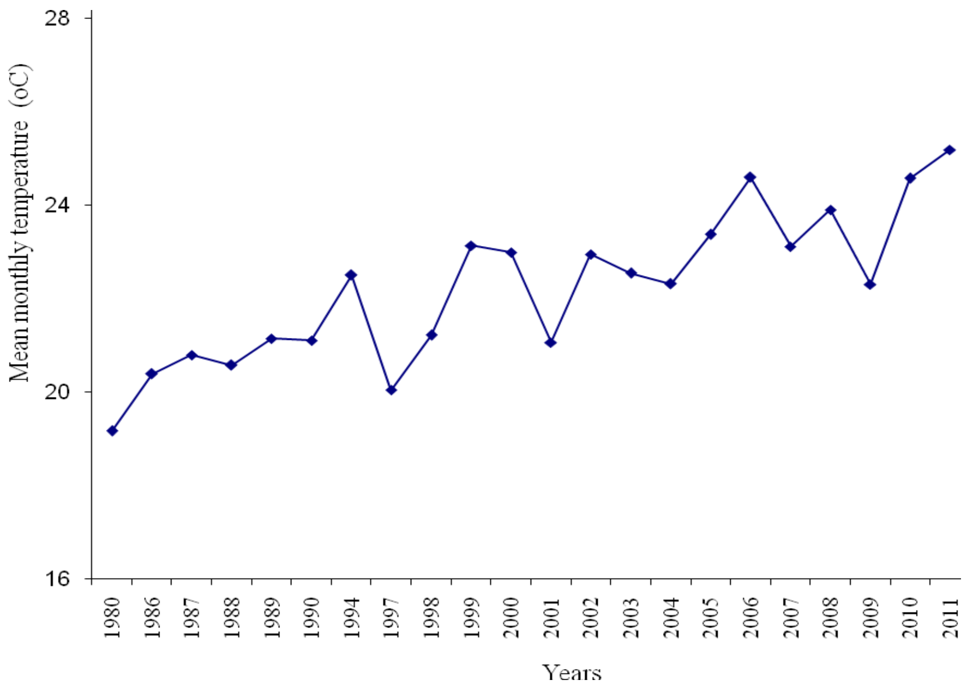

Figure 5: Mean monthly temperature from 1980 to 2011 around the NDUFR

4.6.3 Rainfall changes around the NDUFR

The majority of the respondents (92%) agreed that there have been changes in the rainfall patterns over 20 years. They noticed a change not only in the total amount of rainfall but also in the timing of the rains; with rains coming either earlier or later than expected. But only 8% of the respondents believed that there were no changes in rainfall patterns from the last 30 years. Figure 6 indicates that 74% respondents noticed an increase in the amount of rainfall or a shorter heavy rainy season (unpredicted rainfall). It was further revealed that 19% of the respondents felt that there has been a decrease in the amount of rainfall including dry season starting early and was also longer than usual in the area. However, only 7% believed that there has been no change in annual rainfall for the last 20 years. The trend analysis of the annual rainfall from 1980 to 2011 shows fluctuations with increased annual rainfall (Figure 7). The people's perceptions were in line with the climatic data records.

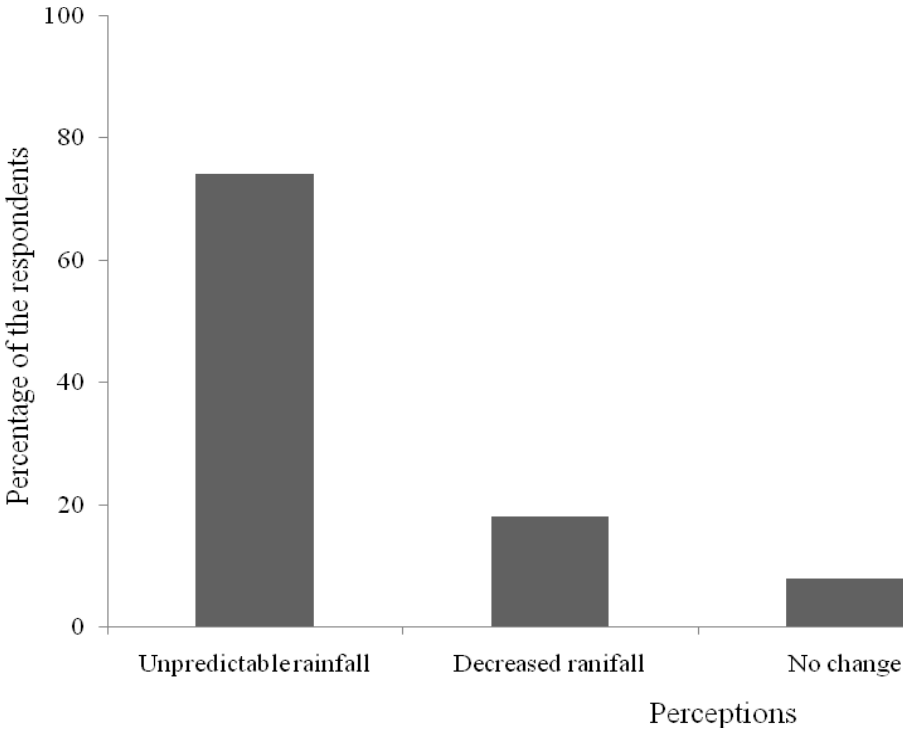

Figure 6: Local perceptions on changes in rainfall patterns around the NDUFR

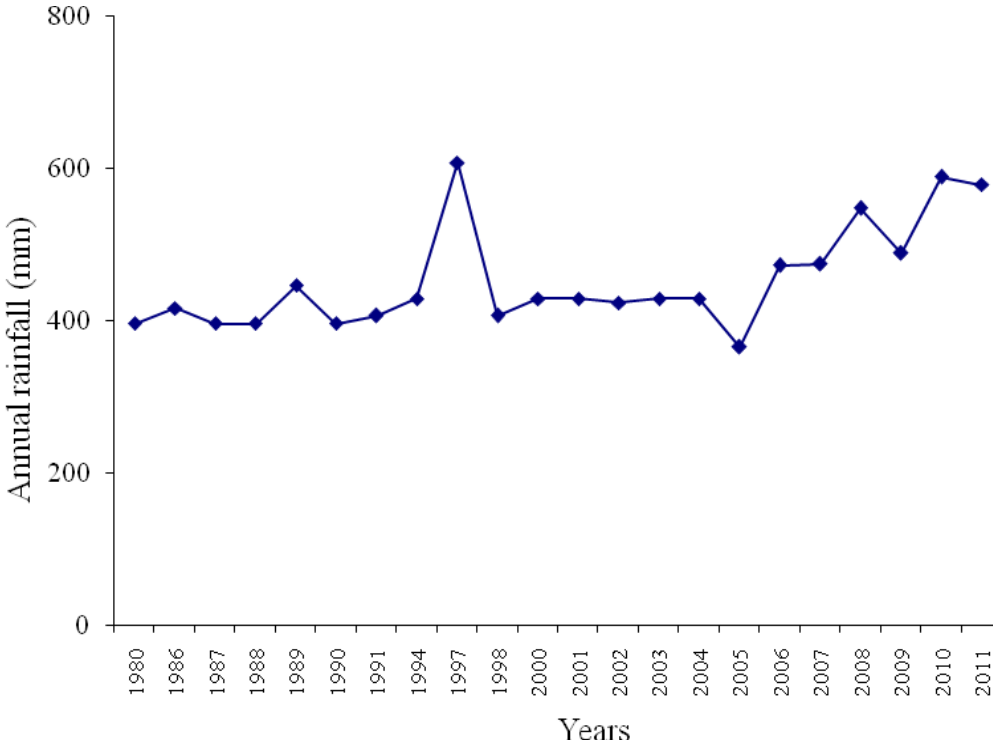

Figure 7: Annual rainfall (mm) patterns from 1980 to 2011 around the NDUFR

4.6.4 Socio-economic factors influencing climate change perceptions

Table 6 shows results of the logistic regression model of peoples' perceptions on climate change and variability. Perceptions on climate change were different from one individual to another and to some extent influenced by a number of socio-economic factors such as gender, marital status, age, education, occupation and residence as presented and discussed in the following sub-sections.

Table 6: Logistic regression model on peoples' perceptions on climate change and variability

Variable	-2 Log Likelihood of Reduced Model	(χ^2)	df	p-value	ß	Exp(ß)	95% Confidence Interval for Exp(ß)	
							Lower	Upper
Gender	39.56	0.05	1	0.821NS	0.08	1.08	0.36	3.27
Marital status	43.04	3.53	3	0.314NS	-0.47	0.62	0.21	1.83
Age	45.63	6.12	2	0.042*	-0.21	0.81	0.27	2.39
Education	62.64	23.12	3	0.000*	-1.54	0.21	0.10	0.45
Occupation	42.44	2.92	2	0.231NS	-0.49	0.61	0.14	2.61
Residence	45.32	5.81	2	0.048*	0.53	1.70	0.78	3.70

NS = Non significant at $p<0.05$, *= Significant at $p<0.05$.

4.6.5 Peoples' perceptions on climate change and variability based on gender

As shown in Table 6, no significant difference (χ^2= 0.05, df = 1, p = 0.821) was observed between gender and their perceptions on climate change and variability in the NDUFR. However, about 48% and 52% of female and male agreed that there have been changes in climate in their area respectively. While only 10% and 9% of female and male respectively believed that there have been no changes in climate in their area.

4.6.6 Peoples' perceptions on climate change and variability based on age

The results suggest that there is significant difference (χ^2= 6.12, df = 2, p = 0.042) between age of the respondents and their perceptions on climate change and variability in the NDUFR. It was learnt that about 60%, 17% and 4% of people aged 30 - 60 years; more than 60 years and 18 - 30 years agreed that there have been changes in climate in their area respectively. This would mean that the elder people have amassed a lot of experience and knowledge on changes in climate and variability in the study area.

4.6.7 Peoples' perceptions on climate change and variability based on occupation

The results revealed that there is no significant difference (χ^2 = 2.92, df = 2, p = 0.231) between occupation of the respondent and perception on climate change in the NDUFR. About 71%, 8% and 2% of farmers, employees and business people admitted to witness changes in climate in the NDUFR. However, about 16%, 2% and 1% of farmers, employees and business people denied witnessing changes in climate in the NDUFR.

4.6.8 Peoples' perceptions on climate change and variability based on residence duration

The results suggest that there is significant difference (χ^2 = 5.81, df = 2, p = 0.048) between residence duration of the respondents and their perceptions on climate change and variability in the NDUFR. It was learnt that about 51%, 26% and 23% had lived in the study area between 30 and 55 years, more that 55 years and less than 30 years respectively. This would mean that the respondents who have lived in the area for a long period of time have accumulated a lot of experience and knowledge on climate change and variability in the study area.

4.7.1 Impacts of climate change and variability on people's livelihoods

As indicated in Table 7, about 43% of the respondents agreed that the most affected activity by climate change and variability was agriculture. Matrix scoring results showed that crop productivity was ranked number one being affected by climate change and variability, followed by health of the people living in the area. Also, results summarized by CRISTAL Model revealed that crop production was mostly influenced by unpredicted rainfall in the NDUFR. Climate change and variability has been reported to affect agriculture, biodiversity, health and infrastructure in Shinyanga Region (Lyimo and Kangalawe, 2010). Lyimo and Kangalawe (2010) found that about 70% of the interviewed households indicated that crop production especially maize was on a decline trend in Shinyanga Region. Similar response was also reported by Senbeta (2009) in West-Arsi Zone, Ethiopia. High sensitivity of agricultural crops to climate change and variability make it vulnerable whenever change occurs. This is caused by unpredicted rainfall mainly short rainy seasons and sometimes rainfall not coming at the expected time compared to previous years. It was revealed that decline in crop yields was also associated with non climatic factors such as decline of soil fertility, pest and diseases and inadequate extension services.

