EXTENT AND CHARACTERISTICS OF ILLEGAL FIREWOOD COLLECTION AND CHARCOAL PRODUCTION ACTIVITIES: A CASE STUDY OF MWEKERA NATIONAL FOREST NO. 6, COPPERBELT PROVINCE, ZAMBIA

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Forestry

2009

ABSTRACT

EXTENT AND CHARACTERISTICS OF ILLEGAL FIREWOOD COLLECTION AND CHARCOAL PRODUCTION ACTIVITIES: A CASE STUDY OF MWEKERA NATIONAL FOREST NO. 6, COPPERBELT PROVINCE, ZAMBIA

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Forest reserves in Zambia have undergone drastic changes over the years due to encroachment by human activities such as agriculture, charcoal production, firewood collection and settlements. Little is known about the extent and characteristics of illegal firewood collection and charcoal production. This case study focuses on Mwekera National Forest No. 6. Objectives of the study are: to conduct a forest cover change analysis from 1984 to 2006, to identify characteristics of illegal charcoal and firewood activities, to determine the extent of illegal firewood collection and charcoal production, and to suggest intervention measures aimed at reducing the illegal activities. The project involved mapping of activities using Global Positioning System (GPS), taking photographs of activities, analyzing satellite images and conducting key informant interviews. Over 3,350 hectares of forest cover was deforested between 1984 and 2000. Between 2000 and 2006, 459 hectares of forest cover recovered. In 2006, 4,836 hectares were open land while 13,051 hectares were forested. Characteristics of the illegal activities were identified. People involved are poor, unemployed and in need of alternative livelihoods. The study recommends that government should fund research on alternative energy sources. Poor communities should be empowered, policies harmonized, and the Forest Department strengthened.

I wish to dedicate this work to my parents, Mr. Malunga Harrison and Ms. Mumba Elizabeth, for their role in my life. They brought me up from childhood, and laid a firm foundation to become the person I am today.

ACKNOWLEDGEMENTS

Successful research in any field is possible with the support from individuals and institutions of both government and private nature. I therefore find it necessary to acknowledge their valuable contributions to the completion of this study. To start with, I would want to appreciate the assistance by the United States government through the United States Aid for International Development (USAID) and the USAID Initiative for Long-term Training and Capacity Building (UILTCB) Programme for awarding me a scholarship that funded my studies. I would like to specifically mention the programme coordinator Dr. Irvin Widers, the UILTCB programme Deputy Coordinator Mywish Maredia, Ben Hassankhani and Dorothy Ntengerenji for their excellent coordination of the programme. I also wish to thank my employer, the Government of the Republic of Zambia (GRZ) through the Ministry of Tourism, Environment and Natural Resources (MTENR) for granting me leave from my job during my study period. On the actual thesis work, the guidance and support I got from my adviser, Professor Larry Leefers can not go without mention. Other Professors at Michigan State University were equally helpful, particularly Professor Kelly Millenbah and David MacFarlane. I also wish to thank Mr. Jay Samek from the Michigan State University Tropical Rain Forest Information Center (TRFIC) for processing and providing me with satellite images on Mwekera National Forest. I would also like to mention students in the Departments of Forestry and Agricultural Economics for their constructive input on my draft chapters. Individuals I owe special mention include Monica Kazolwe, Mukwiti Mwiinga, Dingiswayo Banda, the late Christina Mwale, Stephanie Pittman, Dori M. Pynnonen and Jeffrey W. Schmidt. In the actual

field work, I pay my gratitude to the Principal of Zambia Forestry College, Mr. Saxon Siame, and other staff including Benious Ikachana and Miyoba Milimo. Any institution or individuals not specifically mentioned here due to limited space but rendered help in one way or the other are duly saluted, but any errors, omissions or mistakes that may be detected in this document are entirely mine.

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KEY TO SYMBOLS OR ABBREVIATIONS

Acronym	Full Title
ADMADE	Administrative Management Design for Game Management Areas
ASCII	American Standard Code for Information Interchange
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BC	Before Christ
BSA	British South African Company
CARPE	Central African Regional Programme for the Environment
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resources Management
CBU	Copperbelt University
CEC	Copperbelt Energy Corporation
CFC	Chlorofluorocarbons
CHAPOSA	Charcoal Potential in Southern Africa
CHESCO	Chipata Energy Service Companies
CITES	Convention on International Trade in Endangered Species
CPR	Common Pool Resource
CSO	Central Statistics Office
CV	Coefficient of Variation
DRC	Democratic Republic of Congo
ECZ	Environmental Council of Zambia
EOS	Earth Observing System
ERB	Energy Regulations Board
ESCO	Energy Service Companies

Acronym	Full Title
ESMAP	Energy Sector Management Assistance Programme
ETM+	Enhanced Thematic Mapper Plus
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organization Statistical Database
FD	Forest Department
FNDP	Fifth National Development Plan
FOSA	Forestry Outlook Study for Africa
FRA	Forest Resource Assessment
GDP	Gross Domestic Product
GECP	Global Environmental Change Programme
GIS	Geographical Information Systems
GJ	Giga Joules
GMA	Game Management Areas
GOFC-GOLD	Global Observation for Forest and Landcover Dynamics
GPS	Global Positioning System
GRZ	Government of the Republic of Zambia
HEC	High Exclusion Cost Good
HIV/AIDS	Human Immune Virus/Acquired Immune Deficiency
Syndrome	
HRG	High Resolution Geometry
HTTI	Hotel and Tourism Training Institute Trust
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing System
INCO-DC	International Cooperation with Developing Countries

Acronym	Full Title
INPE	National Institute of Space Research (Instituto Nacional de Pesquisas Espaciais)
IRB	Institutional Review Board
ITCZ	Inter Tropical Convergence Zone
ITTA	International Tropical Timber Agreement
IUCN	World Conservation Union
IUG	Incompatible Use Good
JFM	Joint Forest Management
LCLUC	Landuse and Landcover Change
LESCO	Lundazi Energy Service Companies
LHPC	Lunsenfwa Hydropower Company
LUCC	Landuse and Landcover Change
LZRV	Luangwa Zambezi Rift Valley
MENR	Ministry of Environment and Natural Resources
MFNP	Ministry of Finance and National Planning
MMD	Movement for Multiparty Democracy
MNF	Mwekera National Forest Number 6
MSU	Michigan State University
MTENR	Ministry of Tourism Environment and Natural Resources
MW	Megawatt
NASA	National Aeronautics and Space Administration
NEAP	National Environmental Action Plan
NESCO	Nyimba Energy Service Companies
NHCC	National Heritage Conservation Commission
NNA	Nearest Neighbor Analysis

Acronym	Full Title
NTNU	Norwegian University of Science and Technology
NWFP	Non-Wood Forest Products
PFAP	Provincial Forestry Action Plan
PRS	Poverty Reduction Strategy
SADC	Southern African Development Community
SAFARI	Southern African Regional Science Initiative
SAFNET	Southern African Fire Network
SAP	Structural Adjustment Programme
SD	Standard Deviation
SIDA	Swedish International Development Agency
SQL	Structured Query Language
START	System for Analysis Research and Training
SWIR	Shortwave Infra Red
TFAP	Tanzania Forestry Action Plan
TM	Thematic Mapper
TOE	Tons of Oil Equivalent
TRFIC	Tropical Rain Forest Information Center
UILTCB	USAID Initiative for Long-term Training and Capacity Building
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNZA	University of Zambia
URT	United Republic of Tanzania
USA	United States of America
USAID	United States of America International Development Agency

Acronym	Full Title
USD	United States of America Dollar
WCED	World Commission on Environment and Development
WWF	World Wide Fund for Nature
ZAFFICO	Zambia Forestry and Forest Industries Corporation
ZAWA	Zambia Wildlife Authority
ZCCM	Zambia Consolidated Copper Mines Limited
ZESCO	Zambia Electricity Supply Corporation
ZFAP	Zambia Forestry Action Plan
ZFC	Zambia Forestry College
ZMK	Zambian Kwacha
ZNTB	Zambia National Tourist Board

CHAPTER ONE

INTRODUCTION

1.1 Study Background

Zambia was once known as Northern Rhodesia and was controlled by the South Africa Company from 1891 until its takeover by the United Kingdom in 1923. Independence was secured in 1964, and the name was officially changed to Zambia. The name was derived from the Zambezi River. The landlocked country is home to just over 10 million people of whom 20% live in the capital city, Lusaka, while another 20% live in the Copperbelt region.

Zambia is diverse with land assets encompassing arable land, forests, wildlife and wetlands. There are 487 forest reserves comprising 183 national forests and 304 local forests. These forests are sources of livelihood to local communities and provide raw materials for small and large scale industries. National forests are used exclusively for the conservation and forest development and are under stricter control by the government than local forests, whose forest products may be regulated by local authorities (Traditional Chiefs). The management of national and local forests is vested in the Forest Department (FD), a state-run institution enforcing Forest Act No. 39 of 1973 of the laws of Zambia. Poverty has been exacerbated by high population growth and the HIV/AIDS pandemic leading to degradation of both national and local forests. The exact forest coverage is uncertain because there has been no recent comprehensive forest inventory since the last one was conducted from 1952 to 1967.

Forest resources are now under serious threat mainly from the agricultural land expansion, timber harvesting and firewood extraction, though accurate information on the extent of the resource is lacking. Over 50% of biomass energy in Southern Africa is from natural forests and woodlands (Sepp 2002). Wood-energy is used in countries such as Malawi since trees are easy to access, relatively inexpensive, and the cost of alternative energy options is considered to be too great for local populations (Kalipeni and Feder 1999). This socioeconomic need has in the recent past resulted in depletion of forest areas. According to the Food and Agriculture Organization (FAO), there has been an increase in wood removal from 500 million cubic meters in 1990 to 661 million in 2005, an annual increase of 11 million cubic meters, and an increase of nine million cubic meters per year in western and central Africa, respectively (FAO 2005). Charcoal is used most especially in urban areas of Zambia for domestic heating and cooking.

The heavily populated provinces of Lusaka, Central and Copperbelt have had the biggest deforestation rates (Chidumayo 1996a). The high population provides ready and available market for the charcoal and firewood, especially for forests situated near cities. The charcoal or *malasha* as it is known in the local language is produced on a small scale in traditional kilns out of wood and mud. Most of the local producers sell charcoal and firewood to supplement household income. Ninety-five percent of rural people depend on firewood, and 90% of urban households depend on charcoal (FAO 2001).

1.1.1 Purpose of the Study

This study was aimed at generating a quantitative basis for planning and implementation of Joint Forest Management (JFM) in Zambia by conducting a baseline study of the Mwekera National Forest Number 6 (MNF). This involved a forest cover change analysis from 1984 to 2006 and examining the extent and characteristics of illegal firewood collection and charcoal production activities in MNF. The case study analyzed the effect of proximity of MNF to major roads linking the forest to urban markets, proximity to urban centers and townships that impose resource use demands on nearby forests, and mapping of deforested areas such as those used for cultivation, charcoal production and settlements. Outcomes of the research include mapped open and forested areas, natural features, and roads/trails. Key informants assisted in suggesting mitigation measures related to the illegal activities. These outcomes provide information to the Forest Department needed in making informed decisions on forest-related issues.

1.1.2 Justification

At the national level, biodiversity conservation is relevant in terms of the economic benefits it brings through consumptive and non-consumptive use of forests. Not only is it important from the standpoint of the supply of forest and wood products to the wood-based formal and informal industries, but also for wildlife which attracts international tourism. Indigenous forests in Zambia hold an estimated wood volume of about four billion cubic meters, and commercial plantations have an estimated wood volume of six million cubic meters. Plantations are the main sources of sawn timber, poles and mining timber for

both formal and informal enterprises along with seven million cubic meters of woodfuel consumed every year. The wood panel industry alone is worth about USD two million per annum (FAO 2001).

To effectively manage this economically important sector, there is a need for up-to-date data. Unfortunately, Zambia lacks up-to-date information on forest conditions. The last national inventory was conducted in the early 1960s. Current figures on forest cover are based on estimates and assumptions on what has changed over the last 40 years. Although the area under forest reserves is known, the change in the condition and extent of forest cover affected by settlements, charcoal production, firewood collection and agriculture is no longer accurate. It is generally agreed that deforestation in Zambia is high but the actual rate is not known. The deforestation rates range from 250,000 or 300,000 hectares per year to 900,000 hectares per year (Chidumayo 1996, PFAP 1998). As the 2000 State of Environment in Zambia report puts it, "the variation in estimates shows the uncertainty of the real situation due to the non-availability of reliable data" (ECZ 2001). Thus, improved information is needed.

Information is an important tool in making decisions about conservation and protection of natural resources because, with up-to-date information, it is easier to know choices people make, the costs and benefits of various proposed measures, and the likely outcome of environmental policies. With the scheduled shift in policy to participatory forest management, this study provided the necessary baseline data needed to identify factors that affect the

success of JFM goals and activities. Due to funding and time constraints, this study is limited to MNF which is located on the Copperbelt Province of Zambia.

1.1.3 Statement of the Problem

Deforestation and its associated environmental problems are a threat to ecosystem conservation and hinder socio-economic development. This is blamed on poverty in Zambia where over 70% of the population is classified as poor. Firewood and charcoal have remained the major primary sources of energy in most households. Ninety-five percent of rural people in Zambia depend on firewood, and 90% of urban households depend on charcoal (FAO 2001). The demand for firewood and charcoal will continue to increase as the population continues to expand. Lack of up-to-date information on forest resource inventories in Zambia has made the situation worse. In areas where there is population pressure and a high demand for additional agricultural land, encroachments into the forest reserves have occurred, but no statistical figures on the extent of the encroachments are available. Although the area under forest reserve is known, the change in condition and extent of forest cover affected by settlement, woodcutting, charcoal production, firewood and agriculture is not known. Reliability for all current figures is therefore low. Policy makers and managers need improved information related to deforestation.

1.1.4 Research Questions and Objectives

(a) Research Questions

Since the last national inventory was conducted in the 1960s, current figures on forest cover and growing stock are no longer reliable because of the changes in condition and extent of forest cover resulting from illegal settlements, woodcutting, charcoal production, firewood collection and agriculture. This study identifies and analyzes factors that influence firewood and charcoal extraction such as proximity of the forest area to urban centers, location of roads and trails, and distribution of deforested and open areas within the forest. Specific research questions are as follows:

i. What is the forest cover change in Mwekera National Forest from 1984 to 2006?
ii. What is the extent of illegal firewood collection and charcoal production activities in Mwekera National Forest?
iii. What are the locations and distribution of open areas in Mwekera National Forest?
iv. What interventions should be put in place to mitigate the illegal firewood collection and charcoal production activities in Mwekera National Forest?

(b) Objectives

The overall objective of this study is to generate a quantitative basis for planning and implementing Joint Forest Management in Zambia by conducting a baseline study of Mwekera National Forest.

In order to answer research questions, the following are the specific objectives of the study:

i. To identify the forest cover change that have occurred from 1984 to 2006
ii. To determine the extent of illegal firewood collection and charcoal production activities in MNF,
iii. To identify characteristics of illegal firewood collection and charcoal production activities in MNF, and
iv. To suggest intervention measures to reduce illegal firewood and charcoal activities.

1.2 Country Profile

1.2.1 Location and Terrain

Zambia is a land-locked country sharing borders with Democratic Republic of Congo (DRC) to the north, the United Republic of Tanzania to the northeast, Malawi to the east, Mozambique to the southeast, Zimbabwe to the south, Botswana and Namibia to the southwest and Angola to the west (figure 1). The country is located on a high plateau in Central Africa between latitudes 8 and 18 degrees south of the Equator and between longitudes 22 and 36 degrees east. It has a surface land area of 752,614 square kilometers (290,585 square miles) most of which forms the highest parts of the plateau lying between 1,000 and 1,600 meters above sea level. The highest areas of the country are in the northeastern part of the country, with the plateau gradually sloping to the southwest.

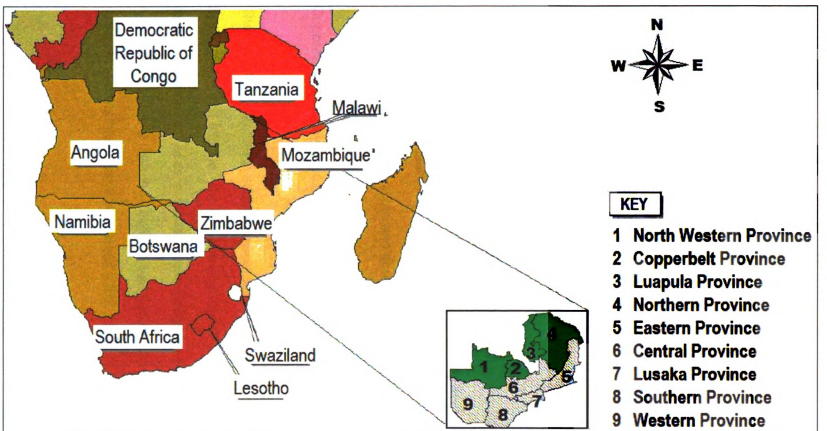

Figure 1. Zambia's Geographical Location, Administrative Boundaries and Neighboring Countries

Source: Adapted from MTENR 2002.

1.2.2 Climate

The country's sub-tropical climate is characterized by three seasons as follows:

(a) a cool and dry season which lasts from May to August and temperatures range from 16^0c to 27^0c.

(b) a hot and dry season from August to October; when temperatures range from 27^0c to 38^0c; and

(c) a warm and wet season from November to April, when temperatures range from 27^0c to 38^0c;

The annual summer rainfall ranges from 500 to 1,500 mm during the period of November-April, varying with latitude and altitude. Mean annual rainfall decreases from the Equator towards the Tropic of Capricorn and from the north and northeast to the south and southwest. The annual rainfall decreases from an average of 1,000 mm or more in the northern parts (including the Copperbelt) to an average of 600 mm in the southern parts (ECZ 2001).

The climate of Zambia is affected mostly by the Inter-Tropical Convergence Zone (ITCZ) and altitude. The movement of the ITCZ north to south and back to north in each rain season causes moist Congo air to prevail over the northern parts more than the southern parts of the country, explaining the variation in amounts of rainfall received (GRZ 2002).

1.2.3 Agro-Ecological Zones

Zambia is divided into four broad agro-ecological regions and zones, based mainly on rainfall, altitude, climate, soils and suitability to crops (figure 2). The farming systems of Zambia vary between agro-ecological zones. As a result, tree-growing practices incorporated in these farming systems also differ considerably between regions. Shifting cultivation systems are practiced in many areas of the country, mainly those with relatively low population densities and fragile low fertility soils. This system, also known as slash and burn, involves the clearing of a small piece of land by felling and burning the forest vegetation.

(a) Region I

This is found in the Luangwa-Zambezi Rift Valley (LZRV), and consists the low rainfall (semi-arid), low altitude, hot and dry areas. In this region, the climate is hot and dry, and the vegetation type is the Mopane or Miombo Woodland. The farming system is largely hand-hoe based. Trees are grown around homestead gardens for fruit production, fuelwood and pole production but rarely integrated with farming systems.

(b) Region IIa

This region consists of a sub-region of the medium rainfall plateau including main farming areas on the plateau of Central, Eastern and Southern Provinces. In this region, the farming systems are characterized by open farming, with animals allowed to move freely on fields in the dry season. This

poses a serious constraint to on-farm tree planting. The main vegetation type is the Miombo and Acacia Woodland.

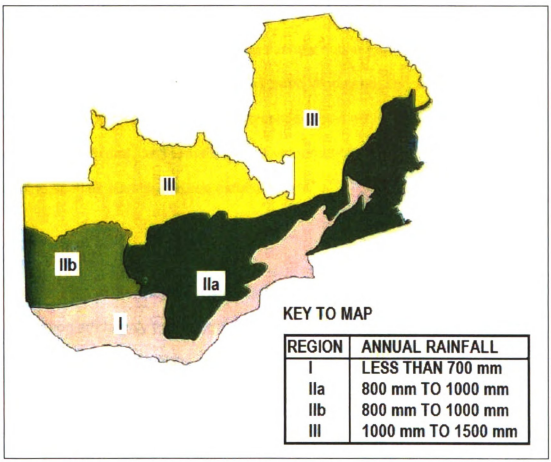

Figure 2. Zambia's Agro-ecological Zones

Source: Adapted from MTENR 2002.

The region suffers low soil fertility, dry season fodder shortages for livestock, and fuelwood shortages caused by agricultural expansion leading to extensive bush clearing and deforestation. In many parts of this region, substantial encroachment of protected forest areas is common. Charcoal production has contributed to the degradation of woodlands and bush-lands.

(c) Region IIb

This sub-region includes the medium rainfall plateau comprising the Kalahari (Barotse) sand plateau and the Zambezi flood plains. In this Region, the soils are good for growing trees such as the cashew nuts and mango. The main vegetation type are the Kalahari and Miombo Woodland, and swamp vegetation. The main crops grown are cassava and millet. Cattle farming is a central part of rural life. Farm forestry development faces the problem of finding species suitable for tree establishment.

(d) Region III

This consists of the Northern High Rainfall Plateau. The farming systems of this region are largely hoe-based. The vegetation type is the wet Miombo Woodland. A form of shifting cultivation, known as the Chitemene is practiced traditionally. In this type of cultivation, trees are lopped and branches burned to add potash and minerals to the soil. Region III is part of the Central African Plateau and covers Northern, Luapula, Copperbelt and Northwestern provinces (figure 2). This region has an annual average rainfall of over 1,200 mm and has the longest growing season of up to 190 days. This is the largest zone with an area of 40.6 million hectares; some of it is set aside for national parks, game management areas and forest reserves. Only 52.7% of the land in this region is suitable for cultivation as the soils are highly leached (ECZ 2001; GRZ 2002). The Copperbelt Province, lies in zone III which receives more than 1,000 mm of annual rainfall (table 1).

Table 1. Agro-Ecological Regions of Zambia

	I	IIa	IIb	III
Annual Rainfall	Low, with less than 800 mm	Medium 800-1,000 mm	Medium 800-1,000 mm	High, with more than 1,000 mm
Altitude	400-900 m	900-1,300 m	900-1,200m	1,100-1,500m
Growing Season (70% Probability)	80-120 Days	90-150 Days	110-150 Days	130-200 Days
Soils	Valley Soils	Medium Soils	Kalahari Sands and Flood Plain Soils	Leached Acid Soils

Source: MTENR 2002.

1.2.4 Drainage

The country's main drainage systems are the Zambezi, Kafue, Luangwa and the Chambeshi-Luapula Rivers, which together with the lakes provide Zambia's most important water, fisheries and tourism resources. Zambia has four main lakes namely, Bangweulu, Mweru, Tanganyika and the man-made Lake Kariba. Several seasonal flood areas also exist in flat swampy and marshy plains such as the Kafue Flats and the Bangweulu and Lukanga Swamps.

1.2.5 Vegetation Types and Status

Storrs (1995) and Fanshawe (1971) divided the country's vegetation into four major categories. These are closed forests, open forests (woodlands), termitaria and grasslands. The closed forests are limited in extent covering only 6% of the country while open forests are the most dominant vegetation

covering 66% of the land (table 2). In terms of status, forest cover is estimated between 55% and 60% (ECZ 2001, Zimba 2003). IUCN (1987) puts the coverage as high as 70%. Of the total area, savannah woodlands account for about 71%. The savannah woodlands in these open forests, including the miombo woodlands, account for the larger part of the vegetation in Zambia. These are dominated by the Miombo, which covers between 41%-55% of the country's total area (Forest Department 1999). About 9.9% of the total land area in Zambia are gazetted Forest Reserves (figure 3). The most important species in these woodlands include *Brachystegia spp.*, *Julbernadia spp.* and *Isorberlinia spp.* Termitaria or woodland vegetation covers about 3.2% and is present in all parts of the country. Grasslands cover 27% and range from pure grassland to grassland with scattered trees (GRZ 2002).

In addition to the natural vegetation types, plantation forests of tropical pines and eucalyptus cover an area of about 61,000 hectares. These have been established countrywide with over 80% of these occurring on the Copperbelt Province. About 50,000 hectares of these industrial plantations are managed by a parastatal company, Zambia Forestry and Forest Industries Corporation Limited (ZAFFICO).

At the Provincial level, the Forest Department manages 7,000 hectares of the regional and local supply plantations, while the remaining balance is managed by private individuals at the semi-commercial and farm levels (FAO 2001).

Table 2. Vegetation Types in Zambia

1. Closed Forests	**Area (1,000 Hectares)**	**Proportion (%)**
Parinari	42	*0.06*
Marquesia	43	*0.06*
Lake Basin	1,556	*2.07*
Cryptoseplum	1,521	*2.00*
Baikiaea	683	*0.91*
Itigi	190	*0.25*
Montane	4	*0.01*
Swamp	153	*0.20*
Riparian	81	*0.11*
2. Woodland (Open Forests)		
Miombo	31,146	*41.41*
Kalahari	8,546	*11.36*
Mopane	3,870	*5.15*
Munga	3,260	*4.34*
Termitaria	2,426	*3.23*
3. Grassland	20,635	*27.44*
4. Open Water	1,050	*1.40*
TOTAL	***75,206***	***100.00***

Source: Adapted from GRZ 2002.

The Zambia Forestry Action Plan (ZFAP) reports that out of this Forest Estate area in Zambia, 44% is set aside for production, 30% for both production and protection, while the remaining 26% is specifically for protection (ZFAP 1997). However, no comprehensive forest inventories have been conducted in the last forty years, and hence existing yield estimates are essentially based on assumptions of changes that have taken place during the last 40 years.

1.2.6 Management of Forest Reserves in Zambia

Forest reserves in Zambia may either be local or national forests (figure 3). The management of national and local forests is vested in the Forest Department (FD), a state-run institution enforcing Forest Act No. 39 of 1973 of the laws of Zambia. In the case of local forests, local authorities (Traditional Chiefs) may regulate the use of forest products by local inhabitants. The national forests, including Mwekera National Forest No. 6 (MNF), are generally larger and are under a more strict protection than local forests (Shitima 2005). Under the Forest Act No.39 of 1973, "all land comprised in a national forest shall be used exclusively for the conservation and development of forests with a view to securing supplies of timber and other forest produce, providing protection against floods, erosion and desiccation and maintaining the flow of rivers" (GRZ 1973).

Forest reserves in Zambia are functionally categorized as production forests or protection forests. Production forests are managed for the present and future production of forestry goods and services for social and economical development. This includes the provision of raw materials for small and large

scale industries, fuel-wood, charcoal and agriculture. Protection forests are maintained as conservation areas for environmental stability. They mainly protect water catchment areas, species ecology, wildlife and cultural sites and control soil erosion.

