FOREST COVER CHANGES AND FOREST MANAGEMENT APPROACHES IN KALULU FOREST RESERVE No. 32, KABWE DISTRICT.

By

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DECLARATION

I, Mwenya Mundende, do hereby solemnly declare that this dissertation represents my own work and that it has not previously been submitted for a degree at this or another University. All maps, tables and figures except for those whose sources have been acknowledged, are original.

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APPROVAL

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ABSTRACT

Zambia's forest resources have been disappearing at an alarming rate. This study reports on forest cover changes and forest management approaches in state-owned forests; a case of Kalulu Forest Reserve No. 32 in Kabwe District, in Central Province. Data was collected through questionnaire survey (83) respondents, key informant interviews, Landsat satellite images for 2000, 2005, 2010 and 2015, and field observations. The questionnaire survey were analysed using some measures of central tendencies that is the mean and mode and content analysis for the qualitative data. The interview data were analysed using content and thematic analysis, while the satellite imagery was analysed using the supervised classification and post-classification (thematic) change detection.

The results show that, 85 percent of the respondents believe that there has been forest cover loss between 2000 and 2015 attributed to an influx in the population of the squatters. Almost all (98 percent) of the respondents had adopted agricultural based livelihoods which entailed forest clearance. More than half (58 percent) of the respondents believed that land was accessible in the forest through allocations by the chief or village headmen. Time lapse satellite imagery showed that there was a reduction in the closed, open vegetation and wetlands by 79 percent, 49 percent and 65 percent, respectively, between 2000 and 2015. There was an increase in cropfield, bareland/settlement and grassland by 78 percent, 55 percent and 17 percent, respectively, during the same period.

The study results suggest that the loss of forest cover could be attributed to a weak institutional framework in that, only 14 percent of the respondents acknowledged that the Forest Department managed the forest reserve while 97 percent of them considered the forest and all its resources being accessible through traditional leaders and political office bearers. Conversely, Forestry Department officials reported being stopped from enforcing their mandate to remove squatters from the forest by political leaders. This suggests conflicts in management of the forest reserve among stakeholders. The study also revealed that 87 percent of the respondents admitted were not aware of any sensitization programmes on forest by the Forestry Department despite the latter's claim of running such programmes.

This study concludes there had been forest cover loss between 2000 and 2005 in Kalulu Forest Reserve No. 32. This was coupled with ineffective forest management approaches used in Kalulu Forest Reserve No. 32 as was the perception of stakeholders in Kalulu Forest Reserve No. 32. The study further concludes that there was no existing link between the Forestry Department and the squatters of Kalulu Forest Reserve No. 32. The study concludes that there that in order protect forest reserves like Kalulu Forest Reserve No. 32, as well as meet the needs of the local people, there is need to establish a robust institutional framework with a strong political will that will ensure sustainable management of state owned forest reserves. The study recommends that there should be more coherence and collaborations created among Forestry Department, political and traditional leaders as well as any other stakeholders in the forest. Additionally, the central government needs to increase budgetary allocations to enhance sensitization campaigns of good forest management in Kalulu Forest Reserve No. 32.

Key words: Forest management, forest cover changes, effectiveness

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ACRONYMS AND ABBREVIATIONS

CFM	Community Forest Management
CIFOR	Center for International Forestry Research
CNRM	Community Natural Resource Management
CSO	Central Statistical Office
DRC	Democratic Republic of the Congo
FAO	Food and Agriculture Organisation
FISP	Farmer Input Support Programme
FRA	Food Reserve Agency
GRZ	Government Republic of Zambia
IDLO	International Law Organisation
ILUA	Integrated Land Use Assessment
ITTO	International Tropical Timber Organisation
IUFRO	International Union of Forest Research Organisations
JFM	Joint Forest Management
KFR	Kalulu Forest Reserve
NRSC	Zambia National Remote Sensing Centre
RECOFTC	Regional Community Forestry Training Center for Asia and the Pacific
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
SDG	Sustainable Development Goals
SVM	School Of Veterinary Medicine

TOA	Top Of Atmosphere
UNDG	United Nations Sustainable Development Group
UNZA	The University of Zambia
USA	United States of America
VFA	Village Forest Area
WWF	World Wide Fund for Nature
ZAFCOM	Zambia Forestry Commission
ZFAP	Zambia Forestry Action Plan

CHAPTER ONE: INTRODUCTION

This chapter presents the background, statement of the problem, objectives of the study, research questions, the significance of the study, as well as how the study was organized.

1.1. Background

The functions of forests to humans, wildlife (natural habitat) and the environment cannot be over – emphasised. Forests provide timber and other non-timber products. From the environmental function, forests protect biodiversity, enhance landscapes, and regulate climate, water and soil (Thompson *et al*., 2009). In addition, they are a home to the largest number of mammals, birds, reptiles and amphibians on various continents (European Commission, 2003).

Sustainable management of forests is emphasized by Sustainable Development Goal (SDG) 15 for halting and reversing land degradation, combating desertification and biodiversity loss. Importantly, sustainable management of forests aids in mitigating the impact of climate change. Therefore, conserving forests and other ecosystems is thus imperative and is one of the 17 Global Goals that make up the 2030 Agenda for Sustainable Development (UNDG, 2015). In as much as forests are one of the most important natural resources, the resource is increasingly under threat, creating a risk for the extinction of many plant and animal species from these forests. The most notable threat to forests is deforestation (WWF, 2015).

Zambia's Forest Act, 2015:7 defines a forest as:

"… any land with a tree canopy cover of more than ten percent and area of more than

zero point five hectares and includes young stands that have not yet reached, but are expected to reach, a crown density of ten percent and tree height of five metres that are temporarily under stocked areas."

Deforestation is defined as the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold (FAO, 2001). It further implies the long-term or permanent loss of forest cover and transformation into another land use. Such a loss can only be caused and maintained by a continued human-induced or natural perturbation which includes areas of forest converted to agriculture, pasture, water reservoirs and urban areas (FAO, 2001)

Deforestation remains one of the national and global challenges the Forestry Departments currently face**.** This is because it is increasingly depleting national and global forests especially due to human activities (Vinya *et al*., 2011).

By implication, deforestation is an environmental problem that requires immediate action of combating it. Its effects are very severe on both the environment and humanity to the extent that if left unchecked could have a serious impact on the immense benefits of forests.

Deforestation in a sense has many drivers which can be distinguished as either direct or indirect. Geist *et al* (2002) indicates that all activities that have a direct impact on forest cover and loss of carbon are classified under direct drivers. For example, agriculture, mining, infrastructure expansion and urban development all belong to direct drivers (proximate drivers). Inversely social, economic, political, cultural, and technological processes that may have an impact on direct drivers are classified as indirect drivers (underlying drivers). For example, population growth, migration, market growth, agro-

technical change, weak governance and enforcement, individual and household behavior are considered as some of the indirect drivers of deforestation (Hosonuma *et al*., 2012).

Current global statistics indicate that deforestation is increasing especially in tropical areas such as the Amazon Forest in Brazil. FAO (2010) shows that an estimated 7.3 million hectares of forest is lost annually due to deforestation and forest degradation globally. Countries with significant deforestation include Brazil, Indonesia, Thailand, the Democratic Republic of Congo and other parts of Africa, others include parts of Eastern Europe.