Climate change is believed to exacerbate human and livestock diseases by changing environmental factors that lead to the growth and development of insects transmitting diseases in the NDUFR. It was learnt that about 40% of the respondents agreed there has been an increase in human diseases including malaria, measles and cholera. Results summarized by CRISTAL Model results show that increase in temperature resulted in an increase in plant and human diseases which were not previously pandemic in the area. For example, increase in mosquito results in an increase in malaria incidences compared to the previous years.

PRA results also suggest that there has been an increase in fire incidences in the NDUFR. Increase in wild forest fires threatens the forest ecosystems. Large number of plant and animal species are threatened by extinction, as climate conditions are changing too quickly for them to adapt (Keller, 2009; Berg *et al.,* 2010). During PRA, respondents mentioned that heavy rains and floods that occurred in 1997 and 2010 caused damages to roads, buildings and destroyed plants in the area.

Besides the negative impacts, climate change and variability was noted in some cases to have positive impacts on rural livelihood. About 32% of respondents felt that in previous days it would take about 6 months for maize to mature but now days it takes about 4 months due to increased temperatures. They also pointed out that previous days it was difficult to cultivate certain crops due to cold temperatures but now days they are able to grow different varieties of crops such as bananas and Mangoes.

Table 7: Peoples' response on climate change and variability impacts

Response	**% Response (n)**
Increased human diseases and decreased agricultural crops	43 (52)
Increased human diseases	40 (48)
Increased plant diseases	14 (16)
Increased both plant and animal diseases	3 (4)
Total	**100.0 (120)**

Note: Figure in the brackets present frequencies of responses and outside brackets present percentages of respondents.

4.7.2 Impacts of climate change and variability on NTFPs and services

The results revealed that about 33% of the people interviewed agreed that there has been a decrease in water resources which affects the availability of Sedge (*C. papyrus*). As shown in Table 8, about 28% and 24% of the respondents pointed out that decreased mushrooms and wild vegetables respectively were attributed to changes in climate and variability. Only 15% of the respondents admitted that wild animal populations have decreased due to climate change and variability. It was acknowledged that decrease in wild animal populations was largely attributed by poaching rather than climate change. This was affirmed by the 4 animals trapped per km which were recovered during transect walk in the NDUFR.

Table 8: Responses on climate change and variability impacts on NTFPs

Response	**% Response (n)**
Decrease in water resources and Sedge (*C. papyrus*)	33 (52)
Decrease mushrooms	28 (33)
Decrease in wild animals	15 (6)
Decrease in *B. rubra* and other wild vegetables	24 (29)
Total	**100.0 (120)**

Note: Figure in the brackets present frequencies of responses and outside brackets present percentages of respondents.

The main reasons that make people collect NTFPs included NTFPs being only available in the forest (42%), to increase income (23%), domestic consumption (17%) and both (18 %). It was learnt that the main constraints to expand uses of NTFPs identified by the respondents were some NTFPs are very rare nowdays (42%), permit being expensive (37%) and restriction "strict by-laws" (20%). Forty three percent of the respondents believed that there has been no increase in NTFPs over 30 years. While 33% and 17% of the respondents reported that honey/ beeswax production and ropes have increased over the last 30 years respectively.

4.8 Vulnerability of NTFPs and Forest Dependent Communities to Perceived Climate Variability and Change

4.8.1 Climate change and vulnerability of NTFPs

Matrix scoring revealed that Sedge (*C. papyrus*), mushrooms and wild vegetables were listed to be the most vulnerable NTFPs in terms of its availability to climate change and variability in the NDUFR. *C. papyrus* were ranked number one being the most vulnerable followed by mushrooms and lastly wild vegetables. It was observed that the growth of *C. papyrus*, mushrooms and wild vegetables depend on rainfall and any changes in rainfall will affect their availability. As indicated in Table 9, about 45% of the respondents agreed that mushrooms and *C. papyrus* were the most vulnerable NTFPs in the NDUFR while only 13% felt that mushrooms were the most vulnerable NTFPs.

Table 9: Response on the vulnerability of the major NTFPs

Response	**% Response (n)**
Wild vegetables	19 (23)
Sedge (*C. papyrus*)	23 (27)
Mushrooms	13 (16)
Both mushrooms and Sedge (*C. papyrus*)	45 (54)
Total	**100.0 (120)**

Note: Figure in the brackets present frequencies of responses and outside brackets present percentages of respondents.

4.8.2 Climate change and vulnerability of forest dependent communities

About 57% and 34% of the respondents felt that women and children were the two most vulnerable social groups to climate change and variability respectively (Figure 8). Only 9% of the people interviewed agreed that elders were the most vulnerable group. The main reasons for women's vulnerability to climate change included dependence on rain-fed agriculture (27%), the main food producers and at risky during pregnancy (50%) and easily attacked by malaria (23%). A study by Senbeta (2009) revealed that women were the most vulnerable group to climate change and variability in West-Arsi Zone, Ethiopia. It was observed that women were responsible for feeding the family, confined at home caring for children and family members and play major role in subsistence agricultural production. They were also more vulnerable to malaria cases during pregnancy (Senbeta, 2009). In most households, women were responsible for taking care of their family. Women were also engaged in the collection of NTFPs mainly wild vegetables and mushrooms which were more vulnerable to climate change and variability. About 78% of women interviewed were engaged in the collection of NTFPs such as Sedge (*C. papyrus*), wild vegetables and mushrooms.

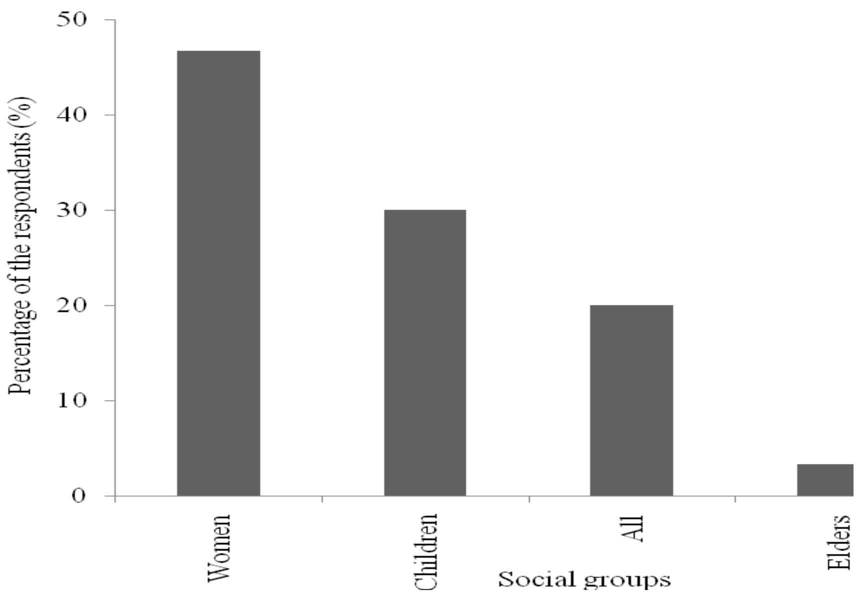

Figure 8: Vulnerability of social groups to climatic change and variability

4.9 Supply, Access and use of NTFPs by Households Living around the NDUFR

4.9.1 Supply of NTFPs by households living around the NDUFR

NTFPs harvested by local communities adjacent to the forest reserve were consumed within households and some were sold to increase households' income. In this study, 76% of the respondents revealed that they have access to the forest resources. Apart from being accessible to these resources, village natural resources committees have established fees for different products from the forest and they are collecting money from permits. Over 70% of the respondents agreed that the supply of NTFPs was not enough. The main reasons cited were decrease in NTFPs and rapid growth in human population around the forest. While 17% and 13% of the respondents felt that the supply of NTFPs was average and enough respectively. The decrease of NTFPs supply could not only be due to increase in human populations around NDUFR but also climate change and variability.

4.9.2 Access to NTFPs by households living around the NDUFR

This study found that about 70% of the respondents agreed to have access to the forest resources while 30% disagree to have access to the forest resources due to restriction (strict by-laws). It was learnt that communities living adjacent to the NDUFR have access to the forest resources. Results revealed that females (65%) admitted to extract NTFPs from the forest more regularly than men. Joint Forest Management (JFM) in New-Dabaga Ulongambi has been providing regulated NTFPs to adjacent communities around the forest (Sumbi, 2004). The access to forest was through permit from the village natural resources committees depending on what type of NTFPs are gathered from the forest. It was learnt that there was no payments for permits related to the extraction of NTFPs for household consumption. However, villagers instigated a by-law where by each person was charged between 1000 and 10 000 Tanzanian shillings depending on how much NTFPs were harvested for sale. This was important for sustainable utilization of the forest resources for present and future generations. It was observed that within the homesteads people usually have home gardens and plant various timber species, horticultural species and seasonal vegetables to meet their own needs and sometimes to sale for additional cash income. This implies that communities around the NDUFR started domesticating some vulnerable NTFPs including *Basella rubra* and *Arundinaria bulgaris* as a coping strategy (Plate 4). An average household owns approximately 4.5 ha, though the amount of land owned varied with the household's economic condition.

Plate 4: *Basella rubra* and *Bamboo bulgaris* planted in the homesteads around the NDUFR

4.9.3 Adaptation strategies to cope with climate change and variability

It can be seen from Table 10 that most of the respondents adapted more than one coping strategy to climate change and variability. Majority of the respondents (96%) adapted diversification of the agricultural crops as a preferred copping strategy to the climate change and variability. Also, use of NTFPs was among the copping strategies to the climate change and variability. It was revealed that 43% of the respondents consume and sale NTFPs from the forest as the climate change and variability coping strategy. They use NTFPs such as wild vegetables and mushrooms, wild fruits, bush meat, animal feeds, honey, poles, woodfuel, wild animals and medicinal plants. NTFPs can either be sold in Kilolo market or Iringa town.

Table 10: Response on various adaptations as coping strategies to climate change

Adaptation strategy	% Response (n)
Diversification of the agricultural crops	96 (115)
Livestock keeping	87 (104)
Delay planting	72 (86)
Tree planting	60 (72)
Use of NTFPs	43 (52)
Use of fertilizers	42 (50)
Conducting petty business	26 (31)
Timber selling from own farm	24 (29)

Note: Figure in the brackets present frequencies of responses and outside brackets present percentages of respondents.

Table 11 shows the amount of NTFPs used and sold per household per year in the NDUFR. Honey and beeswax, weaving grasses (Sedge) and medicinal plants were the most traded NTFPs in the area. It was learnt that the demand for these resources was higher compared to the supply. It was estimated that a household can generate up to 216 992 Tsh per year from selling of NTFPs. The amount of revenue was low because the forest is protected by the village government and the entry to the forest and harvest of

NTFPs were through the permit. There is a need to sensitize communities around the NDUFR on the importance of the law enforcement. About 53%, 24% and 23% of the respondents agreed that wild vegetables, weaving grasses, and medicinal plants respectively could be used to assist households cope with climate change.