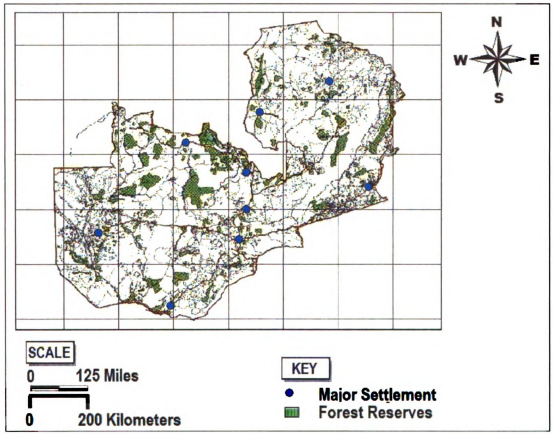

Figure 3. Zambia's Forest Reserves (in green) in Relation to Major Settlements

Source: Adapted from MTENR 2004.

Despite the legal framework being in place, national forests are equally degraded. This is partly because policy makers and mangers are hampered by the lack of up-to-date data on the exact forest coverage in the country and a poorly funded, understaffed and ill-equipped FD.

1.2.7 Land Use Types in Zambia

Zambia is a diverse country with land assets encompassing arable land, forests, wildlife and wetlands. According to the 2000 State of the Environment Report (ECZ 2001), an estimated 45% of Zambia is arable land while 9% is for forestry development (Table 3).

Table 3. Nature of Land Use in Zambia

Nature of Land Use	Percentage Coverage	Comments
Agriculture (22% Arable Land),	45	3% for commercial farming; 20% smallholder farming; and 22% is unused land
Wildlife Development	30	National Parks comprises 8% and Game Management Areas 22%
Forest Development	9	8% is protected forest areas which is on traditional land and 1% is forest reserves which are on state land
Urban Development	2	
Unspecified areas	12	

Source: Adapted from ECZ 2001.

1.2.8 Economic Profile

In the first decade after independence (1964-1975), Zambia was rated among the most prosperous countries in sub-Saharan Africa. Since then, rising oil prices, falling prices of copper (the country's principal foreign exchange earner), changes in domestic agricultural and economic policies and natural calamities such as droughts have reduced Zambia to one of the poorest countries in the region today. Real per capita incomes in 1991 were only 30%

of the 1975 level; formal sector employment decreased to 10% of the labor force in 1990 from 24% a decade earlier, and per capita public expenditure on education in 1990 was only one third of its 1970 level. By 1990 inflation had rapidly increased to 187% from 55% in 1985 (Nsemukila 2001). This resulted in increased consumer prices while there was a reduction in earnings in real terms. Most families could not afford basic household needs. By 1991, an estimated 60% of Zambian households had income levels below the cost of a nutritionally adequate food basket.

Towards the end of 1991 when the new Movement for Multiparty Democracy (MMD) government came into power, an economic reform programme known as the Structural Adjustment Programme (SAP) began. These measures included liberalization of trade, prices, interest and foreign exchange rates, removal of subsidies on consumption, privatization of state-owned companies, reduction of government expenditure and money supply and reform of the civil service (Nsemukila 2001). The effect of SAP on the majority of the people was adverse especially in the short to medium term. Even though inflation has been reduced, formal sector employment went down from 12% in 1996 to about 11% by the year 2000. Between 1990 and 2000 savings declined from 17% of Gross Domestic Product (GDP) to only 6% (Nsemukila 2001).

(a) Economic Changes and Forest Management in Zambia

Shifts in forest management in Zambia can be traced back to two major economic events. First, in 1964 when Zambia gained independence from Britain, the Zambian government nationalized all industries in which copper

was the major foreign exchange earner. With a strong economy, low population and the FD well funded, forests were well managed during this time. The second event was in 1991 when the government privatized industries. The privatization programme was implemented because from 1973 onwards, Zambia experienced deterioration in trade after a dramatic fall in copper prices on the world market.

Effects of privatization reached a climax in 2000 when the mining conglomerate, the Zambia Consolidated Copper Mines Limited (ZCCM), was unbundled and sold off. Over 13,000 people lost their jobs on the Copperbelt Province alone (GRZ 2002). Most of the retrenched workers turned to nearby forest reserves such as MNF for agricultural land, firewood and other forest products. Job losses have contributed to the high rate of deforestation in Zambia which is now estimated to be between 250,000-300,000 hectares per annum (Chidumayo 1996).

Upon realizing the increased pressure and difficulties in managing the forest resources, the government formulated a forest policy in 1999 (Act No. 7 of 1999), though it has not been put into action yet. The main tenet of this policy is the acceptance of communities and other stakeholders in the management of forest resources through participatory management as opposed to the current policy (Act No. 39 of 1973) which is based on policing.

(b) Contribution of Forestry to the National Economy

In 2004, the forest sector contributed an estimated 3.7% to gross domestic product (GDP), compared to agriculture at 7.2%, fisheries at 2.6% and mining

at 8.2%. The largest portion of GDP was associated to mining. However the absence of data in terms of supply (inventory), non-wood forest products (NWFP), industrial timber processing, and the informal firewood and charcoal trade, significantly underestimates forestry's contributions to the national economy and to poverty reduction. Current figures are under-estimated because the bulk of transactions involving forestry resources go undetected by the official accounting system. Without up-to-date information on forest utilization and growing stock, the sustainable management of these resources is difficult. For example, woodfuel from the country's forests and woodlands accounts for 71% of the country's energy consumption and 96% of household energy consumption (MENR 1997, Queiroz 1997). It is estimated that charcoal production provides full-time employment for about 41,000 people in rural and peri-urban areas; another 45,000 are employed in charcoal transportation, marketing, and distribution (GRZ 1997). However most of these activities are treated as illegal and therefore not recognized officially and do not appear in official statistics such as estimates of the contribution of the sector to the GDP.

Other important uses of forest resources in the country include wood for poles in construction, fencing, curios, mine shaft supports and even railway ties. Beekeeping is also a principal source of livelihood in parts of the country, especially in North Western Province. At the national level, it is estimated that national honey production is around 1,500 tons per year (MENR 1997). Therefore, the forest sector can potentially make a major contribution to national and rural household economies as well as to poverty reduction.

(c) Poverty

Between 1991 and 1998, poverty levels increased from about 63% to 73%. Zambia is one of Africa's poorest countries where more than two-thirds of its 11 million citizens live on less than USD one per day. Though poverty levels have fallen from 73% in 1998 to 68% in 2004, population growth is increasing pressure on natural resources and contributing to their depletion. The percentage of people classified as poor is over 70% (GRZ 2002).This means that much of the population lives in households where the income is not sufficient to meet the basic needs. Therefore people are forced into activities like charcoal production and firewood collection which they sell to earn a living. Levels of poverty differ between urban and rural areas in Zambia. According to ZFAP (1998), rural poverty is more widespread than urban poverty.

The economic deterioration of the past two decades has tended to hit the urban poor particularly hard, given their dependence on wage employment for income, on the market for food supplies, and on the government food subsidy programme which was completely discontinued after 1992. Poverty is greatest in the Western and North Western provinces, followed by the Eastern, Luapula and Northern provinces.

The relationship between poverty and environmental degradation has been emphasized since the publication of the World Commission on Environment and Development (WCED) or Bruntland report in 1987 (WCED 1987). The authors noted that poverty may lead to environmental degradation, which in

turn will push the poor even further down into poverty. Thus, in Zambia, the country's Fifth National Development Plan 2006-2010 (FNDP) identified wealth creation through sustained economic growth as the most important element in fighting poverty and placed high priority on sectors that have the best potential to stimulate growth and on sectors such as agriculture, education and health.

(d) Population

The country's population grew at an average annual growth rate of 2.9% between 1990 and the year 2000 (CSO 2000). The projected population for 2007 is 11.5 million persons. With the total surface area of the country at 752,614 square kilometer (290,585 square miles), the population density is 13.7 persons per square kilometer (35.5 persons per square mile). The distribution of the population is such that there are more people living in urban areas, particularly in Lusaka and the Copperbelt, than in rural areas. Apart from the natural increase, the concentration of people in urban areas has been due to in-migration fueled by a search for job opportunities.

One of the major causes of deforestation resulting from firewood collection and charcoal production is due to the fact that only about 20% of the Zambian population has access to electricity. In Zambia, poverty has been exacerbated by high population growth and the HIV/AIDS. The over-concentration of population in urban areas affects the provision of social services and has serious repercussions on the environment, and forests in particular. This, in

turn, implies increased demand for forest products and services in the country.

1.2.9 Zambia's Land Tenure System

Zambia inherited a land tenure system based on two principles, customary and statutory land tenure, from the British colonial rulers (GRZ 1995, 2002, ECZ 2001). The Government owns all the land in Zambia, but the way it is managed depends on what kind of land it is. While Zambia covers a total landmass of 75 million hectares, there are two categories of land ownership as follows:

(a) State Land, comprises 4.5 million hectares (6%), and

(b) Customary Land, comprises 70.4 million hectares (93.9%) (Formerly consisting of Reserve Land, 27.2 million hectares, 36.2%, and Trust Land, 43.3 million hectares, 57.7%).

Any commercial use of trees and forests in Customary or State Land is controlled by the Government through the Forest Department. According to the Land Act No. 29 of the Laws of Zambia, all land is vested in the President of the Republic of Zambia who holds it in perpetuity on behalf of the Zambians. Section 8 of part II of the Land Act of 1995 now provides for the conversion of customary tenure into leasehold tenure by obtaining title to it. This literally converts customary land to leasehold land. The other land tenure system is the statutory or leasehold tenure under which an individual can own land by obtaining a lease title to it for a period not exceeding 99 years (GRZ 1995, Zimba 2003). Such land becomes private property and access to it is restricted by law. After the expiry of the 99 years, regarded as an average

lifetime, the leasehold can be extended. This system is widely practiced along the railway line where the white settlers were concentrated on prime well-serviced land, but it forms the smallest form of tenure in Zambia. It is the most favored system in terms of agriculture development and housing, where land ownership can be used as collateral to obtain loans from banks. A significant amount of land, roughly 40% of the total land area, is allocated to protected areas including national parks, game management areas and forest reserves. Notably, most of the forest reserves are on traditional land (8% of the total 9%); this is land that should be open for community use.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Many concepts have been used in explaining firewood collection and charcoal production activities in Zambia and other countries. This chapter explains the history, origins and literature on issues related to charcoal production and firewood collection in Zambia and other countries. It also presents the institutional, forest policy and legal framework within which forest resources are managed in Zambia. Key forest policy principles and capacity of the Forest Department are outlined. National policy processes and policies that are aimed at reducing poverty, but related to forestry development, are also reviewed.

2.2 Definition of Terms

2.2.1 Firewood and Charcoal

Woodfuel is the principle source of domestic energy in developing countries (Openshaw 1974, Eckholm 1975, Arnold and Jongma 1978, deMontalembert and Clement 1983). Woodfuel includes charcoal as well as firewood (fuelwood), brushwood, twigs, branches, and cut branches (Openshaw 1986).

Firewood is wood which is burnt as fuel for heating (Douglas 1991). The wood is composed largely of lignin, cellulose, and water; the higher the lignin content and the denser the wood, the higher the yield and quality of the charcoal produced from it (FAO 1983). Undried hardwood contains an

average of about 30% water, while softwood contains about 42%, although some of this can be removed by sun or kiln drying (Emrich 1985).

Charcoal is defined as the solid residue remaining when wood is "carbonised" or "pyrolysed" under controlled conditions in a closed space such as a charcoal kiln (FAO 1987). Both firewood collection and charcoal production activities start with selection of prefered trees and cross cutting of felled trees to length.

The first recorded use of charcoal comes from the black pigment used in European cave paintings dating from around 32,000 years ago (Farming and the Countryside 2008). It is not known whether this charcoal was produced deliberately. It is possible that the earliest use of charcoal as a fuel began over 7,000 years ago (5500 BC) in the smelting of copper. The first definite evidence of Mans' involvement with charcoal as a fuel can be traced back 5,500 years in Southern Europe and the Middle East. It is thought that the Egyptians, who were expert metal workers, may have discovered the smelting of iron using charcoal nearly 5,000 years ago and within a further 1,000 years discovered how to produce glass (Farming and the Countryside 2008).

The production of charcoal involves tree felling of particular tree species. Tree felling is followed by stem cross-cutting, kiln building by piling logs and covering with soil, wood carbonization and kiln breaking to recover the charcoal. The main types of earth kilns used are rectangular and circular in shape. In the traditional charcoal kiln or pit, some of the wood loaded into the

kiln is burned to dry the wood and raise the temperature of the whole of the wood charge so that pyrolysis starts and continues to completion by itself. The pyrolysis process produces charcoal which consists mainly of carbon, together with a small amount of tarry residues, the ash contained in the original wood, combustible gases, tars, a number of chemicals mainly acetic acid and methanol - and a large amount of water which is given off as vapor from the drying and pyrolytic decomposition of the wood. When pyrolysis is completed, the charcoal, having arrived at a temperature of about 500° Celsius, is allowed to cool down without access of air; it is then safe to unload and it is ready for use (FAO 1987).

2.3 Forestry Institutional, Policy and Legal Framework

2.3.1 Policy and Legislation Changes in Zambia

Before independence in 1964, during the colonial administration, the forest sector was run by a Forest Division in the Department of Agriculture. This division formulated the first Forest Policy for Zambia (then Northern Rhodesia) in 1949 which was put in place in 1965. The policy broadly covered land protection, wood supplies, timber production, conservation of forest resources, research and extension. Its aim included reserving parts of the country as gazetted forest reserves for both production and protection, ensuring a reliable supply of wood fuel for mining operations and safeguarding nationally important water catchment areas (Shitima 2005). However, the policy did not provide for a broad-based participatory approach to forest management and production that takes account of other sectors and stakeholders. All control of forest ownership, planning and management was

given to the Central Government through the Forest Department. It did not spell out roles and responsibilities for Local Authorities and communities in the management and use of the forest resources. The policy was also silent on gender issues, and as a result, it perpetuated the gross imbalance that exists between men and women with regard to matters of ownership, access, control, derivation of benefits, constraints and impacts of forest resources development and depletion.

Despite FAO (1998) showing that 65% and 70% of Zambia's land area is under one form of forest cover or another, there is evidence of continuing deforestation resulting from various negative factors. The demand for charcoal and firewood has contributed to loss of forests resources in Zambia. The current situation in illegal firewood collection and charcoal production can be attributed to massive job losses resulting from the 1991 privatization and structural adjustment programs (SAP). Most of the retrenched workers turned to the MNF for agricultural land, firewood and other forest products. Due to increases in poverty, woodfuel was the largest source of energy in Zambia, followed by petroleum, electricity and coal (Kalumiana 1997). Overall total energy consumption in the country exceeds 4.5 million tons of oil equivalent (TOE) per annum with each fuel contribution being as follows: woodfuel (68%), petroleum (14%), electricity (12%) and coal (6%).

The high level of deforestation compelled the Zambian Government, through the Ministry of Environment and Natural Resources (MENR, now MTENR), in 1994 to institute ZFAP which was aimed at mitigating the deforestation,

providing a viable policy and legal framework to attract investments, creating responsive corporate/public enterprises, redefining forest land ownership and attracting meaningful commitment from a variety of stakeholders to tree growing, protection and utilization of forest products. The ZFAP was formulated and instituted in 1995 to provide a ministerial framework for the rational management and conservation of Zambia's forest resources and the enhancement of the forestry sector's contribution to socio-economic development, poverty alleviation, improved food security and environmental protection of the country (Zambia).

The ZFAP was Zambia's national response to the aspirations of the FAO-initiated Tanzania Forestry Action Plan (TFAP). The Programme undertook to identify key forest sector issues and opportunities available to resolve them and therefore, enhancing national capacity to formulate, implement and monitor a comprehensive participatory forest sector program (FAO 1998).

The ZFAP, therefore, ushered in a number of coherent changes, which included formulation of the Provincial Forestry Action Plan (PFAP) and redesigning of the Forest Policy and Legislative frameworks. The PFAP undertook to facilitate the formulation of three participatory forest management plans for Central, Copperbelt and Luapula provinces. The PFAP is an integral part of the ZFAP process that aimed at supporting and improving the ZFAP process by strengthening institutions involved in the forestry sector. The PFAP also aimed at increasing both direct and indirect benefits from forests and trees to citizens of the three provinces through

greater involvement of forest dependent communities and resource users, while increasing the revenues accruing to the Government from the forestry sector. The implementation of the first phase of the PFAP lasted from August 1995 to December 1998 (FAO 1998).

Various studies were instituted and data collected under the ZFAP (1995 - 1997). The studies revealed the inadequacies of the old Forest Policy (Forest Act of 1973, Cap 199). This policy did not provide a broad-based participatory approach to forest management and production that takes into account other sectors and stakeholders. The ZFAP and PFAP phases conducted studies aimed at gathering baseline data that was later compounded on some of the above concerns. However, the coverage of the studies was narrow due to the limited time frames and spheres of operation of the ZFAP and PFAP processes. In line with ZFAP and PFAP, over the past ten years, there has been a paradigm shift among African countries to "community forestry" also known as "social forestry", "participatory forestry", "joint forestry management" (JFM) or "collaborative forestry" which aims at participation of all stakeholders in forest management. Thus to institutionalize the interest of all stakeholders, a new forestry policy was formulated in 1998 and Act No. 7 in 1999 though the Act has not yet been put to action. The policy sought to recognize all stakeholders as active participants in the management and utilization of forest resources. Further, the policy paid closer attention to forests outside the protected or gazetted forest estates (PFAP 2005).

2.3.2 Forestry Institutional Framework in Zambia

Zambia's forestry institutional framework is based on the 1973 legislation. The management of national and local forests is vested in the Forest Department, a state-run institution in the Ministry of Tourism Environment and Natural Resources (MTENR), under the Forest Act No. 39 of 1973 (figure 4). The use of the 1973 policy has made it difficult to expand joint forest management. Moreover, the FD is unable to halt the high rate of deforestation which continues to destroy the resources on which poor people rely.

The Forest Department officers interviewed by Shitima (2005) revealed that the FD has inadequate material, human and financial resources. Insufficient financial resource is cited by government officials as the major hindrance in implementing the policy in full as the abolition of the Forest Department and creation of the Forest Commission requires enormous amounts of money.

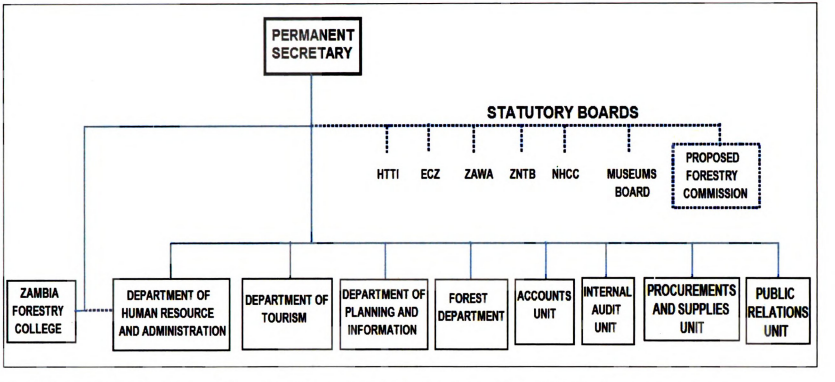

Figure 4. Organization Structure of Ministry of Tourism, Environment and Natural Resources

Source: Adapted from GRZ 2002.

The failures in securing Zambia's forest reserves is attributed in part to conflicting sectoral policies. Various government departments and ministries are seen acting in isolation from other departments thereby causing conflict. Political interference particularly relating to people who have settled in Mwekera National Forest is also cited where the settlers are reported to have the blessings of the local political leadership (Shitima 2005). Forest communities also receive services from public health officials and therefore get understandably confused when foresters come and threaten them with evictions.

2.3.3 Forest Legislation

The Forest Act No. 39 of 1973, Cap 199 of the laws of Zambia was devised with a centralized regulatory management approach in mind. The aims of this Act included to "provide for the establishment and management of national forests and local forests, to make provision for the conservation and protection of forests and trees and to provide for the licensing and sale of forest produce" (GRZ 1973), and like the 1965 policy, its supporting policy, it never provided for community participation and focused mainly on licensing and sale of forest produce.

In terms of restrictions in the 1973 Act, all land comprised in a national forest shall be used exclusively for the conservation and development of forests with a view to securing supplies of timber and other forest produce, providing protection against floods, erosion and desiccation and maintaining the flow of

rivers. According to part III, section 16 of this Act, no person shall without a license do any of the following acts in a national forest:

(a) Fell, cut, fashion, burn, injure, take, collect or remove any forest produce;

(b) Squat, camp, reside, build or excavate, or construct or use any enclosure or construct, reopen or use any road other than a public road or erect or operate any plant machinery or equipment;

(c) Fire any of the undergrowth, grass or forest produce or assist in lighting any fire or allow any fire lit by himself or his employee or agents to enter a national forest;

(d) Graze domestic animals or allow domestic animals to trespass;

(e) Clear, cultivate or break up land for cultivation or other purposes or grow crops;

(f) Enter or be in or upon any national forest in any manner or for any purpose contrary to an order made by the chief conservator and published in the gazette unless he is a traveler on a public road;

(g) Collect any bees, comb honey or beeswax or hang or place on any tree or elsewhere any beehive or other receptacle for the purpose of obtaining any comb, honey or beeswax or be in or upon any national forest for the purpose of collecting any bees, comb honey or beeswax;

(h) Collect any caterpillars or enter or be in or upon any national forest for the purpose of collecting any caterpillars;

(i) Remove or damage any boundary mark, beacon, notice, fence or gate or remove or damage any mark placed on any tree by, or on the authority of a forest officer;

(j) Deposit or negligently allow to fall over or on such national forest any rubbish or debris; and

(k) Restrictions on the manufacture of charcoal: Under this act or any other written law, no person shall without a license manufacture wood into charcoal or offer for sale sell or remove charcoal in or from any state lands or customary area.

This Act is usually blamed for the widespread deforestation as it alienated communities from their forest resources and created conflicts between the FD and the local communities neighboring forest reserves. The National Forest Policy (1965) was revised in 1998, a year following the adoption of ZFAP. The updated version reiterates the principles on which ZFAP is based and outlines goals for the sector, including for the yet to be established Forestry Commission.

The policy also seeks that all stakeholders are given recognition, and are active participants in the management and utilization of the forest resources. Further, the policy pays closer attention to forests outside the protected or gazetted forest estates.

2.3.4 Programmes and Policy Processes Related to Forestry and Poverty

(a) Fifth National Development Plan (2006-2010)

In 1999, the Government of Zambia produced a National Poverty Reduction Action Plan that outlined issues and priorities in relation to community empowerment and poverty reduction. The document provided the basis to

develop the Poverty Reduction Strategy (PRS) 2002-2004 which was launched in July 2002 and consisted of five thrusts:

i. Economic growth focusing on agriculture, tourism, industry and mining;
ii. Social services, especially in health and education;
iii. Infrastructure in terms of energy, transportation, communications, water and sanitation;
iv. Cross-cutting issues of HIV/AIDS, gender and the environment; and
v. Macro-economic policies and good governance progress reports on the PRS identified challenges with regard to implementation, including late disbursement of funds and lack of a systematic process to prioritize interventions.

When the current government took office in January 2002, it instructed the Ministry of Finance and National Planning (MFNP) to prepare the Transitional National Development Plan 2002-2005 as well as five-year plans from 2006 onwards. When the PRS came to an end in 2004, the transitional plan served as the national planning document until the Fifth National Development Plan 2006-2010 (FNDP) was published in June 2006. This latest document identifies wealth creation through sustained economic growth as the most important element in fighting poverty and places high priority on sectors that have the best potential to stimulate growth and on sectors that best address the needs of poor people – agriculture, education and health, for example.

(b) International Conventions and Agreements Related to Forestry

The Government of the Republic of Zambia is party to a number of international conventions and protocols on environmental and biodiversity conservation. Some International Conventions to which Zambia is Party to are as follows:

i. Viena Convention for the Protection of the Ozone Layer-This convention makes a commitment to protect the ozone layer from human induced emissions such as Chlorofluorocarbons (CFCs);

ii. Ramsar Convention on Wetlands-The objective of this convention is conservation and wise use of wetlands through national action and international cooperation;

iii. Convention on Biological Diversity (CBD)-This convention has three goals, the conservation of biodiversity, the sustainable use of the components of biological diversity and the fair and equitable sharing of benefits arising from the use of resources;

iv. United Nations Convention to Combat Desertification (UNCCD)-This convention is aimed at combating desertification, mitigating the effects of drought and contributing to sustainable development;

v. Convention on International Trade in Endangered Species (CITES)-This convention is aimed at protecting certain endangered species of wild fauna and flora from over exploitation through international trade via a system of import/export permit;

vi. International tropical Timber Agreement (ITTA)-This is a commodity agreement to facilitate the trade in tropical timber to ensure exports from

sustainable sources. Country membership is restricted to producers or consumer states.

(c) Regional and International Programmes and Studies Providing Land Cover Change Information

Illegal charcoal production and firewood collection, settlements and illegal cultivation are major contributors to deforestation and land use change. It is important that research on the extent of damage caused by these activities is conducted. Sadly, there is little or no information on the damage these activities have caused to forests in Zambia in past years. However, at regional and international levels, there are a number of programs and studies which aim at providing information about land use change.

Some studies are coordinated by the FAO, Global Forest Resources Assessment (FRA), which are conducted every five to ten years since 1946. Other studies have been conducted by individual scientists on deforestation in various countries world wide. Some of the studies have aimed at understanding tropical deforestation, being an important aspect of global change. It has a large influence on hydrology, climate and global biogeochemical cycles (Crutzen and Andreae 1990, Houghton 1991, Skole 1990, Salati and Vose 1984, Shukla *et al.* 1990).The understanding of tropical deforestation was reported as inadequate for two reasons: a lack of accurate measurements of its rate, geographical extent, and spatial pattern and lack of insight into its causes (Skole in press).

The area of deforestation and the rate of deforestation between 1978 and 1988 for the Brazilian Amazon was determined in 1988 (Skole and Tucker 1993). In this study, 210 Landsat thematic mapper images for the entire legal Amazon of Brazil for 1988 were used. Individual scenes were digitized using visual interpretation and standard vector geographic techniques. To measure deforestation in the Brazilian Amazon, satellite remote sensing provided the best source of information. Landsat Spot and other sensors can be used to develop detailed maps of the rate and geographical extent of deforestation in tropical forest and thus to document the location and expansion of deforestation over time (Skole *et al.* 1994).

