FOREST COVER CHANGE AND ITS EFFECTS ON THE LIVELIHOODS OF THE DEPENDENT LOCAL COMMUNITIES IN MASESE LOCAL FOREST RESERVE IN SESHEKE DISTRICT

BY

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Declaration

I, Arnold Mahonko Banda, do hereby declare that this dissertation represents my own work, and that it has not been previously submitted for a degree, diploma or any other qualification at this university or any other university. Any published work or material from other work that has been incorporated has been duly referenced and acknowledged.

Arnold Mahonko Banda

Certificate of approval

This dissertation of Arnold Mahonko Banda has been approved as partial fulfilment of the requirements for the degree of masters of Science in Geography by the University of Zambia.

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Abstract

Forest play a number of functions such as the provision of wood for timber and fuel, building materials, household implements, wild food, herbal medicines and many others to many rural communities in Zambia including Sesheke District. Forest also provides a wide range of services such as prevention of soil erosion and regulation of climate. Forest cover change has adverse implications on the provision of wood and non-wood forest products to the dependent local communities. This study investigated forest cover change and its effects on the livelihoods of dependent local communities in MLFR. The objectives of the study were to establish the occurrence of forest cover change in MLFR; to determine the extent of forest cover change from 1990 to 2005; to identify the tree species that have been affected by forest cover change; and to assess the effects of forest cover change on the livelihoods of the dependent local communities.

The study used a combination of primary and secondary data. Primary data were collected using interview schedule and field observations for the collection of information on the effects of forest cover change on dependent local communities living within the vicinity of MLFR. The data were collected from Maondo and Mulimambango wards and the sample was proportionally and randomly selected. Secondary data were obtained from archival sources (published and unpublished). These included scenes of landsat images for the years 1990, 2005 and 2005 that were used to establish forest cover change occurrence, extent of forest cover change and tree species that have been affected by forest cover change in MLFR.

To analyse the landsat images, the images were classified and then imported into ArcGis 9.3 to map and determine the annual LUFCC (reduced or increased area cover). The study established that there is forest cover change in MLFR at an average rate of 440.20ha per year or 0.065 percent per year between 1990 and 2005. In 1990 the forested area was estimated at 43,544.68ha and reduced to 36941.61ha in 2005 0r 61.9 percent of the total forest reserve land area of 59,689ha. The extent of forest cover change was estimated at 6.603.07ha equivalent to 15.16 percent for the 15 years period between 1990 and 2005. *Baikiaea* forest and *Kalahari* woodlands are the types of vegetation that have been adversely affected by forest cover change. The major tree species that have been affected are *Baikiaea plurijuga, Pterocarpus mantunesii and rose wood* because of their widely usage commercially and domestically purposes. The product moment correlation coefficient was used to measure the degree of association between distance and amount of firewood used; and distance and amount of money spent buying building materials. The study revealed that there was significant correlation between: (i) distance covered to collect firewood and amount of firewood used per household at a correlation of 0.276 at 0.01 significance level; and (ii) distance covered to fetch building materials and amount of money spent to buy building materials per household at a correlation of 0.213 at 0.05 significance level. Therefore, forest cover change in MLFR has made local communities suffer in terms of shortage of wood products (timber, fuel wood and wood for making household implements) and non-wood products such as wild food, mushroom, medicines, etc., such that they cover long distances to collect these forest products or spend more money buying them.

There is therefore need to formulate new policies that will aim at improving forest management that should also include tree planting in order to reduce the current forest cover change rate in MLFR and embark on alternative forest use to improve the livelihoods of dependent local communities.

Acknowledgement

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List of acronyms

CC	Carbon Cover
CSO	Central Statistical Office
EIA	Environmental Impact Assessment
ETM	Enhanced Thematic Mapping
FAO	Food and Agricultural Organization
FC	Forest Condition
FD	Forestry Department
GPS	Geographical Positioning System
GRZ	Government of the Republic of Zambia
HDF	High Density Forest
LDF	Low Density Forest
LUFCC	Land Use and Forest Cover Change
MDF	Medium Density Forest
MLFR	Masese Local Forest Reserve
NDVI	Normal Difference Vegetative Index
NF	Non Forest

NWFP	Non Wood Forest Products
ODF	Open Density Forest
WFP	Wood Forest Products
ZEMA	Zambia Environmental Management Agency
ZESCO	Zambia Electricity Supply Cooperation
ZMK	Zambian Kwacha

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CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Forests play a number of roles such as the provision of wood fuel, building materials, timber, wild foods and herbal medicine to a number of rural communities and for the country's economic development. Forests also provide a wide range of services such as prevention of soil erosion, regulation of climate, protection of catchment areas and others that create opportunities for the development and enhancement of the well-being of the people. This is particularly true for rural areas like Sesheke District where the majority of local people depend on the forests for their livelihoods. However, some of the practices employed in the harvesting of forest resources are detrimental to the resource base, resulting in forest cover change which has consequently affected the livelihoods of dependent local communities. For example, in Sesheke large volumes of forestry resources are harvested every year and in most cases the methods of extraction of the forestry resources are unsustainable due to lack of supervision. Infrastructure development (electricity pylons and road construction), pressure from human population growth and other land use activities have also led to forest cover change.

Even though the forest resources of Zambia are one of the highest in the Southern Africa region (estimates between 47% - 67% forest cover) it is decreasing at a rate of between 300,000 ha and 445,000ha per annum (Ng'andwe et al., 2007; Mukosha, 2006 and Mbindo, 2007). Literature show that the actual rate of forest cover loss in Zambia is not accurately known resulting in a wide range of figures being reported ranging from 300,000 to 851, 000 ha per annum (Forestry outlook studies for Africa, 2003 and FAO, 2005). Agricultural activities and wood fuel continue to have the

largest share of wood removal in the country with over 7 million cubic metres removed every year . Industrial round wood removal from all forest types combined was projected to reach over 1 million cubic metres and in 2006 was estimated at 59,000$m^3$from indigenous forests (FAO, 2011). It is estimated that the demand for timber will soon outstrip the potential supply of 400,000m^3 per annum (Ng'andwe et al., 2007). The amount of forest loss per year in Zambia is estimated at 0.91%. In total, between 1990 and 2005, Zambia lost 13.6% of its forest cover (FAO, 2011).

Forestry Department and FAO (2008) found out that the mean volume of the forests in Zambia is relatively low, ranging from 40m^3/ha in deciduous *Baikiaea* forest and mopane woodland to 67m^3/ha in evergreen *mavunda* forest and these two types of forests are linked to each other. In Sesheke, *Baikiaea* forest is the common type of forest followed by Kalahari woodlands in Sesheke District and in Masese Local Forest Reserve in particular. The Forestry Department and FAO (2008) contend that forests with tree cover of between 10% and 40% whose volume is reduced to around 40m^3/ha are said to have declined or changed. Therefore, any human activity or indeed a natural cause that may reduce the canopy cover of trees to less than 40% amounts to forest cover change. The implication of this forest cover change is that forest resources base for the provision of wood fuel, building materials, timber, wild foods, herbal medicine and others has declined affecting the dependent local communities.

Literature reviewed indicated that there is evidence of forest cover change in Zambia although the rates of change figures are conflicting. This forest cover change has adverse implication on the provision of both wood and non-wood forest products to the dependent local communities living in the vicinity of Masese Local Forest

Reserve. The livelihoods that have been affected in Masese Local Forest Reserve are provision of wood fuel, poles for construction of houses, industrial timber, wild foods such as mushrooms, fruits, leafy vegetables, tubers, herbal medicine, etc. This study therefore, identified the extent of forest cover change in Masese Local Forest Reserve and its effects on the livelihoods of the dependent local communities.

1.2 Statement of the Problem

The continued increases in loss of forest cover due to unsustainable forest resources utilization such as unsupervised logging, agricultural activities, infrastructure development (electricity pylons and road construction) and other land use activities have led to declining of forest condition, loss of tree species and biodiversity which often affects the livelihoods of the dependent local communities negatively in the long run. Thus, decrease in forest cover threatens not only the environment but also livelihood security for local communities' sustenance.

1.2 Aim

The aim of the study was to investigate forest cover change and its effects on the livelihoods of dependent local communities in Masese Forest Local Reserve.

1.3 Objectives

i. To establish the occurrence of forest cover change in Masese Local Forest Reserve.
ii. To determine the extent of forest cover change in Masese from 1990 to 2005
iii. To identify the tree species that have been affected by forest cover change in Masese.

iv. To assess the effects of forest cover change on the livelihoods of the dependent local communities.

1.4 Research Questions

i. What is the nature of forest cover change in Masese Local Forest Reserve?

ii. What is the extent of forest cover change between 1990 and 2005 in Masese Local Forest Reserve?

iii. What tree species ha**v**e been affected by the forest cover change in Masese Local Forest Reserve?

iv. How have the livelihoods of the people been affected by forest cover change?

1.5 Hypothesis

i. There is a significant relationship between the distances (km) covered to collect firewood and amounts of fire wood (m^3) used per household.

ii. There is a significant relationship between the distances (km) covered to fetch building materials and amount of money spent to buy building materials per household.

1.6 Significance of the Study

Zambia has recorded high rate of forest cover change since 1990. This has brought in suffering to communities that depend on forests resources for their survival. Forestry Management is therefore important for dependent local communities as it can help to minimize future shortage of forests resources for survival of local rural people. The study, therefore, provides information that is of practical use to policy makers and foresters in development plans of the forests. Furthermore, the study was worth undertaking because it adds to literature on current forest cover, extent of forest cover change and the condition of tree species. The study also provided insights to the

many questions regarding LUFFC and its effects to dependent local communities thus contributing to the body of knowledge on forestry management. The study findings will also help government as it embarks on formulating new forest provisions.

1.7 Organization of the Dissertation

This dissertation comprises of six chapters. Chapter one is the introduction to the study. Chapter two reviews the relevant Literature on forest cover change and its effects on the dependent local communities. Third chapter presents a description of the study area. Chapter four describes the methods used to collect and analyse data. Research findings and discussion are presented in chapter five. Chapter six provides a summary of findings and conclusion followed by the recommendations arising from the conclusion.

CHAPTER TWO: LITERATURE REVIEW

The chapter reviews works on forest cover change and its effects on the livelihoods of the dependent local communities.

2.1 Forest cover change and livelihoods at the global scale

There has been increasingly forest cover change in the world for some time since the nineteenth century due to loss of forest cover. Forest cover loss is said to have been highest in Africa and southern America, with the highest net loss in Argentina, Brazil, Democratic Republic of Congo, Zambia and Zimbabwe (FAO 2001). For example, This is due to the fact that humans have most often considered the forest as space that must be cleared in order to develop settlement, agricultural land, commercial and domestic uses and other land uses where it is used beyond its capacity to regenerate itself, as a wood and forage resource (Goudie, 2000; Allen and Barnes, 1985; FAO, 2011 and Turner *et al*., 2003).

The study done by Foley (2007) in Brazil founded out that selective logging, under storey fires, fuel wood harvesting and others are responsible for forest cover change in Brazil. Cleaver and Schreiber (1993) also did a similar study in South East Asia on forest cover change and the results were similar to those of Foley (2007). Globally, between 1990 and 2000 the world lost estimated forest cover of about 8,334,000ha annually with annual loss rate of 0.2 percent. While between 2000 and 2010 total world forest loss was estimated at 5,216,000ha per annum with annual change rate of 0.13 percent (FAO, 2011). The data shows that there was slightly reduction in the world forest cover loss between 2000 and 2010 due to re-a forestation in some parts of the world especially in Europe and North America (FAO, 2011). The other reason could be that other countries didn’t submit forest data to food and agriculture

Organization for data compilation. What is cardinal to note is that the world forest cover is no longer intact but has under gone changes and whose changes has not left dependent local communities unaffected.