Table 11: Amount of NTFPs used and sold per household per year in the NDUFR

Product	Amount used per household per year	Average amount sold per year	Average amount earned per year (Tsh)
Honey (Lt)	6	30	64 992
Medicinal plants (bottles)	4	55	55 000
Weaving grasses (piles)	12	25	49 000
Wild fruits (Kg)	29.63	150	30 000
Wild vegetables (Kg)	22.7	15	17 000
Mushrooms (Kg)	5.8	-	-
Wild animals (Kg)	15.2	-	-
Ropes (bundles)	3	-	-
Total			**216 992**

About 96% of the respondents practice the diversification of crops as a coping strategy to climate change. The main crops intercropped in the growing season included maize, beans, peas and sunflower. A study by Blench (2003) found that farmers minimize or spread risks by managing a mix of crops, crop varieties and sites; staggering the sowing/planting of crops; and adjusting land and crop management to suit the prevailing conditions. In addition, 72% of the respondents admitted to delay sowing seeds due to changes in the rainfall patterns. In West Africa, similar study was done where farmers have been reported to change sowing dates for similar reason (Ingram *et al.*, 2002; Akponikpe *et al.*, 2010).

As an adaptation strategy, local communities (87%) around NDUFR admitted to engage in livestock keeping mainly pigs, chickens, goats and cows. About 57% of the respondents admitted that the existing coping strategies were effective. However, about 30% and 13% disagreed and others uncertain on the effectiveness of the existing coping strategies respectively. Their main recommendations included training on climate change issues for example education on short-term crops with short rotation (53%), establishment of beekeeping enterprises (23%) and formulation of tree planting groups (12%).

4.9.4 Organizations/institutions assisting to cope with climate change and variability

Responses on the knowledge of the existing organizations/institutions that assist local people cope with climate change are presented in figure 9. The responses show that about 54% of the respondents admitted to have received training on coping strategy conducted by the government officials in the area. While 12%, 8% and 6% admitted to have been trained by NGOs, SACCOS and religious groups respectively. However, only 20% of the respondents were not aware of any existing organizations/institutions in the area. This group represents the proposition of the community that probably does not participate in joint forest management.

JFM in the NDUFR is mediated by rules and regulations, which in this study are referred to as institutions. Institutions governing joint action in this study are externally and internally sponsored institutions. These are rules set by the Ministry of Natural Resources and Tourism and those agreed between villagers through their representatives in the NDUFR Forest officials. Joint agreement on rules and regulations between forest officials and local communities is an indication that the community rights are respected. The survival of joint management of natural resources depends very much on the respect of the rights of communities as joint managers. Recognition of the rights of local communities to organize and define their local institutions for natural resource management is a fundamental policy principle that enhances co-management strategies (Metcalfe, 1995).

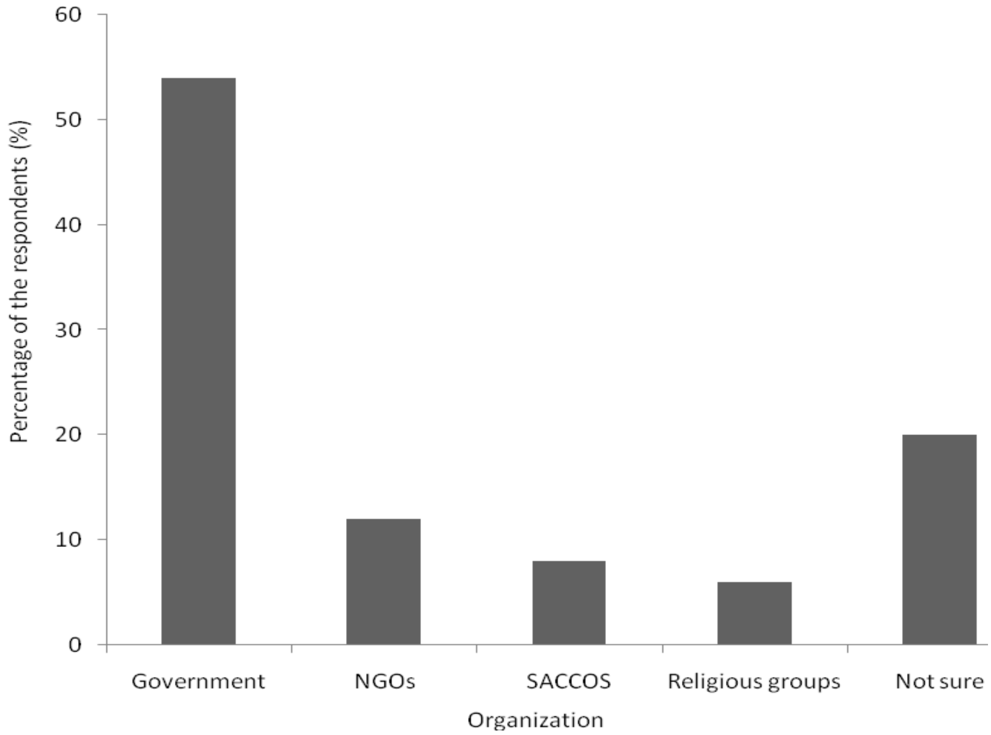

Figure 9: Organizations/institutions that assist local people cope with climate change

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study on the assessment of the role of NTFPs to forest dependent communities as a strategy to cope with the impacts of climate variability and change around the NDUFR found that majority of the interviewees were engaged in the collection of NTFPs both from the forest and farmlands. NTFPs still play a safety net role to assist communities in adverse situation such as crop failure under the current change in climate and variability. A total of 107 plant species and 16 wild animal species were identified to be harvested as NTFPs. This shows that the NDUFR is very rich in diversity of NTFPs and local people living in the area are knowledgeable on different plant and animal species found in the forest. The majority of respondents (82%) around NDUFR admitted to harvest 8 different types of wild vegetables. Moreover, the collection of NTFPs was through the permit from the village government and it was under restrictions. It was revealed that wild fruits are important food supplement in the village and 72% of the respondents admitted to harvest 11 types of wild fruits from the forest. It was clear that mushrooms are harvested during wet season and 83% of the respondents admitted to harvest and consume 10 different mushroom species.

This study recorded and identified a total of 55 plant species that are used by local people for medicinal purposes. The results further revealed that 86 % of respondents were able to mention more than 15 different plant medicinal species. It was learnt that firewood was the most important source of energy used in the area and a total of 34 tree plant species were recorded to be used for woodfuel. Furthermore, a total of 10 grasses were recorded and identified to be used for different purposes. The main uses included weaving basket and mattress, fodder and roofing. About 34% of the respondents admitted to use ropes for various purposes including hanging beehives, house construction, tying firewood, bed weaving and making baskets.

The majority (81%) of the respondents agreed that there have been changes in the climate patterns in the area. The main climatic changes identified by the local people were increase in temperatures and unpredictable rainfalls. Local people felt that climate change was caused by human activities. The study further revealed that majority of the respondents (97%) agreed there have been changes in the temperature in the area. The climatic data records were in line with the people's perceptions. It can be concluded that education level, age and residence duration influenced the peoples' perceptions on climate change and variability impacts.

About 32% of respondents felt that it takes shorter for maize to mature than in the past due to increased temperatures. *C. papyrus*, mushrooms and wild vegetables were listed to be the most vulnerable NTFPs in terms of its availability to climate change and variability. Women were reported to be the most vulnerable social group to climate change and variability. In this study, 76% of the respondents revealed that they have access to the forest resources. It was learnt that village natural resources committees have established fees for different products from the forest and they are collecting money from permits.

It was clear that most of the respondents adapted more than one coping strategy to climate change and variability. Majority (96%) of the respondents practice the diversification of crops as a coping strategy to climate change. Training on climate change issues for example, education on short-term crops with short rotation, establishment of beekeeping enterprises and formulation of tree planting groups were needed to improve people's livelihoods.

5.2 Recommendations

From this study, the following are the recommendations:

i. The government should increase awareness on the effects of climate change and variability issues as well as improve the existing coping strategies to enhance the adaptive capacity and in turn improve peoples' livelihoods. The need to emphasis sustainable harvesting, improve processing and access to NTFPs markets is crucial. Utilization plans of different NTFPs should be developed by the government and local communities should be sensitized to establish forest-based enterprises.

ii. Government policies should therefore facilitate local communities' access to affordable credit with low interest to increase their ability and flexibility to change production strategies in response to the forecasted climate and improve on-farm income-earning opportunities.

iii. Reliable climate and weather information from the nearby meteorological stations should be conveyed to local people through public media to assist them in their agricultural activities.

iv. The Government should enforce laws governing harvest and utilization of NTFPs by providing sufficient budget to carry out forest patrols and support livelihood alternative to local communities around the NDUFR.

v. Furthermore, establishment of additional plantations outside the Forest Reserve using indigenous and exotic species should be encouraged to supply the community with required wood source.

REFERENCES

Abdallah, R.K. (2001). The use of medicinal plants for maternal and child survival in Tanzania. A case study of villages around Zaraninge Forest Reserve in Bagamoyo District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 90pp.

Abdallah, R.K. (2007). Use of medicinal plants for human health in Udzungwa Mountains Forest: a case study of New-Dabaga Ulongambi Forest Reserve, Tanzania. *Journal of Ethnobiology and Ethnomedicine* 3:7-15.

Acharya, K.P. (2003). Conserving biodiversity and improving livelihoods: the case of community forestry in Nepal. Paper presented in International Conference on Rural Livelihood, Forests and Biodiversity, Bonn, Germany. 22pp.

Acharya, K.P. (2004). Does Community Forests Management supports biodiversity conservation? Evidences from two community forests from the mid hills of Nepal. *Journal of Forest and Livelihood* 4: 44 – 54.

Adger, W.N. (1999). Social Vulnerability to Climate Change and Extremes in Coastal Vietnam. *World Development* 27(2): 249 – 269.

Adger, W.N., Brown, K., Fairbrass, J., Jordan, A., Paavola, J., Rosendo, S. and Seyfang, G. (2003). Governance for sustainability: towards a ‘thick’ analysis of environmental decision making. *Environment and Planning* 35: 1095 – 1110.

Akponikpe, P.B.I., Johnston, P. and Agbossou, E.K. (2010). Farmers' perception of climate change and adaptation strategies in Sub-Saharan West-Africa. ICID+18 2nd International Conference. Climate, Sustainability and Development in Semi-arid Regions August 16 - 20, 2010, Fortaleza - Ceará, Brazil. 15pp.

Alig, R., Adams, D. and McCarl, B. (2002). Projecting impacts of global climate change on the U.S. forest and agriculture sectors and carbon budgets. *Forest Ecology and Management* 169:3-14.

Arnold M.J.E., Powell, B., Shanley, P. and Sunderland, T.C.H. (2011). Forests, biodiversity and food security. *International Forestry Review, Special Issue* 13(3).

Arnold, M.J.E. and Pe´rez, M. R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics* 39: 437–447.

Augustino, S. and Gillah, P.R. (2005). Medicinal plants in Urban Districts of Tanzania: Plants, Gender Roles and Sustainable use. *International Forestry Review* 7(1): 44 – 58.

Babbie, E. (1995). *The Practice of Social Research*. Seventh edition. Wadsworth Publishing Company Belmont, California. 101pp.

Bahl, N. (1994). Handbook on mushrooms. Oxford and IBH Publishing CO. Pvt. Ltd., Delhi, India.

Bahru.T., Asfaw, Z. and Demissew, S. (2012). Indigenous knowledge on fuel wood (charcoal and/or firewood) plant species used by the local people in and around the semi-arid Awash National Park, Ethiopia. *Ecology and the Natural Environment* 4(5): 141–149.