Other studies on the Brazilian Amazon basin show that the region has experienced high deforestation rates since the 1970s (INPE 2002). It is estimated that about 20-50% of the deforested areas are in certain stage of secondary succession (Moran *et al.* 1994; Skole *et al.* 1994; Lucas *et al.* 2000; Roberts *et al.* 2002). The rapid regrowth and increasing extent of successional forests play an important role in regional and global carbon budgets. The complexity of vegetation stand structure, the smooth transition between adjacent successional stages, abundant tree species, and heterogeneous environmental conditions often create difficulties in Amazonian vegetation classification. Lu *et al.* (2005) compared the performance of Terra ASTER, Landsat TM, and SPOT HRG data in land cover, especially vegetation classification and explored the suitable image processing routines for vegetation classification in the Amazon. Many previous initiatives only classified the moist tropical forest into two broad categories–successional

forest and primary forest (Adams *et al.* 1995; Roberts *et al.* 1998; 2002, Powell *et al.* 2004). A single class of primary or secondary forest is obviously not sufficient for many applications such as carbon cycling studies. So, a careful delineation of vegetation classes is required.

Landsat TM/ETM+ data are often used for land cover classification (Adams *et al.* 1995, Roberts *et al.* 1998, Lu *et al.* 2004). As higher spatial and/or spectral resolution satellite data are readily available, identification of suitable sensor data for land cover classification in the moist tropical regions is key for providing better classification results. For example, ASTER data with improved spatial and spectral resolutions and SPOT HRG data with high spatial resolution may provide better land cover classification performance than Landsat TM data. Although TM data have been extensively used for land cover classification in the Amazon basin, ASTER and HRG data applications are just beginning. Their capabilities for land cover, especially vegetation, classification are poorly understood.

FAO (2006) under the global Forest Resource Assessment (FRA) programme provided information on forest resources at global level. The total forest area in 2005 was just under four billion hectares. However, the area of forest is unevenly distributed. For example, 64 countries with a combined population of two billion have less than 0.1 hectares of forest per capita. Deforestation, mainly conversion of forests to agricultural land, continues at an alarmingly high rate–about 13 million hectares per year. It is however comforting to learn

that, forest planting, landscape restoration and natural expansion of forests have significantly reduced the net loss of forest area (FAO 2006).

The net change in forest area in the period 2000–2005 was estimated at 7.3 million hectares per year (an area about the size of Sierra Leone or Panama), down from 8.9 million hectares per year in the period 1990–2000 (FAO 2006). South America suffered the largest net loss of forests from 2000 to 2005–about 4.3 million hectares per year–followed by Africa, which lost four million hectares annually. North and Central America and Oceania each had a net loss of about 350,000 hectares, while Asia, which had a net loss of some 800,000 hectares per year in the 1990s, reported a net gain of one million hectares per year from 2000 to 2005, primarily as a result of large-scale afforestation reported by China. Forest areas in Europe continued to expand, although at a slower rate than in the 1990s (FAO 2006).

Other programmes include the Southern African Regional Science Initiative (SAFARI 2000); the Miombo Network, and the Global Observation for Forest and Land Cover Dynamics GOFC-GOLD. The study region for SAFARI 2000 includes Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe. Scientists from these countries collaborated with colleagues from the United States, Canada, the United Kingdom, and Germany to conduct the science initiative. SAFARI 2000 built on ongoing research by the international community and southern African nations. NASA's contribution included observations from several spacecraft, including Terra and Landsat 7; measurements from aircraft, observation

towers, and balloons; and collaborative research with African scientists. Fire is the focus of SAFARI-2000 (Southern African Fire and Atmospheric Research Initiative). SAFARI 2000 brings together scientists from the United States, Africa, and other nations in a multidisciplinary research effort aimed at understanding the sustainability of southern Africa's sensitive and pressured ecosystems (NASA 2000). SAFARI 2000 depends on many nationally and internationally funded projects, including:

- The Miombo Network, which focuses on land use and land-use intensity, and associated landcover changes, in the dry forests and woodlands (Miombo) of South Central Africa. The Miombo Network aims at bringing better understanding on how land use affects land cover and associated ecological processes; the impact of these changes on peoples' livelihoods; and the effects of these changes on global change processes (NASA 2000). The Miombo Network is a partnership of scientists, natural resource managers and policy makers interested in the sustainable development of the Miombo ecosystem and region. The Network was founded in 1995 under the auspices of the IGBP, LUCC and START, and has national level activities in the following countries: Malawi, Mozambique, Zambia, Zimbabwe, Tanzania and South Africa, with coordination provided through Penn State. The network is involved in many Projects and activities which include: Miombo LCLUC, which is a study of processes of Land Use and Land Cover Change (NASA LCLUC Program); Miombo Watch which involves the Mapping and Monitoring Land Cover Changes (GOFC/GOLD) program and programs aimed at capacity building in

use of GIS and remote sensing in environmental modeling and assessment (State Department) and so on (Miombo Network 2004).

- The GOFC/GOLD Program was established within the Integrated Global Observing System (IGOS) to provide a forum for international information exchange and observation and data coordination and a framework for establishing the necessary long-term monitoring systems. The principal role of GOFC/GOLD is to act as a coordinating mechanism for national and regional activities. To achieve its goals, GOFC/GOLD has developed a number of regional networks of data providers, data brokers and data users. These networks of resource managers and scientists provide the key to sustained capability for improving the observation systems and ensuring that the data are being used effectively. GOFC/GOLD networks are currently being developed in various regions including Southern Africa under the MIOMBO/SAFNET programs (GOFC-GOLD 2006).

The University of Virginia annual report of 1998-1999, identifies some challenges Africa faces and efforts to mitigate them. Changes in land use and land cover when coupled with seasonal climate variations threaten water availability, food production, and human health across the continent. Research in the African segment of the Department's Global Environmental Change Program (GECP) is designed to measure these changes, and eventually, predict their impact on both African and global ecosystems. GECP-Africa, combines high-tech methods, such as satellite remote sensing, with field-based studies. There are currently four research initiatives within

GECP-Africa: Central African Region Program for the Environment (CARPE), Miombo, Kalahari Transect, and Southern African Fire and Atmospheric Research Initiative (SAFARI-2000). Each involves collaboration with scientists from Africa, Europe, and numerous United States of America (USA) educational and government institutions as well as components of such international bodies as the United Nations (University of Virginia 1999).

The use of remote sensing and GIS technology has proved effective in management of natural resources. In Zambia, GIS has been applied in the Administrative Management Design for Game Management Areas (ADMADE) wildlife conservation programme under the Zambia Wildlife Authority (ZAWA). This program has over 10 years of experience using GIS technology to support rural communities in managing their natural resources. Through this program, communities living in Game Management Areas (GMAs) become partners with government and private industry to manage their wildlife resources, striving to achieve both conservation and community development. This has been made possible by ensuring that the policy is progressively evolved from a pilot study carried out in the mid-1980's. This policy has subsequently undergone numerous transformations and adaptations in meeting the needs of both the resource and local community land owners. Studies to examine how a set of variables common to most GMAs influence the efficiency of Community-Based Natural Resources Management (CBNRM) approaches in achieving goals of resource conservation and rural development have been conducted and stored in a GIS database (National Parks & Wildlife Services 1999d).

2.4 Forest Resources in Africa

The forests of Africa cover 520 million hectares and constitute more than 17% of the world's forests (UNEP 1999). More than 109 million hectares of forests, lie in the Democratic Republic of the Congo (DRC) (more than 20% of the region's forest cover), while Northern Africa has little more than 9% (FAO 1997a). During 1990-95, the annual rate of deforestation in Africa was about 0.7%, a slight decline from 0.8% during 1980-90 (FAOSTAT 1997). During the 1980s, Africa lost an estimated 47 million hectares of forest. By 1995 another 19 million hectares had been lost (FAO 1997a), an area the size of Senegal. Losses have been particularly high in countries such as Uganda, where forest and woodland cover shrunk from an estimated 45% of total land area in 1900 to only 7.7% by 1995 (Ministry of Natural Resources, Uganda 1995).

Africa's forests are threatened by a combination of factors including agricultural expansion, commercial harvesting of trees for timber, increased firewood collection, inappropriate land and tree tenure regimes, heavy livestock grazing, and accelerated urbanization and industrialization. Drought, civil wars and bush fires also contribute significantly to forest degradation (FAO 1997a and 1998). The production and consumption of firewood and charcoal rose from 250 to 502 million cubic meters during the same period. Recent projections estimate that consumption will rise by another 5% by 2010 (FAO 1997a). At least 90% of Africans depend on firewood and other biomass for their energy needs (FAO 1997a). Total fuelwood (including charcoal) burnt in tropical Africa is estimated at 230 million tons (dry matter) per year and the amount of charcoal consumed is about 11 million tons (Delmas *et al.* 1991).

Firewood and charcoal have affected forests other than the Miombo forest (FAO 2001). In a study on the degradation and destruction of mangroves, it was found that mangrove forests also continue to disappear all over the world. They were estimated to cover 18.1 million square kilometers (7 million square miles) worldwide (Spalding 1997), but a more recent estimate indicates that the figure may now be below 15 million square kilometers (5.8 million square miles). Degradation of mangroves has been caused by nature-induced changes and human-induced changes such as charcoal production and firewood collection.

In Uganda, drastic changes in the forest cover have taken place during the past century. Forest cover is estimated to have been as much as 10.8 million hectares in 1890, 35% of Uganda's land area (Kayanja and Byarugaba 2001). According to the National Biomass Survey (data collected between 1989 and 1995), this has now shrunk to less than five million hectares, or 16% of the land area. FAO in 2000 estimated the deforestation rate in Uganda to be about 0.9% per year based on the change in the amount of bushland and woodlands from 1990 to 1995. These figures imply annual deforestation rates of between 1% and 3%, respectively. Activities such as agriculture and grazing, firewood collection, pit sawing and charcoal production are blamed for the loss.

Deforestation has become a significant problem damaging the environment, the economy, and the welfare of Mozambicans. Deforestation is driven by several different factors such as the necessity of more crop cultivation plots

for an increasing population, and desire for firewood as a source of energy. From 1997 to 2001, over USD 85 million worth of timber was exported from Mozambique (Ghazvinian 2004). Biomass fuels such as firewood and charcoal account for 80%-90% of the energy supply, and in the more rural, remote provinces of Nampula and Cabo Delgado, that percentage is even greater. Sixteen million cubic meters of wood are burned in Mozambique each year to satisfy the country's energy needs.

In Tanzania, forests cover about 33.6 million hectares of forests and woodlands (Hurskainen 1996). These are highly valuable as a source of timber and catchment services (URT 1998). The most important use of wood in Tanzania is for fuel, were about 95% of the country's energy supply is met by fuelwood. Households consume about 97% of wood energy in SADC region mostly for cooking, heating and cottage industries while the industrial sector is second to household sector (SADC Energy Sector 1993). The Tanzania energy policy of 1997 still stresses development and use of indigenous energy sources such as bio-energy, coal, natural gas and hydropower (URT 1997). However, less than 2% of the energy development budget is allocated to wood energy programs, and fuelwood is still regarded as a minor forest product with little market value (TFAP 1989). Yet still, the vast majority of woodfuel consumers cannot afford the high investment costs associated with alternative commercial energy sources (Moyo *et al.* 1993). Availability, reliability of supply and cheaper prices renders fuelwood more preferable than alternative sources of energy. In urban areas the market of charcoal exists because of financial constraints of acquiring alternative

sources of energy (TFAP 1994). The present household fuelwood and charcoal consumption alone is 33.4 million cubic meters. However, the total potential supply for wood energy and sawn timber is only 25 million cubic meters per year. Fuelwood gathering is becoming progressively more difficult as forests shrink further away from population centers.

2.5 Sources of Household Energy in Zambia

In Zambia, households use four main types of fuel, namely firewood, charcoal, kerosene and electricity (table 4). Firewood and kerosene are mainly used in rural areas. The use of animal dung and crop residues is restricted to rural areas. Urban households mainly use charcoal, kerosene and electricity while firewood is used in lesser quantities. Electricity is widely used in medium and high-cost urban residential areas. Less than 20% of the country's population has access to the hydro-electric power grid, the predominant source of electricity (ECZ 2001).

ERB (2007) clearly presents the status of the hydro power system in Zambia. Zambia almost entirely depends on hydropower for its electric power needs. This poses a threat to security of supply, and there is a need to consider diversifying to energy sources such as coal. The current installed capacity in the Southern African Development Community (SADC) region is 53,000MW of which dependable capacity is only about 41,000MW against a demand of 42,000MW (ERB 2007). The region requires a reserve margin of 10% if its economies are to operate smoothly. The Zambia Electricity Supply Corporation (ZESCO) electricity system is more than 40 years old. Audits of

ZESCO electricity network conducted in 1994 concluded that the network required extensive rehabilitation to bring it to the desired operation levels and extend the economic life of the assets.

ZESCO has been forced to initiate a load shedding programme at peak periods due to the increasing demand coupled with the unavailability of some generators at the main power station under the power station rehabilitation project. The country experienced three countrywide power outages in 2006 due to technical faults, and in one instance adverse weather conditions resulted in a mudslide that affected the operations of Kafue gorge power station in 2005.

Following the privatization of ZCCM, there has been an emergence of other players in the electricity sector namely Copperbelt Energy Corporation (CEC), Lunsefwa Hydropower Company (LHPC) and the Zengamina Hydropower Company, an off grid mini hydropower plant. The ERB has also demonstrated its support for renewable energies by promoting the setting up of Energy Service Companies (ESCOs) in Eastern Province. The ESCOs in Eastern Province are small enterprises that provide solar electricity to their clients. They were launched in 1998 with the support of the Swedish International Development Agency (SIDA). Three autonomous ESCOs are presently in existence namely NESCO in Nyimba (operational since 2000), LESCO in Lundazi (operational 2001) and CHESCO in Chipata (operational since 2002) (ERB 2007). The electricity situation in Zambia has been worsened by the opening up of new mines in Northern, Western and Copperbelt provinces and in other parts of the country. The high electricity tariffs and erratic supply of

electricity have led to an increase in the demand for alternative energy sources, especially firewood and charcoal.

Population increase has affected energy demands especially for woodfuel and charcoal. According to Kalumiana (1996a) the most significant factor affecting woodfuel demand in Zambia is population as most woodfuel is consumed at the household level. Kalumiana (1997) reported that woodfuel is the largest source of energy in Zambia, followed by petroleum, electricity and coal. This is corroborated by ZFAP (table 4). Current levels of energy demand in Zambia can be satisfied and wherever possible enhanced by ensuring sustainable regeneration of forests and also by providing alternatives to woodfuel such as biogas, solar power, hydro-electricity and petroleum products like kerosene (FAO 2001). However, these are high capital investment ventures and will need total Government commitment in terms of subsidies, tax alleviation, credits and any such measures that may assist both the urban and rural poor to access these alternative energy sources (FAO 2001).

Table 4. Contribution of Different Energy Sources to Household Energy, 1990 to 1995

Year	Number of Households			Fuel Contribution, %				
	Urban	Rural	Total	Charcoal	Firewood	Firewood and Charcoal	Kerosene	Electricity
1990	648.8	2,031.8	2,714.6	16.9	79.9	96.8	1.3	1.9
1991	677.1	2,113.4	2,790.0	17.1	80.0	97.1	1.0	1.8
1992	698.8	2,156.8	2,855.6	17.0	80.4	97.4	0.7	1.9
1993	721.6	2,216.7	2,938.4	16.8	80.3	97.1	0.7	2.2
1994	743.6	2,276.7	3,020.3	16.5	80.5	97.0	0.6	2.3
1995	781.4	2,350.2	3,131.6	16.2	79.9	96.1	0.6	3.3

Source: ZFAP, Volume II (1998).

2.6 Charcoal Production and Firewood Collection in Zambia

Most studies in Zambia have been conducted in the Miombo woodlands (which cover between 55% and 60% of total land area) by Professor E. N. Chidumayo and A. Marjokorpi (1996-97), M. Grunder (1995), P. L. W. Chitondo (1996) and the Forest Department (1995 - 1999). Some of the studies have attempted to address problems of firewood collection and charcoal production.

FAO (1998) conducted a review on firewood in Zambia in the context of production, supply, demand/consumption and trade. In many areas of Zambia, charcoal production is an important source of cash income. In 1997, the Government estimated that 41,000 rural households were full-time employed in charcoal production, and an additional 4,500 people were involved in transportation, marketing and distribution (GRZ 1997). For instance, approximately 9,000 households, in Chongwe District alone in 2000, were involved in charcoal production, supplying the product to Lusaka. The average per capita income from charcoal production was 4.8 times higher than that from farming (Chidumayo 2001). In communities where forests are in good condition, households collect deadwood, whereas when firewood is scarce, households cut down trees for firewood and markets for firewood are slowly emerging. The average household consumes 100 kg of dry wood per month. Charcoal is a source of cash income for almost half of the households in Katanino, which is near Ndola.

Perhaps most important in Zambia is the contribution of forests to the nation's energy needs, with dry forests providing about 70% of the energy needs

(Ministry of Finance and Planning 2002). 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. Approximately 72% of households in Lusaka use charcoal for cooking and heating while 10% use firewood (Kalumiana 1997). Charcoal consumption increased from 174,000 tons in 1990 to 245,000 tons in 2000 and is projected to reach more than 500,000 tons by 2020 (Chidumayo 2001, Frey and Neubauer 2001). Most charcoal comes from Lusaka, Central and Copperbelt provinces and is sold at municipal markets, by the roadside or at homesteads (Kalumiana 1997).

Wood is carbonized to charcoal in traditional earth kilns, but little is known about the national carbon budget in charcoal production and burning. It is necessary to know the amount and quality of wood used in charcoal production in order to construct the charcoal carbon budget. Two complementary projects were carried out in Zambia during 1993-1994 to generate this kind of data. One was on the Inventory of Wood Used in Charcoal Production and the other was on Emissions Produced in Charcoal Production (Chidumayo 1993).

In line with population, there is a positive correlation between household size and charcoal consumption (R-squared = 0.86) while correlation between per

capita consumption and household size is negative (R-squared = -0.78) (Chidumayo 1993). Mean household size in Zambia increased from 4.7 in 1969 to 5.6 in 1990 and will probably continue to increase up to 2010 and beyond. By implication, average charcoal consumption per household also increased while per capita consumption decreased. For example, gross annual charcoal consumption per household averaged at 1,043 kg in 1983 (Chidumayo and Chidumayo 1984), 984 kg in 1988 (World Bank/ESMAP 1990) and 1,110 kg in 1994 (based on the 1994 survey data). Comparison between 1988 and 1994 did not reveal significant differences ($t < 1.50$; $P > 0.05$). The average annual charcoal consumption in urban Zambia during 1983-1994 was therefore 1,046 kg per household.

The household sector accounts for 96% of total charcoal consumption in the country (Department of Energy 1992). Charcoal consumption increased from 0.33 million tons in 1969 to 0.49 million in 1980 and was 0.69 million in 1990. Consumption is projected to increase to 0.9 million and 1.2 million tons in 2000 and 2010, respectively (table 5).

Nkomeshya (1996) noted that some tree species are under higher threat for harvesting than others. He listed the following species as being most widely used for Woodfuel conversion and utilization: *Julbernardia paniculata, Julbernardia globiflora, Brachystegia boehmii, Brachystegia spiciformis, Bauhinia thoningii, Pericopsis angolensis, Parinari curatellifolia,* and *Uapaca kirkiana*. These tree species are preferred because of their high heat content value and that they last long in burning. Based on the same principle of heat

value and durability in burning, preferred charcoal tree species are not so different from those used for firewood.

Table 5. Charcoal Consumption and Wood Used in Charcoal Production in Zambia

Year	Charcoal Consumption (million tons)	Charcoal Produced (million tons)	Wood Used (million tons)
1969	0.330	0.340	1.479
1980	0.490	0.505	2.196
1990	0.685	0.706	3.070
2000	0.905	0.933	4.056
2010	1.211	1.248	5.428

Source: Chidumayo 1993.

Selectivity in woodfuel tree species harvested has resulted in localized scarcities of the preferred species. However, due to continuously increasing demand for woodfuel and depletion of priority species, current harvesting methods do not segregate on species and this situation has culminated in complete degradation of certain forest areas. Natural regeneration in these areas has become almost impossible (under current institutional arrangements and economic situation) because regrowths are rarely given a chance to develop into mature trees--some are cut immediately when they start to show signs of stem rigidity, and others are destroyed by late fires which are very common, especially in livestock areas and in areas under the slash and burn (Chitemene) system of agriculture. Zambian charcoal and

firewood are estimated to have heat content values of 32.6 and 15.5 GJ/ton, respectively (Department of Energy 1992).

Lack of alternative income generating ventures further alienates rural dwellers from use of charcoal because even those who are able to produce the commodity would rather offer it for sale to fill the income gap and use firewood for their energy requirements. The major problem that has been associated with charcoal production, however, is in the way it is produced and the kind of losses incurred in its production. The earth kilns used are mostly 10% efficient, implying that in the process of producing charcoal from wood, 90% by weight is lost. From 100 tons of wood, therefore, one only expects to get 10 tons of charcoal (Kapiyo 1996).

Other reports published by the Forest Department have indicated that charcoal is the single most depleting agent of forest resources due to the continuous nature of its operations, which run throughout the year. Current rates of harvesting are, therefore, very high, but against a poor monitoring and control system. On average, 2.5 - 3.5 kg of woodfuel are used per household per day in rural areas. This consumption when extrapolated to annual figures and in segregating between charcoal and firewood, amounts to not less than 73 kg per person per annum and 1,025 kg per person per annum for charcoal and firewood, respectively (Forest Department 1999).

In terms of consumption on the Copperbelt Province and Kitwe, in particular, in 1996, the Province consumed 1,138,111 tons of woodfuel out of which

charcoal accounted for 76% of total consumption. The bulk of this fuel was consumed by households (Kalumiana 1996). In addition to local consumption, an equivalent of about 79,140 tons of wood was exported, in the form of charcoal, to Lusaka Urban. Electrified households showed reduced charcoal consumption levels. According to Kalumiana (1996) about 3,538,080 by 25 kg charcoal bags were produced over and above the supply limit for the Province. Even without the portion of charcoal that is exported to Lusaka, the Province's woodfuel balance still shows a negative picture. A total of 424 urban households were enumerated in Kitwe in a survey conducted by Kalumiana in 1996. Among these households, 72% were found to be using charcoal, while 15.6% depended on firewood. With regard to kerosene and electricity, proportions were 57% and 75%, respectively. These figures do not reflect the electrification proportion in the Province, but concerns only those households covered.

2.7 Summary

This chapter reviewed literature on the concepts used in explaining firewood collection and charcoal production. A review of policies and legislation from 1949 made it possible to identify the inadequacies of the current institutional and policy framework in Zambia. A major draw back of Act No. 39 of 1973 is that it does not provide for participatory approach and is silent on gender issues. Restrictions in Zambia's national forests are clearly outlined in the Act but the FD has not enforced it effectively due to understaffing, conflicting policies, inadequate funds, tools and equipment, poverty and lack of political

will. High poverty and unemployment was more wide spread after the SAP and the privatization process of the 1990s.

A review of forests in relation to charcoal and firewood for Uganda (Kayanja and Byrugaba 2001), Mozambique (Ghazvinian 2004) and Tanzania (Hurskainen 1996) showed that deforestation is not only affecting Zambia but is a global problem. One of the causes is that few people have access to hydroelectricity (20% in the case of Zambia). It was also learnt that 41,000 rural household in Zambia were in fulltime employment in charcoal industry (GRZ 1997). Dry forests in Zambia provide about 70% of energy needs. There is a positive correlation between household size and charcoal consumption (R-squared = 0.86) (Chidumayo 1993).

It was noted that the area under forest reserves is known, but the change in the condition and extent of forest cover affected by settlements, charcoal production, firewood collection and agriculture is no longer accurate. This is because the last national inventory in Zambia was conducted in the 1960s and therefore is outdated.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

3.1 Introduction

This chapter provides background information on the study area. It starts by presenting an overview of the Copperbelt Province and finally focuses on Kitwe city, the town in which the study area, Mwekera National Forest No. 6 (MNF), is located. Methods and approaches that were employed in the collection and analysis of the data are presented.

3.2 The Study Area

3.2.1 Choice of the Study Area

The choice of the Copperbelt Province, (where MNF is located) for the study was based on two reasons. First, Copperbelt Province is among the areas with the highest rates of deforestation as well as encroachment on protected forests in Zambia, (Chipungu and Kunda 1994). Second, the Copperbelt is also an area that has been undergoing socioeconomic changes after the privatization of copper mines with subsequent massive loss of jobs. People are now involved in searching for alternative sources of livelihoods including forestry-related activities. People who have encroached on MNF are mostly from townships surrounding the city of Kitwe and are therefore market-oriented in the way they utilize the forest resources. They produce charcoal, collect firewood and cultivate illegally in the forest leading to the damage of this forest reserve which is also a catchment area. MNF has natural vegetation which is dominated by Miombo woodland with mostly *Brachystegia*

spp. and *Julbernardia spp.* The forest is home for diverse species of small animals such as insects, birds, snakes and butterflies.

One unique factor of MNF is that it houses two important institutions of the country, the Zambia Forestry College and the Mwekera Aquaculture Station (Shitima 2005). The Zambia Forestry College started off as a government training institution in the 1940's and later was opened to others due to an increasing need for trained technical staff in the forestry sector and other institutions. The college currently trains a total of 70 diploma and certificate students every year. The ZFC uses MNF as a training ground for their students. The Mwekera Aquaculture Station benefits from the Mwekera Stream for its research ponds. The stream is a significant resource that runs through this forest with a few small waterfalls which attract people for recreation. Other institutions like the University of Zambia and Copperbelt University also conduct practical lessons in the forest. Therefore, given the ecological and economic importance of MNF to the local communities and research and training institutions, it became prudent to study the extent and characteristics of illegal firewood collection and charcoal production in the MNF after which lessons learnt would be applied in other forest reserves in the country.

3.2.2 Description of the Study Area

(a) The Copperbelt Province

The study area lies in the Copperbelt Province between the provincial headquarters Ndola and the city of Kitwe. With Zambia's population estimated

at 10.3 million persons (10,285,631) in the 2000 Census of Population and Housing about 39.9% of the population is concentrated in urban areas, mostly in the Copperbelt and Lusaka provinces. The Copperbelt Province, with an area of 3,101,400 hectares, is the second smallest region in Zambia after Lusaka Province which has 2,187,571 hectares. However, it has the highest proportion of the population of 1,657,646 persons, followed by Lusaka Province with 1,432,401 persons. The Copperbelt Province also has the second highest population density of 58.2 persons per square kilometer (151 persons per square mile) after Lusaka which has 69.7 persons per square kilometer (181 persons per square mile). The region is also one of the wettest provinces in the country after Luapula receiving around 1,500 mm of rainfall. The Province has abundant vegetation including forest woodland. It has the highest number of protected forests with Kitwe, the District in which Mwekera National Forest lies, having six forest reserves (Shitima 2005).