2.1.1 Effects of forest cover change on livelihoods of dependent communities at a global level

Many rural communities have suffered the impact of forest cover change which is a result of declined forest resources although what is documented in most literatures is the extent of forest cover change without its adverse effects on the dependent communities. *Bhatt and Sachan* (2003) attempted to study the effects forest cover change on the local people in the mountain villages of India and found that people covered longer distance (between1.5km and 3km) to collect firewood in the mountain villages of India due to forests that have been affected by forest cover change. *Bhatt and Sachan* (2003) further discovered that fire wood collection was mainly done by women whose time to attend to other livelihoods activities was greatly reduced as most of their time was spent fetching fire wood in the mountains.

2.2 Forest cover change and livelihoods in Africa

According to FAO (2011) five countries with the largest forest area in Africa are Democratic Republic of the Congo, Sudan, Angola, Zambia and Mozambique who together contained more than half the forest area of the continent (55 percent). Countries reporting the highest percentage of their land area covered by forest were Seychelles (88 percent), Gabon (85 percent), Guinea-Bissau (72 percent), Democratic Republic of the Congo (68 percent) and Zambia (67 percent).

FAO (2011) indicates that Southern Africa had the highest net loss at the sub regional level over the last 20 years. Furthermore, countries with large areas of forest, that includes Zambia, reported the most significant losses. In addition to the five countries with the largest forest area, Cameroon, Nigeria, the United Republic of Tanzania and Zimbabwe also reported large losses.

Malawi, Madagascar and Gabon registered the largest annual loss of forest, an area of more than 330 000 ha per year, largely due selective logging and other human interventions. These unsustainable methods of forest utilization have largely led to forest cover change in Africa. According to FAO (2011), annual forest cover change rate in Africa was estimated at 0.56 percent between 1990 and 2000, and at 0.49 percent between 2000 and 2010 respectively. This annual forest cover change rate has negative impacts on the livelihoods of most local communities who depend on the forest resources for survival.

2.2.1 **Effects of forest cover change on livelihoods of dependent communities in Africa.**

In an African context, forests are vital for the welfare of millions of people, especially the rural populace and their use could improve livelihoods and quality of life (Dewees, 1989). Over two-thirds of Africa's population rely directly and indirectly on forests for their livelihoods. However, in about 1990, it was recognised that huge and growing numbers of people in Africa who depend on forestry products for industrial and domestic use has led to predictions of potentially devastating depletion of forest resources, with serious negative livelihood consequences for the rural people (Bernstein *et al.*, 1992; Grainger, 1992). For example, the Mau forest in Kenya has been affected due to forest cover change as a result it has inflicted a lot of suffering on

the largest group of forest dwellers, the Ogiek people who have been living inside the Mau forest, depending on the forest for subsistence and shelter (Obare and Wangwe, 2005).

Most rural African population also depend on wood from forest for making hand tools. Kings et al., (2000) found out that species such as *Pericopsis angolensis, Dalbergia melanoxylon and Afzelia quanzensis* are important species for carving and making hand tools. However, these tree species have been affected by forest cover changes in many African countries.

2.3 **Forest cover change and livelihoods in Zambia**

Zambia's forest resources cover is estimated at between 47% to 67% and is decreasing at a rate of between 300,000 ha and 445,000ha per annumof the total land area (FAO 2005; Ng'andwe et al., 2007; Mukosha 2006 and Mbindo, 2007). About 9.0 percent of the forests in Zambia are gazetted as protected forest areas or local forest reserves, although encroachments in forest reserves are a major problem (GRZ 2006b). Forest cover in Zambia has continued to decline both in quantity and quality due to a number of factors such as the extensive slash and burn practices of shifting cultivation, high demand for wood-based energy, unsustainable use of the few known indigenous commercial tree species, over-grazing and forest fires. In Zambia, between 1990 and 2000, the country lost an average of 445,000 hectares of forest every year and the trend has since continued (FAO, 2005; Mukosha, 2006; Mbindo, 2007).This is due to a number of reasons such as lack of proper management regimes, forestry encroachment, unsustainable forestry utilization, lack of alternatives by people who depend on the forests for livelihood, limited institutional capacity in Forestry Department, etc. (Shitima, 2005).

Forest Cover Change occurs when agents clear forested land and subsequently change its use to another land-use option (i.e. cultivated or built-up land). FAO (2000) defines forest cover change as the "change of land cover with depletion of tree crown cover to less than 10 percent". The change within the forest class (e.g. from an intact forest to an open forest) negatively affects the stand or site and, in particular, it lowers the production capacity of the forest (FAO 2000). The deciduous *Baikiaea* forest is one of the common types of forest in Zambia which is commercially and domestically exploited and it falls under the forest volumes whose stock was found to be lower than 10% during the Integrated Landuse Assessment (FD and FAO, 2008), this therefore, indicates how threatened the Forest reserves are in Zambia which consequently affect people's livelihoods.

2.3.1 **Effects of forest cover change on livelihoods of dependent local communities in Zambia.**

Forests provide important sources of livelihood income for rural people in Zambia, and provide safety nets in times of need (Jumbe et al., 2006). In particular, rural households depend on forest and woodland resources to meet their energy needs, for construction and roofing materials, fodder for livestock, wild foods that support a healthy diet, medicine and timber.

According to GRZ (2007), forests contribute 70 percent of Zambia's national energy needs. Woodfuels (firewood and charcoal) are by far the largest energy source in Zambia and the major commercial forest product from indigenous forests. Annual consumption of woodfuel was more than 7.2 million tons in 2002 (FAO, 2005). Two thirds of this woodfuel is consumed in rural areas where almost all households depend on firewood for domestic use. The data on wood fuel consumption in Zambia is clear

but does not show the tree species that really important as energy sources since not all tree species are good for fuel.

Forests play a vital role in construction materials such as poles, rope fibre, rafters and grass. Kings et al., (2000) states that house and barn construction requires many poles of various dimensions and weights, as well as rope fibre for tying them together and grass for thatching.

Forests also provide the principle materials for timber and for making domestic implements like hoe and axe handles, pestles and mortars, cooking sticks, drums, walking sticks and bow and arrows (Kings et al., 2000).

Forests can contribute directly to income generation by providing formal and informal employment. For example, timber industry in the late nineties, roughly 2000 people found employment harvesting, transporting or processing saw-logs for timber (Jumbe et al., 2006). Between 1993 and 2003 the Zambia Investment Centre recorded 63 companies trading wood and wood products during the period (FSP, 2004).

Honey production is another important livelihood in Zambia. For example, beekeeping sector was recorded as the third largest employer in Kabompo district, North western Province, in 2004 (Kaitisha, 2007 and ITC/DTCC, 2007)).

Mushrooms, fruits, leafy vegetables, tubers and insects collected from miombo woodlands are widely consumed by rural households as wild foods and enrich their starch-based diets with important vitamins and minerals. These foods are often available at the start of the rainy season and thereby serve as an important gap-filler when food stocks are low (Packham, 1993; Chileshe, 2005). Furthermore, for many rural women, trade in forest foods is an important source of cash. More than fifty trees bearing edible fruits are found in Zambia.

Approximately 25 different edible mushroom species have been documented in Zambia (Pegler and Pearce, 1980). In Chiulukire local forest, Eastern Province, eleven species are commonly collected during the rainy season. Women are responsible for collecting mushrooms. The trade of mushrooms is visibly substantial, though volumes traded at national level are unknown. Roots of various species (including Rychnosia, Eminia and Vigna) are harvested to make munkoyo, a fermented non-alcoholic beverage (Zulu et al., 1997). Munkoyo is very popular soft drink in rural areas especially during traditional ceremonies (Malungo, 2001).

A variety of insects are consumed in Zambia and these provide an important source of protein and household income (Illgner and Nel, 2000). More than 60 species of insects in at least 15 families and 6 orders have been reported as food in Zambia (DeFoliart, 1999).The most popular edible insects, in terms of total consumption and trade, are caterpillars. Mbata et al., (2002) describe the use of caterpillars among the *Bisa* people in Northern Province as useful dietary food.

In Kasanka National Park, Northern Province, trade in caterpillars has always been a main source of income, and local chiefs receive a handsome share of this income, which encourages them to promote caterpillar breeding. Nevertheless, villagers reported a decrease in availability during the past decades due to a decline in overall tree cover (Eriksen, 2007). Sometimes trees are cut to facilitate the harvesting of caterpillars, but caterpillars may also provide an incentive for people to regulate bush fires, thereby protecting caterpillars and enhancing woodland regeneration (DeFoliart, 1995).

Roots, shoots, leaves and bark of many plants, as well as animal products, are used for healing and protective purposes. Plant-derived medicines are used in self-treatment of

common ailments, such as coughs, headaches and stomach problems. There are about 30-50 plants used for medicinal purposes and there is a flourishing market in urban areas (Puustjärvy et al. 2005).

The literature searched has revealed that there is forest cover change in the world, Zambia inclusive that has effected people's livelihoods in general but no specific study has been carried out in Masese Local Forest Reserve in Sesheke District despite the threatening indication of forest cover change in the area hence the reason for this study.

CHAPTER THREE: SELECTION AND DESCRIPTION OF THE STUDY AREA

This chapter looks at the selection, location and description of the study area, focusing on the physical characteristics as well as socio-economic characteristics of the area.

3.1 Selection of the Study Area

MLFR in the recent past has been experiencing a change in forest cover arising from unsustainable forests resources extraction. Many rural communities in Sesheke District depend on forests for their livelihoods but there is emanating threats to their livelihoods due to reduction forest cover. MLFR was selected as a study area due to the fact that it has deciduous *Baikiaea* type forest whose mean volume was found to be relatively low by Forest Department and FAO (2008). This motivated the researcher to conduct a study in order to determine the extent of forest cover change in MLFR and find out how local communities have been affected owing to the change in forest cover.

3.2 Location and size of study area

MLFR is located about 4 kilometer north of Sesheke town. It lies between Zambezi River, Sesheke-Livingstone road on the south and Loanja stream on the north, Lwampungu road on the west and Mulobezi road on the eastern part.. Sesheke District is located between 15º 30’S and 17º 40’S and extends from 23º 00’E to 25º 12’E. MLFR lies between 17° 13’S to 17° 40’S and extends from 24° 14’E to 24° 44’E covering areal size of about 59,689.00ha (596.89km^2).