Bailey, K. D. (1994). *Methods of Social Research*. Fourth Edition. Free Press. Toronto. 588 pp.

Basu, J.P. (2009). Adaptation, non-timber forest products and rural livelihood: an empirical study in West Bengal, India. *Earth and Environmental Science* 6: 3 – 8.

Batjes, N. H. (1996). Total carbon and nitrogen in the soils of the world. *European Journal of Soil Science* 47: 151 – 163.

Bawa, K.S. and Dayanandan, S. (1998). Global Climate Change and Tropical Forest Genetic Resources. *Climatic Change* 39(3): 473 - 485.

Belcher, B.M. (2003). What isn't an NTFP? *International Forestry Review* 5(2): 161 – 168.

Berg, M.P., Kiers, E.T., Driessen, G., Van Der Heijden., Kooi, B.W., Kauenen, F., Liefting, M. Verhoef, H.A and Ellers, J. (2010). Adapt or disperse: understanding species persistence in a changing world. *Global Change Biology* 16(2): 587 – 598.

Blench, R. (2003). Forecasts and Farmers: Exploring the Limitations. In: K. O'Brien and C. Vogel (Eds). Coping with Climate Variability. The Use of Seasonal Forecasts in Southern Africa. Ashgate Publishing Limited, Hampshire, England.

Blocknus, J.M. (1993). Strategies for Non-Timber forest products: Are they viable for sustainable forest management? In: *Proceedings of Biri conference on Natural resource Inventory and sustainable management of forested Area in Africa.* January 21-22, 1993, Biri, Norway. 101pp.

Brockington, D. (2007). Devolution, community conservation and forests. On local government performance and village forest reserves in Tanzania. *Society and Natural Resources* 20(8): 35 – 48.

Brooks, N. (2003). Vulnerability, Risk and Adaptation: A Conceptual Framework. Working Paper 38, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich.

Brooks, N., Adger, W.N. and Kelly, P.M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change* 15: 151–163.

Bruce, N., Perez-Padilla, R. and Albalak, R. (2000) Indoor air pollution in developing countries: a major environmental and public health challenge. *World Health Organization* 78: 1097-1092.

Campbell, B.M., Clarke, J., Luckert, M., Matose, F., Musvoto, C. and Scoones, I. (1997). Local level economic valuation of Savannah Woodland resources: Village cases from Zimbabwe. Hidden harvest. Project Series No. 3. International Institute for Environment and Development. London. 125pp.

Cavendish, W. (1998). The Complexity of the Commons: Environmental Resource Demands in Rural Zimbabwe, Working Paper No. WPS 99-8, Centre for the Study of African Economics, Oxford. 52pp.

Chia, E.L., Somorin, O.A., Movik, S., Sonwa, D.J. and Tiani, A.M. (2013). Local vulnerability, Forest communities and Forest-carbon conservation: case of southern Cameroon. *International Journal of Biodiversity and Conservation* 5(8): 498 – 507.

Cocks, M.L. and Wiersum, K.F. (2003). The significance of plant diversity to rural households in the Eastern Cape Province of South Africa. *Forest Trees and Livelihood* 13: 39 – 58.

Conway, G. (2008). The Science of Climate Change in Africa: Impacts and Adaptation. Department for International Development, UK. 43pp.

Cunningham, A.B. (1993). *African medicinal plants*. People and Plants Working Paper No. 1. UNESCO, Paris. 53pp.

Dawson, I. K., Vinceti, B., Weber, J. C., Neufeldt, H., Russell, J., Lengkeek, A. G., Kalinganire, A., Kindt, R., Lillesø, J.P.B., Roshetko, J., Jamnadass, R. (2011). Climate change and tree genetic resource management: maintaining and enhancing the productivity and value of smallholder tropical agroforestry landscapes. A review. *Agroforestry Systems* 81:67-78.

Dery, B.B., Otsyina, R. and Ng'atigwa, C. (1999). Indigenous Knowledge of Medicinal Trees and Setting Priorities for their Domestication in Shinyanga Region, Tanzania. International Centre for Research in Agroforestry, Nairobi, Kenya. 87pp.

DFID (2004). The impact of climate change on the vulnerability of the poor. Department for International Development, UK. Vulnerability no. 3. 6pp.

Dick, W.A., Belvins, R.L., Frye, W.W., Peters, S.E., Christenson, D.R., Pirece, F.J., Vitosh, M.L. (1998). Impact of agricultural management practices on C sequestration in forest-derived soils of the eastern Corn Belt. *Soil and Tillage Research* 47: 243 – 252.

Dixon, R.K., Brown, S., Houghton, R.A., Solomon, A.M., Trexler, M.C. and Wisniewski, J. (1994). Carbon pools and flux of global forest ecosystems. *Science* 263: 185-190.

Duangsa, D. (1996). Principles for a proposed participatory rural appraisal model and implications for practice: In: Report on the Participatory Rural Appraisal Workshop, Indochina Sub-regional Highland Peoples Programme, Vietnam.UNV Home. [Http://www.unv.org] site visited on 12 August 2012.

Eastaugh, C. (2008). Adaptations of forests to climate change: a multidisciplinary review. International Union of Forest Research Organizations, Vienna. IUFRO Occasional Paper No. 21. 85pp.

Easterling, W.E., Aggarwal, P., Batima, P., Brander, K.M., Erda, L., Howden, S.M., Kirilenko, A., Morton, A., Soussana, J.F., Schmidhuber, J. and Tubiello, F.N. (2007). Food, fibre and forest products. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., Hanson, C.E. and Van der Linden, P.J. (Eds.). *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the IPCC. Cambridge University Press, Cambridge, UK, pp. 273 – 313.

FAO (1992). Forest tree and food. FAO, Rome, Italy. 23pp.

FAO (1995). Non Wood Forest Products for rural income and sustainable forestry. NWFPs 7, FAO, Rome. Researching factors that influence successful commercialization of Non-timber forest products (NTFPs). *Lyonia* 5(1): 61 – 72.

FAO (1997). Non wood News, No. 4. FAO, Rome, Italy. 83pp.

FAO (2001). State of the World's Forest. FAO Forestry Paper No. 140. 84pp.

FAO (2002). An introduction bulletin on non-wood forest products. FAO, Rome. 99pp.

FAO (2005). State of the World’s Forests 2005. FAO, Rome. 153pp.

Fisher, M., Chaudhury, M. and McCusker, B. (2010). Do forests help rural households adapt to climate variability: Evidence from southern Malawi. *World Development* 38(9): 1241 – 1250.

Forner, C. and Robledo, I. (2005). An introduction to the impacts of climate change and vulnerability of forestsBackground document for the South East Asian Kick-off meeting of the project Tropical Forests and Climate Change Adaptation. 45pp.

Frontier Tanzania (2001a). New-Dabaga/Ulongambi Forest Reserve - Management and summary report. Doody, K.Z., Howell, K.M. and Fanning, E. (Eds). Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania. 77pp.

Frontier Tanzania (2001b). New-Dabaga/Ulangambi Forest Reserve - Botanical and Forest Use Report. Doody, K.Z, Howell, K.M, and Fanning, E, (Eds.). Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania. 117pp.

Fussel, H. and Klein, R.J.T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change* 75: 301 – 329.

Grimm, A. M., Barros, V.R. and Doyle, M.E. (2000). Climate Variability in Southern South America Associated with El Nin˜o and La Nin˜a Events. *American Meteorological Society* 13: 35 – 58.

Hamilton, E. (1998). An overview of the current situation of non-timber forest products in British Columbia. In: *Non-Timber Forest Products Workshop Proceedings.* 3 -5 April 1998, Alert Bay, B.C. Inner Coast Natural Resources Centre. pp.10 – 14.

Hamza, K.F.S. (1997). *Introduction to Non-Wood Forest Products* (NWFPs). Compendium. Faculty of Forestry and Nature Conservation. Sokoine University of Agriculture, Morogoro, Tanzania. 82pp.

Hamza, K.F.S., Njogoya, J., Msalilwa, U. and Kitula, R.A. (2004). Contribution of medicinal plants to the health of communities living around Mgori forest in Singida, Tanzania. *Journal of the Tanzanian Association of Foresters* 10: 72 – 79.

Harkonen, M. and. Vainio-Mattila, K. (1998). Some examples of natural products in the eastern arc mountains. *Journal of East African Natural History* 87: 265 – 278.

Harkonen, M., Niemelä, T. and Mwasumbi, L. (2003). Tanzanian mushrooms. Edible, harmful and other fungi. *Norrlinia* 10: 1 – 200.

Hedberg, I., Hedberg, O., Madati, P., Mshigeni, K.E., Mshiu, E.N. and Samuelsson, G. (1983). Inventory of plants used in traditional medicine in Tanzania. III. Plants of the families Acanthaceae-Cucurbitaceae. *Journal of Ethnopharmcology* 9: 237 – 260.

Hutton, D. J. (1996). Treatment and pressure sores. *Nursing Times* 18: 1533 – 1534.

Ingram, K.T., Roncoli, M.C., Kirshen, P.H. (2002). Opportunities and constraints for farmers of west Africa to use seasonal precipitation farecasts with Burkina Faso as a case study. *Agricultural Systems* 74: 331 – 349.

IPCC (2001). Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge. 103pp.

IPCC (2007). Summary for Policymakers. In: Solomon, S.,Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (Eds.). Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

IPGRI (2003). Rediscovering a forgotten treasure. IPGRI Public Awareness. Rome, Italy. Available at [http://ipgri-pa.grinfo.net/index.php?itemid=101] site visited on 10 May 2012.

Irland, L., Adams, D., Alig, R., Betz, C.J., Chen, C., Hutchins, M., McCarl, B.A., Skog, K. and Sohngen, B.L. (2001). Assessing socio-economic impacts of climate change on U.S. forest. Wood-product markets and forest recreation. *Bioscience* 51(9): 753 – 764.

Ishengoma, R.C. and Ngaga, Y.M. (2000). Woodfuel Consumption in urban areas of Tanzania. Consultant Report (FORCONSULT and ORGUT) Ministry of Natural Resources and Tourism.

Jarvis, A., Upadhyaya, H., Gowda, C.L., Aggarwal, P.K., Fujisaka, S. and Anderson, B. (2011). Climate Change and its Effect on Conservation and Use of Plant Genetic Resources for Food and Agriculture and Associated Biodiversity for Food Security. FAO report. 26pp.

Kagya, M.A.N (2002). Contribution of Non-Wood Forest Products to Household Economy and Welfare of Women in Meatu District, Shinyanga, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 141pp.

Kajembe, G.C., Mwenduwa, M.I., Mgoo, J.S. and Ramadhani, H. (2000). *Potentials of Non-Wood Forest Products in Household Food Security in Tanzania: The role of gender based local knowledge*. Report submitted to Gender, Biodiversity and Local Knowledge Systems (Links) to strengthen Agriculture and Rural Development. (CGCP/RAF/338/NOR), July 2000. 47pp.

Kajembe,G.C. (1994). *Indigenous Management system as a basic for community forest in Tanzania.* A case study of Dodoma Urban and Lushoto Districts. Tropical Resource Management Paper No. 6. Wageningen Agriculture University, The Netherlands. 194pp.

Katani, J. Z. (1999). Coping strategies against deforestation: impact of socio-economic factors with special attention to gender - based indigenous knowledge: A case study of Mwanza District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 110pp.