The Copperbelt has been the backbone of Zambia's economy. Its mining history dates as far back as the 1890s when the British South African Company (BSA) from South Africa started its operations. Most of the current mines in the province were opened in the 1930s by the British colonial settlers. These mines together with related industries which sprang up in the province contributed significantly to the country's GDP as well as employment. But the economic changes that affected the industry leading to its privatization in the mid 1990s, completed in 2000, have resulted in high unemployment (13,000 miners losing their jobs in the province) and high poverty levels in the province (Shitima 2005). Although mining now

contributes only 6% to the Gross Domestic Product (GDP), it still remains the greatest generator of government revenue and source of foreign exchange (MENR 1994).

The study area, MNF, is located in the city of Kitwe. The population of Kitwe was 199,798, 320,320 and 347,769 in 1969, 1980 and 1990, respectively (Kalumiana 1996). It grew by 4.4% and 0.8% per annum between the 1969 and 1980 and 1980 and 1990 intercensal periods, respectively. The District had the highest population density in the country, which in 1969, 1980 and 1990 was 257.1, 412.2 and 447.6 persons per square kilometer (666, 1,068 and 1,159 persons per square mile), respectively (Kalumiana 1996). This high population density of the Copperbelt Province and Kitwe, in particular, have environmental consequences associated with increased pressure on the environment due to people relying on direct exploitation of natural resources for their livelihoods.

(b) Mwekera National Forest No. 6

The MNF is located in the Copperbelt Province, about 26 kilometers (16.2 miles) east of the center of the City of Kitwe, the third largest city in Zambia (figure 5). MNF lies to the north of Kamfinsa stream, bordered by the Ndola-Mufulira road to the east. The northeast of MNF is bordered by Democratic Republic of Congo (DRC), Kakolo in the West and Misaka in the south (figure 6).

MNF was established in 1946 through a statutory instrument number 72 of 3rd May, 1946 with an original size of 11,129 hectares. In 1951, it was increased by 1,255 hectares to 12,383 hectares through statutory instrument number 23 of 1951.

The last registered official alteration was in 1957 when it was increased to 17,887 hectares through government notice number 268 of 1957 (GRZ 1965) (figures 6 and 7). This seems to be the size of the forest that remained until it started declining through human activities in the late 1980s.

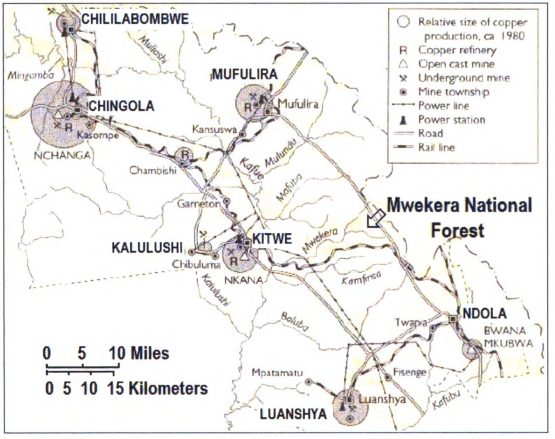

Figure 5. Location of Mwekera National Forest No. 6

Source: Adapted from Gondwe 1999.

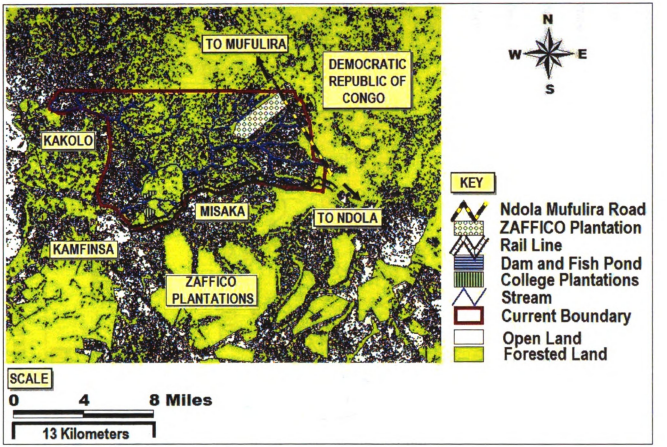

Figure 6. Current Boundary of Mwekera National Forest No. 6

Base Image Source: ASTER Imagery, 8th May 2006.

In 2005, a new boundary was proposed. The study area was the proposed Boundary of Mwekera National Forest Number 6 (figure 7) which starts in the northeast international boundary pillar BP18 on the Zambia-DRC international boundary. The MNF boundary follows the international boundary in a general southeasterly direction for a distance of approximately 2,800 meters (1.8 miles) to its point of intersection with the western boundary of mineral area No. 532m Mwekera to beacon W418 of that mineral area; and then through beacons W419 and W420, and to corner beacon of farm 1835 Mutengo Siding, beacon MCP1.

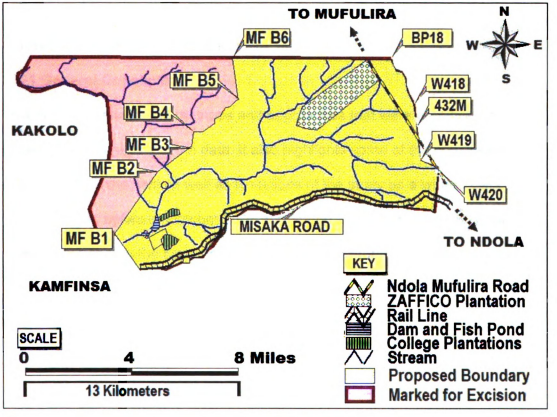

Figure 7. Current and Proposed Boundaries of Mwekera National Forest

Source: Field data collected between October 2007 and March 2008.

It proceeds to MFB1, MFB2, MFB3, MFB4, MFB5, MFB6, and back to international boundary pillar BP18, the starting point. The area within the proposed boundary is 11,539 hectares in extent.

The study area for this research only covers the proposed boundary of MNF. It must be noted that the new CEC electricity grid generally follows the new beacons of the proposed MNF. The area marked for excision was not surveyed. The effort for degazetting is fueled by a large influx of people who extract resources from the forest and live within its boundaries.

3.3 Research Design and Methods

3.3.1 General Concepts

This section presents the methods and approaches that were employed in the collection and analysis of the data. It also highlights some of the constraints encountered in the field as well as limitations of the study as a whole. Data were collected between October 2007 and March 2008 in two phases. Phase 1 involved mapping the boundary of MNF, mapping motor trails and built-up areas in MNF. Phase 2 involved the application of the focal sampling technique with focal areas identified from transects laid out from data in phase 1 and remotely sensed data prepared by the Tropical Rain Forest Information Center (TRFIC) at Michigan State University.

From the remotely sensed data, the extent and distribution of forested and open areas were identified and mapped using Arcview 3.3 software. A forest cover change analysis was done in Arcview 3.3 using digital satellite images

starting from 1984, and including 1989, 1995, 2000 and 2006. The digital satellite images were also used to plan transects/tracks for mapping in phase 2 (figure 8). All starting points (start of transect) located on the baseline were digitally pre-marked and their coordinates saved using a Global Positioning System unit (GPS). The focal sampling technique (Altmann 1974, Borgerhoff Mulder and Caro 1985) was adapted to record the extent and characteristics of illegal firewood and charcoal activities. Final results were reinforced by information from key informants, field observations and secondary data.

Features or activities related to firewood collection and charcoal production such as cultivated sites and settlements were identified and mapped in phase 2. In this study, a settlement was defined as any area with one or more buildings used for shelter. Settlements may have cultivated land and may be used for firewood and charcoal activities. On the other hand, a cultivated site was defined as any area used for growing crops. A firewood and charcoal site was any site with firewood piles, charcoal kiln under construction or with extracted kilns. Overlaps among the illegal activities were determined because the survey sheets (Appendix 1 and 2) had provisions to record all other illegal activities within the site. Because these activities were found in patches of open areas throughout the forest, only X and Y coordinates of the center of the activity (centroids) was recorded as the location. This was because the distances between activities within each patch were too small to justify taking individual coordinates for each activity and would therefore have no influence on the accuracy of the final results. Activities within the patch that were recorded included the number of charcoal kilns under construction,

extracted kilns, firewood piles, number of buildings if any and presence of crops.

3.3.2 Data Collection

Data collection addressed the following objectives in MNF: to conduct a forest cover change analysis from 1984 to 2006, to identify characteristics of illegal charcoal and firewood, to determine the extent of illegal firewood and charcoal activities, and to suggest intervention measures to reduce illegal firewood and charcoal activities. Data was collected in two phases (Phase 1 and 2) and via interviews.

(a) Phase 1-Forest Cover Change Analysis and Mapping of Features

Several steps were completed prior to field sampling which included forest cover change analysis and mapping of features. This data from phase 1 was important because it provided basis for identifying areas of interest used in phase 2. Data collected in this phase would be combined with data in phase 2.

i. Forest Cover Change

Digital satellite images used in forest cover change analysis were obtained from the Michigan State University, Tropical Rain Forest Information Center (TRFIC). This comprised 1984, 1989 and 1995 Landsat TM images, and 2000, and 2006 ASTER images. The Landsat TM missions began in 1982 with Landsat-4 and have continued to the present with the Landsat-7 mission, and images are at a spatial resolution of 30m. ASTER (Advanced Spaceborne

Thermal Emission and Reflection Radiometer) is an imaging instrument that is flying on Terra, a satellite launched in December 1999 as part of NASA's Earth Observing System (EOS), and images are at a spatial resolution of 15m.

ii. Mapping of Features

Activities in the initial stages included collecting data in MNF on major roads and trails, surrounding urban centers, the boundary of MNF, built up areas and streams. Major roads and motor trails linking forests to urban markets were mapped because they provide easy access to urban markets where illegal charcoal, firewood and other forest products are sold. Locations of urban centers and townships collected using a GPS unit were important because such places impose resource use demands on nearby forests (National Parks & Wildlife Services 1999d). It was expected that forest areas located relatively close to urban centers would be at greater risk of resource degradation from unsustainable exploitation and commerce of natural resources than those located further. Mapping the boundary of MNF was necessary as it provided the extent of the study area within which features of interest would be mapped. Built-up areas were mapped including the Aquaculture Research Station and Zambia Forestry College which are the key institutions dependent on MNF. Therefore, establishing the location of these two institutions was important.

Motor trails, roads and the boundary of MNF were mapped by collecting coordinates in segments along the features. Urban centers were mapped as

point locations. Streams and water bodies within MNF were adapted from themes provided by the Forest Management and Planning Unit of the Forest Department. Mapping of illegal activities (charcoal, firewood, cultivated sites and settlements) were planned for phase 2 but those within sight during phase 1 were mapped at the same time with phase 1 features. X and Y coordinates of the center of the activity were recorded as the location of the illegal activities. Other activities within the patch were then recorded as attributes of the patch.

(b) Phase 2-Focal Sampling

To inventory deforested sites and determine the extent of illegal activities in MNF, the focal sampling technique using consecutive transects was used. Transects were laid down using data from phase 1. Areas of interest had more transects laid down and this was later followed by an on-the-ground survey of features.

i. Mapping Features

Phase 2 involved collecting X and Y coordinates of centers of patches of areas used for cultivating crops, settlements, firewood collection, charcoal production and other activities along the transects. The focal sampling method was chosen because analytical studies by Whitesides *et al.* (1988) on the transect method revealed that the method is applicable to a wide variety of research including research on vertebrates and for research on animals living in habitat where visibility is restricted such as in tropical rain forests. This method involved multiple observers (2-4) walking along a transect marked

with projected GPS way points. The length and number of transects in each focal area was defined by the prevailing condition in the forest. The purpose of these comprehensive transects was to identify deforested sites and their characteristics. Transects cut along terrain and across streams in order to include a larger part of the forest and avoid bias (figure 8).

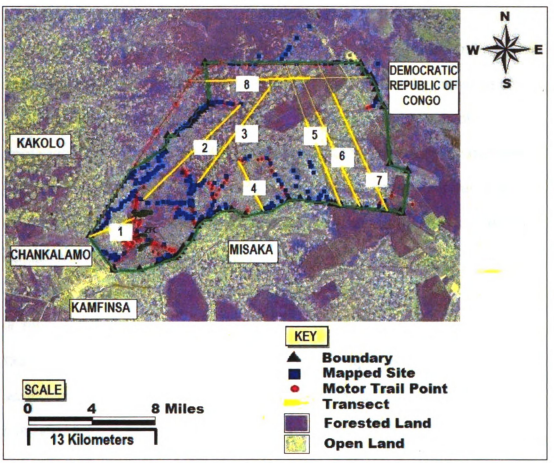

Figure 8. Layout of Transects for Phase 2 Mapping

Base Image Source: ASTER Imagery, 8th May 2006.

In focal areas, data were recorded for a number of parameters including time, location of the site (X and Y coordinates), number of charcoal kilns, number of firewood piles, elevation, and data on species that are actively harvested for

illegal firewood and charcoal production. All data was recorded on survey data sheets (Appendix 1 and 2).

ii. Field Observations

During field survey in areas of interest, observations were made and data on a number of parameters such as type and number of charcoal kilns, vegetation types at the site, undergrowth type, adjacent vegetation and species harvested recorded. Deforested sites were identified by presence of kilns, smoke from kilns, cleared vegetation, number and distribution of trails/roads and the presence of agricultural crops. Descriptive information on how the forest has been altered by roads, settlements, natural features and information on dominant tree species around charcoal fields were recorded on survey data sheets (Appendix 1 and 2).

iii. Photographs

During both phases 1 and 2 of data collection, photographs of features such as streams, vegetation in focal area, kilns, roads and trials, settlements and cultivated fields were taken to capture the scenes and activities in MNF. To safeguard identities, no photographs of people were taken.

(c) Key Informant Interviews

Institutional heads, in their official capacity, were interviewed. They provided specific 'expert' information on the extent and characteristics of firewood and charcoal activities, challenges faced and what is being done to mitigate these

illegal activities. Question guides followed during interviews are presented in Appendix 4.

Key Informants comprised institutional heads of government institutions as follows: The Permanent Secretary-Ministry of Tourism, Environment and Natural Resources (MTENR); the Director, FD-Lusaka; The Principal Extension Officer (FD)-Copperbelt Province; The Principal, Zambia Forestry College; The Director, Zambia Forestry and Forestry Industries Corporation (ZAFFICO); The Principal Research Officer, Division of Forest Research (FD)-Kitwe, District Extension Officer and the District Administrator-Kitwe District.

3.3.3 Confidentiality

All information obtained from this survey pertaining to participants is property of the researcher and the institutions involved and can not be used for any other purposes except for execution of this study. To ensure the confidentiality of the respondents, the participants were not asked to disclose their names during the survey (Appendix 3 and 4).

3.3.4 Tools, Materials and Equipment

A full forest (mensuration tools) inventory kit and GPS unit, digital camera, and other relevant tools were used (Appendix 5). Software during data analysis included ArcView 3.3, CrimeStat II, Microsoft Excel 2000 and Dbase IV. Protective clothing was worn by field personnel including the Major Professor (MSU Forest Department), the Researcher (Masters Candidate), two ZFC Training Officers and eight ZFC students as Research Assistants.

3.3.5 Safety of Personnel

MNF is a safe place to conduct research. However, as in any other natural forest in Zambia, snakes are a common sight even though reports of snake bites are not common. Another potential danger was falling dry trees, falling branches and other accidents caused by personnel falling due to uneven surface, dead logs, and so on. It is also common for people to lose direction within the forest especially if they don't have navigation equipment. Thus, safety of all involved personnel in this study was a priority.

To address the safety concerns, communication among personnel was ensured by requiring that at least one member in the team had a fully charged mobile phone. Mobile phone communication was possible since the entire MNF has mobile network coverage. Prior to field work, location of the nearest hospital/clinic or established centers were identified with map coordinates and details of general working area for a particular day revealed to the College administration. In the case of accidents, the team carried a first aid kit. Any new joining personnel were briefed on the safety plan. Personnel were also required to wear a hard hat and high-visibility field clothing such as an orange survey vest so that it would be easy to see each other between trees. In addition, no personnel were allowed to conduct the field survey alone. A check-in/check-out procedure was used to track location of personnel.

3.3.6 Data Analysis

All features and locations of illegal activities were analyzed using Arcview 3.3 (in vector data format), Dbase IV, Microsoft Excel 2000 and CrimeStat II software. Both vector and raster data formats were used to come up with the

forest cover change maps from 1984 to 2006 at five-year intervals. Characteristics of firewood collection and charcoal production activities were derived from forest cover change analysis, key informant interviews and results from field survey obtained during phases 1 and 2. Data from field observations, photographs, and literature review was also used to confirm the interpretation of results. Photographs of features helped to capture additional information on the current state of MNF.

(a) Forest Cover Change

Both raster and vector data formats were used in forest cover change analysis using Arcview 3.3 software. Images at roughly five-year intervals including Landsat TM satellite images (path: 172 row: 69) for 1984, 1989 and 1995 and ASTER images for 2000 and 2006 were used.

Each image was loaded into Arcview 3.3 by clicking the "Add Theme button" and choosing "Image Data Source" from the "Data Source Types" lists. The Landsat TM images were first converted to grid data format with a cell size of 30m by choosing the "Theme" menu, "Convert to Grid" and accepting to "Convert all bands" option. The 1984 image had 7 bands, the 1989 image had 6 bands while the 1995 image had 7 bands. New maps were then created through the "Analysis" menu, choosing "Map Calculator" and adding bands 2, 3, 4 and 5 of the 1984, 1989 and 1995 Landsat TM images, respectively. These bands were chosen because according to a comparative study of Terra ASTER, Landsat TM, and SPOT HRG data for land cover classification in the Brazilian Amazon, the TM bands 2, 3, 4 and 5 combination provided better

classification accuracies for most land cover classes than TM with all bands, implying that addition of more spectral bands with high correlation coefficients between them may decrease the classification accuracy (Lu *et al.* 2005). With ASTER data, bands 1, 2 and 3 provided the poorest classification results. The accuracy improved when adding more Shortwave Infra Red (SWIR) bands. This indicated the importance of SWIR bands in vegetation classification ((Lu *et al.* 2005). Therefore, in converting the 2000 and 2006 ASTER images to grid data format, the available bands 1, 2 and 3 were merged using the "Map Calculator" function in the "Analysis" menu and with cell size set at 15m. Though this was the poorest, an on-the-ground survey in phase 2 would verify the results.

Each grid (for 1984, 1989, 1995, 2000 and 2006) was then reclassified into forested or open land. These grids were then converted to vector data (Shapefiles) in order to conform to the format of the mapped illegal activities (firewood and charcoal sites, motor trails, roads, and cultivated sites) which were loaded in Arcview as point, line and polygon features. Each of the resulting forest cover maps was clipped to the shapefile for the boundary of MNF in order to determine the forest cover within the study area. This was done by using the commands in the "View" menu which involved choosing the "GeoProcessing Wizard" and checking the "Clip one theme based on another" option. During the clipping process, the forest cover maps for each year were set as Input themes while the MNF boundary polygon was set as the Clip theme.

To determine the areas represented by open and forested polygons of each forest cover theme, the attribute table of each forest cover map was opened followed by choosing "Start editing" in the Table menu. A numeric field for area was added and the area computed by clicking the "Calculate" button to display the "Field Calculator" dialog and typing the expression: **[Shape] . ReturnArea.** Using Microsoft Excel 2000, areas of polygons of open and forested lands were summarized to show the trends over time.

(b) Analysis of Mapped Features

Cultivated areas, settlements, firewood and charcoal sites, motor trails and other features were initially entered into Arcview 3.3 in vector data format as point data. Coordinates and other attributes of the sites were tabulated in Microsoft Excel 2000 and converted to Dbase IV file format. The features were then loaded into Arcview 3.3 by choosing the "Projects" menu and the "Structured Query Language (SQL) Connect" button. In the "Connections" dialog, Dbase Files was specified and the "Connect" tab clicked. This was followed by specifying the table with the entries of the particular activity and pressing "Query". "Add Event Theme" in the "View" menu was then tapped in which the X Field (Latitude column in the table) and the Y field (Longitude column in the table) were specified. This loaded the attributes of the features which included Longitudes and Latitudes, number of charcoal kilns, crops grown, type and number of structures and other data. The boundary points, ZFC plantations, dam, fish ponds and other built up areas were later digitized as polygon features. This was done by choosing the "View" menu, "New Theme" option and choosing "Polygon" while the theme representing

boundary points was active. Using a mouse, the boundary points were used as vertices to come up with the MNF boundary as a polygon theme. Motor trails, the CEC electricity grid, roads and other line features were digitized using a mouse to create line features. Firewood, charcoal, cultivated areas, and settlements were left as point data, taken from the center of the patch where the illegal activities occurred.

To determine illegal activities located in open and forested areas, a spatial join between the 2006 forest cover map and the attributes of each illegal activity (settlements, cultivated sites, firewood and charcoal sites, respectively) was done. The 2006 forest cover theme was made active and then the "Open Theme Table" button was clicked followed by choosing the "Shape" field in the table. The Shape field in the attribute table of each illegal activity was also opened. The "Join" button was clicked and this appended the attributes of the 2006 forest cover theme into the attribute table of each illegal activity. Statistics including sum, count, mean, variance and standard deviation were obtained from the statistics function in the "Field" menu of Arcview 3.3. The end product provided the extent, pattern and some clues on the characteristics of illegal firewood collection and charcoal production activities in MNF.

To determine the distribution of all the illegal activities in relation to roads and motor trails, buffers at distances of 200m, 400m, 600m, 800m, 1,000m, 1,200m, 1,400m, 1,600m, 1,800m and 2,000m were assessed. This was done by making the motor trails and roads theme active and choosing "Create

buffers" in the "Theme" menu. The "Features of a Theme" was checked followed by checking "At a specified distance of" and specifying the distances up to 2,000m (1.25 miles) from motor trails and roads at 200m (0.13 miles) intervals respectively. The number of activities falling within each of the specified buffers was determined by using the "Clip" function found in the "View" menu. "Geoprocessing Wizard" was chosen followed by "Clip one theme based on another". The theme containing point locations of all illegal activities was used as the input theme while buffers at each specified distances were used as the Clip themes respectively. The results were output themes containing illegal activities falling within each buffer. Summary statistics were then obtained using the Summarize button. The results were graphed to determine the relationship between Motor trails and locations of illegal activities.

To assess the locations and distribution of illegal activities within MNF, CrimeStat II software was used to calculate the mean nearest neighbor (point) distance and mean nearest neighbor standard deviation. This involved assessing the mean nearest neighbor distances of firewood and charcoal, settlements and cultivated sites, respectively. CrimeStat II is a spatial statistics package that can analyze crime incident location data. Its purpose is to provide a variety of tools for the spatial analysis of crime incidents or other point locations. It is a stand-alone Windows 2000® program that can interface with most desktop geographic information systems (GIS) (Levine 2002).

To assess the mean nearest neighbor distance between points of illegal activities, files in Dbase IV format containing point locations of firewood and charcoal, settlements and cultivated sites were entered by pressing the "Data setup" tab as Primary Files. A primary file is a point file with X and Y coordinates. CrimeStat II can read a variety of file formats including ASCII, and ArcView® 'shp' (Levine 2002) among others. Under "Variables" option, the file and column containing the X and Y coordinates were defined. In the "Measurement Parameters" tab, measurement units of the geographical area of the study area and the type of distance measurement to be used were also defined as 115,390,000m^2 (45 square miles) and "Direct", respectively. Specifying type of distance as Direct, sets CrimeStat II to calculate distances as the shortest distance between two points. In the "Spatial Descriptions" tab, the "Distance Analysis I" option was chosen followed by checking the "Nearest Neighbor Analysis (nna)." CrimeStat II computed the mean nearest neighbor distance and standard deviation of the mean nearest neighbor distance for firewood and charcoal sites, settlements and cultivated sites. The output file was saved to a text file.

To assess the mean nearest neighbor distance between different illegal activities (firewood and charcoal sites to settlements, firewood and charcoal sites to cultivated sites and cultivated sites to settlements, respective point locations (including overlaps) were entered into CrimeStat II by pressing the "Data setup" tab as Primary Files. Mean nearest neighbor distances were computed by pressing the "Spatial Descriptions" tab, choosing the "Distance Analysis I" option, and checking the "Nearest Neighbor Analysis (nna)." The

output matrix was saved to a text file. The mean nearest neighbor distances were used to give insight on the relative locations and distributions of the illegal activities. This information would also help the FD to estimate the extent of the encroachment and intervention measures to curb the problem.

(c) Analysis of Key Informant Responses

Key informants provided specific information to be used for identification, planning, implementation, and evaluation of the forest management system in Zambia. Analysis involved formulation of interview summary sheets. This reduced the information into manageable themes and recommendations. Each summary provided information about the key informant's position, reason for inclusion in the list of informants, main points made, implications of the observations, and any insights or ideas the interviewer had during the interview.

3.3.7 Dissemination

The results of this survey will be used at the local level through the Extension Services at the Zambia Forestry College that carries out community work with the Mwekera community and surrounding area. In addition, the thesis will be available through the university libraries. Findings of the study will be converted into recommendations to the Forest Department and agencies involved in the promotion of sustainable forest management and Community Based Natural Resources Management (CBNRM). The study will also help inform policy makers.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, findings are presented on forest cover change and the extent and locations of illegal firewood and charcoal activities. Characteristics of illegal firewood collection and charcoal production are derived from results. Views of key informants on the illegal activities are also presented. Results are based on field surveys conducted between October 2007 and March 2008. Forest cover change results are presented first, followed by results on the extent and location of illegal firewood collection and charcoal production activities. These are presented along with results of related activities such as agriculture, sand mining and settlements. Characteristics of firewood and charcoal activities and views of key informants are presented last. In section 4.3, the discussion of findings is presented. The discussion gives a review on the origins of the people involved in illegal activities in MNF. It also explores the reasons that led people to venture into the illegal activities, trends in forest cover change, and location and extent of illegal activities.