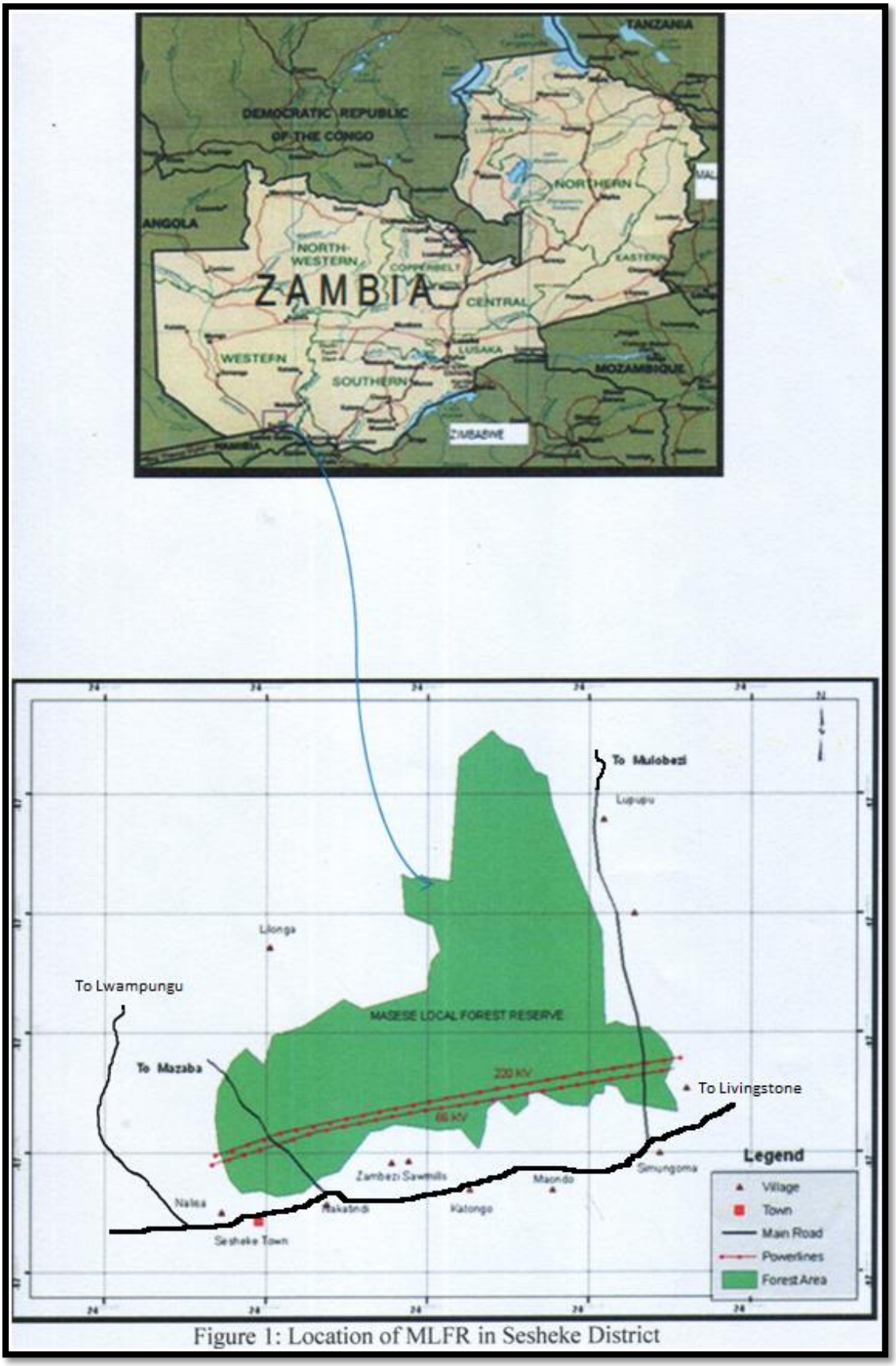

Figure 1: Location of MLFR in Sesheke District

3.3 Physical characteristics of the Study Area

The Physical characteristics of MLFR which have been considered in this section include relief and drainage, climate, vegetation and soils.

3.3.1 Relief and Drainage

MLFR is a dissected plateau sloping towards the Zambezi River with the elevation of between 900m and 1200m above sea level. It is drained by Zambezi River and Loanja Stream.

3.3.2 Climate

The area experiences modified tropical type of climate with three seasons namely: cold dry season (May to August), hot dry season (September to October) and hot wet season (November to April). Temperature varies from mean maximum of 30°C and mean minimum of 20°C. The study area has the greatest temperature extremes with hot maximum of about 40^{o} C and freezing in dry cold season to about 4^{o} C. MLFR receives less than 800mm of rainfall annually. This climate favours the growth tree species such as *Baikiaea plurijuga, Pterocarpus antunesii*, rose wood and others.

3.3.3 Vegetation and Soils

The vegetation of MLFR is mainly dry deciduous forest which has two layers confined to the dry *Kalahari* sands. The diversity and variation are influenced by among other things soil conditions, drainage and their physiographic position.

3.3.3.1 Soils

Sesheke is part of Western Province that has *Baroste* sand type of soil. The study area has a Kalahari sandy type of soil which are of two kinds namely moderately leached and strongly leached red soils. The *Kalahari* sands favours the growth tree species such as *Baikiaea plurijuga*, *Pterocarpus antunesii* and rose wood

3.3.3.2 Types of vegetation

Fanshawe (1971) classified the vegetation of Sesheke District as follows: *Baikiaea* forest that are dominated by *Baikiaea plurijuga* (commonly known as *Zambezi* Teak or *Mukusi*) and *Pterocarpus antunesii* (locally known as *Mukwa*). *Baikiaea* is the dominant forests type in Sesheke District and in MLFR in particular it is scattered across the forest. The *Kalahari* woodland is also dotted on the forest. The above types of vegetation play important role in as far as human survival in Sesheke District is concerned. Commercial loggers who exploit *Baikiaea plurijuga* (*Mukusi*), *Pterocarpus antunesii (Mukwa*) and rose wood (*Muzauli*) which are commercially valuable trees employ local people. Most of the timber harvested by timber merchants is mainly exported as processed logs.

There are also other species such as AfzeliaQuanzansis (*Mwande*), *Entandrophragma caudatum*, (*Mupumena),Pericopsis angolensis* (*Mubanga*), *Burkea africana* (*Musheshe)* and *Combretum imberbe* (*Muzwili*) that are used for making curios, hand tools, pestles etc. Local people also use the vegetation for various purposes such as wood fuel, medicine, construction materials and collect fruits, mushrooms and leaves for food.

3.4 Demographic factors

According to CSO (2010), the population of Sesheke District has been steadily growing since 1990. In 1990, the population of Sesheke District stood at 68,424 people with the growth rate of 1.4 and density of 2.3 people per square kilometre. In 2000, population growth was at 1.3% and 78,169 people. The population density was 2.7 people per square kilometre. The population for 2010 stood at 99,384 people with the growth rate of 2.4%. The population density is 3.2 persons per square kilometre though the population is concentrated in certain areas especially along the Livingstone – Sesheke road, Zambezi River, defunct Zambezi Saw Mills and Sesheke town. Masese Local Forest Reserves is found near Maondo and Mulimambango wards (settlements) where the population is quite concentrated with 28.5 percent of total population of Sesheke District. The total population in these wards is 28,349 while the number of households is 5, 863.

3.5 Economic characteristics

The major economic activities of the study area are small-scale trade such as sale of fish, agricultural produce and other forestry products. The source of income for the local people is limited due to lack of modern industries apart from timber merchants in which many people are employed. The income levels of the people in the area are equally low.

The economy of the people in vicinity of MLFR is centred on small-scale agriculture (crop production and livestock rearing) and fishing. There are also commercial timber merchants who process logs mainly for export. Furthermore, forest resources play a significant role in the socio-economic of dependent local communities such as providing materials for making curios, dug-out canoes, hand tools and poles for building houses.

CHAPTER FOUR: METHODOLOGY

This chapter outlines the sources of data and methods used in data collection, sampling procedure and data analysis.

4.1 Sources of data

Secondary data was obtained mainly from archival sources (published and unpublished). This also covered an extensive review of existing literature; both published and unpublished, on forest cover change and its effects on dependent local communities all over the world. Scenes of land sat images of 1990, 2000 and 2005 that were captured between August and September were downloaded using the Path-Row 174072 respectively. The data was used to detect land use classes, determine forest cover change occurrence, detect extent of forest cover change and tree species that have been affected in MLFR.

4.2 Methods of primary data collection

Primary data utilized interview schedule, interview guide and field observations for the collection of information on effects of forest cover change on dependent local communities living within the vicinity of MLFR. The data was collected from Maondo and Mulimambango wards. These are the settlements that are within vicinity of MLFR.

4.2.1 Field survey

This was undertaken to gather information on what tree species have been affected by forest cover change in MLFR and how the livelihoods of the people have been affected by forest cover change utilizing instruments such as interview schedule.

4.2.2 Interview schedule

The information collected under this instrument included the history of MLFR and the people in their present location, economic activities, and status of wood and non-wood forestry products and there availability including distances of their location in

the forest. Also information on common tree species and their availability was gathered using this instrument. Interviews were held with the key informants to know history of MLFR, find out tree species that have been affected by forest cover change and to find out how livelihoods of the local people have been affected by forest cover change.

4.2.3 Field Observations

A GPS was used to record ground control points and photos were captured for field observations. These were undertaken to validate the forest cover change, vegetation types and livelihoods that have been affected by forest cover change in MLFR. Field observations were used to validate whether landsat images depicts what is actually on the ground.

4.3 Sampling Procedure

The study utilized two percent of heads of households in the two wards, which were the study sites thus Maondo and Mulimambango to administer interview schedule. The total number of households was 5,863 and 2 percent of that was 117.26 households. This was rounded off to the nearest workable figure of 120 for easy determination of proportion. A proportional sample was preferred to ensure equal representation of different classes of local residents. Random sampling was used to avoid bias in the result and initial selection of respondents. Thus, a proportion of 36 households from Maondo and 84 households form Mulimambango. All the names of the heads of various households in the sampled villages were extracted from the registers that are regularly updated and kept at Sesheke District Administration Office. The names of heads of households were written on pieces of paper and a random sample numbering 120. The time and financial resources available to the researcher could not allow for whole population to be involved

4.4 Sample size

The size of the sample comprised 120 households from Maondo and Mulimambango wards to administer interview schedule. The sample of 120 was seen as appropriate

for the two wards due to the limited time in which the research was to be conducted. It is also a reasonable sample size whose results could be inferred onto the whole population of the MLFR because it above 30, the rule of thumb.

4.5 Data Analysis

4.5.1 Images and map analysis

Masese Local Forest Reserve area was cut from the area covered by a scene of 174072 of Land-sat images since the entire scene was not needed. Below is a set of scenes referred above.

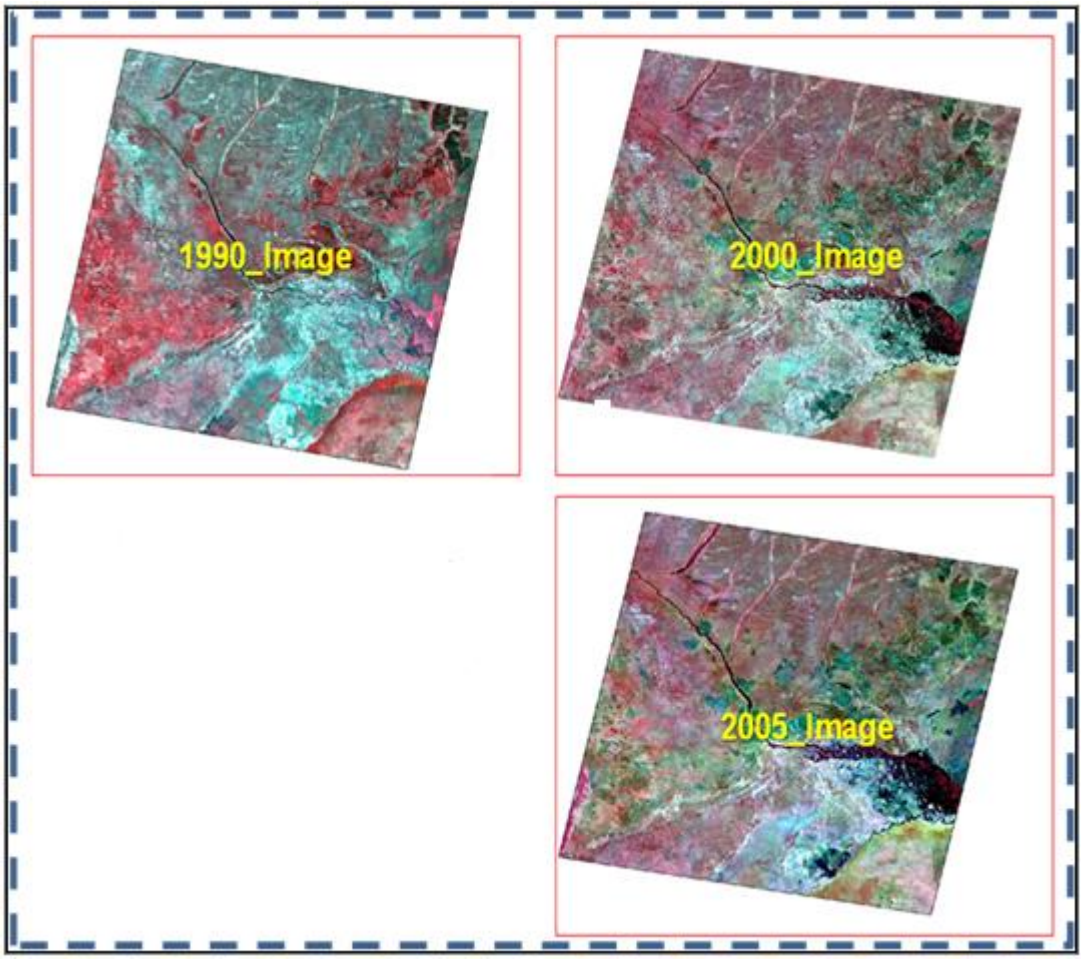

Figure 2: Land-sat ETM Scenes

Table 1 – Details of satellite images used

Date	Platform	Sensor	Format	Bands	Path-Row
10/08/ 1990	Landsat 5	ETM	TIFF	7	174-072
29/09/ 2000	Landsat 5	ETM	TIFF	7	174-072
25/08/ 2005	Landsat 5	ETM	TIFF	7	174-072

Remote sensing was used to analyze land sat images and Google image to detect forest and non-forest classes. The classified images were then imported into ArcGIS 9.3 to map and determine the annual land use forest cover change (reduced or increased area cover).