Katoomba Group (2009). Getting Started on REDD in Tanzania: A Scoping Study for the Katoomba Ecosystem Services Incubator. Unpublished research report. 45pp.

Keller, M. (2009). Climate Risks and Development Projects. Assessment Report for a Community-Level Project in Guduru, Oromiya, Ethiopia. 31pp.

Kilonzo, M. (2009). Valuation of Non-timber forest products used by communities around Nyanganje forest reserve, Morogoro,T anzania. Unpublished Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 112 pp.

Kirilenko, A.P. and Sedjo, R.A. (2007). Climate change impacts on forestry. *Proceedings of the National Academy of Sciences* 104: 19697 – 19702.

Koziell, I. and Saundres, J. (2001). Diversity not adversity: sustaining livelihoods with biodiversity. International Institute for Environment and Development, London, UK. 74pp.

Kuhnlein, H.V. (1989). Nutrient values in indigenous wild berries used by the Nuxalk people of Bella Coola, British Columbia. *Journal of Food Composition and Analysis* 2: 28 - 36.

Leach, G. (1990). Agroforestry and the way out for Africa. In: Suliman, M. (Ed). *The Greenhouse Effect and Its Impact on Africa*. London: Institute for African Alternatives. pp. 38-52.

Leff, B., Ramankutty, N. and Foley, J.A. (2004). Geographic distribution of major crops across the world. *Global Biogeochemistry* 18: 1005 – 1012.

Lema, T.A. (2003). The role of non-timber forest products in household food security and women income in Morogoro Rural District, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro. Tanzania, pp109.

Lindner, M., Maroschek, M., Netherer, S., Kremer, Antoine, Barbati, A., Garcia-Gonzalo, J., Seidl, R., Delzon, S., Corona, P., Kolström, M. (2010). Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. *Forest Ecology and Management* 259(4): 698-709.

Loo, J., Fady, B., Dawson, I., Vinceti, B. and Baldinelli, G. (2011). Climate change and forest genetic resources - state of knowledge, risks and opportunities. FAO background study paper no. 56. 29pp.

Lovett, J.C. and Wasser S.K. (1993). *Biogeography and Ecology of the Rain Forests of Eastern Africa.* Cambridge University Press, Cambridge.

Lovett, J.C. (1998). Eastern tropical African centre of endemism: a candidate for World Heritage Status? *Journal of East African Natural History* 87: 359 – 366.

Lovett, J.C., Hatton, J., Mwasumbi, L.B. and Gerstle, J.H. (1997). Assessment of the Lower Kihansi Hydropower Project on the Kihansi Gorge, Tanzania. *Biodiversity and Conservation* 6: 915 – 933.

Lyimo J. G. and Kangalawe, R. Y. (2010). Population dynamics, rural livelihoods and environmental degradation: some experiences from Tanzania. *Environment Development and Sustainability* 12(6): 985 – 997.

Lyimo, J.G. and Kangalawe, Y.M. (2010). Vulnerability and adaptive strategies to the impact of climate change and variability. The case of rural households in semi-arid Tanzania. *Environmental Economics* 1(2): 89 – 97.

Magessa, F.B. (2008). EAC Strategy to Scale Up Access to Modern Energy Services. Tanzania Country Report and Implementation Workplan. 41 pp.

Makonda, F.B.S (1997). The role of non wood forest products to the livehood of rural communities of Geita District Mwanza. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 129pp.

Malimbwi, R.E., Luoga E.J. and Hassan, S. (2002). Inventory of Nyanganje Forest Reserve in Kilombero, Morogoro, Tanzania. Unpublished Report. 43pp.

Mann, A., Amupitan, J.O., Oyewale, A.O., Okogun, J.I., Ibrahim, K., Oladosu, P., Lawson, L. Olajide, I. and Nnamdi, A. (2008). Evaluation of *in vitro* antimycobacterial activity of Nigerian plants used for treatment of respiratory Diseases. *African Journal of Biotechnology* 7(11): 1630 – 1636.

Mátyás, C. (2007). What do field trials tell about the future use of forest reproductive material? In: J. Koskela, A. Buck, E. Teissier du Cros (Eds.), *Climate change and forest genetic diversity: Implications for sustainable forest management in Europe* (p. 53-69). Rome, Italy: Bioversity International.

Medius, K. (1998*)*. Medicinal Plants and Herbalist Preferences around Bwindi Impenetrable Forest, Uganda. Dissertation for Award of MSc Degree at Makerere University, Uganda, 71pp.

Metcalfe, S.C. (1995). Communities, parks, and regional planning: A co-management strategy based on the Zimbabwean experience. In J.A. McNeely (Ed.), *Expanding Partnerships in Conservation*, Island Press, Washington DC. pp. 270 – 279.

Mettrick, H. (1993). *Development Oriented Research in Agriculture*. An ICRA textbook. Wageningen, the Netherlands. 287pp.

Mhinte, A.R. (2000). Analysis of Rural Households Coping Strategies Against Seasonal Food Insecurity in Kilosa District. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro. Tanzania, pp121.

Minja, R. (1994). The role of non-timber forest products in parts of Iringa Region, Tanzania. In: *Extractivism and potentialities of multiple uses Forest Reserves in Africa.* A workshop held in Naro Moru, Kenya, 8 – 13 May 1994.

MNRT (1998). *National Forest Policy*, The United Republic of Tanzania, Dar es Salaam, March 1998, Government Printer, Dar es Salaam, Tanzania. 59pp.

MNRT (2005). Ministry of Natural Resources and Tourism. Participatory Forest Resource Assessment guide. Dar es Salaam, Tanzania. 44 pp.

MNRT (2009). Participatory Forest Management in Tanzania: 1993 - 2009. Lessons learnt and experiences to date. Forestry and Beekeeping Division. Dar es Salaam. 72pp.

Mogaka, H., Simons, G., Turpie, J., Emerton, L. and Karanja, F. (2001). Economic aspects of community involvement in sustainable forest management in Eastern and Southern Africa, IUCN, Nairobi, Kenya. 18pp.

Msuya, T.S. (1998). Uses and indigenous conservation methods of wild plants. A case of West Usambara Mountains, Tanzania. Dissertation for Award of MSc Degree at University of Norway, 112pp.

Msuya, T.S., Kideghesho, J.R and Mosha C.E.T. (2010). Availability, Preference, and Consumption of indigenous forest foods in the Eastern Arc Mountains, Tanzania *Ecology of Food and Nutrition* 49: 208 – 227.

Mukhopadhyay, D. (2009). Impact of climate change on forest ecosystem and forest fire in India. *Earth and Environmental Science* 6(3): 20 – 27.

Munishi, P.K.T., Soka, G.E., Kingazi, S.P. and Mbije, N.E. (2007). Attitudes of local communities toward biodiversity conservation in the Uluguru rain forests of the eastern arc mountains of Tanzania. *Journal of the Tanzania Association of Foresters* 11: 1 – 10.

Mvungi, E. (2001). Iringa residents are living on wild vegetables. In: Mtanzania (A Tanzanian) Newspaper P1. June 21, 2001.

National Bureau of Statistics (2004). The United Republic of Tanzania. Population and housing census. Available on [http//:www.Tanzania.go.tz/ census/ regions.htm] site visited on 22 May 2012.

Nielsen, M.R. (2006). Importance, cause and effect of bushmeat hunting in the Udzungwa Mountains, Tanzania: Implications for community based wildlife management. *Biological conservation* 128: 509 – 516.

Nyingili, B.R. (2003). *Contribution of non-wood forest products to household food security in Mbozi District*, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 118pp.

Obua, J., Bananaand, A.V. Turyahabwe, N. (1998). Attitudes of local communities towards forest management practices in Uganda: the case of Budongo Forest Reserve. *Commonwealth Forest Review* 77(2): 113 - 118.

Oduro, K.A. (2002). Multi-purpose rainforest management in Ghana: an exploratory study. Forestry Research Institute of Ghana, Tropenbos Ghana Programme Final Report. 63pp.

Ongugo P. and Mwangi E.N. (1996). Common property and Forest Resource Management in Kenya. Paper presented to the East African Symposium on Common Property Management, Uganda International Conference Centre from 26th - 28th March 1996.

Parent, C. (1977). Food value of edible mushrooms from Upper Shaba. *Economic Botany* 31: 436 – 445.

Parmesan, C. and Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421: 37 – 42.

Parry, M., Rosenzweig, C., Iglesis, A., Fischer, G. and Livermore, M. (1999). Climate change and world food security: a new assessment. *Global Environmental Change* 9: 551 – 567.

Paulo, T. (2007). Contribution of non timber forest products in improving livelihood of rural community in Kilwa District, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro,Tanzania, 118pp.

Perez, M.R., Ndoye, O. and Eyebe, A. (1999). Marketing of Non wood forest products in the humid forest zone of Cameroon. *Unasylva* 50: 12 – 19.

Peters, C.M. (1994). *Sustainable harvest of non-timber plant resources in tropical moist forest: An ecological primer.* Biodiversity Support Program-WWF, Washington, DC. 43pp.

Posey, D. A. (Ed.). (1999). *Cultural and Spiritual Values of Biodiversity.* London: United Nations Environmental Programme & Intermediate Technology Publications. 56pp.

Ravindranath, N.H. (2007). Mitigation and adaptation synergy in forest sector. *Mitigation Adaptation Strategies for Global Change* 12: 843 – 853.

Regmi, B.R., Morcrette, A., Paudyal, A., Bastakoti, R., Pradhan, S. (2010). Participatory tools and techniques for assessing climate change impacts and exploring adaptation options: a community based tool kit for practitioners. Livelihoods and Forestry Programme, DFID, Nepal. 58pp.

Rehfeldt, G. E., Wykoff, William R., Cheng, C. Y. (2001). Physiologic plasticity, evolution, and impacts of a changing climate on Pinus Contorta. *Climatic Change*, 50: 355-376.

Rosenzweig, C. and Parry, M. (1994). Potential impact of climate change on world food supply. *Nature* 367: 122 – 138.

Ruffo C.K., Birnie A. and Tengnäs B. (2002). *Edible wild plants of Tanzania*. Regional land management unit, SIDA, Nairobi, Kenya. Pp 766.

Ruffo, C.K., Mwasha, N. and Marie, C. (1989). Medicinal Plants in the East Usambara. In *Forest Conservation in the East Usambara Mountains, Tanzania*. Edited by Hamilton AC, Bensted-smith R. Switzerland and Cambrige, UK. pp. 195 – 206.

Schippers, R. (1997). Domestication of Indigenous Vegetables for Sub-Saharan Africa: A Strategy Paper. R. Schippers and Budds, African Indigenous Vegetables, Workshop Proceedings, January 13- 18, 1997, Limbe, Cameroon. pp. 125 – 135.

Scholes R, Linder S (1998). Chapter 12: Forests. In: Feenstra J, Burton I, Smith J, Tol R (eds) Handbook on methods for climate change impact assessment and adaptation strategies. UNEP-Vrije Universiteit, Amsterdam.

Senbeta, A.F. (2009). Climate Change Impact on Livelihood, Vulnerability and Coping Mechanisms: A Case Study of West-Arsi Zone, Ethiopia. MSc. Thesis Submitted to Lund University Masters Program in Environmental Studies and Sustainability Science (LUMES). 54pp.

Shackleton, C. and Shackleton, S. (2004). The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science* 100: 658 – 664.

Shackleton, C.M. (2001). Re-examining local and market orientated use of wild species for the conservation of biodiversity. *Environmental Conservation* 28: 270 – 278.