Zambia is not exempted from deforestation and forest degradation. With forest cover estimated at approximately 45.9 million hectares (ha) or 61.04 percent of the total land cover, deforestation rate has been approximated between 79,000 and 150,000 ha annually (ILUA, 2016).

Similarly, Chidumayo (2012) reported that the country - wide annual rate of decline in forest area increased from 0.34 percent (or 157 300 ha) for the period between 1965 and 1996 to 0.66 percent (or 307 900 ha) for the period between 1965 and 2005. FAO (2012) identifies the direct drivers of deforestation in Zambia as: (a) Agricultural expansion (b) Infrastructure development (c) Wood extraction (d) Fires.

Despite the relatively high rates of deforestation, there are diverse forest management approaches used in order to conserve and preserve forests. These management approaches vary from forest to forest, from district to district and overall from country to country. At most, these forest management approaches can be attributed to the type of forest, the financial capacity to manage the forest and the purpose of the

forest.

According to the Global Forest Coalition (2012) the effectiveness of the type of forest management is observable in the deforestation patterns of a particular forest. It is assumed, without focusing so much on the underlying causes, that good forest management practice or approaches leads to less or no deforestation and forest degradation whereas the opposite can also be assumed to be true. However, this can also be dependent upon the type of forest management strategy being used.

In Zambia Fortress Management, Joint Forest Management (JFM) and Community Forest Management approaches have been used (CFM) (Vinya *et al*, 2011; Bwalya, 2007; Nurse, and Malla, 2005). As for the Forestry Department in Kabwe where this study was conducted, the Joint Forest Management, and the Fortress Management approaches had been administered (Kabwe Forestry Department, 2013).

Over the past decade fortress conservation management approach has been enforced in Kalulu Forest Reserve (KFR). However, the current state of the forest reserve suggest that the fortress conservation has not worked effectively in the face of increasing demand for the forest resource from the illegal squatters.

This research therefore, sought to examine the forest cover changes and forest management approaches in Kalulu Forest Reserve and the areas adjacent to the forest.

1.2. Problem Statement

Kalulu Forest Reserve (KFR) no. 32 was gazetted to secure the protection of an aquifer which is located within the reserve. Human settlements, livestock rearing, charcoal production and crop production were illegal within the reserve. These exclusionary

regulations are a classic feature of protected areas management, which is the dominant forest management approach in Zambia. However, from the mid-1990s to 2012, squatters settled inside KFR No. 32 and are engaged in pastoral agriculture, crop production and charcoal production, among other activities (Kabwe Forestry Department, 2013). This evidence of human encroachment and their simultaneous activities in KFR could have resulted into forest cover loss and degradation, and deterioration of ground water resources. Forest degradation results in loss of ecosystem services, soil erosion and negatively affects forest dependent livelihoods. This necessitated the need to examine the extent of the forest loss and the effectiveness of forest management approaches used in KFR No. 32 in protecting and preserving the forest reserve.

1.3. Aim

The aim of this study was to assess the effectiveness of forest management approaches in KFR No. 32 through forest cover changes.

1.4. Specific Objectives

The specific objectives were to:

1. Analyze forest cover changes in Kalulu Forest Reserve, between 2000 and 2015.
2. Evaluate the effectiveness of the forest management approaches in reducing adverse forest cover changes.
3. Assess the knowledge and perceptions of stakeholders on the forest management and forest cover changes in KFR.

1.5. Research Questions

The research questions in this study were:

The research questions in this study were:

1. To what extent has the forest cover changed in Kalulu Forest Reserve between 2000 and 2015?
2. How effective are the current forest management approaches towards adverse forest cover changes?
3. How do stakeholders perceive the current forest management approaches and forest cover changes?

1.6. Significance of the Study

The research findings could contribute to addressing forest management challenges in state owned forests such as Kalulu Forest Reserve in the face of growing pressure from human activities. This study could provide useful information to policymakers on forest management related issues at both local and national level. Lastly, the findings could contribute to improved forest management in the face of growing pressure from human activities.

1.7. Organisation of the Dissertation

This dissertation comprises seven chapters. Chapter One presents the introduction for the study. Literature review is presented in Chapter Two and the study area is described in Chapter Three. Methodological approaches are discussed in Chapter Four. Presentation of the research findings, discussion and interpretation of the findings is given in Chapter Five. Finally, in Chapter Six, the summary, conclusions and recommendations are presented.

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CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of forest cover changes and its drivers, peoples' perceptions of forest management and forest management approaches used in Zambia.

2.2 Drivers of Forest Cover Changes

There are many factors that could lead to forest cover changes world over. The emphasis however, in this section is the major drivers of deforestation at a local scale such as KFR:

2.2.1 Poverty, Overpopulation and Urbanization

Poverty is an important driver of forest cover changes and many studies in Africa have documented the role poverty plays in forests loss and degradation. Reducing poverty in African countries, especially in forest communities could lead to lower rates of deforestation and degradation (Fischer *et al*., 2005; Soriaga and Walpole, 2007). Poverty and overpopulation are believed to be the main causes of forest loss. Chakravarty *et al* (2012) stated that there is good evidence that rapid population growth is a major indirect and over-arching cause of deforestation. The demand for more food and space which requires more land for agriculture is the biggest challenge of all to achieve sustainable management of human life support system and habitation. This in turn results in increased clearance of forests. Arguably, controlling population growth could promote environmental sustainability. FAO (2018:51) states that "the loss of forests occurs mainly in developing countries, particularly in sub-Saharan Africa, Latin America and Southeast Asia. As populations increase and forest land is converted for agriculture

and other uses, forest area is declining in every climatic domain except temperate ones".

Africa has one the highest population density globally. This increase in population will increase the demand for land to cultivate and fuel wood for energy. Increase in population will also lead to increased poverty as too many people will depend on few individuals for support. The increase in poverty causes many families to depend totally on the forests for survival, through logging and slash-and-burn farming (Das Gupta *et al*., 2011).

As the population grows, the needs of people increase which further lead to deforestation. Forests shrink to a great extent to meet the requirements such as construction of roads, development of houses, mineral exploitation and expansion of industries. Increased population directly demands more land to be used for the expansion of cities and construction of housing for settlements. D'ettorre (2013) argued that the rising demand for mineral and wood resources is threatening millions of hectares of forest. Considering the fact that the 'world has become predominantly urban'.

Additionally, Holland (2017) stated that due to overpopulation, more land is needed to establish housing and settlements, as well as the construction of many, more roads and highways in order to accommodate many people who drive. There are also more people that come with high demand for farmland to grow food and raise livestock—resulting in deforestation. Logging industries will also cut down trees for furniture, paper, building materials, and many more products. These are a direct result of growing human population and is the reason why it's important to purchase from sustainable companies which actively work against deforestation.

2.2.2 Agricultural Expansion

Agricultural expansion is another obstacle to the sustainable forest management in Africa.