4.2 Results

4.2.1 Forest Cover Change Analysis

(a) Current Area of MNF

To determine the forest cover change that has occurred in MNF, digital satellite images starting from 1984, 1989, 1995, 2000 and 2006 obtained from TRFIC of Michigan State University were analyzed using Arcview 3.3. The extent of open and forested land in 1984 was estimated at 1,941 hectares

(11%) and 15,946 hectares (89%) respectively out of the total 17,887 hectares (figure 9). It is obvious that this area was opened up by people from nearby townships in Kitwe like Mufuchani, Riverside, Kapoto, and Buchi. These are the areas closest to the open areas.

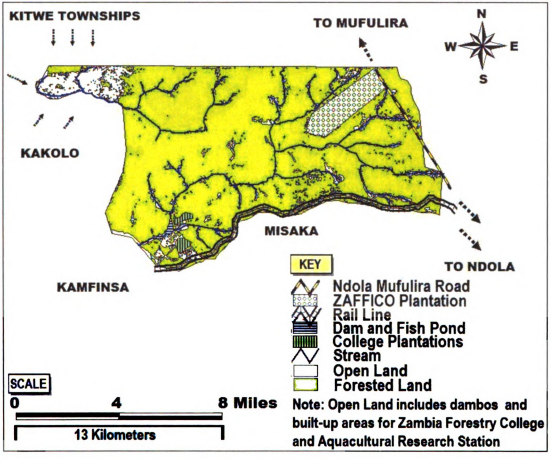

Figure 9. The Extent of Forested and Open Land in Mwekera National Forest No. 6, 1984

Base Image Source: Landsat TM Imagery, 9 June 1984.

In 1989 (figure 10), the open areas extended inwards in a Southeastern direction. Forested areas reduced from 15,946 hectares (89%) in 1984 to 15,585 hectares (87%) in 1989. The total loss in forest vegetation cover between 1984 and 1989 was 361 hectares (2%).

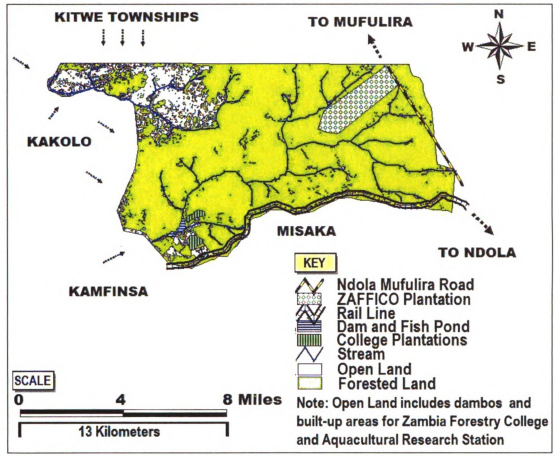

Figure 10. The Extent of Forested and Open Land in Mwekera National Forest No. 6, 1989

Base Image Source: Landsat TM Imagery, 9 June 1989.

In 1995 (figure 11), the extent of open areas increased from 2,302 hectares (13%) in 1989 to 3,950 hectares (22%) leaving a forested area of 13,937 hectares (78%). Between 1989 and 1995, 1,647 hectares (9%) of forest cover was lost. During this period, the extent of open areas shifted southeastwards and southwards towards ZFC. In the same period, another area to the southeastern corner of the forest near Sakanya in Ndola was cleared.

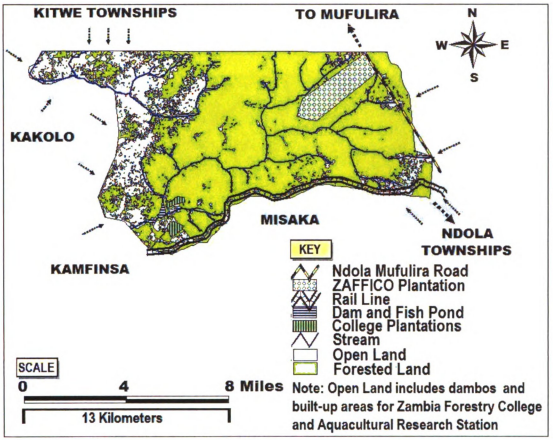

Figure 11. The Extent of Forested and Open Land in Mwekera National Forest No. 6, 1995

Base Image Source: Landsat TM Imagery, 9 June 1995.

The extent of open areas increased from 22% in 1995 to 5,295 hectares (30%) in 2000. A total of 1,346 hectares (8%) of forest cover was lost between 1995 and 2000. The pattern of the open areas remained relatively the same as in 1995 except that the southern parts of MNF including Misaka Forest were now cleared (figure 12). The open areas also extended from east to west and northwards towards the ZAFFICO plantation. From 1984 to 2000 3,355 hectares was converted to open land. The total extent of open areas in 2000 was therefore the cumulative loss (3,355 hectares) and areas that were open in 1984 (1,941 hectares) giving 5,295 hectares.

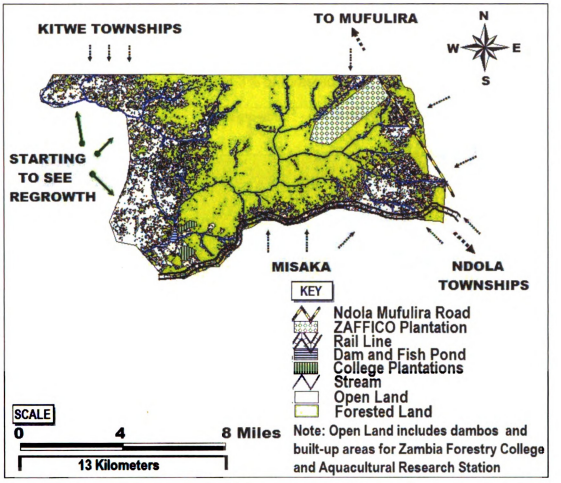

Figure 12. The Extent of Forested and Open Land in Mwekera National Forest No. 6, 2000

Base Image Source: ASTER Imagery, 8th June 2000.

Between 2000 and 2006, the study reveals that 459 hectares of forest cover was recovered through natural regeneration (figure 13, 14, table 6). This was possible because once preferred trees are exhausted, the firewood harvesters and charcoal producers move to new areas leaving abandoned areas regenerating.

In 2006 (figure 13), out of the 17,887 hectares of the total area of MNF, 13,051 hectares (73%) were forested while 4,836 hectares (27%) were open areas. This indicates a recovery of 3% of forested area.

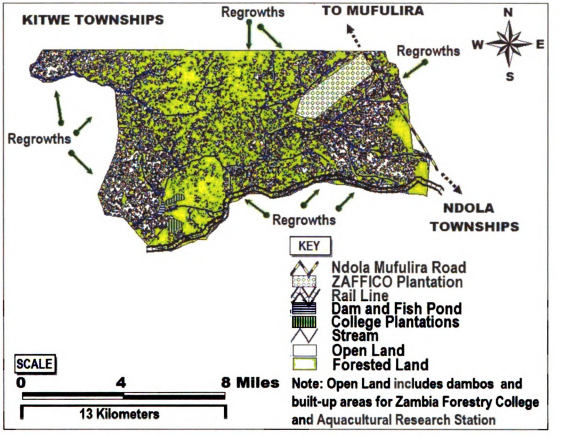

Figure 13. The Extent of Forested and Open Land in Mwekera National Forest No. 6, 2006

Base Image Source: ASTER Imagery, 8th May 2006.

Table 6. Summary on Extent of Forested and Open Land in Current Boundary of Mwekera National Forest No. 6, 1984 to 2006

YEAR	Forested %	Open %	Forested (Ha)	Open (Ha)	Total	Loss (-) or Gain (+) (Ha)	Rate per annum (Ha)
1984	89	11	15,946	1,941	17,887		
1989	87	13	15,585	2,302	17,887	-361	-72
1995	78	22	13,937	3,950	17,887	-1,647	-275
2000	70	30	12,592	5,295	17,887	-1,346	-269
2006	73	27	13,051	4,836	17,887	+459	+77

Source: Field data collected between October 2007 and March 2008.

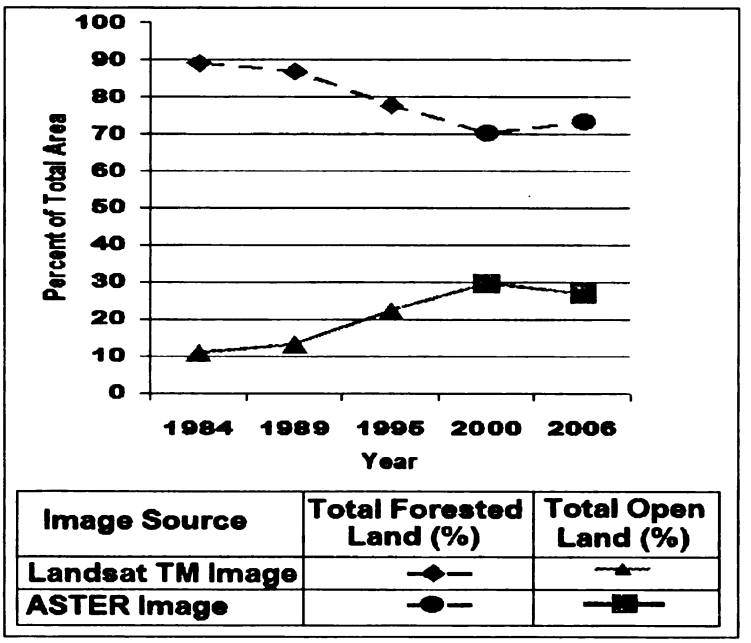

Figure 14. Extent of Forested and Open Land in Mwekera National Forest No. 6, 1984 to 2006

(b) Proposed Area of MNF

Out of the 17,887 hectares of the current area of MNF, 6,348 hectares is marked for excision. This would leave 11,539 hectares of protected forest area if approved (figure 15). Of the proposed 11,539 hectares, 2,885 hectares (25%) is open land while 8,654 hectares (75%) is the forested area. This section of the Forest reserve has been proposed for excision in order to resettle people illegally in MNF. This was as a result of increase pressure for agricultural land resulting from increased population.

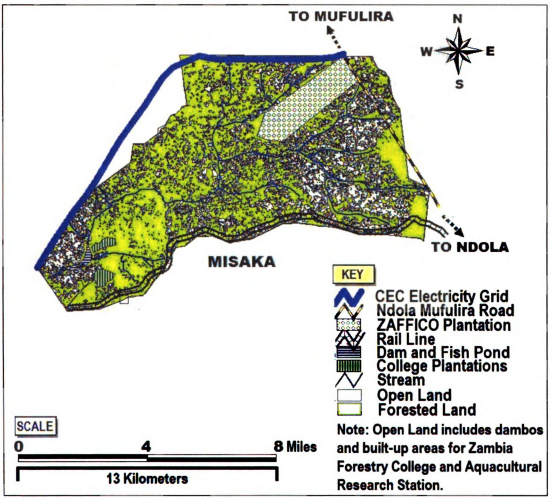

Figure 15. The Extent of Forested and Open Land in the Proposed Mwekera National Forest No. 6, 2006

Base Image Source: ASTER Imagery, 8th May 2006.

The social economic changes in the country due to SAP and privatization left many people unemployed and in need of alternative livelihoods.

The proposed area was the focus for gathering data on motor trails, charcoal sites, firewood sites, settlements and cultivated areas; these features were mapped using GPS. Following the part of proposed boundary of MNF is a CEC Electricity Grid that supplies electricity to the new mine in the Democratic Republic of Congo (DRC).

4.2.2 Extent and Location of Illegal Activities

Features that were mapped during the study include motor trails, settlements, cultivated sites, sand mine sites, charcoal sites, firewood sites and locations of surrounding townships. The on-the-ground data collection supplemented satellite images which gave an estimated forest cover change over time. Vegetation loss in MNF was caused clearly by two activities;

- firewood collection and charcoal production, and
- agricultural encroachments

In the two phases of mapping, a total of 398 sites used for cultivation, charcoal, firewood and settlements were recorded (figure 16). These deforestation activities overlapped. For example, 39 sites used for firewood, charcoal and cultivation where also settlements. Two hundred and thirty settlements were also cultivated sites but had no firewood and charcoal activities. Thirteen sites were cultivated sites and also firewood and charcoal sites but were not used as settlements. Eleven sites were firewood and

charcoal sites and also settlements but had no cultivation activities. Thirty-nine, 59 and 7 sites were used exclusively for firewood and charcoal, cultivation and settlements, respectively.

The total number of sites mapped was 102 firewood and charcoal sites, 341 cultivated sites and 287 settlements. Subtracting the overlaps among the three illegal activities gave 398 as the total number of mapped sites (figure 16).

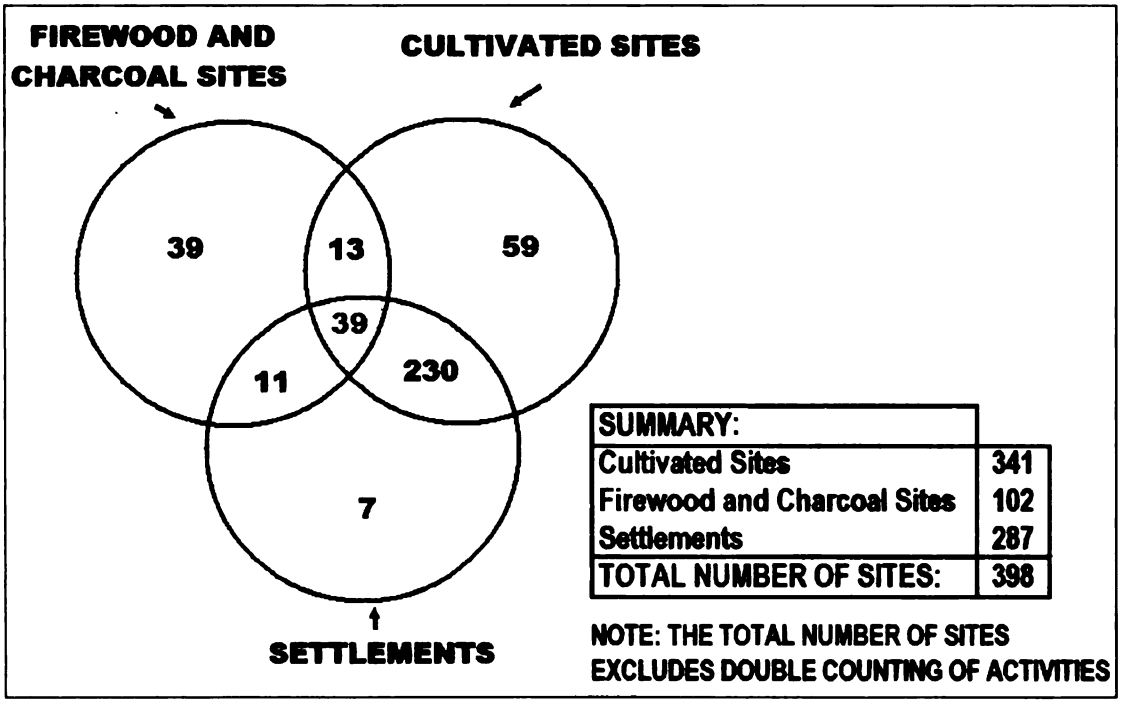

Figure 16. Total Number of Sites Used for Cultivation, Firewood, Charcoal and Settlements, 2007

To determine the relationship between Illegal activities and the forest cover map, the attribute table of each mapped illegal activity and the attribute table of the 2006 forest cover map were joined using the "Spatial joint" function in Arcview 3.3. It was found that at least 52% of all the illegal activities mapped

were located in forested areas (figure 17). In many cases, the activities are associated with deforestation and the creation of open areas.

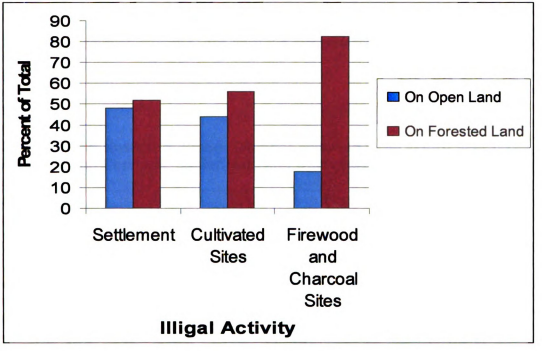

Figure 17. Illegal Activities in Mwekera National Forest No. 6 Located in Forested and Open land, 2007

Note: Percentages include double counting of activities (see figure 16).

The effect of nearby townships on the extent and locations of deforestation in MNF was visible from the maps (figures 9 – 13). Open areas were found closer to surrounding townships in Kitwe including Mufuchani, Riverside, Kapoto, Kwacha East, Kamitondo, Buchi, Kakolo, Kamfinsa, Ndeke, Mulenga, Chamboli, Luangwa, Zamtan and Chankalamo.

The mean nearest neighbor distance ranged from 216 m (0.14 miles) (firewood and charcoal point locations to cultivated point locations) to 395 m

(0.25 miles) (firewood and charcoal point locations). The highest variation of distances from the mean nearest distance was found between firewood and charcoal sites with 470 m (0.29 miles) standard deviation and 119% coefficient of variation (table 7). The coefficient of variation ranged from 71% to 119% indicating high deviations from the mean nearest distance for all activities.

Table 7. Mean Nearest Neighbor Distance between Point Locations of Firewood and Charcoal, Settlements and Cultivated Sites

	Cultivated Sites	Firewood & Charcoal Sites	Settlements
Cultivated Sites (n=341)			
Mean	222 m	-	-
SD	158 m	-	-
CV	71%	-	-
Firewood & Charcoal Sites (n=102)			
Mean	216 m	395 m	-
SD	154 m	470 m	-
CV	71%	119%	-
Settlements (n=287)			
Mean	222 m	229 m	257 m
SD	192 m	169 m	251 m
CV	86%	74%	98%

Source: Field data collected between October 2007 and March 2008

(a) Charcoal and Firewood Sites

A total of 102 sites were found with firewood piles and charcoal production activities (figure 16). These were counted during boundary mapping, mapping of trails (phase 1) and in phase 2 along transects. In the 102 sites, 71 piles of firewood, 137 charcoal earth kilns under construction and 594 extracted kilns were counted. Therefore, the total number of charcoal kilns (under construction, extracted) and firewood piles was 802 (figure 18). These data provide a baseline for future monitoring. There was more charcoal production compared to firewood collection because charcoal is preferred to firewood by most households. It was, however, difficult to distinguish between piles of wood for firewood and piles to be used in charcoal production. It must be noted however that in areas that have been abandoned and the forest recovered through regeneration, traces of extracted kilns and motor trails have since disappeared. Hence the total number of extracted kilns is likely much higher than is reported in this study.

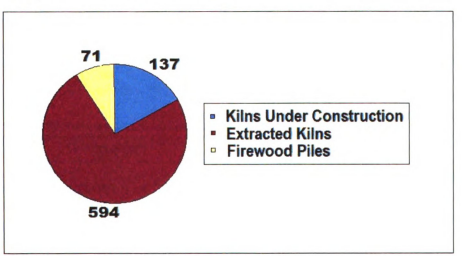

Figure 18. Number of Firewood Piles, Extracted Kilns and Kilns Under Construction, 2007

In terms of location and distribution, charcoal and firewood sites were mostly located towards the northeast of ZFC and more concentrated in the center of the proposed MNF (figure 19). The average distribution of firewood and charcoal sites (102 sites) was estimated at one charcoal and firewood site for every 113 hectares.

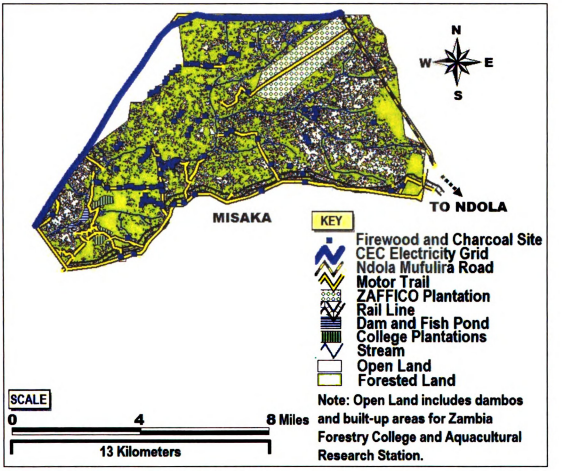

Figure 19. Distribution of Charcoal and Firewood Sites in Mwekera National Forest No. 6

Base Image Source: ASTER Imagery, 8th May 2006.

The mean nearest neighbor distance for charcoal and firewood point to point locations was 395 m (0.25 miles), 216 m (0.14 miles) between cultivated sites

to firewood and charcoal sites and 229 m (0.14 miles) for firewood and charcoal sites to settlements (table 7).

The number of charcoal and firewood sites located in forested areas was 82% of the total firewood and charcoal sites mapped. This was based on the ASTER imagery and validated from field plot data. Only 18% were located in open areas of MNF.

(b) Settlements

Out of the 398 total number of sites, 287 sites were settlements. A settlement was defined for purposes of this study as any site with at least one or more buildings. The settlements were of the following types: shelter, trading centers (grocery stores and corn grinding mills), recreation centers (beer houses and sports fields), schools and churches (figure 20).

In 287 settlement sites, a total of 830 structures used for shelter were counted. Twenty-two shelters had no roofs. This small number of shelters was considered under construction and not yet habitable (figure 21).

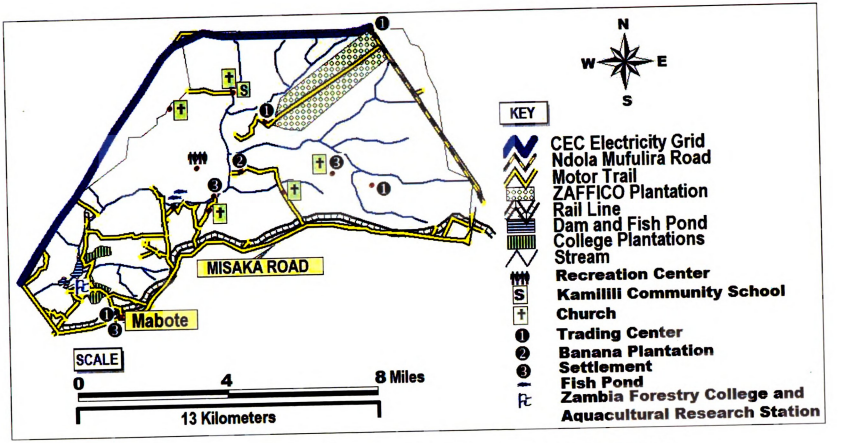

Figure 20. Locations of Some Major Types of Settlements in Mwekera National Forest No. 6, 2007

Settlements and cultivated sites were found along motor trails and near water sources and were mostly located in areas previously used for charcoal production and firewood collection.

Some shelters were permanent in construction. The study recorded designs and materials used in the construction of the shelters. Of particular interest was the type of roofing materials used (figure 21). Grass and iron sheet roofs were most common. This information was collected to indicate the permanence of the squatters in MNF.

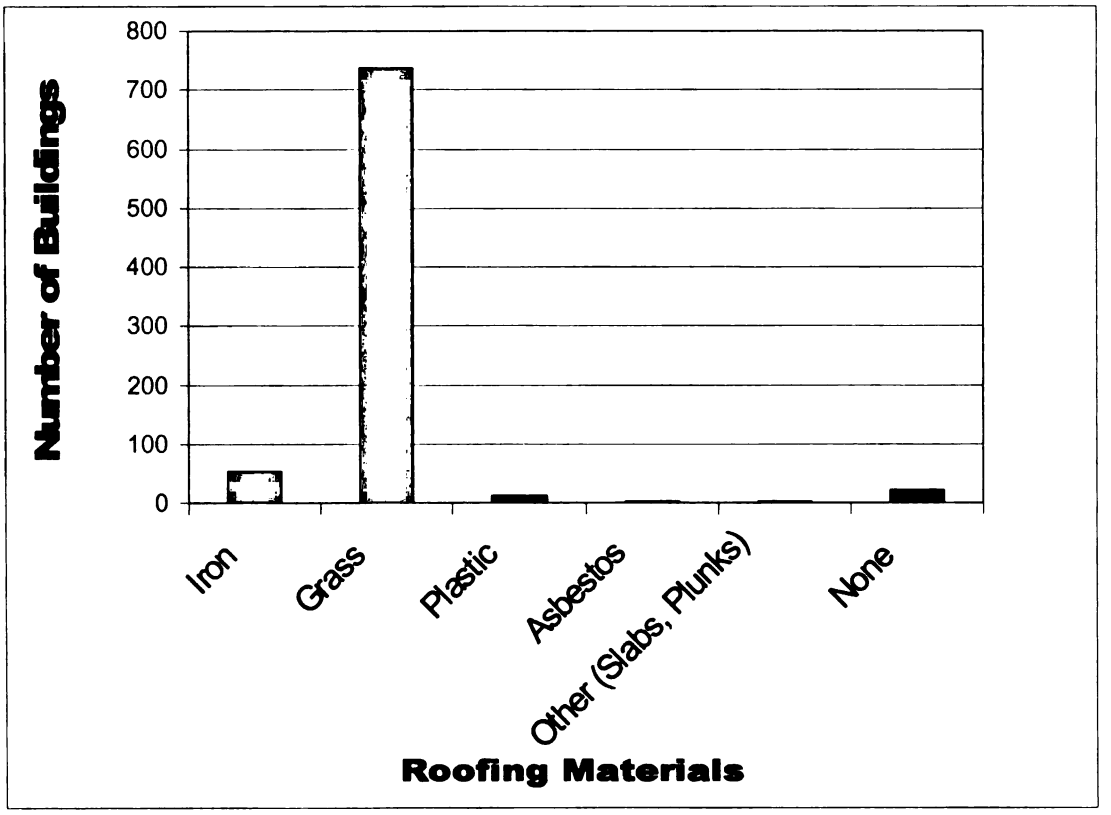

Figure 21. Roof Types Used for Shelters in Mwekera National Forest No. 6, 2007

Some houses were made of burnt bricks with roofs covered with iron sheets (figure 22). It is obvious from the materials used that this structure is meant to be permanent.

Figure 22. A House made of Burnt Bricks and Iron Sheets in Mwekera National Forest No. 6, 2007

i. Schools

A total of three community schools were recorded within the national forest. These are schools built by the forest communities using their own resources. Children of squatting communities from various parts of the forest learn at these schools (figure 23).

Figure 23. A Community School in Mwekera National Forest No. 6, 2007

ii. Trading Centers

Trading centers included grocery stores where commodities such as cooking oil, sweets, clothes, sugar and detergent pastes are sold (figure 24).