Shaghali, C.F., Mabula, C.K. and Mmari, C. (1998). Biodiversity and human activities in the Udzungwa Mountain Forest, Tanzania. *Journal of East African Natural History* 87: 1 – 2.

Sherbinin, A., VanWey, L., McSweeney, K., Aggarwal, R., Barbieri, A., Henry, S., Hunter, L.M. and Twine, W. (2008). Rural Household Demographics, Livelihoods and the Environment. *Glob Environmental Change* 18(1): 38-53.

Stile, D. (1988). Arid land plants for economic development and desertification control. Desertification control Bulletin No. 17 UNEP, Nairobi, Kenya. pp.18-21.

Sumbi, P.E. (2004). Community perceptions on costs and benefits of different forest management approaches: A case study of Udzungwa Mountains forests and the surrounding Miombo woodlands, Tanzania. Dissertation for Award of MSc Degree at University of Wales, UK, 116pp.

Sunderlin, W.D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L. and Wunder, S. (2005). Livelihoods, forests, and conservation in developing countries: An Overview. *World Development* 33(9): 1383 – 1402.

Temu, R.P.C. and Andrew, S.M. (2008). Endemism of plants in Uluguru Mountains. *Forest Ecology and Management* 255(7): 2858 – 2869.

Thuiller, W., Lavorel, S., Sykes, M. T., Araújo, M. B. (2006). Using niche-based modelling to assess the impact of climate change on tree functional diversity in Europe. *Diversity and Distributions* 12:49-60.

Torrey, J.G. (1992). Can plant productivity be increased by inoculation of tree roots with soil microorganisms? *Canadian Journal of Forest Research* 22(12): 1815 – 1823.

Totten, M., Pandya, S.I. and Janson-Smith, T. (2003). Biodiversity, climate, and the Kyoto Protocol: risks and opportunities. *Frontiers in Ecology and the Environment* 1: 262 – 270.

UN (1994). Population, Environment and Development linkages In: UN Population and Development: Proceeding of the United Nations Expert Group Meeting on Population, environment and Development. UN Head Quarters, 20 - 24 January 1992. pp. 55 - 65.

URT (2003). Initial national communication under the United Nations Framework Convention on Climate Change (UNFCCC). Vice President's Office. Dar es Salaam. 166pp.

USAID (2007). Adapting to climate variability and change. A Guidance Manual for Development Planning. [http://pdf.usaid.gov/pdf_docs/PNADJ990.pdf] site visited on 18 July 2012.

Veltheim, T. and Kijazi, M. (2002). Participatory Forest Management in the East Usambaras. East Usambara Catchment Forest Project. Technical Paper No. 61. Forestry and Beekeeping Division and Metsahallitus Consulting, Dar es Salaam, Tanzania and Helsinki, Finland. 132pp.

West, T.O. and Marland, G. (2002). A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: comparing tillage practices in the United States. Agric. *Ecosystem and Environment* 91: 217 – 232.

Wickens, G. E. (1991). Management issues for development of non-timber forest products. *Unasylva* 42(165): 3 – 8.

Wilkinson, K.M. and Elevitch, C.R. (2000). Non-timber forest products for pacific islands: an introductory guide for producers. Agroforestry Guides for Pacific Islands No. 3. Permanent Agriculture Resources, Holualoa, Hawaii, USA. 29pp.

Williams, S. E., Bolitho, E. E. and Fox, S. (2003). Climate change in Australian tropical rainforests: an impending environmental catastrophe. *Proceedings of the Royal Society of London* 270:1887-1892.

World Bank (2008). The World Bank presented a major overhaul to their estimates of global poverty. [http://beyondthoughts.posterous.com/poverty-around-the-world-global-issues] site visited on 12 July 2012.

APPENDICES

Appendix 1: Household questionnaire

Section A: Background information

Respondent code number …............ Date……/……/2011

District………… Division……….……… Ward…………….Village …………………….

1. Age …..……years

2. Gender: 1. Male 2. Female

3. Marital status: 1. Single 2. Married 3. Widowed 4. Divorced

4. Ethinic group ....

5. Age of a household head:

   1. 18 - 30 years

   2. 30 - 60 years

   3. Above 60 years

6. Education level of the respondent:

   1.College

   2. Secondary level

   3. Primary level

   4. Adult education

   5. None

7. Occupation:

   1. Employed 2. Farmer 4. Business 5. Jobless 6. Others

8. Household size (number of people in household)……………

9. For how long have you been residing in this village......................?

10. What are main sources of food in the household?

1. Own produce from agriculture
2. Purchase from market
3. Gathering from the wild
4. Both sources or a combination

11. What are the sourses of food and income?

Source	Amount consumed	Amount sold per year	Amount of money earned per year

Section B: Information on Livehood and NTFPs

12. Does your family have access to forest?

1. Yes
2. No

13. If yes, who has access to the forest?

1. Men
2. Women
3. Both

14. How far is the forest area from the house/measured in terms of distance……………..

(km) measured in terms of time (in minutes walking) ………….. (min)?

15. What types of NTFPs do you collect under the current climate change and variability?

NTFPs	Species	Quantity collected			Frequency of collection	Where product is mainly collected from farmland, woodland, forest	Quantity consumed per year	Quantity sold per year	Amount of money earned per year
		Weekly	Monthly	Yearly					

16. What factors make you go for collection of NTFPs?

i) ………………………………………………………………………….

ii) ………………………………………………………………………….

iii) ………………………………………………………………………….

(Use separate sheet if the list is long)

17. What are the constraints to expand uses of NTFPs in this village?

i) ………………………………………………………………………….

ii) ………………………………………………………………………….

iii) ………………………………………………………………………….

(Use separate sheet if the list is long)

18. Which types of NTFPs have decreased over 30 years ago?

i) ………………………………………………………………………….

ii) ………………………………………………………………………….

iii) ………………………………………………………………………….

iv) ………………………………………………………………………….

(Use separate sheet if the list is long)

19. Which type of NTFPs have increased over 30 years ago?

i) ……………………………………………………….…………………….

ii) …………………………………………………………………………….

iii) …………………………………………………………………………….

iv) …………………………………………………………………………….

20. Do you preserve any NTFPs?

1. Yes 2. No

21. If yes, what do you preserve and why?

NTFPs preserved	Use	Reason

Section C: Information on climate change aspects

22. Do you agree that climate has changed in your area?

1. Yes 2. No

23. If yes, how do you persive the change?

i) ……………………………………………………….…………………….

ii) …………………………………………………………………………….

iii) …………………………………………………………………………….

iv) …………………………………………………………………………….

24. What do you think are the causes of climate change?

1) Human activities

2) Punishment from God

3) Others (specify)

4) Uncertain

25. What are the effects of climate change and variability on the NTFPs and your livelihood?

Effect on NTFPs	Effect on livelihood

26. Which NTFPs do you think are more vulnerable to climate change and variability?

i) …………………………………………….…………………….

ii) ………………………………………………………………….

iii) ………………………………………………………………….

iv) ………………………………………………………………….

27. Which social groups do you think are vulnerable to the climatic change and variability?

1. Children 2. Elders 3.Women 4. All

28. Why do you think the above mentioned social groups are more vulnerable to climate change and variability?

…………………………………………………………………………………………

29.How do your household cope with the effects of climate change and variability?

………………………………………………………………………………………..

30. Which existing NTFPs are used or could be used to assist household/community cope with the current climate change and variability?

…………………………………………………………………………………………

31. Which organizations/institutions are available in your area have assisted you to cope with the changes occurring? ………………………………………………………….

32. Are the existing coping strategies working or effective?

    1. Yes 2. No

33. If, no what could be done?

    ……………………………………………………………………………………….

34. How is the suppy of available NTFPs to the community?

    ……………………………………………………………………………………….

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Appendix 2: PRA Checklist

a) What types of NTFPs do you collect under the current climate change and variability?

b) What are the main three important NTFPs in the area?

c) What are the livelihood resources present in the area?

d) What are the current and past climatic hazards in the area?

e) Which NTFPs do you think are more vulnerable to climate change and variability?

f) Which NTFPs are collected by men/women/chidren from the forest?

Type of NTFPs	Men	Women	Chidren

g) Which social groups do you think are vulnerable to the climatic change and variability?

h) How does community cope with the effects of climate change and variability?

i) Which existing NTFPs are used or could be used to assist household/ community to cope with the current climate change and variability?

j) Are there any by-laws in your village used to control NTFPs resources?

Appendix 3: Checklist for Transect Walk

Recorder:……………… Date:………………….. Forest………………..

Transect No. ……..…..…. CLUSTER No. …………..…

Plot No.	Type of NTFPs	Local name	Growth form	Parts used	Availability

Appendix 4: Checklist for Key Informants

1. What are the main socio-economic activities of communities surrounded in the area?
2. What is the average income from each activity?
3. Who has the asses to the forest?
4. What kinds of benefits are obtained from the forest?
5. What non-timber forest products available and used in the village?
6. How is the suppy of available NTFPs to the community?
7. Which kind of NTFPs do they preseve and why?
8. Which NTFPs do you think are more vulnerable to climate change and variability?

7) Which social groups do you think are vulnerable to the climatic change and variability?

8) Why do you think the above mentioned social groups are more vulnerable to climate? change and ariability?

9) How do community cope with the effects of climate change and variability?

10) Which existing NTFPs are used or could be used to assist household/community to cope with the current climate change and variability?

11) What organization/institutions are available in your area to assist you cope with the changes occurring?

Appendix 5: Checklist for Focused Group Discussion

1) What are the livelihood resourses from the village?

2) What non-timber forest products available and used in the village?

3) What are the previous and current climatic hazard faced by the village?

4) What are the impacts of the previously mentioned climatic hazard on the livelihood resourses?

5) What are the impacts of the previosly mentioned climatic hazard on the NTFPS?

6) For each impact, what are the coping strategies?

7) Which existing NTFPs are used or could be used to assist household/ community to cope with the current climate change and variability?

8) Which social groups do you think are vulnerable to the climatic change and variability?

9) Why do you think the above mentioned social groups are more vulnerable to climate change and variability?

10) How do community cope with the effects of climate change and variability?

11) What organization/institutions are available in your area to assist you cope with the changes occurring?