It is a major cause of deforestation especially agricultural plantations. An increasing supply and demand for agricultural products is driving producers to clear forests at an alarming rate. Subsistence agriculture in forest communities in most African countries occurs through slash-and-burn, a practice that involves the cutting down of trees and burning them to open up an area for cultivation (Hauser and Norgrove, 2013). After two or three seasons of cultivation the farmer abandons the plot and colonizes a new forest area as the old plot loses fertility due to the burning of the soil (Mitchell *et al*., 2007). Eventually, it will reforest, but it will take many years to return to its original condition. Both subsistence and mechanized forms of agriculture play a significant role in forest loss and degradation. Deforestation happening in Africa is partly due to agribusinesses undertaken by large multinational corporations involved in plantation agriculture. This is largely due to a growing demand for cash crops. Muller *et al.,* (2011) indicated that there exists 'three proximate causes of deforestation' with a focus on mechanized agriculture, small scale agriculture and cattle ranching. The mechanized agriculture is an intensive production cash crops, including soybean, sugarcane, and rice and it is largely based on big production units, heavy machinery accompanied by heavy capital investments. The expansion of mechanize agriculture has led to the increase in deforestation. However, the rate of deforestation that can result from these practices are massive over a long period of time. Cattle ranching contributes to the conversion of forests to accommodate the breeding of cattle for beef production (Muller *et al.,* 2011*).*

Similarly, WWF (2015) added that due to overgrowing demand for food products, many trees are chopped down for crops and for cattle grazing. Over 40 percent of the forests are cleaned to obtain land and meet the needs of agriculture and wood.

2.2.3 Lack of secure land tenure

The local populations in many communities in Africa have little or no incentive to protect the forest resource because they feel they have no stake in it as the governments of these countries continue to appropriate forest lands and its resources. For example about 97 percent of natural forests in Cameroon belong to the government, while all natural forests in Democratic Republic of Congo (DRC) are government owned (Cotula & Mayers, 2009). However, the scenario may be different in Zambia. According to GRZ (2009:9), "…9.9 percent of the total land area is gazetted as forest reserves. The whole estate occurs on state, trust and reserve lands". Considering that forests covered 66.4percent of the total land area, the amount of forest cover not left unmanaged by the government is relatively large. There is a clear indication that land tenure in these countries is unclear or insecure even though countries allocate community forests for the benefit of the communities. This in itself is a drive to foster forest cover changes in the sense of deforestation or forest degradation especially when the local communities feel they are not part of natural resources management.

Chakravarty *et al* (2012) indicate that cultivators at the forest frontier often do not hold titles to land (absence of property rights) and are displaced by others who gain tenure over the land they occupy. This means they have to clear more forest to survive. Chakravarty *et al* (2012) continue to state that poorly defined tenure is generally bad for people and forests. In many countries government have nominal control of forests but are too weak to effectively regulate their use. This can lead to a tragedy of the commons where forest resources are degraded. In frontier areas deforestation is a common practice and legalized way of declaring claim to land and securing tenure (Hardin, 1968).

2.2.4 Logging

Ronca (2016) suggested that logging affects the environment in several ways. Since trucks and large equipment need to get into the forest in order to access trees and transport timber, loggers must clear large areas for roadways. Selective logging where only the most valuable trees are felled doesn't help matters, as one falling tree can bring down dozens of surrounding trees and thin the forest's protective canopy. The forest canopy is important to the forest's ecosystem because it houses and protects plant, animal and insect populations. It also protects the forest floor, which slows down soil erosion (Ronca, 2016). Furthermore, illegally harvested wood finds its way into major consumption markets, such as the U.S., and European Union, which further fuels the cycle (WWF, 2015). It cannot be overstated that illegal logging hampers sustainable forest management and development of forest management that enables individuals to earn a living and protect nature and the climate in the long term (Federal Ministry of Food and Agriculture, 2019)

2.3 Sustainable forest management approaches at a global scale

Forests cover 30 percent of the world's land area (Keenan *et al*., 2015) and it is difficult to think of individuals that do not depend on forest products and services in some form on a regular basis.

Forest management plans are established for different or multiple purposes, such as production, conservation and provision of environmental services. FAO (2015:15) stated that "managing forests responsibly and sustainably requires a balanced approach encompassing the three pillars of sustainability – economic, social and environmental".

According to the FAO (2000), the focus over the past decade has been on sustainable

forest management, an approach that balances environmental, socio-cultural and economic objectives of management in line with the Forest Principles. Additionally, FAO (2003:4) stated "These efforts have stimulated changes in forest policy and legislation and in forest management practices in many countries. Public participation in forest management has increased in many countries. Broader approaches to forest management, such as ecosystem management and landscape management, are becoming more widely accepted and implemented." The approaches acknowledge the changes in ecological and social systems, the merits of adaptive management, and the importance of cooperative approaches in decision making. Global forest trends show that there has been a net rate of forest loss between 2010 and 2015 more than that in the 1990s showing that forest area fell by 3percent from 1990 (4128 Million ha) to 2015 (3999 Million ha). This can be attributed to poor forest management practices especially in the low and middle income countries (MacDicken *et al*., 2015). On an international level, efforts to encourage sustainable forest management include initiatives to achieve a common understanding of the concept through the development of guidelines by which sustainability of forest management can be assessed, monitored and reported at national and local levels (FAO, 2015).

2.4 Forest management approaches in Zambia

The Forest Department in Zambia has employed different forest management approaches since its inception in order to manage forests sustainably. The following are some of the approaches used:

2.4.1 Protected Areas Management or Fortress Conservation

The Fortress conservation approach is an approach that facilitated for the creation of

National Forests, Forest Reserves and Local Forests with the idea of excluding the communities from using forest resources completely. Also referred to as 'fences and fines' in that the forest is enclosed in a fence and if any individuals are found in the forest extracting any forest products, they are subjected to fines. Forested protected areas are established to conserve water catchment areas and protect biodiversity from damaging processes, such as deforestation, through legal or other effective means (Mickels-Kokwe and Kokwe, 2012).

This is an approach that seeks to preserve wildlife and their habitat through forceful exclusion of local people who may have traditionally relied on the environment in quest for their livelihoods (Brockington *et al*., 2006). This approach leads to the communities adjacent to the forest to have restriction of access to the forest resources both timber and non – timber products unless with the permission from the Minister as stipulated in section 15 (1) of the Forest Act 2015.

However, Shortages of manpower; lack of resources for law enforcement inside protected forest areas; increasing pressure from a growing population; commercial export production and a changing political environment all combined to effect the failure of this forest management approach (Bwalya, 2007).

There has been an upward trend in deforestation since the 1990s and as a result, the Zambian government faces the major challenge of reducing forest cover loss. It was in response to this challenge that the government started piloting JFM.

2.4.2 Joint Forest Management (JFM)

JFM is a community based sustainable forest management initiative. JFM was a

response to the challenges faced in the Fortress Conservation approach or Protected Areas Management. Bwalya

(2007) points out that there is some empirical evidence supporting the hypothesis that forest resources are managed more efficiently and in a more sustainable way under JFM than under central management, fortress conservation.