The satellite images for the area were masked using the vector layer for Masese. The masked Landsat images were pre-processed using a scene for spot 5 image to co-register their pixels and the resulting image for Masese was categorized into "forest and non-forest" classes. The pixel values for the resulting image was taken as the percentage forest cover based on the pixels from the high resolution forest/non-forest image that go into making a single output pixel. A number (i.e. several hundred) of randomly selected pixels from the sub-sampled image with their corresponding percentage tree cover according to pixel was computed using Random Forest (R). The levels of percentage tree cover were later re-sampled into standard categories of forest conditions in 1990, 2000 and 2005.

The re-sampled images were used to classify the images wall-to-wall according to the current LUFC on which, the thematic (bare soil, regenerated bare soil, vegetation changed, vegetation intact) differences between the years under review were generated and computed to obtain the LUFCC over 10, 5 and 15 years.

4.5.2 Field data analysis

Descriptive statistics comprising of frequencies and percentages were used to analyse field data. Graphical representations of these data were made where necessary using tables and graphs. Quantitative data was analysed using SPSS and product moment correlation coefficient was used to measure the degree of association between the following variables:

i. Distance covered to collect firewood and amount of fire wood used per household
ii. Distance covered to fetch building materials and amount of money spent to buy building materials per household.

CHAPTER FIVE: RESULTS AND DISCUSSION

This chapter presents and discusses the results. The analysis and discussion of results is based on the objectives starting with first objective, and then the same is done for all other objectives.

5.1 Occurrence of forest cover change in MLFR (1990 – 2005)

The interpretation of the mapping results starts with details on the forest condition (FC), land use and forest cover (LUFC), and the land use and forest cover change (LUFCC) over the years under review. This provides a basis for determining the current status of the vegetation for the area. For instance, based on the image data of 1990 and 2005 processed for Masese the LUFC annual average rate of change was estimated to be 440.20ha per year and the total current forested land is estimated at 36,941.61ha of the total forest reserve land area of 59,689ha. Therefore, the findings agree with that of FAO (2005); Ngandwe et al.,(2007); Mukosha (2006) and Mbindo, (2007) that indicates that Zambia's forest resources loss is at rate of 445,000ha per annum of the total area. This implies that MLFR has not been spared from forest cover change challenges.

5.1.2 Forest conditions each year 1990, 2000 and 2005

In 1990, the total area with the high density forest (above 80% CC), cover within the Masese Local Forest Reserve area was estimated at 19,268.16haand reduced to 11,347.59ha in 2005. Medium density forest area (50% to 79% CC) did not have remarkable change. Low density forest area (30% to 49% cc) showed slight increase between 1990 and 2000 Open density forest area (10% to 29% CC) showed remarkable increase in area. Generally, high density forest area (HDF) revealed that the coverage was decreasing while open density forest area (ODF) was increasing implying that there is forest cover change

Table 2 –Forest Conditions from 1990 - 2005

Forest Condition	Years		
	1990 (area in ha)	2000 (area in ha)	2005 (area in ha)
HDF	19,268.16	10,902.12	11,347.59
MDF	16,052.31	16,389.68	16,221.85
LDF	8,158.61	14,909.46	12,190.60
ODF	10,459.55	12,778.94	14,455.96
NF	5,750.37	4,708.80	5,473.01

Source: Land sat images statistical data

5.1.3 Land use and forest cover (LUFC) for each year 1990, 2000, and 2005

Table 3 shows that the forest area in MLFR has been reducing in hectors since 1990 to 2005. For instance in 1990 the forested area reduced from 43,544.68ha to 36,941.61ha in 2005 out of total forested land of 59,689ha. On the other hand non-forested area increased to 22,747.39ha. The non-forest area includes cultivated land ZESCO pylons, river-line areas or dambos, water, and roads within Masese. Table 3 shows the status of LUFC for the years 1990, 2000 and 2005.

Table 3 – Status of LUFC (1990, 2000 and 2005)

LUFC	Area in ha (1990)	Area in ha (2000)	Change between 1990-2000	Area in ha (2005)	Change between 2000-2005	Predicated change in ha 1990-2005
Forest area	43,544.68	37,373.26	6,171.42	36,941.61	431.65	6,603.07
Non forest area	16,144.32	22,315.74	6,171.42	22,747.39	431.65	6,603.07

Source: Landsat images statistical data

5.1.4 Land Use and Forest Cover change (LUFCC) between 1990 - 2005

Based on the change detection analysis for satellite image data of 1990 and 2000 annual LUFCC is estimated to be 6,171ha and between 1990 and 2005 the annual LUFCC was estimated at 6,603ha equivalent to 15.16 percent for the period of 15 years. By 2010 the annual LUFCC was estimated at 7034.72ha. The distribution of results for the change detection analysis over the area is accounted for under specific themes of how much land in 1990, 2000 and 2005 was bare and is still bare, was bare and has regenerated, was forest and is now bare, was forest and is still forest respectively.

Each of the thematic areas has a raster map showing the actual thematic change, loss of forest cover and overall change due to infrastructure development and agricultural activities depicted from the satellite data.

5.2 Extent of forest cover change in Masese Local Forest Reserve (1990 – 2005)

This section presents and discusses the findings of the detected extent of forest cover change from landsat images of MLFR from 1990 to 2005.

5.2.1 Extent of forest cover change between 1990 to 2000

The maps for Masese images for 1990 and 2000 show the detected thematic forest cover change over a period of ten years where red to deep brown represents forest; white patches stands for bare soil (land); greenish patches is wet bare soils; blue to black represents water and red line is the boundary for the forest reserve. There was slightly remarkable forest cover change during the period under review due to the fact that there was pressure on the forest resources owing increasing population and unsustainable commercial activities in the forest (see Figure 3 and 4).

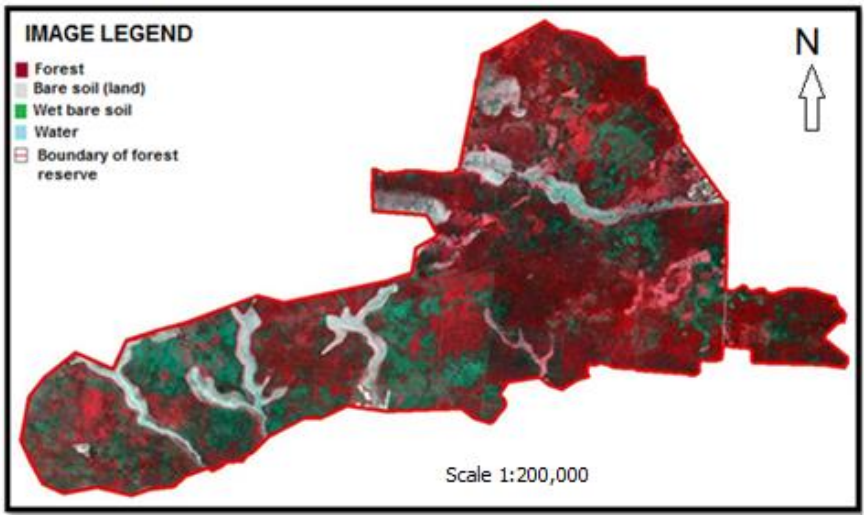

Figure 3: Analysed image of MLFR for the year 1990
Source: landsat images

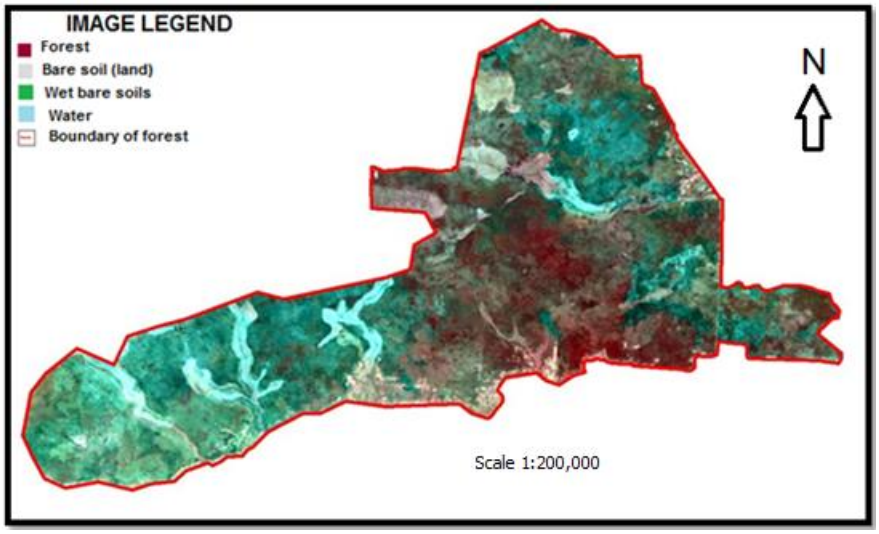

Figure 4: Analysed image of MLFR for the year 2000
Source: landsat images

The image layers were converted to normalize difference vegetative index (NDVI) and categorized to determine and detect thematic (forest) change over a period of 10 years between 1990 and 2000 as Figure 5 show thematic change detection of LUFCC results.. The detection determined that in 1990 Masese Local Forest Reserve was fairly covered with forest as red to deep blown thematic colour shows on the map. However, it is evident that in 2000 the forest cover had reduced in the forest reserve

as white patches and greenish patches represent bare land and wet bare soils which is devoid of forest.