Appendix 6: NTFPs and uses identified in the NDUFR

	Vernacular name	Scientific name	Growth form	Uses	Part used	Availability
31	Maheha	*Aerva leucura*	shrub	Roofing	Whole plant	Whole year
1	Likamanda	*Agelaea sp.*	Tree	Medicine (stomachache)	Sap	Whole year
2	Mtanga	*Albizia gummifera*	Tree	Medicine, poles, tool handle,	Stem bark	Whole year
3	Mulanzi	*Allundinalia bulgaris*	Shrub	Bamboo juice	Sap	Whole year
4	Ulelema	*Amanita loosii*	Mushrooms	Mushrooms	Whole plant	Wet seasons
5	Nguyugu	*Amanita masasiensis*	Mushrooms	Mushrooms	Whole plant	Wet seasons
6	Wilelema	*Amanita zambiana*	Shrub	Vegetable	Leaves	March- may
7	Mchicha pori	*Amaranthus spinosus*	Shrub	Vegetable	Leaves	March- may
8	Mpumu	*Aphloia theiformis*	Tree	Poles, firewood, Tool handles	Stem bark	Whole year
9	Mtowo	*Azanza garckeana*	Tree	Fruit and firewood	Stem and fruits	Whole year
10	Mbasamono	*Bersama abyssinica*	Tree	Medicine (stomach ark, convulsion, Snake bite	Stem bark and leaves	Whole year
11	Mwitsa	*Bridelia micrantha*	Tree	Medicine, firewood, building poles, fruits	Stem bark and fruits	Whole year
12	Winyamikwee	*Cantharellus isbellinus*	Shrub	Vegetable	Leaves	March- May
13	Wisogoro,	*Cantharellus platyhullus*	Shrub	Vegetable	Leaves	March- May
14	Wisogoro	*Cantharelus platyphyllus*	Shrub	Vegetable	Leaves	March- May
15	Muholo	*Canthium oligocarpum*	Tree	Firewood , fruits, building poles, tool handles	Stem bark and fruits	Wet seasons
16	Mlelulelu	*Casearia gladiiformis*	Tree	Medicine (conception), Firewood, Fruits	Leaves, fruits and Stem bark	Whole year
17	Msegela	*Cassipourea gummifera*	Tree	Poles, Firewood	Stem bark	Whole year
18	Mkalifya	*Caylusea abyssinica*	Shrub	Medicine, vegetable	leaves	Wet seasons
19	Mnung'anung'a	*Clausena anisata*	Tree	Medicine (convulsion)	Leaves	Whole year
93	Lutogo	*Cleomea hirta*	Shrub	Vegetable	Leaves	March- May
20	Mvulugu	*Croton mycrostacharica*	Tree	Medicine and firewood	Leaves and Stem bark	Whole year
21	Milulu	*Cyperus papyrus*	Grass	Handcrafts	Stem bark	Whole year
22	Kihala	*Cyperus sp.*	Shrub	Roofing and thatching	Whole plant	Wet seasons
82	Nyava	*Dactyloctenium aegyptica*	Grass	Roofing	Whole plant	Whole year

	Vernacular name	Scientific name	Growth form	Uses	Part used	Availability
23	Lidasi	*Datura culeastrum*	Tree	Medicine (diarrhea and skin rushes)	Leaves	Whole year
24	Msisina	*Diospyros whyteana*	Tree	Medicine (stomachache), firewood, building poles, tool handles	Roots	Whole year
76	Nyanandala	*Dolichos trilobus*	Shrub	Animal feeds	Whole plant	Whole year
25	Mkangalowo	*Dombeya rotundifolia*	Shrub	Medicine (detoxification)	Leaves	Whole year
26	Mnyainyai	*Embelia schimperi*	Climber	Medicine, abdominal pain and fodder	Leaves and roots	Whole year
27	Lilimbili	*Ensete ventricosum*	Shrub	Medicine, prevent lightening , Toothache	Leaves	Whole year
86	Nyakibiki	*Erythrococca kirkii*	Climber	Ropes (Basket weaving)	Stem bark	Wet seasons
28	Mhekele	*Euclea divinorum*	Tree	Medicine and tooth brush	Stem bark	Whole year
29	Mhenyi	*Faurea saligna*	Tree	Medicine during breastfeeding, fruits	Stem bark	Whole year
30	Mtogo	*Faurea sp.*	Shrub	Vegetable	Leaves	March- May
32	Mfilfila	*Garcinia volkensii*	Tree	Medicine and firewood	Stem bark and leaves	Whole year
33	Mdobole	*Hagenia abyssinica*	Tree	Medicine and firewood	Stem bark	Whole year
34	Muhang'ana	*Hagenia diversifolius*	Shrub	Ropes, weaving	Stem bark, leaves	Whole year
89	Lwisenga	*Heliotropium zeyleanicum*	climber	Ropes	Stem bark	Whole year
35	Likweta	*Hyphaene compressa*	Grass	Handcrafts	Stem bark and leaves	Whole year
36	Mbechela	*Juniperus procera*	Tree	Poles, firewood and beehives	Stem bark	Whole year
37	Kichuguu	*Lactarius edulis*	Mushrooms	Mushrooms	Whole plant	Wet seasons
38	Wisiga	*Lactarius kabansus*	Mushrooms	Mushrooms	Whole plant	Wet seasons
72	Lugeni	*Laportea ovalifolia*	Shrub	Medicine (Anti-diabetes)	Leaves	Whole year
39	Mpalapala	*Macaranga kilimandscharica*	Tree	Medicine, firewood and building poles	Roots, Stem bark and leaves	Whole year
40	Mtamu	*Maytenus acuminata*	Tree	Medicine, making spear, firewood	Stem bark, leaves and roots	Whole year
41	Mwefi	*Myrica salicifolia*	Tree	Medicine and basket weaving	Leaves and Stem bark	Wet seasons

	Vernacular name	Scientific name	Growth form	Uses	Part used	Availability
42	mngogo	*Nuxia congesta*	Tree	Poles, firewood and tool handle	Stem bark	Whole year
43	Lwenyi	*Ocimum suave*	Shrub	Medicine (abdominal pain, backache after delivery) and aphrodisiac	Roots	Whole year
44	Mheti	*Ocotea usambarensis*	Tree	Medicine and Firewood	Stem bark	Whole year
45	Mliandege	*Olinia rochetiana*	tree	Medicine and firewood	Stem bark	Whole year
46	Mdunula	*Osyris Lanceolata*	Shrub	Medicine, fuelwood and building poles	Stem bark	Whole year
92	Mbigili	*Oxygonum sinuatum*	shrub	Vegetable	Leaves	Wet seasons
47	Mianzipoli	*Oxystenanthera abssyinica*	Shrub	Poles	Stem bark	Wet seasons
48	Msaula	*Parinari excelsa*	Tree	Medicine, fruits and stem preferred for making beehives	Stem bark	Dry seasons
49	Mpodo	*Podocarpus latifolius*	Tree	Medicine (stomachache) and firewood	Leaves	Whole year
50	Mdeke	*Polysius fulva*	Tree	Poles, making beehives	Stem bark	Whole year
51	Mwiluti	*Prunus africana*	Tree	Medicine, poles, firewood, tool handles	Stem bark	Whole year
96	Mfwifwi	*Psorospermum febrigugum*	Shrub	Fruits	Fruits	Whole year
52	Mnyalati	*Rapanea melanophloeos*	Tree	Poles	Stem bark	Whole year
53	Kihanga	*Rhamnus mucronata*	Shrub	Medicine (abdominal pain)	Roots	Wet seasons
54	Kitunumbi	*Rhus sp.*	Shrub	Medicine (detoxification)	Roots	Whole year
55	Mwifya	*Rubus sp.*	Tree	Medicine (epilepsy, convulsion)	Stem bark and leaves	Whole year
56	Uhinda	*Russula cellulata*	Mushrooms	Mushrooms	Whole plant	Wet seasons
80	Lizwana	*Saba comorensis*	Tree	medicine and fruits	Stem bark and fruits	Whole year
57	Mhogolo	*Schreber alata*	Tree	Medicine, tool handles, firewood	Stem bark	Whole year
58	Mgogola	*Scolopia stolzii*	Tree	Medicine (Conception)	Leaves	Whole year
98	Mtali	*Sesamum calycinum*	Shrub	Handcrafts, animal feeds	Whole plant	Whole year
59	Mnavu	*Solanum nigrum*	Shrub	Vegetable	Leaves	March- May

	Vernacular name	Scientific name	Growth form	Uses	Part used	Availability
60	Sungasunga	*Sonchus schweinfurthii*	Shrub	Medicine (measles), Aphrodisiac, Vegetable	Leaves and roots	Whole year
61	Muvengi	*Syzigium cordatum*	Tree	Medicine, firewood, building poles, fruits	Stem bark and fruits	Dry seasons
62	Mpusa	*Teclea nobilis*	Tree	Poles, tool handle, Firewood	Stem bark	Whole year
63	Masikio ya Tembo	*Termitomyces letestui*	Mushrooms	Mushrooms	Whole plant	Wet seasons
64	Mikusu	*Uapaca kirkiana*	Tree	Medicine and firewood	Bark and stem	Whole year
65	Lugoka	Unidentified	Grass	Animal feeds	Whole plant	Wet seasons
66	Msiusi	Unidentified	Tree	Medicine and firewood	Bark and stem	Whole year
84	Mataji	Unidentified	Shrub	Ornamental	Leaves	Whole year
85	Lisilu	Unidentified	Shrub	Roofing	Whole plant	Wet seasons
87	Muita	Unidentified	Tree	Firewood, building poles	Stem bark	Whole year
88	Lufufugala	Unidentified	Climber	Ropes	Stem bark	Whole year
90	Nyegeta	Unidentified	Climber	Ropes	Stem bark	Wet seasons
91	Kimilafi	Unidentified	Shrub	Hunting tool (making spear)	Stem bark	Whole year
67	Mtanangwe	Unidentified	Shrub	Medicine (detoxification)	Leaves and roots	Whole year
74	Lipogo	Unidentified	Shrub	Medicine (Pneumonia)	Roots	Whole year
94	Mtasamani	Unidentified	Tree	Poles, firewood and tool handles	Stem bark	Whole year
95	Uyoga mkufu	Unidentified	Mushrooms	Mushrooms	Whole plant	Wet seasons
73	Litoganigo	Unidentified	Tree	Medicine (Stomachache)	Stem bark	Whole year
99	Mlillulilu	Unidentified	Shrub	Handcrafts	Stem bark	Whole year
100	Ligonelavana	Unidentified	Shrub	Mattress	Whole plant	Whole year
101	Kingatona	Unidentified	Tree	Medicine and firewood	Roots	Whole year
68	Muhenyi	Unidentified	Tree	Medicine and firewood	Stem bark	Whole year
69	Nyakasage	Unidentified	Tree	Medicine (detoxification)	Stem bark	Whole year
70	Libagwi	Unidentified	Shrub	Medicine (increase blood)	Leaves	Wet seasons
71	Mkungasale	Unidentified	Shrub	Medicine (toothache and stomachache)	Roots	Whole year
75	Mnyagawi	Unidentified	Climber	Medicine (hick up)	Leaves	Whole year
77	Mtando	Unidentified	Tree	Medicine (earache)	Leaves	Whole year
78	Mnunu	Unidentified	Tree	Medicine (stomachache)	Stem bark	Whole year
79	Mwasa	Unidentified	Shrub	Medicine (Pneumonia)	Leaves	Whole year

	Vernacular name	Scientific name	Growth form	Uses	Part used	Availability
81	Mtaniwe	Unidentified	Tree	Making spear	Stem	Whole year
83	Nzedi	Unidentified	Climber	Poles	Stem bark	Whole year
102	Msada	*Vangueria infausta*	Tree	Fruit and firewood	Stem bark and fruits	Whole year
103	Msambalawe	*Vangueria volensii*	Tree	Fruit and firewood	Stem bark and fruits	Dry seasons
104	Mtuguto	*Veronica subligera*	Tree	Medicine and firewood	Leaves and Stem bark	Whole year
97	Linyamalala	*Vigna pubescens*	Shrub	Roofing	Whole plant	Wet seasons
105	Kiwangaduma	*Zanha africna*	Tree	Medicine, tool handles	Leaves and Stem bark	Whole year
106	Mlung'ulung'u	*Zanthoxylum chalybeum*	Tree	Medicine, poles, firewood, Tool handles	Stem bark and fruits	Whole year
107	Mlung'ulung'u	*Zanthoxylum deremense*	Tree	Medicine, Poles, firewood and tool handles	Stem bark	Whole year

Appendix 7: Relative frequency of the common NTFPs recorded during transect walk in the NDUFR