With the non-commencement of the Forests Act of 1999, the GRZ established JFM under a series of Statutory Instruments in 1999 and 2006. Between 2000 and 2005, the government transferred over 200,000 ha to 10 forests under JFM pilots. JFM was also piloted through the Provincial Forestry Action Programme after 2006, with the aim of testing and generating JFM guidelines. JFM has had little success since 2006 and donors have reportedly been reluctant to continue with the programmes or develop new interventions (Bwalya, 2007). Bwalya (2007:137) concluded that JFM in Katanino was rather ineffective because the "… monitoring procedures were largely nonfunctional". Also, the lack of training and lack of remunerations which made the community not to ask questions as the monitors were working without pay, hence crumbling the whole system. Additionally, Bwalya (2007) continues to state that there was basically a lack of knowledge among community members about JFM with over 81 percent of the respondents not being aware of whether or not their Village Resource Management Committee (VRMC) was working. Lastly among the constraints highlighted in the study, Bwalya (2007) showed that from the Forestry Department's perception there was lack of appreciation of the long term nature of the JFM benefits and could be seen by a non-cohesive response in the beginning of this program. In a similar study, Phiri (2009:124) concluded on the low participation in JFM activities

citing "...to lack of remuneration in cash or in kind for their involvement in JFM activities and the inability of the Forestry Department to devolve enough power and decision-making authority to the local communities". Lastly, Phiri (2009) concluded that the perception among the local people is that the JFM programme was not successful. Phiri (2009:127) indicates the assumption by the respondents stated that "…there was no improvement in their livelihoods that could have been attributed to the JFM programme". In response other initiatives or approaches have been introduced such as Community Forest Management (CFM).

2.4.3. *Community Forest Management (CFM)*

There has been an introduction of Community Forest Management approach in the Forest Act of 2015, which calls for the establishment of Community Forest Management groups to help manage forest resources. This in turn aims to address the various failures of JFM. Community forestry refers to the management of forestlands and natural resources by local people, for commercial and non-commercial purposes. It is characterized by (1) the use of forest resources by local people, on an individual or household basis, for consumption and sale; and (2) the community management of forests, which refers to a collaborative enterprise conducted by a group of local people who manage forest either independently or with outside support for the production of resources for consumption and sale (RECOFTC, 2005).

Zulu (2008) states that Community forest management was introduced as the solution under a regime requiring communities to demarcate a village forest area (VFA), elect a 10-member village forest committee to lead the Community Natural Resource Management (CNRM) efforts, formulate and enforce rules governing forest use and

management, prepare a forest management plan, and enter into a forest management agreement with the state. Communities assume full ownership rights, contingent on following terms of the agreement.

The Forest Act No. 4 of 2015 introduces the concept of community forest management groups. Section 32 of the Act shows the responsibilities of the community forest management groups which are but not limited to: "(a) protect, conserve and manage the community forest or part thereof pursuant to the community forestry agreement and the management plan for the community forest; (b) formulate and implement forest management consistent with traditional forest user rights of the local community in accordance with sustainable forest management; (c) protect sacred groves and protected trees in the community forest; (d) assist the Director in enforcing the provisions of this Act in relation to illegal harvesting of forest produce; (e) with the approval of the Director, enter into partnerships with other persons for the purposes of ensuring the efficient and sustainable conservation and management of the community forest; (f) keep the Director informed of any developments, changes and occurrences within the community forest which are critical for the conservation of biodiversity; (g) help in fire-fighting within and around the community forest; and (h) do any other thing that is necessary for the efficient conservation and management of the community forest". This allows for the community forest group to participate in forest conservation and also provide consultations in forest management. With this, the forest user are given rights such as: "*(a)* collection of medicinal herbs; *(b)* harvesting of honey; *(c)* harvesting of timber or fuel wood; *(d)* grass harvesting and grazing of animals; *(e)* collection of forest produce for community based industries; *(f)* eco-tourism and

recreational activities; *(g)* scientific and educational activities; *(h)* plantation establishment through non-resident cultivation;

(i) the right to enter into contracts to assist in carrying out specified silvicultural operations; (j) development of community forest wood and non-wood based industries; and (k) any other benefits which may be agreed upon between the community forest management group and the Director". Rasolofoson *et al*., (2015:275) concluded that "decentralization of forest management to local communities in Madagascar has not, on average, achieved its forest conservation goal. In terms of deforestation, we cannot detect an effect, on average, of CFM compared to no CFM, even after restricting the sample to only where we have information to suggest CFM implementation on the ground". Further they pointed out that CFM initiatives were ineffective because of poor study design. Lastly, to explain the ineffectiveness of CFM, Rasolofoson *et al* (2015) describe inadequate integration of local participation, resource capture by elites, unfulfilled support promises by different organizations, and lack of capacity of the community and state, among other factors. While these studies point to institutional and policy shortcomings, it can be stated that CFM performance has had no impact in terms of delivering a central objective of reducing deforestation.

2.5 Challenges in Forest Management Approaches

The prominent challenges associated with African forest management can be categorized being the high usage of fuel wood and continuing forest loss and degradation. However, separating economic growth from deforestation is possible but requires institutional changes, new policy approaches and knowledge management. One such area to explore, would be look at is REDD+ mechanism (Kalinda *et al.,* 2008).

Common challenges faced by the Forestry Department on reserves include encroachment, lack of maintenance of forest boundaries and poor fire management (Shitima, 2005). On customary lands, illegal charcoal and timber production have flourished (Kleinschmit *et al.,* 2017). The following are some of the identified challenges and opportunities in some of the approaches.

One of the greatest challenges in forest management being deforestation. As earlier indicated, deforestation remains a global and critical issue. In Zambia for example, charcoal production and slash and burn agriculture are perceived to have some negative impact on the forest resource in that these require clearing to see to that these activities happen (Shitima, 2005). Chidumayo (1987) highlights that these are often associated with massive loss of biodiversity (fauna and flora) and some high productive ecosystems.

Binkley (1999) states that the key challenge in natural forest management is to produce industrial timber at an acceptable cost while protecting critical environmental values on precisely the same areas used for timber production.

Another challenge is resource allocation. Regular resources assessments are not carried out due to inadequate financial data for management, is inadequate management and is not based on informed decision. Furthermore, there is a serious underestimation of forest sector to the national economy (Kiimu, 2014) In addition, Kiimu (2014) stated that limited knowledge on lesser used tree species and Non – timber Forest Products and forest services is also another challenge. Other challenges include; inadequate capacity to implement forest programmes poor working conditions, facilities and remuneration

(Kiimu, 2014)

According to the International Tropical Timber Organization (ITTO) and FAO (2012), other challenges include inconsistent forest policy and legal frameworks: problems arise when laws (both within the forest sector and between sectors) are incoherent, unrealistic and unenforceable and fail to address forest land tenure and use rights. Insufficient enforcement capacity is often due to institutional weaknesses coupled with a lack of transparency and accountability in the implementation of the policy and legal frameworks. Deficiencies in coordination between forest law enforcement and judicial bodies decrease the risk of being caught and prosecuted. The enforcement of regulations to promote efficient industrial capacity is often weak, leading to a disproportionate demand for logs that drives illegal forest land conversion, logging in national parks and other protected areas, and the over-harvesting of production forests.