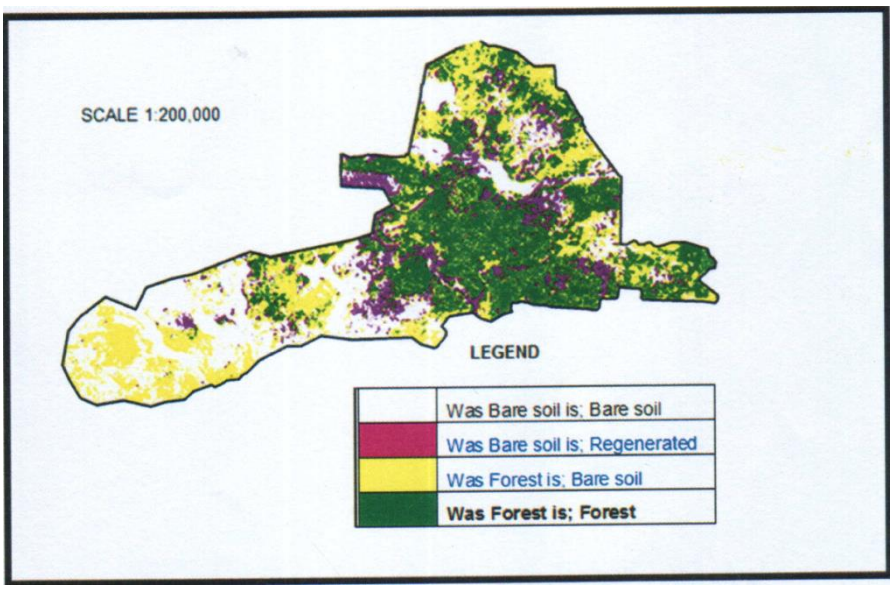

Figure 5: Extent of forest cover change in MLFR between 1990 – 2000
Source: Landsat images

5.2.2 Extent of forest cover change between 2000 to 2005

The maps for Masese Images for 2000 and 2005 show the detected thematic forest cover change over a period of five years where red to deep brown represents forest; white patches stands for bare soil (land); greenish patches is wet bare soils; blue to black represents water and red line is the boundary for the forest reserve

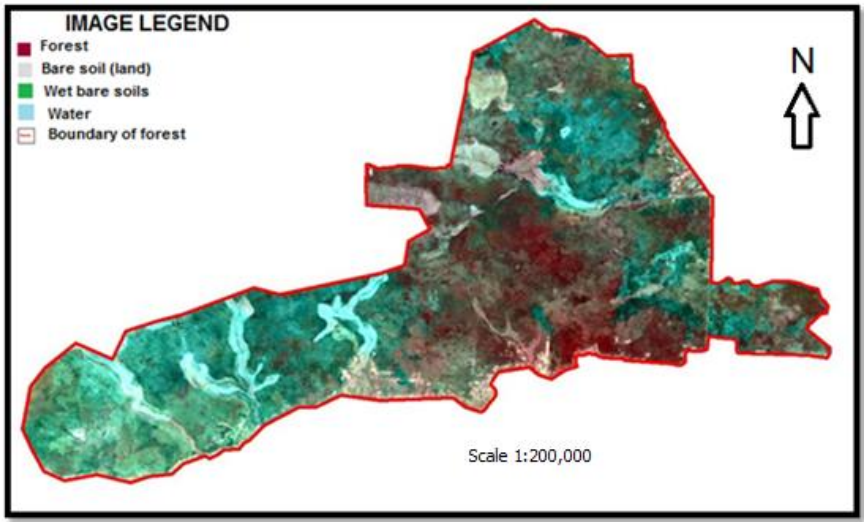

Figure 6: Analysed image of MLFR for the year 2000
Source: Landsat images

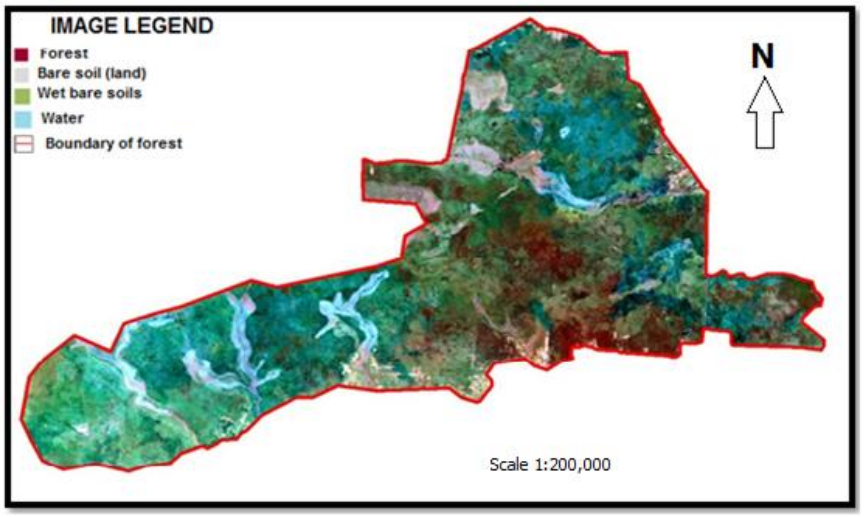

Figure 7: Analysed images of the year 2005
Source: landsat images

The image layers were converted to normalized difference vegetative index (NDVI) and categorized to determine and detect thematic (forest) change over a period of 5 years between 2000 and 2005 as Figure 8 show thematic change detection for the LUFCC results. Thematic change detection results indicate that forest reduction continued furthermore in 2005.

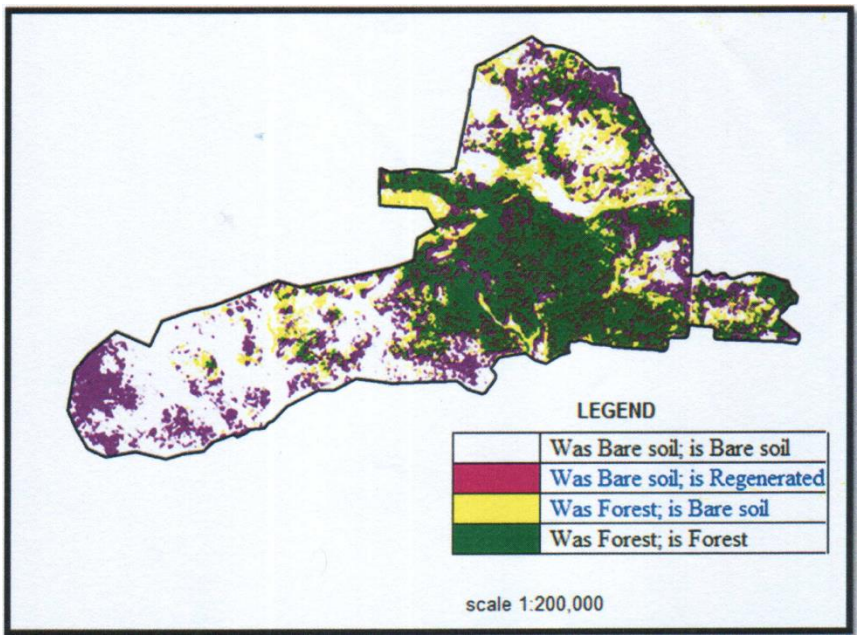

Figure 8- Extent of forest cover change in MLFR between 2000 -2005
Source: landsat images

5.2.3 Extent of forest cover change between 1990 - 2005

The maps for 1990 and 2005 show the detected thematic forest cover change over a period of fifteen years where red to deep brown represents forest; white patches stands for bare land; greenish patches is wet bare soils; blue to black represents water and red line is the boundary for the forest reserve. See Figures 9 and 10.

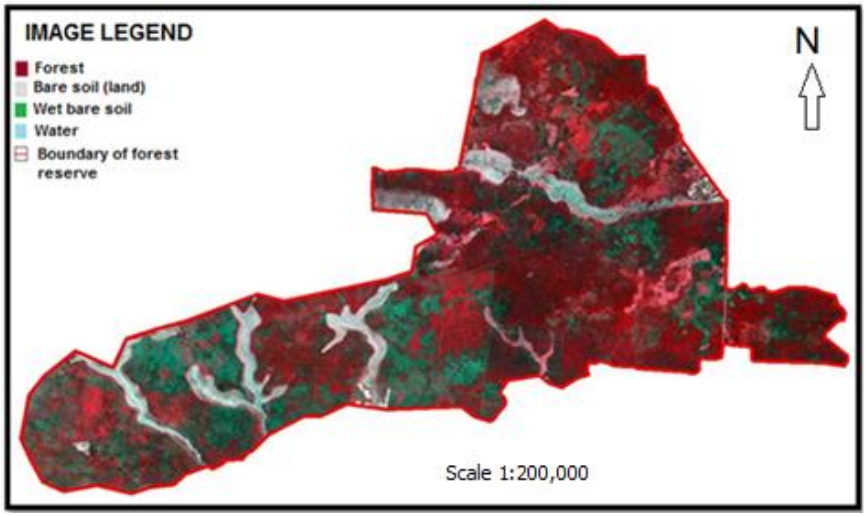

Figure 9: Analysed image of MLFR for the year 1990
Source: landsat images

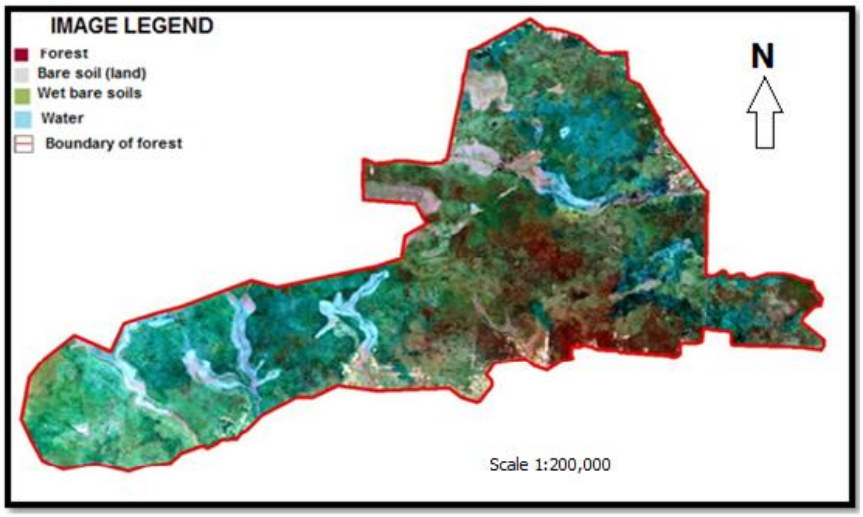

Figure 10: Analysed image of MLFR for the year 2005
Source: landsat images

The image layers were converted to normalized difference vegetative index (NDVI) and categorized to determine and detect thematic (forest) change over a period of 15 years between 1990 and 2005 as thematic figure 11 show the LUFCC results.

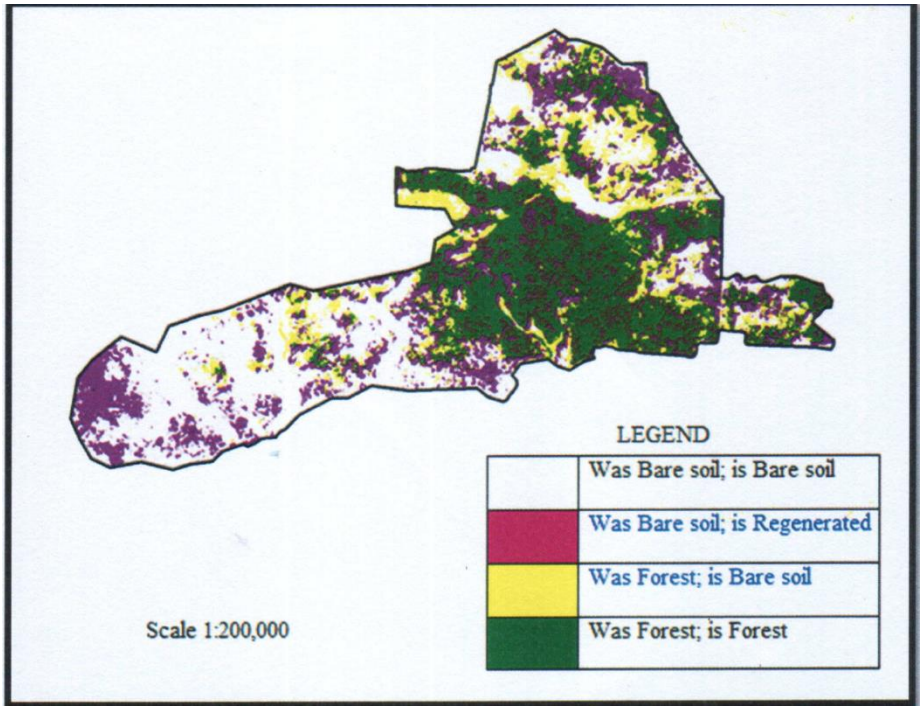

Figure 11 - Extent of forest cover change between 1990 and 2005
Source: landsat images

Therefore, the LUFCC results in maps and statistical analysis show that there was remarkable negative forest cover change since 1990 to 2005.