	Vernacular name	Scientific name	Relative frequency
1	Mtanga	*Albizia gummifera*	17.95
2	Msaula	*Parinari excelsa*	6.45
3	Mheti	*Ocotea usambarensis*	5.34
4	Mpusa	*Teclea nobilis*	5.26
5	Mikusu	*Uapaca kirkiana*	4.67
6	Mdeke	*Polysius fulva*	4.15
7	Mvulugu	*Croton mycrostacharica*	3.97
8	Mfilfila	*Garcinia volkensii*	3.86
9	Hala	*Cyperus sp.*	3.56
10	Lufufugala	Unidentified	3.56
11	Mtogo	*Vernonia myriantha*	2.97
12	Mbasa mono	*Bersama abyssinica*	2.97
13	Mpumu	*Aphloia theiformis*	2.97
14	Mtaniwe	Unidentified	2.74
15	Maheha	*Aerva leucura*	2.67
16	Mulanzi	*Allundinalia bulgaris*	2.61
17	Sungasunga	*Sonchus schweinfurthii*	2.37
18	Msegela	*Cassipourea gummifera*	2.37
19	Mleluleu	*Casearia gladiiformis*	2.37
20	Muholo	*Canthium oligocarpum*	2.37
21	Mhekele	*Euclea divinorum*	2.08
22	Mvulugu	*Croton mycrostacharica*	2.07

	Vernacular name	Scientific name	Relative frequency
23	Kihaga	*Rhamnus mucronata*	2
24	Mvengi	*Syzigium cordatum*	1.78
25	Mnyalati	*Rapanea melanophloeos*	1.78
26	Mwiluti	*Prunus Africana*	1.78
27	Logolomosi	*Olinia rochetiana*	1.78
28	Mwefi	*Myrica salicifolia*	1.55
	Total		**100**

Appendix 8: List of recorded and identified NTFPs commonly used for medicinal purposes in the NDUFR

	Vernacular name	Scientific name	Growth form	Part used	Availability
2	Likamanda	*Agelaea sp.*	Tree	Sap	Whole year
3	Mtanga	*Albizia gummifera*	Tree	Bark	whole year
4	Mbasamono	*Bersama abyssinica*	Tree	Bark	Whole year
5	Mwitsa	*Bridelia micrantha*	Tree	Bark	whole year
6	Mlelulelu	*Casearia gladiiformis*	Tree	Bark and leaves	Whole year
7	Mkalifya	*Caylusea abyssinica*	Shrub	leaves	Wet season
1	Mnung'anung'a	*Clausena anisata*	Tree	Leaves	whole year
8	Mvulugu	*Croton mycrostacharica*	Tree	Leaves	whole year
9	Lidasi	*Datura culeastrum*	Grasses	Leaves	Whole year
10	Msisina	*Diospyros whyteana*	Tree	Roots	whole year
11	Mkangalowo	*Dombeya rotundifolia*	Shrub	Roots and bark	whole year
12	Mnyainyai	*Embelia schimperi*	Climber	Leaves and roots	Whole year
13	Lilimbili	*Ensete ventricosum*	Shrub	Leaves	whole year
14	Mhekele	*Euclea divinorum*	Tree	Leaves	whole year
15	Mhenyi	*Faurea saligna*	Tree	Bark	whole year
16	Mfilfila	*Garcinia volkensii*	Tree	Barks and leaves	whole year
17	Mdobole	*Hagenia abyssinica*	Tree	Leaves, roots	whole year
46	Lugeni	*Laportea ovalifolia*	Shrub	Leaves	Whole year
18	Mpalapala	*Macaranga kilimandscharica*	Tree	Roots and leaves	Whole year
19	Mtamu	*Maytenus acuminate*	Tree	Stem, leaves and roots	whole year
20	Mfusta	*Myrianthus arborea*	Tree	Leaves	Whole year
21	Mwefi	*Myrica salicifolia*	Tree	Stem	Whole year
22	Mngogo	*Nuxia floribunda*	Tree	Roots	whole year
23	Lwenyi	*Ocimum suave*	Shrub	Roots	Whole year
24	Mheti	*Ocotea usambarensis*	Tree	Bark	whole year
25	Mliandege	*Olinia rochetiana*	Tree	Bark	Whole year
26	Mdunula	*Osyris Lanceolata*	Shrub	Leaves and roots	whole year
27	Msaula	*Parinari excels*	Tree	Roots and leaves	Whole year

	Vernacular name	Scientific name	Growth form	Part used	Availability
28	Mpodo	*Podocarpus latifolius*	Tree	Leaves	Whole year
29	Mwiluti	*Prunus Africana*	Tree	Bark and leaves	whole year
30	Kihanga	*Rhamnus mucronata*	Shrub	Roots	Wet season
31	Kitunumbi	*Rhus sp.*	Shrub	Roots	whole year
32	Mwifya	*Rubus sp.*	Tree	Leaves	Wet season
52	Lizwana	*Saba comorensis*	Tree	Roots and leaves	Whole year
33	Mhogolo	*Schreber alata*	Tree	Stem	whole year
34	Mgogola	*Scolopia stolzii*	Tree	Leaves	whole year
35	Sungasunga	*Sonchus schweinfurthii*	Grasses	Leaves	Whole year
36	Muvengi	*Syzigium cordatum*	Tree	Roots and leaves	whole year
37	Mikusu	*Uapaca kirkiana*	Tree	Bark	whole year
41	Msiusi	Unidentified	Tree	Bark	whole year
42	Mtanangwe	Unidentified	Shrub	Leaves and roots	whole year
48	Lipogo	Unidentified	Shrub	Roots	whole year
40	Kingatona	Unidentified	Tree	Roots	whole year
43	Muhenyi	Unidentified	Tree	Leaves and roots	whole year
44	Nyakasage	Unidentified	Tree	Roots	whole year
38	Libagwi	Unidentified	Grasses	Leaves	Wet season
45	Mkungasale	Unidentified	Shrub	Roots	whole year
39	Mnyagawi	Unidentified	Climber	Leaves	Wet season
47	Litoganigo	Unidentified	Tree	Leaves	whole year
49	Mtando	Unidentified	Tree	Leaves	whole year
50	Mnunu	Unidentified	Tree	Stem	whole year
51	Mwasa	Unidentified	Shrub	Leaves	whole year
53	Mtuguto	*Veronica subligera*	Tree	Leaves	Whole year
54	Kiwangaduma	*Zanha africna*	Tree	Leaves, bark and stem	whole year
55	Mlung’ulung’u	*Zanthoxylum deremense*	Tree	Roots and leaves	whole year

Appendix 9: List of recorded and identified NTFPs commonly used as woodfuel in the NDUFR

	Vernacular name	Scientific name	Growth form	Availability
1	Mpumu	*Aphloia theiformis*	Tree	whole year
2	Mtowo	*Azanza garckeana*	Tree	whole year
3	Mwitsa	*Bridelia micrantha*	Tree	whole year
4	Muholo	*Canthium oligocarpum*	Tree	whole year
5	Mlelulelu	*Casearia gladiiformis*	Tree	whole year
6	Msegela	*Cassipourea gummifera*	Tree	whole year
7	Mvulugu	*Croton mycrostacharica*	Tree	whole year
8	Mfilfila	*Garcinia volkensii*	Tree	whole year
9	Mdobole	*Hagenia abyssinica*	Tree	whole year
10	Mbechela	*Juniperus procera*	Tree	whole year
11	Mpalapala	*Macaranga kilimandscharica*	Tree	whole year
12	Mtamu	*Maytenus acuminate*	Tree	whole year
13	Mfusta	*Myrianthus arborea*	Tree	whole year
14	Mngogo	*Nuxia congesta*	Tree	whole year
15	Mheti	*Ocotea usambarensis*	Tree	whole year
16	Mliandege	*Olinia rochetiana*	tree	whole year
17	Mdunula	*Osyris Lanceolata*	Shrub	whole year
18	Mpodo	*Podocarpus latifolius*	Tree	whole year
19	Mdeke	*Polysius fulva*	Tree	whole year
20	Mwiluti	*Prunus africana*	Tree	whole year
21	Mhogolo	*Schreber alata*	Tree	whole year
22	Muvengi	*Syzigium cordatum*	Tree	whole year
23	Mpusa	*Teclea nobilis*	Tree	whole year
24	Mikusu	*Uapaca kirkiana*	Tree	whole year
27	Msiusi	Unidentified	Tree	whole year
25	Muita	Unidentified	Tree	whole year
29	Mtasamani	Unidentified	Tree	whole year
26	Kingatona	Unidentified	Tree	whole year
28	Muhenyi	Unidentified	Tree	whole year
30	Msada	*Vangueria infausta*	Tree	whole year
31	Msambalawe	*Vangueria volensii*	Tree	whole year
32	Mtuguto	*Veronica subligera*	Tree	whole year
33	Mlung’ulung’u	*Zanthoxylum chalybeum*	Tree	whole year
34	Mlung'ulung’u	*Zanthoxylum deremense*	Tree	whole year

Appendix 10: List of recorded and identified NTFPs commonly used as poles in the NDUFR

	Vernacular name	Scientific name	Growth form	Availability
1	Mtanga	*Albizia gummifera*	Tree	whole year
2	Mpumu	*Aphloia theiformis*	Tree	whole year
3	Mwitsa	*Bridelia micrantha*	Tree	whole year
4	Muholo	*Canthium oligocarpum*	Tree	whole year
5	Mlelulelu	*Casearia gladiiformis*	Tree	whole year
6	Msegela	*Cassipourea gummifera*	Tree	whole year
7	Mnung'anung'a	*Clausena anisata*	Tree	whole year
8	Mvulugu	*Croton mycrostacharica*	Tree	whole year
9	Msisina	*Diospyros whyteana*	Tree	whole year
10	Mhekele	*Euclea divinorum*	Tree	whole year
11	Mdobole	*Hagenia abyssinica*	Tree	whole year
12	Mbechela	*Juniperus procera*	Tree	whole year
13	Mpalapala	*Macaranga kilimandscharica*	Tree	whole year
14	Mtamu	*Maytenus acuminata*	Tree	whole year
15	Mfusta	*Myrianthus arborea*	Tree	whole year
16	Mngogo	*Nuxia congesta*	Tree	whole year
17	Mliandege	*Olinia rochetiana*	tree	whole year
18	Mdunula	*Osyris Lanceolata*	Shrub	whole year
19	Mianzipoli	*Oxystenanthera abssyinica*	Shrub	whole year
20	Msaula	*Parinari excelsa*	Tree	whole year
21	Mpodo	*Podocarpus latifolius*	Tree	whole year
22	Mdeke	*Polysius fulva*	Tree	whole year
23	Mwiluti	*Prunus africana*	Tree	whole year
24	Mnyalati	*Rapanea melanophloeos*	Tree	whole year
25	Mhogolo	*Schreber alata*	Tree	whole year
26	Muvengi	*Syzigium cordatum*	Tree	whole year
27	Mpusa	*Teclea nobilis*	Tree	whole year
29	Msiusi	Unidentified	Tree	whole year
32	Muita	Unidentified	Tree	whole year
30	Mtasamani	Unidentified	Tree	whole year
28	Kingatona	Unidentified	Tree	whole year
31	Muhenyi	Unidentified	Tree	whole year
33	Nyakasage	Unidentified	Tree	whole year
34	Mtuguto	*Veronica subligera*	Tree	whole year
35	Kiwangaduma	*Zanha africna*	Tree	whole year
36	Mlung’ulung’u	*Zanthoxylum deremense*	Tree	whole year