2.3 Forest Cover Changes

Jiménez *et al* (2018:1) states that "land use and cover changes (LUCC) have been identified as one of the main causes of biodiversity loss and deforestation in the world. Fundamentally, the urban land use has replaced agricultural and forest cover causing loss of environmental services. Monitoring and quantifying LUCC are essential to achieve a proper land management".

In recent years, researchers primarily utilize satellite remote sensing with vegetation surface temperature, terrain elements and other forest vegetation on the ground to identify sub-categories (Jiménez *et al*., 2018).

Mbindo (2003) in discussing some of the major causes of forest cover loss cited

increased pressure on the forest. This is evident in cities like the capital Lusaka that has exerted pressure on the Chibombo forest reserves close to the city. Much of the pressure is being accelerated by an increase in population without corresponding increase on material wealth i.e. poverty leading to unsustainable exploitation of forest resources for timber, wood fuel and other forest products. Kajoba and Chidumayo (1999) previously had indicated that the encroachment into forest reserves by settlers for the purposes of agricultural purposes. Additionally Kajoba and Chidumayo (1999:64) indicated that "…this created a potential conflict between conservation of a forest on the one hand, and the need to meet land requirements on the other". However, Kalinda *et al* (2008:80) in the ILUA report concluded that "… evidence from the analysis of the ILUA data indicates that most of the country's forests are in good condition and the rates of deforestation are quite modest …the data indicate that only 5 percent of the total forests are severely degraded and over 69 percent of the forests are in good condition".

Kalinda *et al* (2008) recommended that an additional ILUA be conducted as deforestation rates could only be assessed using remote sensing images by comparing past and present-day images, which this paper aimed at achieving.

2.4 Knowledge, Attitudes and Perceptions towards Forest Management

Shitima (2005), observed that the management of natural resources including forests is based on a set of values, ethics and norms which are part of a given system of knowledge. Broadly, there are two types of systems of knowledge; indigenous knowledge which is also erroneously referred to as 'traditional' or non-modern knowledge on one hand, and western 'scientific' or 'modern' knowledge on the other.

Ratsimbazafy (2012) stated that local people have diverse perceptions towards forests.

Some people perceive the forest as a source of rain and as a resource for maintaining the fertility of the land, and therefore worth protecting. Others perceive the forest as an important source of supplemental income and agricultural land, and of these, majority being the young and middle aged men who depend entirely on agriculture plus some cash from the forest resources. Additionally, Ratsimbazafy (2012) indicate that people were aware of the existence of the forest reserve and more than half were in favor of conservation of the Makira forest, and still more than half agreed that it was the local community's responsibility to safeguard the forest in their surroundings.

Inanc (2017:3023) on knowledge and perceptions concluded that "that people's positive perceptions of forest conservation were strongly influenced by their educational level and assessment about park management. Gender, age, family size had less influence … Perceptions were relative to benefits obtained from park due to the current management approach". Therefore, educational level is one of the variables which affect people's perception about forest conservation of forested areas. Furthermore, the findings from Inanc (2017) revealed that people's agreement on the necessity to protect forest for future generations compels them to develop positive attitudes about protected areas. The reference to future generations in supporting biodiversity and forest conservation is very important and needs support from the park staff for more generalization.

2.5 Summary of the Chapter

The literature reviewed shows various elements of forest cover changes especially deforestation and the challenges and opportunities associated with different forest management approaches.

Most studies usually focus on the failures of a particular forest management approach in one area. Forest cover changes are dealt with separately from forest management approaches. The current study aimed to address different forest management approaches and forest cover changes in one area overtime. This therefore, is the research gap that this study addresses.

CHAPTER THREE: DESCRIPTION OF STUDY AREA

3.1 Introduction

This chapter is to presents the description of the study area. It covers the location, physical characteristics and the social and economic situation of the forest area.

3.2 Location and Size

The Kalulu Forest Reserve (KFR) No. 32 is situated in the north-western part of Kabwe (Figure 3.1). More precisely, Kalulu Forest reserve is 4,672.08 hectares and is in the southern part of Muwowo ward which is surrounded by four wards namely Ben Kafupi, Chilalila, Muwowo East and Munga. It is one of the smallest forests in Central Province and is managed by the Forestry Department which also manages other forest reserves in Central Province and the nation at large.

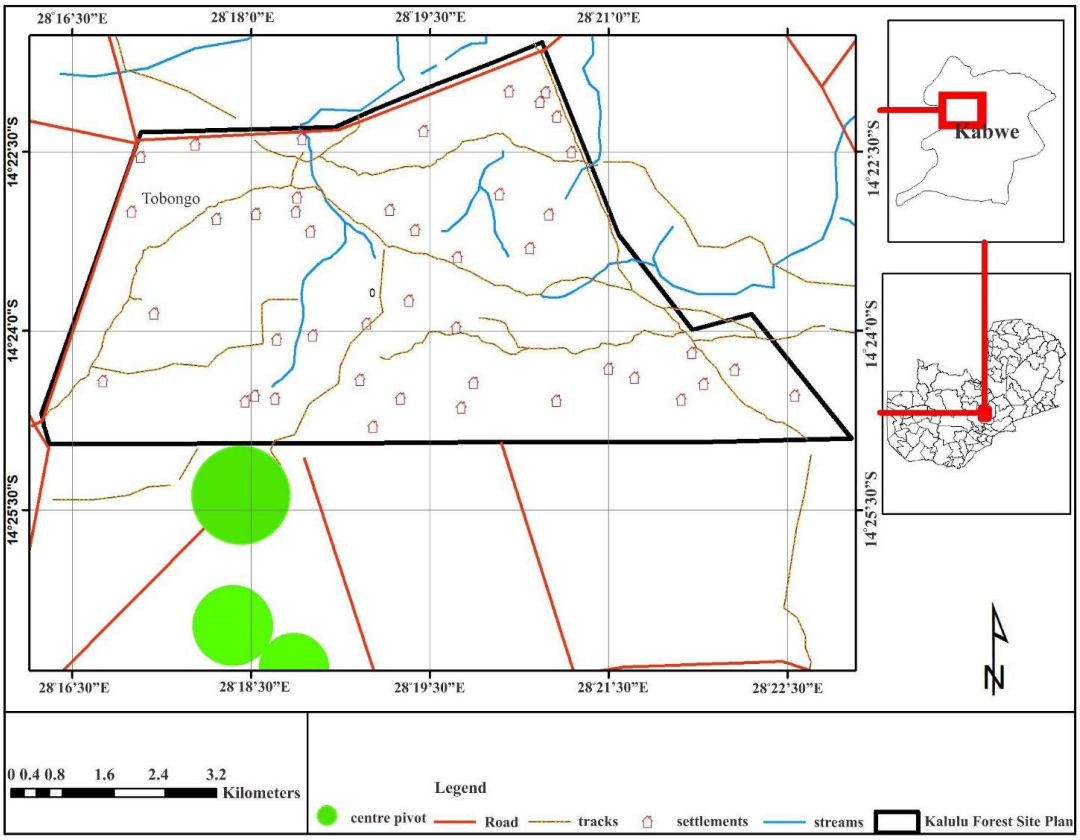

Figure 3.1 Map of Kalulu Forest Reserve
(Source: National Remote Sensing Centre, 2016)

3.3 Physical Characteristics

3.3.1 Climate

The average total annual rainfall in Kabwe is 966mm. The rainy season occurs between October and April. December and January are the wettest months (Kabwe Meteorological Department, 2015). Kalulu Forest Reserve receives approximately the same amount of rainfall. However, due to the current high temperature prevailing in the area, evapo-transpiration is high and exceeds precipitation. The average mean daily temperature range in Kabwe is between 23 – 26 °C in the hottest months. Mean maximum temperature in October has been estimated at 32.1°C. The mean daily temperature range in the coldest months (June and July) is between 16-20 °C, with the mean minimum temperature in June being at 9.9°C (Kabwe Forestry Department, 2014).