Forest cover in MLFR has continued to decline both in quantity and quality just like elsewhere in the world due to a number of factors such as the extensive practice of shifting cultivation, high demand for wood-based energy, unsustainable use of the few known indigenous commercial tree species and others (FAO, 2005; Mukosha, 2006; Mbindo, 2007).

5.3 Tree species affected by forest cover change in MLFR

This section gives a summary status of the vegetation types in Masese forest. It further shows the forest types and tree species that have been affected by forest cover change in MLFR.

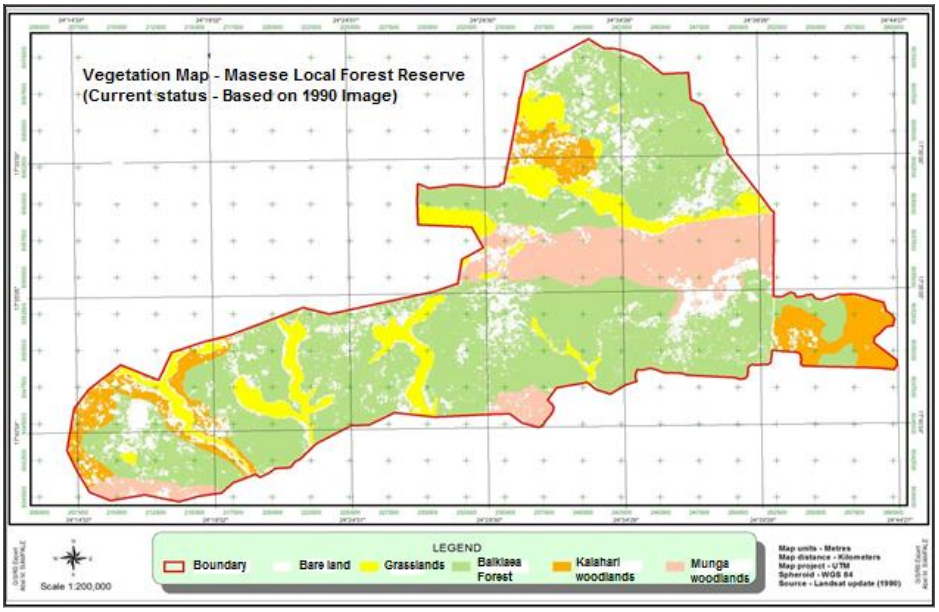

Figure 12: Map showing the vegetation types in MLFR – 1990
Source: Landsat images

Figure 12 shows that in 1990 the predominant *Baikiaea* forest was well spread across MLFR.

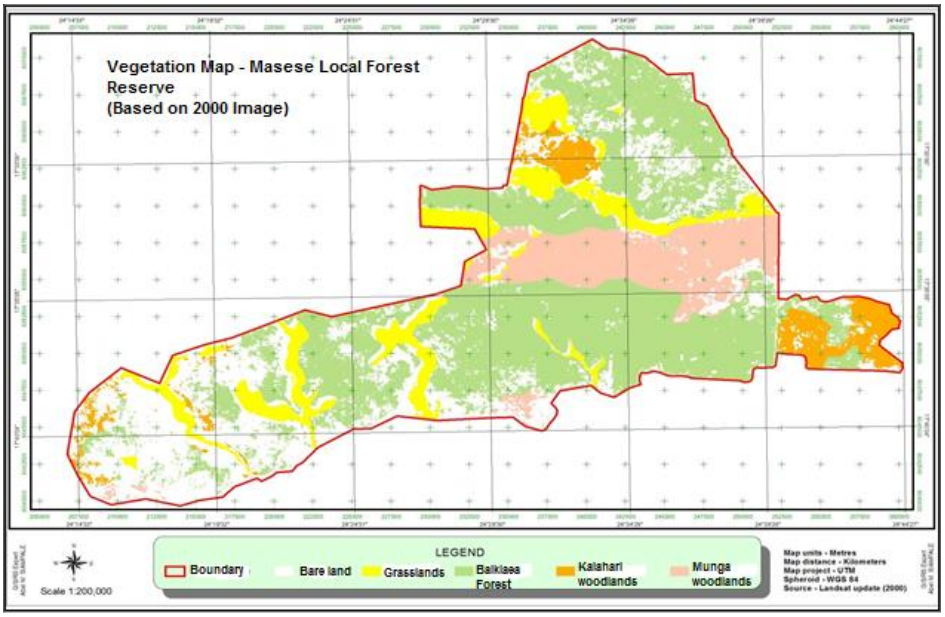

Figure 13: Vegetation types in MLFR – 2000
Source: Landsat images

The map shows that in 2000 the predominant *Baikiaea* Forest cover reduced especially between latitudes 24º 14’ 33’’E and 24º 19’ 22’’E

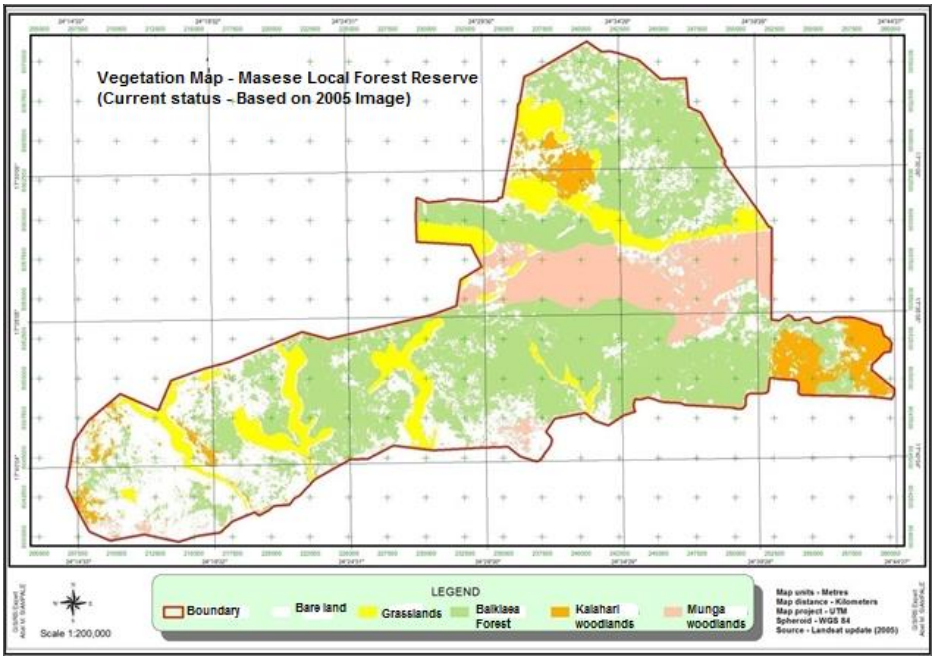

Figure 14: Vegetation types in MLFR – 2005

Source: Landsat images, 2005

The map shows that in 2005 the dominant *Baikiaea* Forest cover has further declined especially between latitudes 24º 14’ 33’’E and 24º 23’ 00’’E

Generally, the maps of vegetation types of 1990, 2000 and 2005 indicate that the *Baikiaea* Forest which is the commonest and valuable forest type for both commercial and domestic use have been decreasing in coverage and status from the west towards the East. The tree species that have been adversely affected are *Baikiaea plurijuga*, *Pterocarpus antunesii* and rose wood because these are widely used tree species for commercial and other domestic purposes. The main challenge in MLFR is extensive practice of shifting cultivation, high demand for wood-based energy, unsustainable use of the few known indigenous commercial tree species and the poor method of harvesting these tree species. Just as outlined by Foley (2007) in Brazil and Shitima,

(2005) in Zambia who found out that unsustainable logging, under storey fires, unsustainable fuel wood harvesting and others are responsible for forest cover change.

The study therefore established that there is forest cover change in MLFR at an average rate of 440.20ha per year or 0.067% per year between 1990 and 2005. In 1990 the forested area was estimated at 43,544ha and reduced to 36,941.61ha in 2005 or 61.9 percent of the total forest reserve land area of 59,689ha. The extent of forest cover change was estimated at 6,063.07ha between 1990 and 2005. Therefore, there was a decrease of forest cover 6,603.07ha equivalent to 15.16 percent in the period of fifteen years that has also affected the availability of some valuable tree species. *Baikiaea* forest and *Kalahari* woodlands types of vegetation are the ones that have been adversely affected by forest cover change. The identified proximate cause of LUFCC for the area is infrastructure development (settlements, ZESCO pylons and road) closely linked with encroachment cultivation by necessity which is carried out by the human population from the surrounding areas that have gained access to the forest land illegally.

In and around Masese like elsewhere in Zambia, the land conversions are associated with the "rule of proximity" which was interpreted from the remote sensing data following the linear pattern of settlement establishment evident alongside the road. For instance, when the bridge across the Zambezi River on Nakatindi-Road was completed the probability of land use change due to extensive and intensive natural resource utilization in the forest area along and close to the road became very high. This is because of the road network that enhanced access to resources. The rule of proximity is based on accessibility; cultivatable, extractable, and unprotected (ACEU).

Table 7 – ACEU Rule Interpretation

Accessible	In gently undulating terrain ~10 km from existing roads; in valley/hilly areas ~ 3 km from existing roads, tracks or settlements.
Cultivable	In areas where subsistence agriculture is predominant it may include any soils capable of supporting subsistence farming and close to people's settlements (villages).
Extractable	At least 50% of the woody biomass consists of material with economic value greater than the cost of extraction. This may include wood fuel/charcoal, timber, poles and forage.
Unprotected	Not within national protected areas, or private landholdings where forest conservation laws are effectively enforced.

Source: Adapted from Siampale (2008)

Table 7 presents a "rule of proximity" to resource utilization based on opportunities for accessibility, cultivatable, extractable, and unprotected (ACEU). The proposed "ACEU" rule states that any forest or woodland in a developing country context is likely to be deforested within 50 years whenever it is accessible and where local actors are able to reach the area as is the case with Masese which lies less than 1km from the main tarred road and villages. Cultivable and Extractable is where land can be used for subsistence or commercial crops for a value; in Masese people are currently using the land illegally for subsistence crop production. Lastly, it is unprotected where land tenure regime does not prevent extraction or conversion. In Masese, there is poor forest management due skeleton staff and lack of forest guards to supervise and monitor forest resources extraction.

The trend in LUFCC in the area is likely to be the same for some time in the future with a possibility of becoming slightly higher than at present unless some conservation initiatives are embarked on. Communities should embrace enrichment planting in areas that are degraded and devoid of tree cover.

5.4 Effects of Forest Cover Change on the Livelihoods of the Dependent Local Communities

This section presents results and discussion of the effects of forest cover change on the livelihoods of the local people in MLFR.

5.4.1 Shortage of fire wood

Figure 15 show that only 9.3% of the respondents indicated that they cover less than 1km to collect fire wood from the forest. The majority of the respondents cover a distance of between 1km and 1.99km to collect the fire wood from the forest. Figure 15 shows the average distances people cover to collect fire wood.