Figure 24. Shopping Center near ZAFFICO Plantations in Mwekera National Forest No. 6, 2007

In some places, corn grinding mills were found. These businesses enjoy a wide market from charcoal producers, firewood collectors and farmers within the national forest.

iii. Shelters for Recreation

In some areas, squatters have set up recreation centers where they congregate to take the elicit brew called Kacasu, Munkoyo and other drinks. One such place in MNF is in an area of the forest called *katoka mema* by the locals (figure 25). It was also common to find sports fields in some locations of the national forest where various sports activities, especially football, are played.

Figure 25. Katoka Mema Recreation Club in Mwekera National Forest No. 6, 2007

A similar place close to the ZFC is known as Mabote. Mabote is used both for recreation and providing shelter to three families. Mabote is only 1.5 km (0.9 miles) southeast of ZFC.

Most settlements in Mwekera National Forest were located west of ZFC, in the southeast, in the center of MNF in the east and towards north near the ZAFFICO plantation (figure 26). There was an average of one settlement for every 40 hectares in MNF.

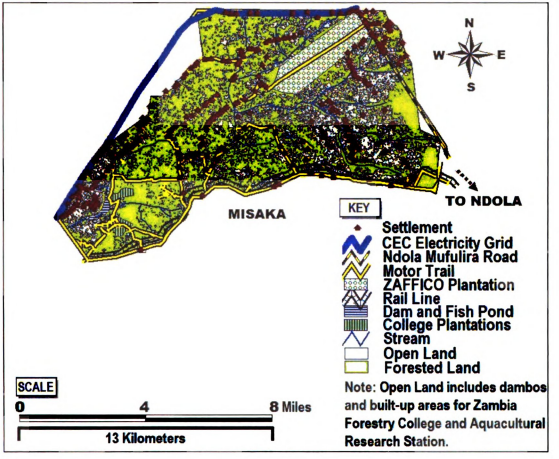

Figure 26. Distribution of Settlements in Mwekera National Forest No. 6

Base Image Source: ASTER Imagery, 8th May 2006.

The mean nearest neighbor distance between settlement point locations (table 7) computed using CrimeStat II software was 257 m (0.16 miles). A mean nearest neighbor distance of 229 m (0.14 miles) was found between firewood and charcoal sites to settlements while 222 m (0.14 miles) was found

between settlements to cultivated sites. The number of settlements located in forested land was 52% while those located in open land was 48%.

(c) Cultivation in Mwekera National Forest

Arising from settlements, the squatters are involved in subsistence farming in addition to charcoal production and firewood harvesting. Three hundred Forty-one sites out of 398 sites mapped were cultivated sites. On cultivated sites (which includes some firewood and charcoal sites and settlements) a wide variety of crops were grown including maize, cassava, sweet potatoes, mangos, pumpkins, and other crops (figure 27).

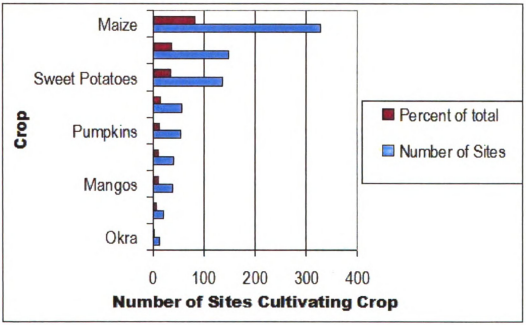

Figure 27. Major Crops Grown in Mwekera National Forest No.6, 2007

Bananas were grown on most settlements around MNF. One banana plantation was found with drip irrigation equipment in the eastern side of MNF (figure 28).

Figure 28. Banana Plantation in Mwekera National Forest No. 6, 2007

In dambos of the forest, some communities grow rice. In terms of livestock, they keep a wide variety including chickens, ducks, goats and pigs (Figure 29).

Figure 29. Livestock-Pig Rearing in Mwekera National Forest No. 6, 2007

Other squatters are involved in aquaculture and apiculture. The owners of the fish ponds have blocked Mwekera and other streams in order to divert

sufficient water for the ponds. Some squatters are involved in beekeeping where various types of hives including bark, frame, grass and dandant hives are used.

Few cultivated sites were found close to ZFC. Cultivated sites followed a similar trend with firewood and charcoal; 56% and 44% were located in forested and open lands, respectively (figure 17, 30).

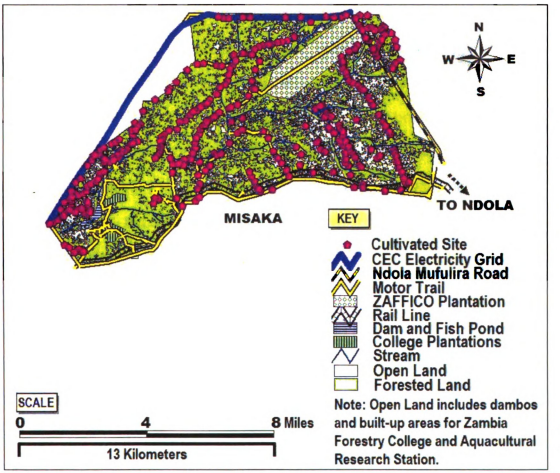

Figure 30. Distribution of Cultivated Sites in Mwekera National Forest No. 6

Base Image Source: ASTER Imagery, 8th May 2006.

The average distribution of the 341 cultivated sites was one site for every 34 hectares. The mean nearest neighbor distance between cultivated point locations was 222 m (0.14 miles), 216 m (0.14 miles) between firewood and charcoal sites to cultivated sites and 222 m (0.14 miles) between settlements to cultivated sites (table 7).

(d) Sand Mining

Sand was mined 1.34km (0.8 miles) southwest of ZFC. Trucks (of various sizes) transport sand to townships like Ndeke, Luangwa, Mulenga, Zamtan, Riverside, Kapoto and other nearby townships which is used as building sand in construction projects. In the mining process, trees have been up-rooted causing depressions where water stagnates during the rainy season (figure 31). This area was in the past cleared for firewood and charcoal. The area had regenerated, but is currently under a new threat of sand mining. The area is now prone to erosion.

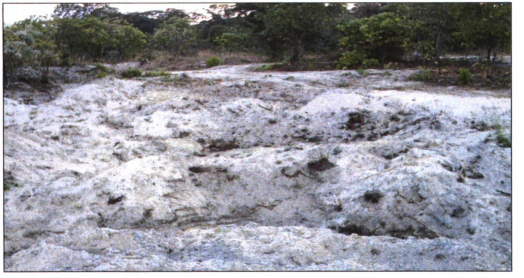

Figure 31. Sand Mining Site in Mwekera National Forest No. 6, 2007

(e) Motor Trails

Settlements, charcoal kilns, firewood stacks, cultivated areas and sand mines were linked by a network of either foot or motor trails (figure 32). Notable among the trails, is one that runs northeast from MFB4 through the center of the forest, and through a firebreak at ZAFFICO plantations and ends up at Ndola Mufulira road near Pillar 18 (International Beacon). This trail was specifically used in 1980s and early 1990s to smuggle goods from Zambia to DRC (then Zaire) and is known by the locals as Smuggler Road. Currently, the trail is used to transport various goods including charcoal and firewood to Kitwe, Ndola and Mufulira. Another motor trail runs from MFB5 and ends at Kamilili Community School near Kamilili Stream. A number of trails branch off from Misaka road and run inwards and go across the Mwekera stream.

A recent development affecting access to MNF has been the construction of the CEC electricity grid from the southwestern side of MNF starting at MFB1 through MFB2, MFB6 and crossing the Ndola Mufulira road near BP18 into the new DRC mine (figure 32). The access road was made for routine maintenance of the electricity grid by the Copperbelt Energy Corporation (CEC) of Zambia; it has opened up new access in and out of MNF. It was observed that the access road was being used to transport charcoal and firewood into Kitwe. The trail provides a quick link to nearby townships of Buchi, Kamitondo, Kwacha, Riverside, Ndeke and other places often using vehicles, wheelbarrows, bicycles and head loads. It is therefore clear that motor trails have effect on the management of MNF. Illegal activities were connected by a close network of motor and foot trails. The number of illegal

activities falling within 200, 400m, 600m, 800m, 1,000m, 1,200m, 1,400m, 1,600m, 1,800m and 2,000m buffer distance from motor trails and roads were assessed (table 8).

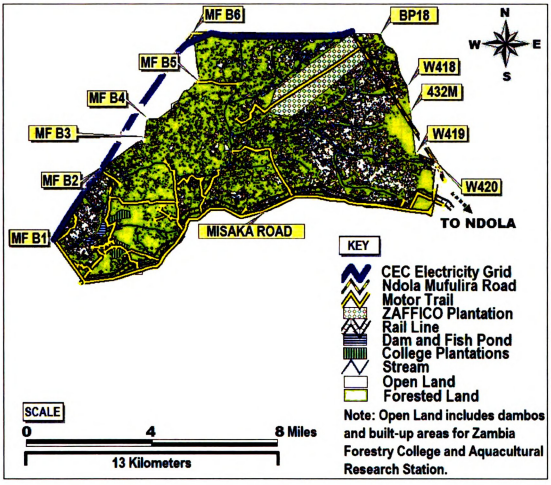

Figure 32. Motor Trails in Mwekera National Forest No. 6

Base Image Source: ASTER Imagery, 8th May 2006.

Ninety-four percent of sites (charcoal and firewood, cultivated sites and settlements) were found within 2,000 m (1.25 miles) from motor trails (table 8). The number of activities increased as the buffer distance was increased. It is interesting to note that as many as 63% of total sites surveyed where located within 800 m (0.5 miles) from motor trails and roads. These results

show that it would be possible to get 94% of all sites by surveying areas in the range of 2,000 m (1.25 miles) from motor trails and roads alone.

Table 8. Number of Illegal Activities Located within Specified Distances along Motor Trails and Roads

BUFFER DISTANCE	NUMBER OF ILLEGAL ACTIVITIES (SITES)	PERCENT OF TOTAL SITES (%)
200 m	162	41
400 m	190	48
600 m	215	54
800 m	249	63
1,000 m	274	69
1,200 m	306	77
1,400 m	330	83
1,600 m	359	90
1,800 m	366	92
2,000 m	375	94

Source: Field data collected between October 2007 and March 2008.

There was a positive relationship (R^2=0.97) between the distance from motor trails or road and the number of sites located within that distance along the motor trails (figure 33).

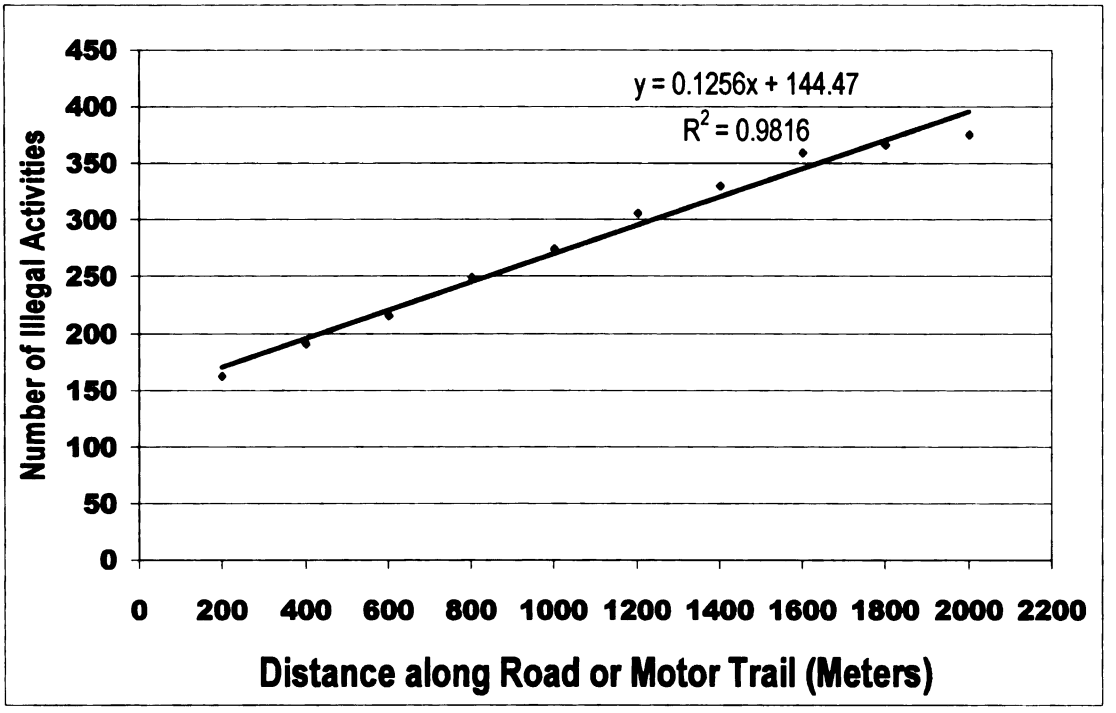

Figure 33. Number of Illegal Activities Located within Specified Distances along Motor Trails and Roads, 2007

4.2.3 Characteristics of Charcoal and Firewood Activities in MNF

Characteristics of illegal charcoal production and firewood collection were derived from the examination of the following factors: sequence or processes involved in the illegal activities, mode of transporting charcoal and firewood, harvesting pattern, species harvested, charcoal production process, firewood collection process, network of trails, legality of the activities and the people involved.

(a) Sequence of Illegal Activities

Vegetation loss in MNF has been caused by land clearing for the following two reasons: firewood and charcoal production and agricultural encroachment.

One characteristic of charcoal and firewood activities is that the areas that are opened up are often used for cultivation and such areas eventually become settlements.

Starting from firewood and charcoal sites, the area is slowly transformed into a cultivated field (figure 34). The charcoal producers and firewood collectors slowly setup more permanent structures made of unburnt bricks with either grass, iron sheets, plastic, planks or asbestos roofs. The charcoal producers or firewood collectors often continue with their illegal activities undisturbed; understaffing and lack of equipment for the FD translates into not conducting operations in most areas of the forest. The unemployed (retrenched or retired) are usually the first to encroach into the forest reserves by starting firewood collection or charcoal production. At the same time, they may start cultivating fast growing crops like pumpkins and maize usually on extracted kilns. These small gardens are expanded over time. During the same time, they may decide to erect temporary structures and keep livestock as they continue the firewood and charcoal production activities.

With time, more family members and friends may join the squatters thereby expanding the temporary settlement into a more permanent settlement. As the population increases in that particular area of the forest, community structures headed by a chairman or headman are established.

On the other hand, the firewood collectors and charcoal producers may abandon the already cleared site to other areas with more charcoal and

firewood preferred trees. This leaves the land open to other people. Sometimes, the headmen, firewood collectors and charcoal producers may sell the cleared land to other people seeking agricultural land. Of course, it is not theirs to sell. In other cases, people will just move to abandoned areas without any permission.

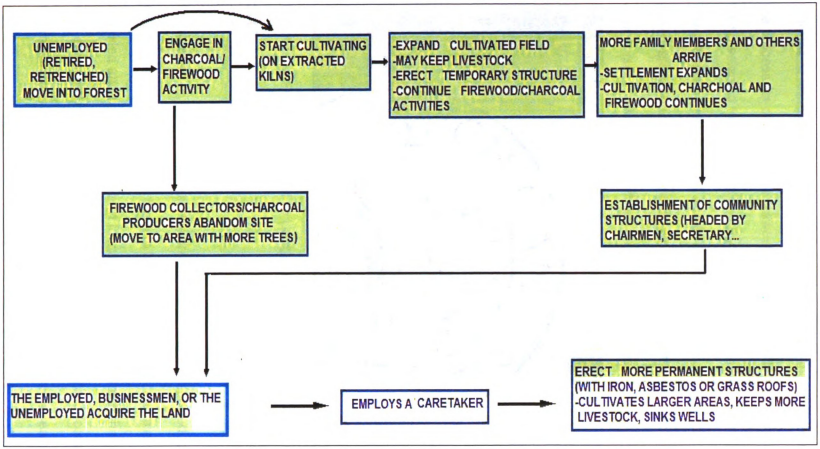

Figure 34. Sequence of Illegal Activities in Mwekera National Forest No. 6, 2007

(b) Firewood and Charcoal Production Process

In terms of firewood and charcoal processes in MNF, the study revealed that the process for charcoal and firewood both started with selection of trees, felling selected trees, cutting to length and piling the cut pieces (figure 35). The preferred trees includes *Julbernardia paniculata, Julbernardia globiflora, Brachystegia boehmii, Brachystegia spiciformis, Bauhinia thoningii, Pericopsis angolensis, Parinari curatellifolia,* and *Uapaca kirkiana.*

Figure 35. Felled Trees Cut to Length in Readiness for Kiln Building, 2007

In the case of firewood, the pieces are collected and transported to markets and households after cutting them to lengths. As for charcoal, the cut pieces are piled and covered with earth for carbonization after which the charcoal was extracted (figures 36 and 37). In MNF, the charcoal producers mostly use the rectangular earth kiln while in some instances, the circular earth kiln was used.

Figure 36. Logs Piled in Readiness for Covering with Earth, 2007

Figure 37. Earth Kiln Partly Covered with Earth, 2007

Though some of the charcoal and firewood is used for energy needs of the settlers within MNF, much of the harvest of firewood and charcoal extracted target charcoal and or firewood markets in nearby townships (figure 38).

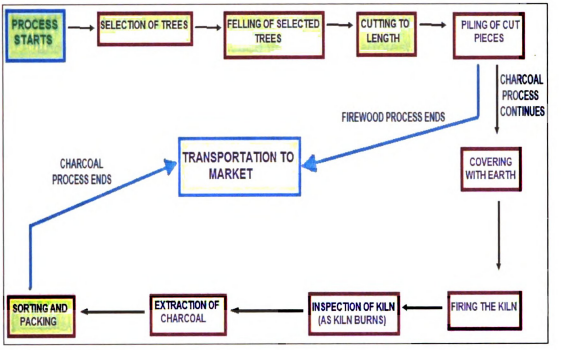

Figure 38. Firewood Collection and Charcoal Production Processes, 2007

(c) Characteristics of Firewood and Charcoal Production Activities

The study identified the following characteristics of charcoal and firewood production activities:

(i) Legality of the Activity-The study confirmed that a characteristic of firewood and charcoal production in MNF is that it is done illegally. According to the current Act Number 39 of 1973, firewood collection and charcoal production are prohibited in a National Forest. It may only be allowed if the coup system is in place. This system allows charcoal production and firewood collection in local forests, under a license obtained from the Forest Department. The situation of the MNF is mirrored on many national forests across the country.

(ii) Type of Kiln-The field survey revealed that both rectangular (figure 37) and circular earth kilns were used through out the forest for charcoal production. A total of 131 (96%) rectangular kilns and 6 (4%) were found in MNF.

(iii) Network of Foot and Motor Trails-The study found that in parts of the forest where charcoal and firewood production was intense, a close network of both motor and foot trails also existed. As an area is being opened for charcoal and firewood, foot paths and motorable trails mostly of natural earth have been identified (figure 32).

(iv) Selectivity in Harvesting-The selectivity in trees harvested has influenced the location and distribution of the illegal sites. It was observed that where preferred trees were available, active sites of charcoal production and firewood collection were also found (figures 19, 26, 30).

(v) Raw Materials and Tools Used-The major raw materials used in charcoal and firewood were trees of the following tree species: *Julbernardia paniculata, Julbernardia globiflora, Brachystegia boehmii, Brachystegia spiciformis, Bauhinia thoningii, Pericopsis angolensis, Parinari curatellifolia,* and *Uapaca kirkiana* (Nkomesha 1996). It was observed that in the absence of these trees, alternative species which were left out at first such as *Marquesia macroura*, *Uapaca* species and *Dalbegia* species are used. In terms of tools, harvesters used simple axes, hoes, shovels, and metal bars and match sticks for firing the kilns.

(vi) People Involved-Most of the people involved are unemployed and energetic youths out of school and children of retrenched workers from mines. Others are the old people probably retired from various jobs on

the Copperbelt Province and from various parts Kitwe, Mufulira and Ndola (Shitima 2005). It was clear that these people fall in the poor income brackets of the population.

(vii) Mode of Transport-From the production process, charcoal is usually packed in 25-50kg bags. In the case of firewood, no packing is done other than piling. The two commodities are then transported to sales points through motor and foot trails by using wheelbarrows, bicycles, vehicles and headloads through distances of over 20km (12.4 miles) in the case of Kitwe, to townships such as Luangwa, Mulenga, Ndeke and Riverside.

4.2.4 Views of Key Informants

Informants comprised institutional heads of government as follows: the Director, FD-Lusaka; The Principal Extension Officer (FD)-Copperbelt Province; The Principal, Zambia Forestry College; The Director, Zambia Forestry and Forestry Industries Corporation (ZAFFICO); The Principal Research Officer, Division of Forest Research (FD)-Kitwe, District Extension Officer and the District Administrator-Kitwe District.

Key informant interviews were summarized into 8 manageable themes and recommendations. The themes include:

(a) Current and past management activities conducted in MNF and other forest reserves in Zambia,

(b) illegal activities in MNF and other forest reserves;

(c) The effects of illegal activities,

(d) Past and current studies conducted in MNF and other forest reserves,

(e) Collaboration among stakeholders in forest management,

(f) Conflicts related to forest management,

(g) Mitigation measures to stop illegal activities, and

(h) Future plans for management of forest reserves.

(a) Current and Past Management Activities Conducted in MNF and Other Forest Reserves.

A respondent pointed out that the FD, Kitwe District Office has been inactive in past years due to many reasons including inadequate transport and funding. It was noted, however, that the FD was still doing something to curb illegal charcoal, firewood and timber production by mounting road blocks at Kafue Bridge and Sabina. The respondent explained:

> We have been going around townships and markets confiscating charcoal and other timber products. Most of these operations are done on foot, due to lack of vehicles.

Another respondent explained that in forest reserves in Zambia, charcoal production and firewood collection is allowed only through use of licenses and the coup system. In a coup system, the forest is demarcated into areas for firewood collection and areas for charcoal production where trees to be removed are marked. Trees that would provide seeds for natural regeneration are left behind. Older and sick trees are removed for charcoal and firewood. In MNF, charcoal production and firewood collection is illegal because no licenses or the coup system are allowed. The coup system was done in Misaka Forest in the 1990s. The respondent explained:

> When trees were exhausted in Misaka Forest, the people refused to move out of the reserve and instead settled there. The past experience in Misaka led the FD not to open up new coups in MNF. The coup system failed mainly because people refused to move after

> producing charcoal and harvesting firewood after the end of the coup system. In the coup system, the law does not allow erection of permanent structures. Instead, people began to put up permanent structures and some even started cultivating.

Asked whether the FD would recommend the coup system in any forest reserve on the Copperbelt Province, the respondent agreed, but on condition that people are educated on the restrictions of the system. The respondent said:

> It would also be necessary for people to sign agreements that would stipulate conditions. One of the conditions would be to agree not to settle or cultivate in the forest reserve after the coup system is completed. Currently, there is no district practicing the coups on the Copperbelt Province.

(b) Illegal Activities in MNF and Other Forest Reserves

Respondents from the FD emphasized that the Department was concerned with the current illegal firewood collection and charcoal production and deforestation in general. One respondent said:

> Charcoal is causing major damage to forest reserves compared to firewood. The situation started after people lost jobs during the Structural Adjustment Programmes (SAP) in the 1990s. This has been worsened by understaffing in the FD and lack of equipment.

Respondents further explained that in MNF, people have destroyed large chunks of forests due to cultivation, settlements, firewood collection and charcoal production. Another respondent said:

> Some people have even set up banana plantations, maize fields and fish ponds. People involved include high ranking civil servants who are supposed to be a law abiding citizens and those who lost jobs during SAP. Due to poverty, charcoal production from MNF has also increased since people want to survive, especially those not employed. Others have put up permanent houses in the forest reserves because they claim they have no where else to settle. Sand mining is another illegal activity in MNF.

(c) Effect of Illegal Activities

Respondents emphasized the importance of MNF to training and biodiversity conservation. One responded said:

> MNF is a laboratory where students do practicals in courses like botany, silviculture, mensuration and other forestry courses at Zambia Forestry College. Being a laboratory, it has several species of interest to training. Illegal activities mean that species are now dwindling; therefore we do not have enough for research. The few tree species remaining will limit student's knowledge. Biodiversity has been destroyed and it is difficult to restore if these acts continue.

The respondent explained further that the illegal activities have also affected the level and quality of water in Mwekera Stream which is the main source of water to the ZFC and Aquacultural Research Station. Trees have been cut right on banks and crops grown resulting in sheet erosion. The dam is now shallowing, and it is likely that in future there will be little water in the dam for consumption. Due to contamination, the dam was invaded with foreign vegetation (weeds). This was affecting college machinery especially at the water works leading to constant breakdowns.

Illegal firewood collection and charcoal production activities have also attracted mushrooming of illegal homesteads in MNF. Some of the people illegally settled in MNF have a tendency to conduct other acts like thefts. Students and staff at college have lost property in houses, hostels, water works and workshops. These are facilities students are supposed to use and this means that college is being incapacitated. The general environment along the stream is eroded, and the future uncertain.

In terms of effect on research works, a respondent narrated that illegal activities have affected plantation trials and the botanical reserve which has been well maintained by the college because of their proximity. However, the major threat is that the illegal actors are getting closer and closer to the remaining intact forest.

(d) Past and Current Studies Conducted in MNF and Other Forest Reserves. Respondents from the FD explained that most studies in the Department have been conducted by the Forest Management and Planning Unit based at the Forest Department headquarters in Lusaka. Some studies where conducted under the ZFAP and PFAP projects in specific areas of Zambia in the 1990s. This generated information on forest reserves on the Copperbelt Province since it was one of the provinces included in the two projects. The Forest Research Division of the FD has also conducted various studies in many areas of Zambia, including MNF. A respondent explained that MNF has been used for forest research since the 1950s. Some of the research activities that have been conducted include:

i. Provenance trials and species trials-This research involved testing of exotic species on their growth and productivity within Miombo woodlands.
ii. Botanical Reserve-This is the indigenous vegetation set aside for monitoring change induced by both natural and human changes. Mwekera Botanical Reserve is now maintained by ZFC staff and students. Researchers from the Copperbelt University (CBU) and the University of Zambia (UNZA) conduct practicals in the reserve.

iii. Fire trial plots-These trial plots were established in 1960 and aimed at determining how Miombo woodland respond to harvesting and other management regimes. Zambia Forestry College has been managing the fire trial plots. There are three plots: one is for completely protected from fire, one for early burning and one for late burning trials.

iv. Fire trials- These experiments were conducted in MNF in 1994 and 1995 and were aimed at measuring the effect of temperature on different bark thickness.

v. Bark harvesting research-This research involved researchers from the Zambia (Copperbelt University), Britain and Germany. Trees were debarked in order to determine their recovery rate in MNF.