3.3.2 Soils and Vegetation

Soils of Kabwe have been classified as Sand veld (Kajoba and Chidumayo, 1999). Sand veld soils are those that comprise a wide range of coarse and fine-grained sandy to clay soils and formed through long periods of seasonal leaching on a maturely eroded topography (Kabwe Municipal Council and Environmental Council of Zambia, 2008). The soils are usually dark grey to brown somewhat pale when cultivated depending on the content of organic matter. Subsoil texture characteristics become more clayey with increased depth. The soils range from strongly to slightly acid (pH 4.5 to 6.0) and medium fertility. The general topography of Kalulu Forest Reserve is flat with a few notable hill formations within the Forest Reserve (Kabwe Municipal Council and Environmental Council of Zambia, 2008). Vegetation in Kabwe is predominantly

Miombo woodland. The main tree species of the Kalulu Forest Reserve are the *Brachystegia* species (Mutondo), the *Combretum* species, the *Pterocarpus* species (Mukwa) and the *Albizia* species.

3.4 Social and Economic Situation

Currently, most of the squatters are those that have been retrenched or retired or ex – service men from the army, police, teaching service, mines, Zambia Railways and the private sector. Furthermore, the population of livestock has been estimated at over 560 cattle, 313 pigs and 1,200 goats within Kalulu Forest reserve (Kabwe Forestry Department, 2013).

Major crops grown in Kalulu include maize (*Zea mays*), soya beans (*Glycine max*), sweet potatoes (*Ipomoea batatas*), groundnuts (*Arachis hypogaea*) and vegetables. Cotton and sunflower are grown on a small scale. The squatters do not only clear land to grow crops, but also cut trees for various uses such as fuel wood for cooking and charcoal for sale. Houses are made of tree stamps covered with mud made from cement and roofs thatched by grass (Shula, 2012).

With the increased population of both humans and livestock, the forest reserve faces degradation and deforestation. This is because the population requires more land for agriculture and other livelihood activities that require the clearing and burning of trees. Secondly, the domesticated animals would need to graze in the forest reserve area. The general infrastructure in Kalulu Forest Reserve is comprised of village huts (which are the majority of housing structure), permanent housing structures, a school and a medical center. Roads in the forest reserve were generally gravel and foot paths created by the squatter.

CHAPTER FOUR: RESEARCH METHODOLODY

4.1 Introduction

This chapter presents the following: the research design, target population, sample size and sampling procedures, research instruments and data collection procedure. Also it covers problems encountered during data collection, limitation of the study, reliability and validity of the study, data analysis and ethical consideration.

4.2 Research Design

A descriptive survey research design was used in this study. According to Shuttleworth (2008) a descriptive survey design is as a scientific method which involves observing and describing the behavior of a subject without influencing it in any way.

The researcher chose it because it was suitable for acquiring information about one or two more groups of people about their characteristics, opinions, attitudes, or previous experiences. In addition, this design was selected because it is not limited to fact finding but also leads to the formulation of solutions to significant problems (Kothari, 2012). Also this study involved measurement, classification, analysis, comparison and interpretation of data (Kothari, 2004; Kombo and Tromp, 2006). Furthermore, the researcher selected this design because in this study it gave a description of what was happening in Kalulu Forest Reserve, focusing on the characteristics of a particular individual or a group of people.

4.3 Target Population

The target population for the study included KFR inhabitants and four traditional leaders. Individuals from Kabwe Forestry Department, Provincial Forestry Department,

and Lukanga Water and Sewerage Company were also part of the target population.

4.4 Sampling Techniques and Sample Size

4.4.1 Sampling Techniques

The researcher was unable to obtain a sampling frame from the Forestry Department in Kabwe because they claimed they did not have control of all the activities within and out of the Forest Reserve. Quota sampling method was used with regards the Northern, Southern, Eastern and Western part of the forest. Elder (2009:5) defines quota sampling as "… selection with controls, ensuring that specified numbers (quotas) are obtained from each specified population subgroup (e.g. households or persons classified by relevant characteristics), but with essentially no randomization of unit selection within the subgroups". Unfortunately, the disadvantage with quota samples is the difficulty to include some respondents rather than others and there is potential for selection bias, which can result in a sample that is unrepresentative of the population. However, even when using a probability sampling, sometimes partial quota sampling can be useful. In some studies, traits of a certain subgroup interact with other traits of another subgroup.

With KFR, in each quota, 20 respondents were interviewed except the southern part which had 23 people interviewed because the majority of the respondents were based there, giving a total of 83 respondents as the sample size. Thus, due to population distribution and the lack of the sampling frame, systematic random sampling technique was used as opposed to simple random sampling. This technique targeted the people currently living in the forest reserve as well as communities adjacent to the forest reserve. Semi – structured interviews were conducted on the sampled households to acquire the

necessary information from the population under study.

Key informants from Kabwe Forestry Department, Provincial Forestry Department, Lukanga Water and Sewerage Company and a traditional leader were purposively selected by virtue of their positions.

4.4.2 Sample Size

The inhabitants (83) were selected as they were in the reserve. The key informants from the Forestry Department were selected due to that fact that they are the custodians of the forests in the district and the province as a whole. The traditional leader was selected because he/she is the representative of the people in the forest. The ideal situation would have been to interview all the traditional leaders, unfortunately the other traditional leaders were unavailable for interviews during the data collection period. A key informant was selected from the local water utility company because he was able to share his perspectives on what was obtaining in Kalulu Forest. The researcher was convinced this was a fair representation of the target population.

4.5 Data Collection

This section presents methods used in this study to collect data.

4.5.1 Primary Data

The researcher collected data by establishing contact with firstly the three traditional leaders within KFR no.32. A semi-structured interview guide (Appendix A) served as the primary data collection tool in this study. The questions in the interview guide potentially could be obtained through written responses rather than through interviews as this would save research time and resources. However, the use of interviews for

qualitative data collection was selected for several reasons. First, the personal interaction of interviews allows the opportunity for immediate clarification of the interview questions. Secondly, interviews reduce a number of sources of error that could be introduced if it were written responses i.e. missing or incomplete responses and false interpretations of grammar and spelling. With the interview guide, each respondent after consenting was subjected to an interview (Appendix A) which were all conducted by the researcher. The study used one on one interviews, with each respondent interviewed mostly in a private environment that afforded comfort and convenience, and in most instances, and that was their homes. As part of the consent process, participants were informed that they have the option of refusing to answer any question or discontinuing the interview at any time. The interview guide had questions on the challenges and opportunities of the current forest management practices. It also covered mostly household demographics, livelihood strategies, knowledge on forest status and forest management approaches. Adult household members with knowledge about the general livelihood of that particular household were particularly interviewed.