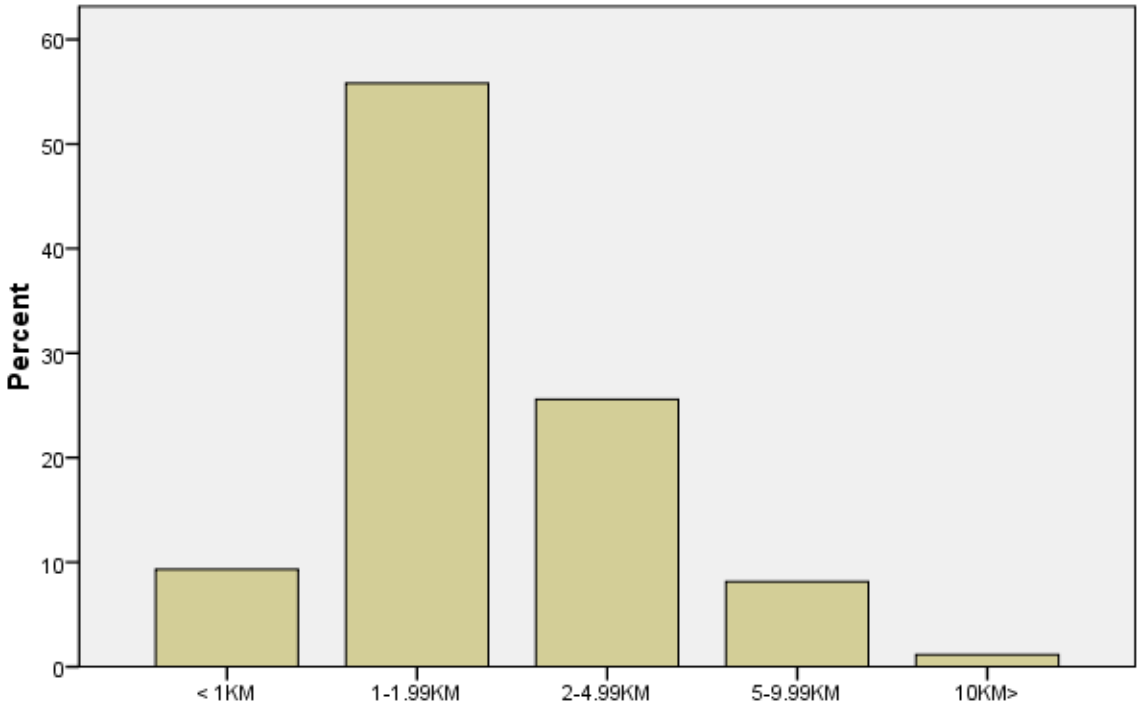

Figure 15 – Bar chart showing distance covered to collect fire wood

The findings agree with Bhatt and Sachan (2003)'s findings that showed that women covered an average distance of between 1.5km to collect firewood in the mountain villages of India. Bhatt and Sachan (2003) also found out that fire wood collection is mainly done by the women and so is the situation in Masese. On average, women use 55% of the total labour energy expenditure on fire wood collection. Men and children contribute the rest. The study also revealed that only 5% of the 120 respondents buy fire wood for their domestic use. The rest of the respondents (95%) collect their own fire wood. Further, interviews revealed that people use less than $1m^3$ and poor quality of fire wood that cannot provide the needed energy to prepare food in time. Therefore, local communities (mostly women) along Masese spend more time collecting fire wood than on other important household economic ventures just like the case in India's mountain villages. The study also indicated that 74.2% households use less than $1m^3$ of fire wood

(1m^3 estimated to 1 standard scotch cart). Reasons alluded to are distances covered to fetch firewood and the high cost of the commodity. Under normal circumstances, a house hold requires between 2m^3 and 3m^3 per month to sufficiently supply energy for cooking and heating though the amount may differ according to season (Bhatt and Sachan 2003). The study therefore, revealed that there is increased distance covered to collect firewood due to shortage of the commodity in the vicinity.

5.4.2 Shortage of building materials

The study revealed that there is a corresponding increased distance from where the local access building materials such as poles and rafters coupled with increased cost of building materials to shortage of building materials. The situation has not only affected the local people in terms of distance to access materials and high cost of procuring them but it has also lowered the quality their houses. This is due to the fact that there is scarcity of scarce good quality poles and rafters in the forest since the forest cover has declined. According to King et al., (2000) a house construction requires many poles and rafters of various dimensions and weights, as well as rope fibre for tying together and grass for thatching. In a situation where poles and rafters are few and not straight the house will be of poor quality as photo 1 shows because of wide gaps that make it difficult to fill in the mad.

Plate1: House made out of poles and mad in the village.

This house located in Mulimambango ward was built out of few poles and rafters that were not straight. The fibre for tying it together and thatch the grass were also not adequate to make the house strong. Local people also cover long distances to fetch building materials from Masese Forest as figure 16 shows.

Figure 16 shows that only 8.1percent of respondents indicated that they are able to access building materials on a distance less than 1km. The rest of the local people cover the distances of more than 1 km apart from 32 percent who indicated that they do not fetch building materials but rather they prefer buying in order to avoid suffering by carrying heavy loads of building materials over a long distance.

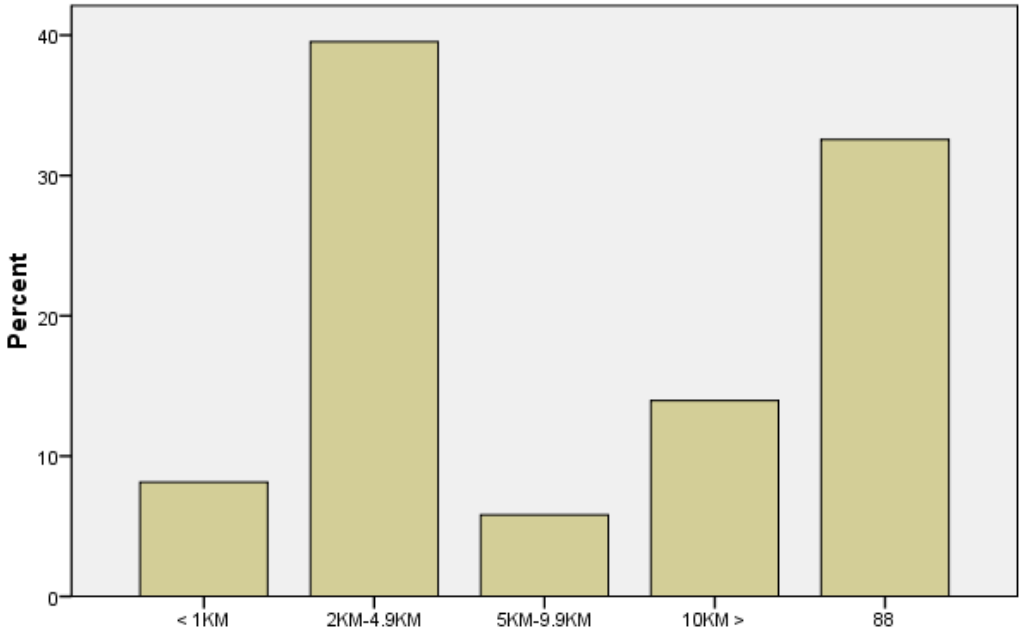

Figure 16 – Bar chart showing distance (km) covered to collect building materials

5.4.3 High cost of building materials

The cost of building materials such as poles, rafters and thatching grass was observed to be on a high side in comparison to the average annual income of local people (which is K200 per household annually). For example, 55 percent of the respondents indicated that they spent between K5 andK10.99 to buy thatching grass and poles respectively. On the other hand 19percent of the respondents indicated that they spend above K10 per pole. Only 16 percent of respondents spent between K2 and K4.99 per bundle of grass and pole respectively. The rest of respondents indicated that they do not buy building materials because they cannot afford but instead source them on their own from the forest. The escalating cost of building materials is due the deplorable condition of the forest where most valuable building materials have declined as a result of forest cover change.

5.4.4 Shortages of exploitable tree species for timber

The declining status of predominant *Baikiaea* Forest that include tree species such as *Baikiaea plurijuga* (*Mukusi), Pterocarpus antunesi (Mukwa) and Rose wood (Muzauli) as detected by land sat images*, that are exploitable species for timber in Masese has affected the livelihoods of the local communities that depend on timber industry for income.

Table 5: Some selected tree species and their uses in MLFR

S/N	Name of tree species	Uses	Availability status	
			Abundant	Not abundant
1	*Baikiaea plurijuga*	Timber, poles, dugout canoes, curios, hand tools, mortars and pestles, fuel wood, etc.	23%	77%
2	*Pterocarpus antunesi*	Timber, poles, dugout canoes, etc,	21%	79%
3	*Rose wood*	Timber, poles, rafters dugout canoes, curios, hand tools, mortars and pestles, fuel wood, etc.	23%	77%

Source: Field data, 2013

Table 5 shows that some selected tree species that are important for their usage are no longer in abundance in MLFR. This is in conformity with the findings of FD and FAO, 2008; FAO, 2005; Mukosha, 2006; Mbindo, 2007 and Jumbe et al., 2006 who state that declining status of trees species cauased by unsuataible exploitation of tree species due to forest cover change has a negative bearing on the local people that are directly and indirectly employed in timber industry. this also leads to increased cost of timber production due lond distance from where exploitable tree species for are found that results into low productivity and consequently low profit. The interview conducted with the timber company operators revealed that the cost of production has increased due long

distance from where mature trees (30cm DBH) are found. Economically, this means that at some time some workers may be laid off in order to reduce the cost of production, an action that will affect the households of the people employed in logging companies.

5.4.5 Shortage of tree species for making household implements

The declining status of some exploitable tree species for dugout canoes, making curios, hand tools, mortars and pestles, cooking sticks, drums walking sticks in Masese has affected the livelihoods of the dependent local communities. Kings et al., (2000) found out that species such as *Pericopsis angolensis, Dalbergia melanoxylon and Afzelia quanzensis* are important species for carving and making hand tools.

Table 6: Tree species used to make household implements in MLFR

S/N	Name of tree species	Uses	Availability status	
			Abundant	Not abundant
1	*Perocopsis angolensis*	Dugout canoes, curios, hand tools, mortars and pestles, fuel wood, etc.	23%	77%
2	*Dalbergia melanoxylon*	Curios, hand tools, mortars and pestles, fuel wood, walking sticks	21%	79%
3	*Afzelia quanzensis*	Curios, hand tools, mortars and pestles, fuel wood, walking sticks, etc.	23%	77%

Source: Field data, 2013

These are the same species that are common in Masese though their availability has declined. The results show that 23% of the respondents indicated that most valuable tree species are no longer in abundance. This is also evident on the analysed maps that proved that most vegetation types have declined in MLFR. Traditionally, *Lozi* people treasure canoes, drums and walking sticks and the disappearance of tree species that are good for

processing these wood products has negative consequences on the livelihoods and culture of local people in Sesheke.

5.4.6 Shortages of Non-wood forest products (NWFP)

Forest cover change in Masese did not only affect the local communities in terms of shortage of wood products but has also affected the provision of non-wood products such as wild foods, medicines, honey and beeswax, etc.

5.4.6.1 Shortages of wild foods

Mushrooms, fruits, leafy vegetables and tubers are wild foods that are widely collected and consumed by rural households in Sesheke although their availability has declined.

Table 7: wild foods and their availability in MLFR

S/N	Name of wild food	Availability status	
		Abundant	Not abundant
1	Mushrooms	23%	77%
2	Fruits	21%	79%
3	Leafy vegetables	23%	77%
4	Tubers and roots	23	77%
5	Insects	23	77%

Source: Field data, 2013

These foods are enriched with starch-based diets endowed with important vitamins and minerals that are vital for poor rural communities (Campbell et al., 2002). According to the research findings which are similar to that of Packham (1993) and Chileshe (2005) these foods serve as an important gap-filler when food stocks are low in rural areas. Furthermore, for many rural women, trade in forest foods is an important source of

income. However, trade in forest foods has reduced in Sesheke District due to scarcity of products in the forests.

Roots of various species (including Rychnosia, Eminia and Vigna) are harvested to make a fermented non-alcoholic beverage, *munkoyo* (Zulu et al., 1997). *Munkoyo* is a popular local soft drink, in particular amongst women and children, and also used during traditional ceremonies (Malungo, 2001). The study found out that 77% of respondents complained that roots for making *Munkoyo* are no longer in abundance in the areas where they used to dig the roots as other people are now cultivating such that they are denied access especially during cropping season. The roots are also small because plants are disturbed by frequently cutting of vegetation as people prepare their fields for cultivation.

A variety of insects is consumed in Zambia and these provide an important source of protein and household income. More than 60 species of insects in at least 15 families and 6 orders have been reported as food in Zambia (DeFoliart, 1999). Mbata et al. (2002) describe the use of caterpillars among the *Bisa* people in Northern Province. However, this study found out that insects are not popular food amongst the *Lozi* people of Sesheke District in Western Province because traditionally insects are not part of their menu.