(e) Collaboration among Stakeholders in Forest Management.

Respondents acknowledged that conflicting policies among government sectors was affecting operations of the FD. There was need to have policies harmonized and to ensure that stakeholders were involved. The FD in Kitwe has been working with the Kitwe City Council, Forest Research Division and the Zambia Police Service. One respondent however expressed concern over the way the courts of law have been handling forestry-related cases. The respondent made reference to one operation which was conducted by the FD, ZFC, Zambia Police Service and the office of the Kitwe District Commissioner, in which an attempt was made to remove squatters from MNF. Those who were apprehended and taken to courts of law were fined as low as ZMK 27,000 (USD 8) each. According to the respondent, these penalties were very

low to serve as a deterrent to the offenders. The respondent appealed for stiffer penalties so that offenders do not repeat their illegal acts.

(f) Conflicts Related to Forest Management

Some respondents questioned the reason for degazetting forest reserves. One respondent explained:

> Forests are being degazetted but there are no serious plans to remove people from the remaining gazetted areas so that forests are left to recover.

A government official responded that:

> It was not government policy to promote degazetting of forest reserves. Government knows the importance of these reserves.

The government official however acknowledged that there was serious encroachment of Zambia's forest reserves. He explained that much of the encroachment started with charcoal and firewood activities after which other people take advantage and settle on the open lands to start subsistence farming. The situation started after the redundancies created during the job losses due the Structural Adjustment Programmes (SAP) in which the Copperbelt Province suffered job loses from the sale of ZCCM and the reduced size of the civil service through the Structural Adjustment Programme. This meant that the responsible ministry (Ministry of Tourism, Environment and Natural Resources) remained understaffed and incapable of protecting the forest reserves. To solve the problem of illegal activities in forest reserves, he suggested that the concept of JFM should be applied to make people appreciate forests.

Illegal activities have also affected ZAFFICO. According to one respondent, illegal activities in ZAFFICO plantations start after people clear the indigenous trees within and around the pine and eucalyptus plantations. Later, they begin to get pine and eucalyptus poles. The company is lucky in that pine and eucalyptus do not produce good charcoal. In the case of MNF, the respondent stated:

> The problem facing MNF is partly due to lack of monitoring. People have all the time and courage to go into MNF to cultivate and build shelters. ZAFFICO does not have serious problems with settlements due to zero tolerance principle towards the squatters.

The respondent added that policy conflicts have also limited the FD's capacity to conduct JFM in most of its forest reserves because all people with whom they would practice JFM are illegal squatters. JFM would only be effective if the proposed 1998 policy, which has provision for JFM, is put in place. Political will is critical in this issue.

Another respondent pointed out that the lack of dialogue among departments/sectors has led to conflicts where for instance, departments under Ministry of Health and Ministry of Agriculture and Cooperatives have implemented projects within the national forest with the squatters.

Respondents were also concerned with the lack of stiffer penalties resulting in increased numbers of people dealing in illegal charcoal and firewood. This has made it very unsafe to conduct operations. The charcoal producers and firewood collectors react when they are apprehended. To safely conduct an operation, more than one armed police officer is required.

(g) Efforts to Stop Illegal Activities

Some officers interviewed attributed the failures of the FD to conflicting sectoral policies. The FD would be more effective if all stakeholders worked together. In the case of agricultural activities conducted by departments under the Ministry of Agriculture and Cooperatives in protected areas, the responsible department should first consult the FD before implementing programmes in a forest reserve. In contrast, these departments have followed people where they live regardless of the legal status. It was noted that there has been a change recently because personnel from the Ministry of Agriculture and Cooperatives have started consulting the FD, at least in the Copperbelt Province, before implementing programmes.

Other efforts by the Forest Research Division includes a plan with the District Forest Office in Kitwe where mining companies would target people settled in reserves to produce bamboos for the mines. This would act as an income substitute and would help to reduce reliance on charcoal for livelihood. This would be a kind of integrated management scheme. However, the FD was not ready to accept the approach and the initiative never advanced.

Another project on the Introduction of sustainable charcoal production schemes is currently running. This project is being tried in Northern (Kaputa) and Copperbelt (Ndola) provinces using the bio-gasification technology. The technology uses plantation and other wood-related waste to produce electricity and charcoal. To implement the project, the division had to collect information on the available wood resource in the two districts. Communities

have been encouraged to start establishing plantations. The assessment has estimated that in the Kaputa bio-gasification Project, 9,000 tons of wood would be required while 3,000 tons of charcoal could be produced. The Forest Research Division has embarked on a program to plant 1,200 hectares of plantations for the bio-gasification project. For the Copperbelt Province, a gasification project has been installed at ZESCO Training School in Ndola.

Another respondent suggested that JFM could work for MNF since the forest is well known for its minor forest products such as honey and mushrooms. To add value to the forest, ecotourism should be established in MNF. Biodiversity conservation should be emphasized because the forest has unique vegetation types.

(h) Future Plans for Management of Forest Reserves

Short-term plans of the FD were to conduct inspections in forest reserves and conduct patrols with involvement of stakeholders. Long-term plans were to facilitate institutional reforms, review the current structure and acquire plant and equipment. The Department was already promoting involvement of people in forest management through community forestry. In addition, the Department also planned to foster institutional reforms and hoped that the Forest Department would be transformed into the Forestry Commission through Act 7 of 1999. The Department also plans to produce management plans for forest reserves in the country which will be used as tools to manage the forest.

Concerning illegal settlements, it was explained that the Government had come up with a strategy to degazette some areas of Misaka, Maposa and the Western part of MNF. Despite the boundaries for degazettion being surveyed and submitted to Government, the statutory instrument for MNF is not yet out. Most respondents acknowledged that a number of reserves have been degazeted in the past years. The purpose was to decongest the forest reserves so that squatters are moved to degazetted areas. The FD was aware of the fact that in past degazettions, there has been no serious effort to move people out of the remaining gazetted areas. This time, the FD was in the process of carrying out a head count. The FD, the Kitwe City Council and the District Commissioner's office, have asked Chairmen of the squatting communities to submit lists of people illegally occupying the lands within MNF. After this process, FD staff will go to verify. Once the statutory instruments are out, the squatters will be removed from the remaining forest reserve. One government official explained that a proposal was made to the Copperbelt provincial administration to form a buffer zone around forest reserves which would be given to retired foresters and agricultural officer. Another respondent suggested:

> The current structure, for instance does not have forest guards, people who are supposed to be on the ground protecting the forest. People, including politicians should be sensitized on the importance of forests. The organizational structure of the FD should be revised so that it is more responsive.

Other respondents suggested that industrial sawmilling should be equipped with electricity generators that use wood wastes as used in countries like India and China.

In terms of training, ZFC should revise the curriculum so that it includes topics on how to control illegal activities in forest reserves. The curriculum should include strategies that involve all stakeholders. Most respondents felt that sustainable management of forest resources in Zambia would only be realized when all stakeholders are involved. This calls for amendment of the current forest policy to one that allows participatory management.

4.3 Discussion

From an institutional economics point of view, Mwekera National Forest No. 6 has High Exclusion Cost (HEC) characteristics and can be conceptualized as a Common Pool Resource (CPR) (Ostrom 1990, Schmid 1987). This is a resource system of a size which makes it costly (though not impossible) to exclude people from deriving benefits from its use. On the other hand, MNF can also be viewed as an Incompatible Use Good (IUG), in that, the forest officers and environmentalists are interested in ecosystem services and other research benefits. The charcoal producers and firewood collectors on the other hand are interested in harvesting the trees and this creates conflicts between the two incompatible users of the resource.

The origin of the people involved in illegal activities in MNF which includes setting up settlements, illegal cultivation, sand mining, charcoal production and firewood collection are classified in two categories by Shitima (2005). One group includes people from the mining townships and farming areas of the nearest cities of Kitwe, Ndola and Mufulira. These are people in search of alternative livelihoods in response to various socio-economic factors that had

taken place in the Copperbelt Province and other parts of Zambia in the 1990s. The majority of settlers are ex-miners who had lost their jobs because they were retrenched, laid off or retired (Shitima 2005). They found it necessary to augment their activities with some agricultural production and started cultivating around the forest reserve. The other category are the younger, mainly in their late twenties or thirties. These are people who have little or no education and have no skills and therefore, no formal work experience. With no prospects for formal employment, they have resigned themselves to earning a living the best they can within the forests including Mwekera National Forest (Shitima 2005).

The increase in the number of people engaging in illegal activities in MNF can be attributed to the worsening economic situation in the country. This is also attributed to increasing population over time. The country's population grew at an average growth rate of 2.9% between 1990 and 2000 (CSO 2000). More people live in Lusaka and Copperbelt Province. One implication of increased population is the high demand for basic social needs which includes energy. The most important contribution of forests to Zambia as a nation is perhaps energy, with dry forests providing 70% of energy needs (MFNP 2002).

The proximity of MNF to townships in Kitwe, Ndola and Mufulira made the forest even more vulnerable. This is also the case for Game Management Areas (GMAs) located relatively close to urban centers. They are at greater risk of resource degradation from unsustainable exploitation and use of natural resources *(National Parks & Wildlife Services 1999d).* The effect of the

influx of people into MNF is initially spotted in the western part of the forest in 1984 (figure 9). These are areas close to Kitwe townships of Mufuchani, Buchi, Ndeke, Riverside, Mulenga, Zamtan, Chankalamo and Kamfinsa. The loss in vegetation is attributed to charcoal production and firewood collection activities at that time. The effect of nearby townships on the extent and locations of open lands in MNF was visible from forest cover change analysis maps (figures 9-13). The southern part of the forest, south of the rail line was encroached by settlers in Misaka Forest. Most of people settled in Misaka Forest in the 1990s when this forest was used for the coup system. These people settled in the area illegally. As reported during key informant interviews of this study, the people refused to move out when trees were exhausted but instead put up permanent structures and started cultivating. When trees were exhausted in Misaka Forest, they began crossing into MNF for firewood, charcoal and other forest products.

The eastern side of the forest was affected by townships in Ndola such as Sakanya, Chifubu, Kaniki from 1995 (figures 11). Over time, the situation worsened since in Zambia, there is a positive correlation between household size and charcoal consumption (R-Squared=0.86); mean household size in Zambia increased from 4.7 in 1969 to 5.6 in 1990 (Chidumayo 1993). As the population size increased in surrounding townships, the demand for charcoal and other forest products also increased. The household sector accounts for 96% of total charcoal consumption in the country (Department of Energy 1992).

The increase in open lands between 1984 and 2000 (figures 9-12) could be attributed to the poor economic situation in Zambia towards the end of the second Republic during the 1990s. This period of time was characterized by high inflation rates, high cost of essential commodities, unemployment and shortages of essential goods. In 1991, the government estimated that 41,000 rural households were fulltime employees in charcoal production and an additional 4,500 people involved in transportation, marketing and distribution (GRZ 1997). During this period, the Movement for Multiparty Democracy (MMD) had taken office in 1991 and started a major economic shift from nationalization to privatization of industries and the Structural Adjustment Programme.

The transition from nationalization to privatization had negatively affected households especially on the Copperbelt Province. This period was characterized by job losses. The privatization programme was implemented because from 1973 onwards, Zambia experienced deterioration in trade after a drastic fall in copper prices on the world market. Privatization reached climax in 2000 when ZCCM was unbundled and sold. Over 13,000 people lost jobs (GRZ 2002). The closing of most industries on the Copperbelt Province meant that people could no longer meet basic needs and therefore looked for alternative livelihoods in nearby forest reserves. Over time, more industries were privatized hence more people lost jobs. Without any source of stable income, the members of the retrenched families moved into MNF and started illegal activities such as charcoal, firewood, cultivation and setting up illegal settlements.

Between 2000 and 2006, MNF gained 459 hectares of forest cover (table 6). This is attributed to secondary growth in many areas of the forest that were earlier cleared for charcoal and firewood. It was observed that areas west of MNF which were cleared in 1984 and earlier years had shown signs of recovery by 2006 (figure 13). The average rate of loss of vegetation in MNF was 134 hectares per annum, between 1984 and 2006 (table 6). Recovery was possible because one of the characteristics of firewood collection and charcoal production is that, once preferred trees are exhausted, the charcoal producers and firewood collectors usually relocate to new area with preferred trees, hence making it possible for the areas abandoned to regenerate. With passage of time, areas abandoned by firewood collectors and charcoal producers are later used for either settlements or cultivation by the next group of people who's interest is mainly agriculture (figure 34). This is because people want to take advantage of the already cleared land to start agricultural activities.

The number of illegal activities located in either forested or open areas, the average number of illegal activities per hectare, the mean nearest neighbor distance between illegal activities and the number of illegal activities located within specified buffer distances along roads and motor trails gave the relative locations and distribution of the illegal activities. The total number of firewood and charcoal sites was 102, 341 cultivated sites and 287 settlements. This gave an average of one firewood and charcoal site for every 113 hectares, one settlement for every 40 hectares and one cultivated site for every 34 hectares. From these ratios, it was observed that settlements and cultivated

sites appeared to follow a similar pattern of distribution. Part of the reason for this similarity was due to overlaps, out of the 341 sites used for cultivation, 269 were settlements (figure 16). Cultivated sites and settlements were denser in distribution than firewood and charcoal sites.

These results are also shown by the mean nearest neighbor distances between illegal activities computed in CrimeStat II (table 7). Results showed mean nearest neighbor distances of between 216 m (0.14 miles) and 395 m (0.25 miles). Mean nearest neighbor distances between cultivated sites and between settlement sites to cultivated sites had the same value of 222 m (0.14 miles) though the standard deviation showed more variability for settlements to cultivated sites than between cultivated point locations alone. The highest mean nearest neighbor distance was 395 m (0.25 miles) and a standard deviation of 470 m (0.29 miles) was found between firewood and charcoal site point locations. This showed that charcoal and firewood sites exhibited higher variability from the mean nearest point distance. Overall, the pattern showed localized exploitation of wood resources in the case of firewood and charcoal activities (figure 19). The short mean nearest neighbor distances of less than 400 m (0.25 miles) for all activities, showed evidence that the illegal activities were related to one another (figure 34).

By using the "Spatial Join" function in Arcview 3.3, it was found that at least 52% of all the illegal activities mapped were located in forested areas (figure 17). The number of charcoal and firewood sites located in forested lands was 82% of the total charcoal and firewood sites mapped. This was possible because the raw material used in firewood collection and charcoal production

are preferred trees such as *Julbernardia paniculata, Julbernardia globiflora, Brachystegia boehmii, Brachystegia spiciformis, Bauhinia thoningii, Pericopsis angolensis, Parinari curatellifolia,* and *Uapaca kirkiana.* These trees are preferred because of their high heat content values and that they last long in burning (Nkomesha 1996). One of the characteristics of charcoal and firewood production was the tendency to selectively harvest. This has led to patches of open areas in the forest (figure 19). The selectivity in trees harvested has influenced the locations and distribution of the illegal sites. Only 18% of charcoal and firewood sites were located in open areas. This can be attributed to people returning to areas that had regenerated over time. On the other hand, in the absence of preferred trees, illegal firewood collectors and charcoal producers would return to areas that were earlier cleared to cut lesser charcoal and firewood tree species such as *Marquesia Macroura*, *Albizia* spp., *Pseudolachynostylis maprounefolia*, *Syzygium spp.* and other species.

Cultivated sites and settlements also followed a similar trend as firewood and charcoal were 56% and 52% where located in forested lands, respectively. This can be attributed to activities supporting the livelihood of these forest communities such as subsistence farming, charcoal production and firewood collection. The squatters practice shifting cultivation in which they move to forested lands, cut down trees (and convert some to charcoal and firewood) and then burn the remaining trees and branches to boost fertility of the soil. The cultivated fields (figure 30) are usually abandoned for fresh pieces of land once crop yields begin to decline. On the other hand, the squatters have

deliberately located their settlements in forested lands so that they are able to do farming and at the same time produce charcoal and harvest firewood which they use for cooking and selling (figure 27).

It was observed during the field survey that that areas under firewood and charcoal activities showed concentration in places where preferred trees were abundant. Unlike firewood and charcoal sites that are located in areas with preferred trees, settlements and cultivated sites were located even in areas were trees have already been depleted (previous firewood and charcoal sites).

All major illegal activities were connected by a close network of motor and foot trails. Ninety-four percent of sites (charcoal and firewood, cultivated sites and settlements) were found within 2km (1.25 miles) along motor trails or roads (table 8). The number of activities increased as the buffer distance was increased. It was interesting to note that as many as 63% of total sites mapped where located within 800 m (0.5 miles) along motor trails and roads. These results show that it would be possible to get between 63-94% of all sites by surveying areas in the range of 800 m - 2,000 m (0.5 -1.25 miles) along motor trails and roads alone. A linear relationship was found between distance from motor trails and the number of sites located within that distance from the motor trails showing a positive relationship (R^2=0.97) (figure 33). These trails are used in transporting various forest products to markets often using vehicles, wheelbarrows, bicycles and head loads (figure 32). It is therefore clear that motor trails affect the management of MNF. The

construction of the CEC electricity grid that supplies power to the new DRC mine, for instance has opened more access to MNF through the maintenance trail along the grid. This trail is now used by charcoal producers and firewood collectors to transport their products to nearby townships of Buchi, Kamitondo, Kwacha, Riverside, Ndeke and other places.

This study also revealed that the squatters have built structures of various designs. This is an indication that the squatters have committed enormous resources and effort in the forest reserve. This has implications on the ease with which people can be resettled from the forest. From the design and materials used, it would be possible to project the level of permanence of the structures. For instance, close to 10% of squatters used expensive iron and asbestos roofing sheets (figures 21 and 22) for their shelters. These are factors that should be considered when carrying out sensitization programs for resettling the people from MNF. The more investment squatters make, the more likely people will resist any programmes to resettle them from the forest reserves. The types of shelters built in the forest also gave an indication on the complexity of the community structures in MNF. The presence of community schools (figure 23), trading centers (figure 24), and recreation centers (figures 25) showed how serious the squatters are in making MNF a better place for themselves.

It is obvious that for the illegal activities to reach this extent in MNF, there has been little or no enforcement of the law. It was observed that areas close to the college had very few settlements and charcoal activities. This was

attributed to frequent patrols conducted by the ZFC students and staff. The lack of enforcement in past years has contributed to the rapid loss of the forest. It is clear that where enforcement has been effective, encroachment has been minimal. As reported by one respondent during key informant interviews, ZAFFICO does not experience serious problems with settlements due to its zero tolerance principle with squatters. Due to lack of enforcement, a section of the MNF has since been named *Kuma Ilange*, meaning, self allocation of land. This implies that anyone is free to enter and allocate themselves the land in the national forest without approval from authorities. Many squatters therefore clear land for purposes of solidifying land claims and increasing the size of allocations.

With the trend when forest reserves have been degazetted by the government in the past (see appendix 7), the hope of the squatters is to lobby government to degazette the area once they have illegally settled usually through their chairpersons who usually work together with area Members of parliament. The situation is made worse by the lack of coordination among government ministries and departments. Similar information was obtained by Shitima (2005) who reported that while foresters insist that people within MNF were illegal squatters who needed to vacate the protected forest, local politicians such as the Member of Parliament, councilors and party chairmen assured the squatters that no one would evict them. Local politicians even promised the squatters that they would soon get title deeds to the land they are occupying.

It is worrying to see forests being degazetted without any serious plans to resettle people from areas that remain gazetted. The planned excision of over 6,000 hectares will leave 11,539 hectares in MNF (figures 7 and 15) gazetted. The scheduled resettling of people to degazetted areas will be a short-term solution provided monitoring is not effective and as long as the FD remains under-funded, and lacks tools and equipment. The situation will be worsened if stakeholders will not be involved in forest management. The incentive to rule violation or at least to non-co-operation on the part of resource users is almost always increased by the fact that relations between them and the state bureaucracy are usually distant and antagonistic and that, in many cases, state regulations have had the effect of setting the government against the peasant when successful resource management precisely requires the opposite circumstances (Bromley and Cernea 1989).

Another factor that should be addressed in order to effectively manage forest resources in Zambia is the status of people involved in the illegal activities. Illegal firewood harvesters and charcoal producers are poor, unemployed and not educated. This was revealed from the characteristics of the illegal activities. For instance, the tools used are simple axes, shovels and hoes. Sadly, the method used to produce charcoal, the earth kilns, are mostly 10% efficient. It is therefore important for government to introduce programmes that aim at empowering the poor in society and to invest in research aimed at use of more efficient stoves or improving energy sources such as the Kaputa and Ndola bio-gasification projects of Northern Province and the Copperbelt Province.

The consequences of continued deforestation of MNF are many, including erosion and shallowing of the Mwekera dam which has resulted in reduced quality and quantity of water to the Mwekera community. There is also a diminished number of tree species for forestry training at ZFC. For the Aquacultural Research Station which relies on water from Mwekera dam for their fish ponds, the reduced level and quality of water affects research programmes at the institution.

It is therefore clear that if forest reserves are to be sustainably managed in Zambia, a lot has to be done in ensuring that the policy accommodates community participation. The government should also work on reducing poverty levels and increasing access and reliability of electricity in Zambia since less that 20% of Zambia's population has access to hydroelectric power (ECZ 2001). It is also critical for the government and private sector to invest in alternative sources of energy.

CHAPTER FIVE

SUMMARY AND RECOMMENDATIONS

5.1 Introduction

A summary on the findings of this study is presented in this chapter. Based on the findings, recommendations for the government and other policy makers have been made. Finally suggestion for other researchers and areas of further study are noted.

The primary aims of this study were to establish a quantitative basis for assessing deforestation and to contribute to effective and participatory forest resource management. Survey objectives were as follows:

i. To identify the forest cover change that have occurred from 1984 to 2006,
ii. To determine the extent of illegal firewood collection and charcoal production activities in MNF,
iii. To identify characteristics of illegal charcoal production and firewood collection in MNF, and
iv. To suggest intervention measures to reduce illegal firewood and charcoal activities.

Conducting a forest cover change and determining the extent of illegal firewood collection and charcoal production should help authorities' to better plan the management of forest reserves in Zambia. From the case study, authorities would have information on the locations, and actual extent of forested and open areas. In addition, the identified characteristics of illegal

firewood and charcoal production activities and views of key informants together with incorporated findings from other studies such as Shitima (2005) made it possible to make meaningful conclusions aimed at addressing the problem.

5.2 Summary of Findings

Several factors have combined to result in the encroachment and deforestation of Mwekera National Forest. These include macro-economic policies such as economic liberalization and privatization of mines and other companies. It was clear from the forest cover change analysis that MNF has lost forest cover in extent of 3,355 hectares between 1984 and 2000. It is also interesting to note that MNF had recovered 459 hectares of forest cover between 2000 and 2006. A field check confirmed that recovery was due to regeneration of areas that were earlier cleared in the 1980s and 1990s. The current extent of forested areas stands at 13,051 hectares while 4,836 hectares is the extent of open areas in the current boundary. The heavy loss of forest cover has prompted the government to propose excision of 6,348 hectares from the current 17,887 hectares. This is in an effort to resettle people who have illegally lived in the MNF. If approved, only 11,539 hectares of national forest area will remain. In the proposed boundary, forested areas are 8,654 hectares in extent while open areas are 2,885 hectares in extent.

The study also revealed the location and distribution of features and activities related to charcoal and firewood activities such as settlements, agricultural activities, sand mining and motor trails within the proposed boundary of MNF.

Settlements were of five main types, shelter, churches, schools, trading centers and recreation centers. This meant that the forest communities have now established various institutional structures implying that there intentions are to stay in the forest permanently. This could also be seen from the materials used in constructing the structures where some settlers have used expensive construction materials such as burnt bricks for walls and iron sheets or asbestos for roofing.

At least 52% of activities (including charcoal, firewood settlements, cultivated and sand mining sites) fell in forested areas. These activities, at least initially, are driven by availability of trees. Charcoal production and firewood collection was found to be the primary reason why people moved to MNF with 82% of such sites located in forested areas. In terms of distribution, the study found that there was one charcoal-related site for every 113 hectares, one cultivated site for every 34 hectares, and one settlement for every 40 hectares. The selectivity in harvesting trees during firewood collection and charcoal production has led to patches of open areas. This distribution is also confirmed by results of nearest neighbor distance between point locations of illegal activities (table 7). The mean nearest neighbor distance of illegal activities was less than 400 m (0.25 miles).

It was also found that illegal activities were connected by a close network of motor and foot trails with 94% found within 2km (1.25 miles) from motor trails (table 8). The number of activities increased as the buffer distance was increased. There was positive relationship (R^2=0.97) between buffer distance

from motor trails and the number of illegal activities within that distance from the motor trail (figure 33).

The loss in vegetation has been enabled by the responsible department (FD) which is understaffed and poorly funded. The department also lacks equipment to fully manage the forest reserves in the country at the time when the majority of people in the country survive on less than a dollar per day. The situation has been worsened by lack of coordination among government ministries like the Ministry of Agriculture and Cooperatives, and the Ministry of Lands. Politicians are also reported (Shitima 2005) to conflict with each other when it comes to management of the forest resources.

Increased illegal firewood and charcoal activities in MNF are also blamed on the population increase in Zambia. This means that the demand for various social needs, including energy has, increased. With only 20% of total population with access to electricity means the 80% of population have to look for alternative energy such as firewood and charcoal. High electricity tariffs, frequent power cuts and high costs of alternative energy (diesel, petrol and kerosene) have worsened the situation.

The study also identified major characteristics of firewood and charcoal which formed the basis for formulation of strategies aimed at mitigation the deforestation in MNF. The firewood collectors and charcoal producers used headload, vehicles, wheelbarrows and bicycles to transport their produce through a network of motor and foot trails. The study confirmed that the activities were illegal in a national forest like MNF, and this showed that the

policy issues related to forest management have not been enforced. It was also noted that Act No. 39 of 1973 does not allow for participatory management of forest resources with affected communities.

The people involved in illegal activities are poor and in need of land, food and other social needs. Hence, the poverty situation is key in resolving the problem of deforestation in MNF and other forest reserves. The government should come up with income-generating activities aimed at empowering communities. The methods of charcoal production which are only 10% efficient mean that lots material is wasted during production. This calls for the government and private sector to invest in research that will introduce efficient and modern methods of charcoal production. The effect of the surrounding townships on the forest reserve was examined. With the expanding population and the positive correlation between charcoal and firewood demand and household size, it is expected that the demand for firewood and charcoal will increase over time.