4.5.2 Secondary Data

Much of the secondary data was collected from the National Remote Sensing Centre (NRSC) and those were the Landsat satellite images of the years; 2000, 2005, 2010 and 2015. The images were obtained at 172-070 (path and row) on 04th September, 2000, 18th September, 2005, 25th May, 2010 and 26th June, 2015. The images were used to check the trend and changes of land use and land cover of KFR no.32. Furthermore, other collaborating information from the NRSC database such as health facilities, schools and village centres, were used to verify the findings. Google Earth was also used for this

verification. Other supporting data were collected from libraries and internet sources.

4.5.3 Key Informant Interviews

The researcher used the interview schedule for key informant interviews. These interviews were administered to the Forest Department officials, one local traditional leader who is also a resident of KFR, and one from Lukanga Water and Sewerage Company (LuWSC). The researcher followed the standard questions with one or more individually tailored questions to get clarification or probe a person's reasoning (Appendix A, B and C).

4.5.4 Direct Observations

The researcher also conducted direct observations in the study area to find out the kind of human interactions with the environment that contributed to environmental degradation. The researcher specifically conducted observations in the areas adjoining water sources and grazing lands. Also on forest cover evidence of forest reserve use for example, crop production, charcoal production as well as timber felling. The researcher also intended to use this to assess the state of the forest, the deforested areas, the agricultural activities both crop and pastoral farming. Using this method allowed the researcher to verify some statements made by respondents and key informants as well as validate the land use/cover maps.

4.6 Data Analysis

4.6.1 Qualitative and Quantitative Analysis

Quantitative data was analysed by using measures of central tendency, thus, the mean and mode which helped generate graphical presentations were done using graphs, charts, and tables. This analysis was conducted using the software package, Minitab 14

(McKenzie, 2004).

Qualitative data gathered from the questionnaires, interviews and document reviews were analysed using the Content Analysis in QDA miner 3.2 (Provalis Research, 2004) software. Content analysis is an important and powerful tool in analyzing data as it organizes valid inferences from texts (or other meaningful matter) into fewer content categories based on explicit rules of coding and themes (Babbie, 2007; Saldana, 2009).

4.6.2 Forest Cover Assessment

The extent of forest cover loss was analysed using land cover maps of the forest reserve generated from the satellite images from 2000 to 2015. Supervised image classification using the maximum likelihood classifier was used to classify the satellite images in ENVI 5.1 and, ArcGIS 10.3 software. Cross tabulation was then used to quantify the extent of forest cover loss to different land use/cover classes. The details of the forest cover assessment are given below.

Image Pre-processing

To reduce pixel mix up between crop fields and bareland/settlements, some of the precautionary measures were done and these included image pre-processing, spectral mixture analysis and image segmentation.

Raw imagery (i.e., the original pixel digital values for every one of the spectral bands) has to be converted into valuable reflectance data, a critical element in vegetation mapping. Hence radiometric corrections were performed, where the image of each spectral band belonging to 2000, 2005, 2010 and 2015 was converted from digital number to absolute spectral radiance (units of energy) and then to Top Of Atmosphere

(TOA) spectral reflectance within the ENVI 5.1 software to obtain the corrected images.

Image Classification

For processing the images, spectral signatures were created by selecting training sites based on the identification of similar areas for each land cover. Prior knowledge of the area helped in the selection of the training sites. To identify the different land use classes, some visual patterns such as tone, texture and shape were used. To obtain the different land cover classes (bareland/settlements, closed Vegetation, cropfield, grassland, open vegetation, water, and wetland), supervised image classification was conducted using the Maximum Likelihood Classifier. The Maximum Likelihood algorithm obtains a spectral image of each land use class through variance and covariance statistics of the set of training sites identified in the image and calculates the probability of belonging to each class according to the spectral signature (Pontius et al., 2004).

Classification accuracy assessment

One of the most important final step in the image classification process is accuracy assessment. The aim of accuracy assessment is to quantitatively assess how effectively the pixels were sampled into the correct land cover classes. A total of 257, 248, 324, 216 random ground truth points for 2000, 2005, 2010 and 2015, respectively, were created covering different land cover classes. Historical Google earth imagery was used as reference data to identify the true land cover classes. This allowed for the determination of the number of pixels correctly and incorrectly classified. The error matrix table was then generated detailing the user accuracy (omission error),

producers' accuracy (commission error), overall accuracy and the kappa coefficient. Congalton (1991) defines producer's accuracy as:

The map accuracy from the point of view of the map maker (the producer). It answers the question of how often the real features on the ground correctly shown on the classified map or the probability that a certain land cover of an area on the ground is classified as such. The producer's accuracy is calculated as:

$$\text{Producer's accuracy} = \frac{Total\ number\ of\ correct\ pixels\ in\ a\ category}{Total\ number\ of\ pixels\ of\ that\ category\ derived\ from\ the\ reference\ data\ (i.e.,row\ total)}$$

Congalton (1991) further explains that user's accuracy is from the point of view of a map user, not the map maker. The User's accuracy essentially tells users how often the class on the map will actually be present on the ground. This is referred to as reliability.

$$\text{User's accuracy} = \frac{Total\ number\ of\ correct\ pixels\ in\ a\ category}{Total\ number\ of\ pixels\ of\ that\ category\ derived\ from\ the\ reference\ data\ (i.e.,column\ total)}$$

Land cover change detection

The area covered by each land cover / use type was computed from the classified image for 2000, 2005, 2010 and 2015 respectively. The post classification cross tabulation technique was used to detect changes between different land covers/ uses in the classified images during the study period 2000 and 2015.

4.7 Ethical Considerations

Prior to conducting the study, the researcher sought permission from the Forestry Department in Kabwe. Further, the researcher sought permission from the traditional

authorities from the communities adjacent to Kalulu Forest Reserve and the local leaders for the squatters. The researcher obtained informed consent before interviewing all the respondents. He did this by clearly explaining the research to the respondents before securing their consent. Before the interviews, the researcher made it clear to respondents to withdraw at whatever time they wished they could.

Lastly, the findings and interpretations were honestly and objectively presented. Furthermore, in the presentation of the findings, the researcher avoided untrue, deceptive, or doctored results. Above all, the researcher during the course of the research maintained confidentiality and kept all respondents anonymous before, during and after the study.

4.8 Limitations of the Study and Challenges Encountered During the Study

Although the objectives of the study were achieved, it was not a smooth sailing study to arrive at this. The approach of having to interact with respondents with regards the questionnaire based interviews were effective within the first few weeks of data collection up until a certain period when the settlers began to refuse to be interviewed. Further investigation revealed that the traditional leaders had instructed some squatters not to respond to any question even though prior consent was sought from the traditional leaders before commencing the study. Following this constraint, further consent was sought from more traditional leaders, responses from the subsequent respondents were sounding "coached" as though the respondents were told exactly what to say.