5.4.6.2 Shortage of medicinal plants

There are a number of indigenous plant species as *Strychnos cocculoides, Solanum delagoense, Ximeniacaffra, Diplorhynchus condylocarpon, Croton megalobotrys* and

others were found in MLFR that are used to treat different diseases. There were a number of medicinal plants that were identified to have medicinal values in MLFR as shown in Table 8.

Table 8: Medicinal plants and their uses in MLFR

S/N	Name of medicinal plants	Uses	Availability status	
			Abundant	Not abundant
1	*Solanum delagoense*	Stomach pains, headache, skin infections, wounds, etc.	23%	77%
2	*Ximenia caffra*	STIs, stomach pains, headache, fever, constipation, etc.	21%	79%
3	*Croton megalobotrs*	Curios, hand tools, mortars and pestles, fuel wood, walking sticks, etc.	23%	77%
4	*Strychnos cocculoides*	STIs, stomach pains, headache, etc.	23%	77%
5	*Diplorhynchus conylocarpon*	STIs, stomach pains, headache, etc.	23%	77%

Source: Field data, 2013

Therefore, the findings agree with that of Puustjärvy et al., (2005) that indicates that there is a number of plant species that are used for medicinal purposes in Zambia. All these plant species used to be found within easy reach of Masese Local Forest Reserve. However, these species are no longer found within easy reach due to declined status of vegetation in the forest.

5.4.6.3 Reduction in the availability of honey and wax

According to ITC/DTCC (2007) Northwestern Province is the main beekeeping area in Zambia with an estimated 70 percent of the country's beekeepers living in this province. They produce between 90 and 95 percent of locally traded and above 95 percent of the

exported honey. In Western Province, Kaoma is the main beekeeping area while for Sesheke beekeeping is done at very small scale. Only 25% of respondents attributed beekeeping as a source of livelihoods. Further probe revealed that there are no beekeeping farmers in Masese instead people, especially men, just collect honey from natural beehives in the trees which involves cutting barks of trees. This method of honey harvesting is destructive as some trees are cut down completely and it involves smoking that kills bees. The rapid disappearing forest in Masese has led to a decline in honey production.

The study therefore, revealed that the local communities who live in the margins of Masese Local Forest have been affected by the forest cover change. The study further revealed that there is a significant association or correlation between:

i. Distance (km) covered to collect firewood and amount of fire wood (m^3) used per household as shown by table 9.

Table 9: Correlation between distances covered to collect firewood and amount of firewood a household uses per month

		Amount of firewood a household uses per month in cubic meters	Distance covered to collect firewood from the forest
Amount of firewood a household uses per month in cubic meters	Pearson Correlation	1	-.276**
	Sig. (2-tailed)		.002
	N	120	120
Distance covered to collect firewood from the forest	Pearson Correlation	-.276**	1
	Sig. (2-tailed)	.002	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

Table 9 shows that there is significant correlation of 0.276 at 0.01 significance level implying that the longer the distance firewood if found in MLFR the lesser the amount of firewood a household uses per month.

ii. There is also association between the distance (km) covered to source building materials and amount of money spent to buy building materials per household as table 10 shows.

Table 10: Correlation between distance covered to fetch building materials and amount of money spent to buy building materials

		Distance covered to collect building materials in (KM)	Amount (ZMK) spent to buy building materials
Distance covered to collect building materials in (KM)	Pearson Correlation	1	-.213*
	Sig. (2-tailed)		.019
	N	120	120
Amount (ZMK) building spent to buy building materials	Pearson Correlation	-.213*	1
	Sig. (2-tailed)	.019	
	N	120	120

*. Correlation is significant at the 0.05 level (2-tailed).

Table 10 shows that there is correlation of 0.213 between distance covered to fetch building materials and amount of money spent to buy building materials at 0.05 significance level.

Therefore, it is clear that there are long distances to sources of fire wood and building materials in Masese Local Forest Reserve which has resulted into escalating prices of fire wood and building materials per cubic meter. There is also a decline in the usage of non-

wood products in the area since they are scarce. Local people are made to buy some forest resources and those who do not afford to buy them ends up using poor quality forest resources to sustain their livelihoods.

6.0 CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions and Recommendations

The first part of this chapter presents a summary of the study findings and the second part is made up of recommendations of the study.

6.1 Conclusions

The study established that forest cover change has occurred in MLFR at the projected change rate of 0.067 percent per year and the extent of forest forest cover change was detected at 6.603.07ha equivalent to 15.16 percent between 1990 and 2005. The forest cover change that has adversely affected *Baikiaea plurijuga, Pterrocarpus antunesi*, Rose wood and others that are major and widely used tree species has inflicted a lot of suffering on dependent local communities as they have lost their source of livelihoods and made their living conditions deplorable. Local people cover more than 1km to fetch fire wood, building materials, timber, and wood for carving household implements, wild foods, honey and medicinal plants due to shortage of these forest resources within vicinity of MLFR. This implies that the longer the distance fire wood and building materials are fetched from the higher the cost of buying them. In turn those local people who can't afford buying this forest resources end up using poor quality of fire wood and building materials obtained from other lesser important tree species.

6.2 Recommendations

i. There is need to formulate new policies that will aim at improving forest management that should also include tree planting exercises in order to reduce the current forest cover change rate in MLFR

ii. Local people should exploit other tree species for commercial and domestic purposes instead of depending on only those tree species that are adversely affected.

iii. Local people should engage in other alternative sustainable forest resources utilization such as bee keeping and mushroom growing so as to improve their livelihood.

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APPENDICES

1: GIS and related analysis tools

Software package	Accessibility	Remarks
(1) ArcGIS 9.3	ESRI Proprietary	Image Processing and Analysis
(2) ArcView 3.3	ESRI Proprietary	Map View and Image processing
(3) GRASS GIS	Open Source	Image re-sampling for % tree cover computation from remote sensing.
(4) Spring 5.1.6	Open Source	Vector Map Topology Building (Generating Map Statistics)
(5) Random forest (R)	Open Source	R is a language and environment for statistical computing and graphics strongly known for random forest classification using of a script

2: Standard categories of forest conditions

Forest Strata (Crown Density)	Description
(1) High Density Forest (80% & Above CC)	These are pristine forests with trees that have above 80% canopy cover. Normally they are located in protected areas and far from human activities /settlements.
(2) Medium Density Forest (50 – 79% CC)	These are usually secondary forests with trees having 50 – 79% canopy cover. They are found in old fallow land, old settlements with vigorous (fast growing)
(3) Low Density Forest (30 – 49%)	These are fragmented forests with trees that have 30 – 49% canopy cover (e.g. forests along main roads or and near towns/cities).
(4) Open Density Forest (10 – 29% CC)	These are badly fragmented forests with trees having 10 – 29% canopy cover. They are isolated patches of forests within farming areas and settlements
(5) Not Forest (< 9% CC, with isolated trees)	Depleted forest areas with less than 9% canopy cover. This class also includes other land (not considered as forests) such as the inland water and large swamps.

3 – Household questionnaire

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF GEOGRAPHY

HOUSE HOLD SURVEY ON
EFFECTS OF FOREST COVER CHANGE ON THE LIVELIHOODS OF THE DEPENDENT LOCAL COMMUNITIES IN MASESE FOREST RESERVE IN SESHEKE DISTRICT

Respondent Nº ☐

General information household

01. Household Nº ☐ **02. Village.....**

03. District..... **04. Occupation.....**

05. Sex..... **06. Age.....** **07.Level of education.....**

08. How long have you been living in this village?.....

09. Effects of forest cover change on the provision of goods and services

	1	Shortage of edible leaves			9	Shortage of mushrooms
	2	Shortage of roots			10	Shortage of honey/beeswax
	3	Shortage of fuel wood			11	Shortage of trees for timber
	4	Less rainfall			12	Shortage of poles and rafters
	5	No/shortage of edible insects			13	Less/no income
	6	Shortage of thatching grass		others		
	7	Shortage of fibres				*Multiple choices

	8	shortage of herbal medicines			

10. Notes

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11. Common Valuable trees species and their uses in MLFR

NO	Common local name	Scientific name	Available		uses
			YES	NO	
1					
2					
3					
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5					
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12. Note:

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13. What do you use for cooking or heating?

	1	**Electricity**
	2	**Charcoal**
	3	**firewood**
	4	**Others**

14. If you use firewood, do you buy it or collect from the forest yourself or your family?

	1	**Buy**
	2	**Collect it ourselves**
	3	**Both**

15. if you collect firewood yourself, how far do you collect it from?

	1	**Less than 1KM**
	2	**1KM to 1.99KM**
	3	**2KM to 4.9KM**
	4	**5 KM to 9.9KM**
	5	**10KM and above**

16. If you buy firewood and charcoal, how much do you spend per month in Zambian Kwacha?

Firewood			Charcoal		
	1	**Less than 5000**		**1**	**Less than 5000**
	2	**5000 to 10000**		**2**	**5000 to 10000**
	3	**10001 to 15000**		**3**	**10001 to 15000**
	4	**15001 to 20000**		**4**	**15001 to 20000**
	5	**Above 20000**		**5**	**Above 20000**
	88	**Not applicable**		**88**	**Not applicable**

17. Note

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18. How much firewood do your family use per year?

	1	**Less than 1m^3**
	2	**1.1m^3 to 2m^3**
	3	**2.1m^3 to 3m^3**
	4	**3.1m^3 to 4m^3**
	5	**Above 4m^3**

19.Note.....
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20. Did you buy the building materials (poles, rafters, grass, fibre, etc) you used to build house(s)?

	1	**Bought**
	2	**Collected from the forest**
	3	**Both**

21. Note

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22. If you bought the materials, how much did you spend in Zambian Kwacha?

per pole			**Per bundle of Grass**			**Anthill soil per wheel bar**		
	1	**1000 to 1999**			**1000 to 1999**			**1000 to 1999**
	2	**2000 t0 4999**			**2000 t0 4999**			**2000 t0 4999**
	3	**5000 to 10999**			**5000 to 10999**			**5000 to 10999**
	4	**10000 and above**			**10000 and above**			**10000 and above**
	88	**Not applicable**		**88**	**Not applicable**		**88**	**Not applicable**

23.Notes.....
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24. if you collected building materials yourself, how far did you collect them from?

	1	**Less than 1KM**
	2	**1.1KM to 1.99KM**
	3	**2KM to 4.9KM**
	4	**5 KM to 9.9KM**
	5	**10KM and above**
	88	**Not applicable**

25. Shortage of straight poles for home construction

	1	**Less than 5m^3**
	2	**5.1m^3 to 10m^3**
	3	**10.1m^3 to 15m^3**
	4	**15.1m^3 to 20m^3**
	5	**20.1m^3 and above**

26. Notes

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27. Do you use herbal medicine from the forest for various illnesses?

1	**Yes**	
2	**No**	

Note

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28. If yes in question 77, do you buy or collect medicine from the forest yourselves?

	1	**Buy**
	2	**Collect it ourselves**
	3	**Both**
	88	**Not applicable**

29.Notes.....
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30. Household economic activities

	1.	Livestock rearing
	2.	Fishery
	3.	Timber exploitation
	4.	Charcoal production
	5.	Curio making
	6.	Crop production

	7.	Beekeeping
	8.	Mining/extraction
Others		wild food collection
Others		
*Multiple choices		

31. Notes

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32. Which forestry products do you obtain from the forest?

1.	Fuelwood	
2.	Timber	
3.	Poles	

4.	Rafters	
5.	Thatching grass	
6.	Fibres	
7.	Fruits	
8.	Small game	
9.	Honey	
10.	Waxes	
11.	mushrooms	
12.	Medicines	
13.	Vegetable plants	
14.	Roots	
15.	Insects	
other		

33. Notes

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