Some respondents interviewed suggested that government should consider establishing a buffer zone around MNF where they could settle foresters and retired environmental officers in addition to re introducing forest guards in the Forest Department structure. Other respondents suggested that while the government of the Republic of Zambia had found it necessary to degazette whole or parts of some forest reserves, it should work out strategies aimed at ensuring that areas that remain as gazetted forests are protected. One way would be by carrying out a head count in affected forests before people are

resettled to degazetted areas. Participatory management of should be put in place in local forests while efforts should be made to involve more stakeholders and encourage collaboration among government sectors in the case of national forests.

5.3 Recommendations

5.3.1 Introduction

Having determined the extent and characteristics of firewood collection and charcoal production, it is vital to consider recommendations that will enable the mitigation of the current problems. These recommendations are derived from key informant interviews and study results. The case study focused on the Mwekera National Forest, but recommendations are much broader in scope.

5.3.2 Recommendations

(a) Conducting Forest Inventory of Zambia Forest Stock

The government and other stakeholders should address the problems of inadequate resources, lack of equipment and low staff capacity that have prevented Zambia from conducting a national forest inventory since it gained independence in 1964. The absence of data, in terms of supply (inventory), non-wood forest products, industrial timber processing, and the informal firewood and charcoal trade, significantly underestimates forestry's contributions to the national economy and to poverty reduction.

(b) Resettling People from Gazetted Forest Areas

The Government should come up with an efficient system of resettling people from forest reserves who are involved in illegal activities. The head count for MNF should be done as soon as possible so that people within the gazetted forest areas are moved to degazetted areas. The FD should at the same time find ways of ensuring that people do not return to the gazetted areas by strengthening law enforcement, sensitization and embracing the local people at the same time. This would give time for open areas to regenerate.

(c) Coordination and Collaboration across Government Sectors

The Forest Department and other government departments should work together, and every effort should be made to pursue joint initiatives. FD should collaborate with the Department of Energy to reorganize the charcoal and firewood industry. The FD should also improve the efficiency of charcoal production and conduct consumption surveys with the Central Statistical Office (CSO), the informal sector. The FD should also market forestry at local and international level. Integrated land use programs such as agroforestry that would enhance agricultural productivity and meet wood needs of people should be promoted.

(d) Improving Monitoring and Evaluation

To reduce encroachment into forest reserves, frequent monitoring of the forest is required. This would enable authorities to detect and address any illegal activities earlier before the illegal actors establish themselves. The Forest Department should demonstrate forestry's importance to the national

economy and livelihoods by developing indicators and survey questions that would measure the sector's contributions in these areas. The Forest Department should also promote awareness by organizing briefings for both newly and re-elected members of Parliament and also raise awareness among representatives of civil society and other stakeholders

(e) Strengthening the Role of Forestry in Poverty Alleviation

Since 70% of Zambia's population is classified as poor and forests serve as safety nets for the poor in the country, the role of forest in poverty alleviation should be strengthened through participatory management. But the problem facing forestry administration in Zambia is the government's delay to establish the Forestry Commission which is called for in the Forests Act No. 7 of 1999. Despite Parliament's enactment of the law, government still has not issued a Commencement Order. This means there is no legal framework to allow for participatory management in the forest resources. Therefore, the Zambian Cabinet should urgently make a decision on the way forward.

(f) Promoting Alternative Energy Sources

The Zambian Government should promote policies that put emphasis on the sustainable management of the charcoal and firewood industry through the promotion of good woodland management and by supporting the National Policy on Wood-fuel as embodied in the National Energy Policy of 1994. In drawing up a fuelwood energy policy, the study proposes that four major aspects should be considered:

i. Identify the present size and characteristics of the wood resource and its future development.
ii. Determine the present consumption pattern of firewood and charcoal and probable future development.
iii. Examine the present supply chain of the woodfuel resources from production to distribution to consumption and
iv. Assess the possibilities of rationalization and improvement of the woodfuel resources.

(g) Strengthening GIS Technology in Forest Management

The government should invest money in the acquisition of digital satellite images and capacity building in GIS technologies. Such technology would assist in estimating land cover change of all forest reserves in the country before on the ground surveys are conducted.

5.4 Limitations of the Study

The main limitation of the study was the time required to do a traditional systematic forest survey and missing or unavailable initial data for planning of the study since the last comprehensive inventory was conducted 40 years ago. To address the problem of time, the study applied focal sampling with transects planned from a digital vegetation map. This enabled the researcher to concentrate only in areas of interest. The current electricity-supply problem being experienced in Zambia caused delays in the completion of the study due the frequent load shedding programmes. In addition inadequate transport meant that programs could not be done as scheduled. The college at the time

only had two running vehicles. Nonetheless, data collection was completed over a 6 week period (Appendix 6). It was also hard to make timely communications and research due to limited access and speed of the internet. Other limitations related to the methods and approach are noted below.

- The use of ASTER and Landsat TM images may have affected the accuracy of the results on the forest cover change since they may not be strictly comparable,
- Due to the complexity of illegal activities on the landscape, more spatial detail may be needed instead of midpoints of patches,
- The study only considered key informants in their official capacities; this could have limited the responses thereby affecting recommendations,
- Only one case study of Mwekera National Forest was done, it is therefore not known how well results and recommendations can be generalized.

5.5 Suggestions for Further Study

While every effort was made to cover all the relevant aspects necessary to the theme of this study, the subject is too diverse to be covered exhaustively in a study of this scope. Therefore, the following have been suggested for further study:

- Study the supply chain, from forests to end users,
- Determining the amount of charcoal and firewood produced from Zambia's forest reserves,

- Similar studies on the extent and characteristics of illegal activities in other protected forest areas should be conducted in order to come up with national figures.
- Study the effects of poverty and HIV/AIDS on deforestation in Zambia,

APPENDICES

APPENDIX 1. SURVEY INSTRUMENTS: BOUNDARY MAPPING

A. Forest Reserve Form 1

FOREST RESERVE FORM
MWEKERA NATIONAL FOREST NO. 6

ENUMERATOR: DATE:

PROVINCE: CODE #:
DISTRICT: CODE #:

AREA (Ha) CO-ORDINATE ZONE: 35

POSITION/ SITE							
Altitude (m)							
GPS x (m) E							
GPS y (m) S							

Other Information/Sketch Map:

B. Roads/Trails Inventory-Form 2

MWEKERA NATIONAL FOREST NO. 6
FOREST TRAIL/ROAD INVENTORY

ENUMERATOR:		DATE:	
TRIAL/ROAD NAME/No.		TIME START:	
LEGAL DESCRIPTION:			

SEGMENT NO.		**Position**	GPS x (m) E		**Altitude**
			GPS y (m) S		

GROUND COVER TYPE: (*check all that apply*)

Soil		Rock		Bituminous, Concrete		Other	

FOREST CONDITION, FEATURES AND ACTIVITIES ALONG TRAIL (*check all that apply*)

Intact Forest		Charcoal		Firewood		Settlement	
Secondary Growth		Agriculture					

CONNECTIONS TO SEGMENT .....

Schematic Drawing:

Photo Record: (*Photo number, Photo point and direction*)

APPENDIX 2. SURVEY INSTRUMENTS: INVENTORY DATA COLLECTION

A. Transect form 1

MWEKERA NATIONAL FOREST NO. 6

TRANSECT-FORM 1

ENUMERATOR:	

PROVINCE:		CODE #:	
DISTRICT:		CODE #:	
FOREST AREA:		CODE #:	

TRANSECT No.:		DATE:	

Altitude (m):	
GPS x (m) E:	
GPS y (m) S:	
Co-ordinate Zone:	

General description and observations along the transect (...location, landuse, vegetation types, undergrowth type, adjacent vegetation, roads/trails etc)

.....

.....

.....

.....

Photo Record: (*Photo number, Photo point and direction*)

B. Main Plot-Form 2

MWEKERA NATIONAL FOREST NO. 6
MAIN PLOT-FORM 2

ENUMERATOR:	DATE:	TIME START: .....
PLOT No.:	NAME OF SITE:	

POSITION/ SITE												
Altitude (m)												
GPS x (m) E												
GPS y (m) S												

SITE CHARACTERISTICS-**Land Use and Landscape Characteristics**

A. Undisturbed Forest/ Site description: *(Tick all that apply)*

Undisturbed Natural Forest | Natural shrub | Natural grassland | Wetland | Other (Describe):

B. Disturbed Forest/ Site Description:

CAUSE OF DISTURBANCE:

I. CHARCOAL ACTIVITY — **State of Kiln:** Under construction | Extracted | Total kilns at site:
Tree Species Used: .....

II.FIREWOOD HARVESTING — Number of Piles: | List Major species harvested: .....

III. SETTLEMENTS — Year settled: .....

Number of shelters by roofing type at settlement

Iron sheets: | Asbestos: | Grass: | Other (Describe:

IV. AGRICULTURE — Type (s) of farming ..... List of crops grown: .....

V. OTHER LAND USE: .....

C. Hydrology: *(Tick all that apply)*

No water: | Stream/flowing water | Pond/standing water | Forested wetland | Well

Other (Specify .....

APPENDIX 3. LETTER OF CONSENT

TITLE OF STUDY: EXTENT AND CHARACTERISTICS OF ILLEGAL FIREWOOD COLLECTION AND CHARCOAL PRODUCTION ACTIVITIES; A CASE STUDY OF MWEKERA NATIONAL FOREST NO. 6, COPPERBELT PROVINCE IN ZAMBIA

Dear Study Participant,

The purpose of the study will be to generate a quantitative basis for planning and successful implementation of Joint Forest Management in Zambia. This study is being carried out for academic purposes, specifically as a partial fulfillment of a Masters of Science Degree in Forestry from the Michigan State. The research is sponsored by the United States Agency for International Development (USAID).

The results of the study will be used at the local level in integrating strategies through the Extension Services unit at Zambia Forestry College. In addition, the thesis will be available through the university libraries and findings will be converted into recommendations to the Forest Department and agencies involved in the promotion of sustainable forest management. The interview should only take 20-30 minutes. The information gathered from the participants will be regarded as confidential and your participation in this study will be completely voluntary. You can choose not to answer any particular question or not to participate in the research entirely. Your responses to questions will be combined with comments from other respondents and will not be attributed to you.

If you have any questions about the study protocol, please contact Dr. Larry Leefers, Department of Forestry, Michigan State University, 126 Natural Resources Bldg., East Lansing, MI 48824, USA 517-355-0097 (Leefers@msu.edu) or Malunga Mwelwa, Masters Candidate, Zambia Forestry College, P/B 1 Mwekera, Kitwe, Zambia., +260-02-239009 (malungam@msu.edu). If you have any questions regarding your role and rights as a study participant, or would like to register a complaint about this study, you may contact, anonymously, if you wish, Dr. Peter Vasilenko Director of Human Research Protection Programs, at 517-355-2180, FAX: 517-432-4503, email: irb@msu.edu, or regular mail: HRPP, 202 Olds Hall, East Lansing, MI 48824.

Thank your for helping in the study research. Participation in this study is strictly voluntary; and if you participate in the interview, we accept it as your consent to use the responses as part of your views on forest resources and deforestation.

Larry Leefers,
Associate Professor,
Department of Forestry,
Michigan State University,
126 Natural Resources Building,
East Lansing, MI 48824.

Malunga Mwelwa Mwape
Masters Candidate,
Department of Forestry,
Michigan State University,
126 Natural Resources Building,
East Lansing, MI 48824.

APPENDIX 4. QUESTION GUIDES FOR KEY INFORMANT INTERVIEWS

A. List of Participant for Key Informant Interviews

01	The Permanent Secretary, Ministry of Tourism, Environment and Natural Resources, Lusaka, Lusaka province
02	The Director of Forestry, Forestry Headquarters (FD) Lusaka, Lusaka province
03	The Principal, Zambia Forestry College, Kitwe, Copperbelt Province.
04	Principal Extension Officer (FD), Copperbelt Province, Ndola
05	Chief Research Officer, Division of Forest Research (FD), Kitwe
06	District Extension officer (FD), Kitwe District, Copperbelt Province
07	The Director, Zambia Forests and Forest Industries Corporation, Ndola, Copperbelt Province
08	The District Administrator-Kitwe District, Copperbelt Province

B. Interview Question Guide-Respondent No. 1

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER: DATE:

RECORDER:

RESPONDENT NO.: 01

1. I am aware that the government is currently implementing/enforcing the following policies related to forest management:

    a. **Act No. 39 of 1973**

    b. **Act No. 7 of 1999.....**

    1.1 Are there other policies regarding forest management that the Ministry is currently *following/ (or planning to)* in addition to the existing policies above?

2. What are the policies regarding illegal activities such as firewood collection and charcoal production?

3. What other plans does Government have in relation to the Reserved Forest Areas; say in the next five years?

B. Interview Question Guide-Respondent No. 2

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER:	DATE:
RECORDER:	
RESPONDENT NO.:	02

1. What management activities (or policies) do you conduct in relation to illegal firewood collection and charcoal production in Forest Reserves in Zambia?
2. Are these activities (**in 1 above**) different among provinces?
3. What legal operations are currently being allowed in Forest Reserves in Zambia?
4. What are the illegal operations being experienced in the Forest Reserves in Zambia?
5. Does your Department collaborate with other organizations in the management of the Forest Reserves on illegal firewood collection and charcoal production?
6. Who are the stakeholders in the management of the Forest Reserves in Zambia?
7. Do you plan to involve more stakeholders in the management of the Forest Reserve?
8. Has your department conducted any studies on illegal activities in recent years in any Forest Reserve in Zambia?
9. What plans do you have for the next five years in relation with the illegal activities in Forest Reserves?

B. Interview Question Guide-Respondent No. 3

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER: DATE:

RECORDER:

RESPONDENT NO.: 03

1. How do illegal activities affect training of students at your College?
2. What studies does your College currently undertake in MNF in relation to illegal firewood collection and charcoal production?
   2.2 Does the College curricula have courses that address management strategies for mitigating illegal firewood collection and charcoal production in MNF?
3. What measures/strategies/activities have you put in place in the past five years to mitigate illegal activities?
   3.1 Are students involved in these activities?
4. Does the Forest Department collaborate with your organizations in the management of the MNF on issues of illegal firewood collection and charcoal production?
5. What plans do you have for the next five years in relation with the illegal activities in MNF?

B. Interview Question Guide-Respondent No. 4

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER:		DATE:	
RECORDER:			
RESPONDENT NO.:	04		

1. What management activities do you conduct in relation to illegal firewood collection and charcoal production in Forest Reserves in the Copperbelt Province?
2. Are these activities **(in 1 above)** different among districts in the Province?
3. What legal operations are currently being allowed in the Forest Reserves on the Copperbelt Province?
4. What are the illegal operations being experienced in your Province?
5. Does your Office collaborate with other organizations in the management of the Forest Reserves on illegal firewood collection and charcoal production?
6. Who are the stakeholders in the management of the Forest Reserves in your Province?
7. Do you plan to involve more stakeholders in the management of the Forest Reserve?
8. Has the Provincial Office conducted any studies on illegal activities in recent years in any Forest Reserve in the Province?
9. What plans do you have for the next five years in relation with the illegal activities in Forest Reserves on the Copperbelt Province?

B. Interview Question Guide-Respondent No. 5

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER:	DATE:
RECORDER:	
RESPONDENT NO.:	05

1. What research operations is your Division currently undertaking in MNF and other Kitwe-area forests?
2. **If yes to 1 above**;
   - 2.1 Do illegal activities affect your research activities?
   - 2.2 Does your Division conduct research on illegal firewood collection and charcoal production?

3 What do you suggest should be done to mitigate the effects in 2.1 above?

4 What plans do you have for the next five years in research related to illegal firewood collection and charcoal production activities in Forest Reserves?

B. Interview Question Guide-Respondent No. 6

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER: DATE:

RECORDER:

RESPONDENT NO.: 06

1. What management activities do you conduct in relation to illegal firewood collection and charcoal production in Forest Reserves in Kitwe District?
2. What legal operations are currently being allowed in the Forest Reserves in Kitwe district?
3. What are the illegal operations being experienced in forest reserves in your District?
4. Does the District Office collaborate with other organizations in the management of the Forest Reserves on illegal firewood collection and charcoal production?
5. Who are the stakeholders in the management of the Forest Reserves in your District?
6. Do you plan to involve more stakeholders in the management of the Forest Reserves in your District?
7. Has the District Office conducted any studies on illegal activities in recent years in any forest reserve in Kitwe district?
8. What plans do you have for the next five years in relation with the illegal activities in Forest Reserves on the Kitwe district?

B. Interview Question Guide-Respondent No. 7

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER: DATE:

RECORDER:

RESPONDENT NO.: 07

1 What are the various legal and illegal activities experienced in your plantations?

2 How do you mitigate illegal activities in your plantations?

3 Does the Forest Department involve your organization in the management of the Forest Reserves or other related forestry activities?

4 What would you like government to do to improve the situation of the Forest Reserves under the Forest Department?

B. Interview Question Guide-Respondent No. 8

MWEKERA NATIONAL FOREST NO. 6

QUESTION GUIDE

INTERVIEWER:	DATE:
RECORDER:	
RESPONDENT NO.:	08

1. What role (s) does your office play in the management of Forest Reserves in Kitwe?
2. Are there any conflicts reported to your office regarding management of Forest Reserves?

If yes to 2 above;

2.1 What do you think would be the best way possible to manage these conflicts?

3. Does the Forest Department involve your office in the management of the Forest Reserves or in other environmental activities?
4. What are the possible livelihood sources of the majority of the people living in Kitwe?
5. How available and accessible is environmental awareness information to Kitwe residents?
6. How best can your Organization be involved in the management of Forest Reserves?
7. What would you like the Forest Department to do to mitigate illegal firewood collection and charcoal production in the Forest Reserves?
8. What other plans does your Institution have in relation to illegal firewood collection and charcoal production activities say in the next five years?

9. How can we form, sustain, and evaluate effective collaborative natural resource planning and management processes of our Forest Reserves?

APPENDIX 5. BUDGET AND MATERIALS REQUIRED

A. Budget

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
1	**Stationary**	Acquisition of research materials				
1.a	Printing Ink		1,000,000	3 packs	3,000,000	750
1.b	Pencils		10,000	1 box	10,000	2.5
1.c	Box Files		30,000	4 Box files	120,000	30
1.d	Pens		10,000	1 box	10,000	2.5
1.e	Bond Paper		30,000	4 reams	120,000	30
1f	Note Books		30,000	1 Pack	30,000	7.5
1g				**Sub total:**	**3,290,000**	**822.5**

A. Budget (cont'd)

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
2	**Equipment**	Acquisition of research materials				
2.a	GPS unit		800,000	1 unit	800,000	200
2.b	USB Connector cable		200,000	1	200,000	50
2.c	2 1GB SD Card		120,000	Memory Cards	240,000	60
2.d	Digital camera		1,000,000	1	1,000,000	250
2.e	Removable storage media		1,000,000	1 External Hardrive	1,000,000	250
2.f	Map of Zambia		100,000	4 maps	400,000	100

A. Budget (cont'd)

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
2.g	Digital Land cover maps		400,000	Digital Land cover Maps: 1990 and 2000 maps	400,000	100
2.h				**Sub total:**	**4,040,000**	**1010**
3	**Personnel**					
3.a	Allowance for Field Assistants	Reconnaissance of study area	50,000	1 Day x 10 personnel	500,000	125
3b		Key Informant Interviews and obtaining key information from institutions in-Lusaka	300,000	2 days x 2 personnel	1,200,000	300

A. Budget (cont'd)

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
3c		Key Informant Survey and desk research-Kitwe & Ndola	50,000	2 days x 2 personnel	200,000	50
3d		Boundary Mapping	50,000	4 days x 10 personnel	2,000,000	500
3e		Inventory data Collection	50,000	10 Days x 10 Personnel	1,000,000	250
3f		Data entry and processing	50,000	10days x 4 personnel	2,000,000	500
3g				**Sub total:**	**6,900,000**	**1725**

A. Budget (cont'd)

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
4	**Travel**					
4.a	Fuel for transportation to institutions	Key informant interviews- Kitwe and Ndola	6,000	130 litres	780,000	195
		Lusaka interviews	6,000	300 liters	1,800,000	450
4.b	Fuel to travel around and within MNF	Boundary Mapping	6,000,	330 litres	1,980,000	495

A. Budget (cont'd)

ITEM NO.	EXPENSE ITEM	ACTIVITY	COST PER UNIT (ZMK)	UNITS REQUIRED	PROJECTED TOTAL	
			Unit Price (Description)		TOTAL COST (ZMK)	TOTAL COST (USD)
4c		Inventory data collection	6,000	500litres	3,000,000	750
4d				**Sub total:**	**7,560,000**	**1,890**
5.a				**Total Amount**	**21,790,000**	**5447.5**
5.b				**Contingency 10%**	2,179,000	544.75
5.c				**GRAND TOTAL**	**23,969,000**	**5992.25**

ZMK = Zambian Kwacha currency, USD= United States Dollars currency, Exchange Rate applied is USD 1 = ZMK 4,000

B. Budget Justification

	Item	Justification
1.	Stationary	USD 822.5 (ZMK 3,290,000). This amount will be required for purchase of office materials such as paper used in day to day running of the *research*.
2.	Equipment:	USD 1,010 (ZMK 4,040,000). will be required to purchase GPS unit, RS-232 USB connector, external hard drive, Digital camera for taking field photos and for purchase of maps (Digital satellite maps and printed). These will be required for planning work while the GPS unit will be the main equipment used in the field for determining locations in the study area.
3.	Personnel	The USD 1,725 (ZMK 6,900,000) will be required to pay allowances to research assistants during data collection and analysis.
		A rate of USD 12.5 (ZMK 50,000) per day will be required to pay each research assistant as meal allowance within Kitwe and Ndola. ZMK 300,000 (USD 75) per day will be paid to two researcher assistants traveling out of Kitwe and Ndola as subsistence allowance.
4.	Travel:	USD 1,890 (ZMK 7,560,000) will be required to cater for travel needs during data collection within and around the project area and for administrative works during the entire project time. These travels will include fuel to conduct Key informant interviews and field data collection within and around the 17,887hectares forest.
5.	**TOTAL PROJECT COST:**	USD 5,992.5 (ZMK 23,969,000), is the total research cost. This amount includes a 10% contingency totaling USD 544.75 (ZMK 2,179,000) required to offset unforeseen changes such as fluctuating fuel prices and inflation.

B. Budget Justification (Cont'd)

	Item	Justification
4.	Travel:	USD 1,890 (ZMK 7,560,000) will be required to cater for travel needs during data collection within and around the project area and for administrative works during the entire project time. These travels will include fuel to conduct Key informant interviews and field data collection within and around the 17,887ha forest.
5.	**TOTAL PROJECT COST:**	USD 5,992.5 (ZMK 23,969,000), is the total research cost. This amount includes a 10% contingency totaling USD 544.75 (ZMK 2,179,000) required to offset unforeseen changes such as fluctuating fuel prices and inflation.

C. Contributions of Home Country Institution

Capital Equipment: Vehicles and office, computers, printers	The home institution will provide vehicles, office space and other accessories necessary to run the GIS-ArcView software.
Subsistence Allowance for the Researcher when out of Kitwe.	The home institution will pay ZMK 300,000 (USD 75) per day to the researcher traveling out of Kitwe and Ndola as subsistence allowance.
Internet communication.	The home institution will provide internet access during the entire project time.
Stationary for Survey training with Research assistants & Seminars.	The home institution will provide Bond Paper, Printing Ink, Pencils, Writing Boards, Box Files, Pencils and Pens and other materials for training research assistants and for holding seminars.

APPENDIX 6. WORKPLAN

The duration of the research is estimated for about twelve (12) months. The details of the research activities and period of time are as shown in this appendix.

Personnel will include the Major Professor (MSU Forest Department), the Researcher (Masters Candidate), two ZFC Training Officers and eight ZFC students as Trainer- Research Assistants.

A. Work Plan

	MONTH, 2007												MONTH, 2008					
Activity	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
1. Research proposal write up.	■	■	■	■	■	■												
2. Submission to the Department. of Forestry-Michigan State University.					■	■												
3. Survey instrument design.			■	■	■	■												
4. Submission of survey instrument to the MSU Institutional Revision Board (IRB).					■													
5. Writing of Introduction, literature review and research methodology.				■	■	■												
6. Revision of above three Chapters (item 5) by advisor and committee members.						■	■											

A. Work Plan (cont'd)

	MONTH, 2007												MONTH, 2008					
Activity	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
7. Survey Pre testing and survey instrument amendments. **(Return to Zambia for research)**																	
8. Office setup in Zambia, Recruitment of research assistants, acquisition of materials and equipment.																	
9. Field Data Collection (Key informants interviews, field observations, Inventory data).																	
10. Data Coding and Analysis.																	
11. Write up of thesis																	
12. Circulation of draft thesis to committee members																	
13. Thesis Defense																	

APPENDIX 7. DEGAZETION AND EXCISION IN ZAMBIA

The following tables indicate the forest reserves which were affected in the degazetion and excision process between 2004 and 2007. The information was compiled by the Forest Management and Planning Unit of the Forest Department.

A. Degazetion and Excision on the Copperbelt Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Njiri National Forest No. 16	6,698		
2.	Ichimpe National Forest No. 8, Kalulushi		3,579	5,665
3.	Mufulira Local Forest No. 42		1,200	5,233
4.	Chibuluma NF Extension No. 22		543	894
5.	Chibuluma National Forest No. 7		278	442
6.	Lushishi National Forest No. 11		2,880	3,513
7.	Nsato National Forest No. 17, Mufulira		4,216	4,500
8.	Kamenza National Forest No. 19		3,166	3,844
9.	Chingola Local Forest No. 43	660		
10.	Maposa Local Forest No. 4		4,637	4,345
11.	Luano National Forest No. 12		5,614	8,330
	TOTAL	**7,358**	**26,113**	

B. Degazetion and excision in Eastern Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Chipata Local Forest No. 55		70	1,618
2.	Kamkomole Local Forest No. 151		793	583
3.	Mvuvye National Forest No. 32		50,976	29,961
	TOTAL		**51,839**	

C. Degazetion and excision in Lusaka Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Lusaka South Local Forest No. 26		**2,100**	2,698

D. Degazetion in North-Western Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Acres National Forest No. 105		**29,659**	38,998

E. Degazetion in Southern Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Ntobolole Local Forest No. 422		**3,828**	5,872

F. Degazetion in Western Province

No.	Name of Forest	Degazetion (Ha)	Excision (Ha)	Balance (Ha)
1.	Masese National Forest No. 194		**6,015**	54,820

The Forestry Department between the period from 2004 to 2007 has given out land approximately ***126,912 hectares***.

Source: Forest Department 2007.

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