Despite the aforementioned constraints along with the time and resources limitations, the number of the respondents were adequate to achieve the study objectives.

CHAPTER FIVE: PRESENTATION AND DISCUSSION OF RESEARCH FINDINGS

5.1 Introduction

This chapter presents the results of the forest cover changes and forest management approaches in Kalulu Forest Reserve (KFR) No. 32 in Kabwe, Zambia. The results are based on 83 household interviews, key informants, interviews and post classification change detection based on satellite images for the period between 2000 and 2015. It also assesses the knowledge and perceptions of stakeholders on forest cover changes and forest management.

5.2 Household Demographics and Livelihood Strategies

Of the 83 respondents interviewed, 89 percent were men and 11 percent were women. These statistics also represent the gender of the heads of households interviewed. Most (61 percent) of the respondents had primary education level, 12 percent had basic education, 16 percent had attained senior secondary education, and 1 percent had tertiary education. There were 10 percent of the respondents who had no formal education. The age of the respondents ranged from 25 to over 85 years with an average of 53 years (Figure 5.1).

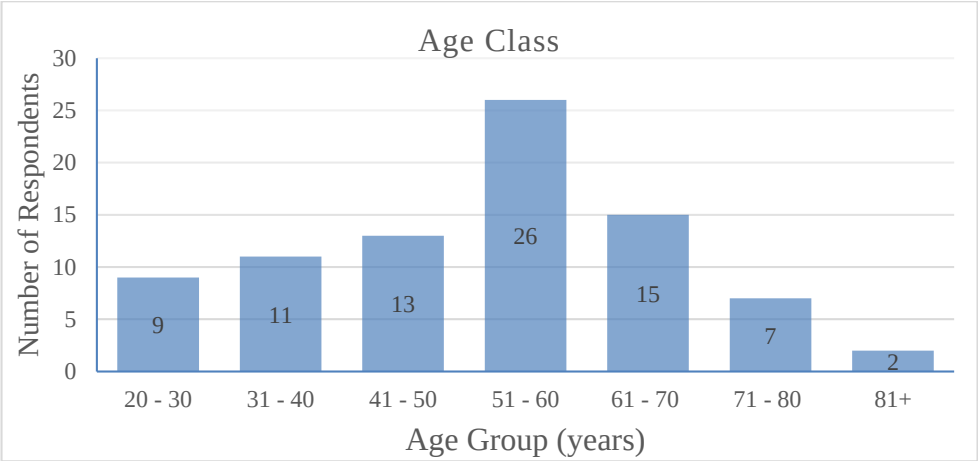

Figure 5.1: Age class of the respondents.
Source: Field Data, 2016

The minimum number of occupants per household was one and the maximum was 15. The average number of occupants per household was seven.

Figure 5.2 shows the number of years the respondents have been in Kalulu Forest Reserve. The results suggest that the period from 2000 to 2015 recorded a major encroachments in the reserve.

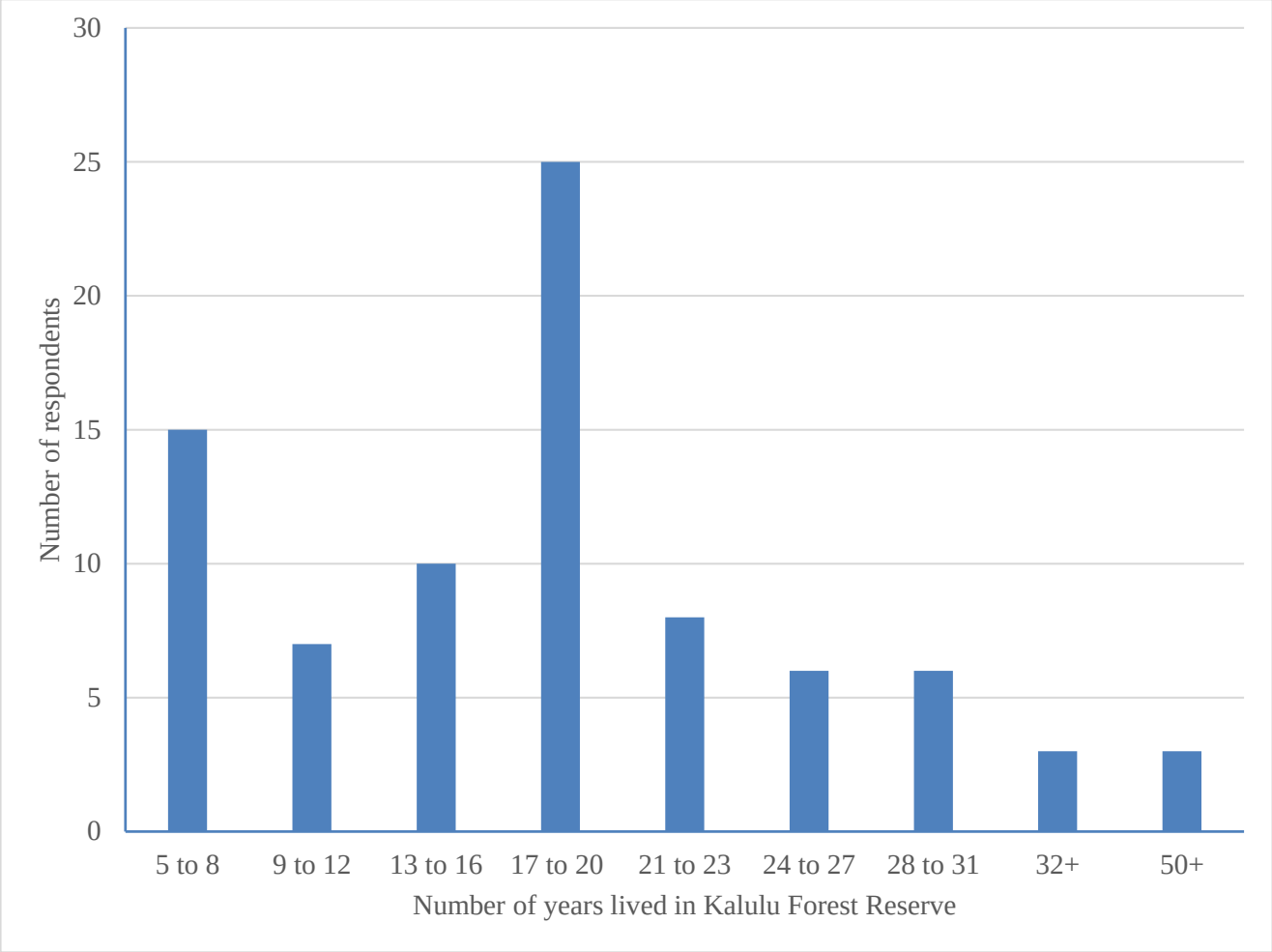

Figure 5.2: Number of years lived in Kalulu Forest Reserve
(Source: Field Data, 2016).

5.2.1 Livelihood activities

Figure 5.3 shows that the major livelihood activities in the reserve are agriculture and charcoal burning.

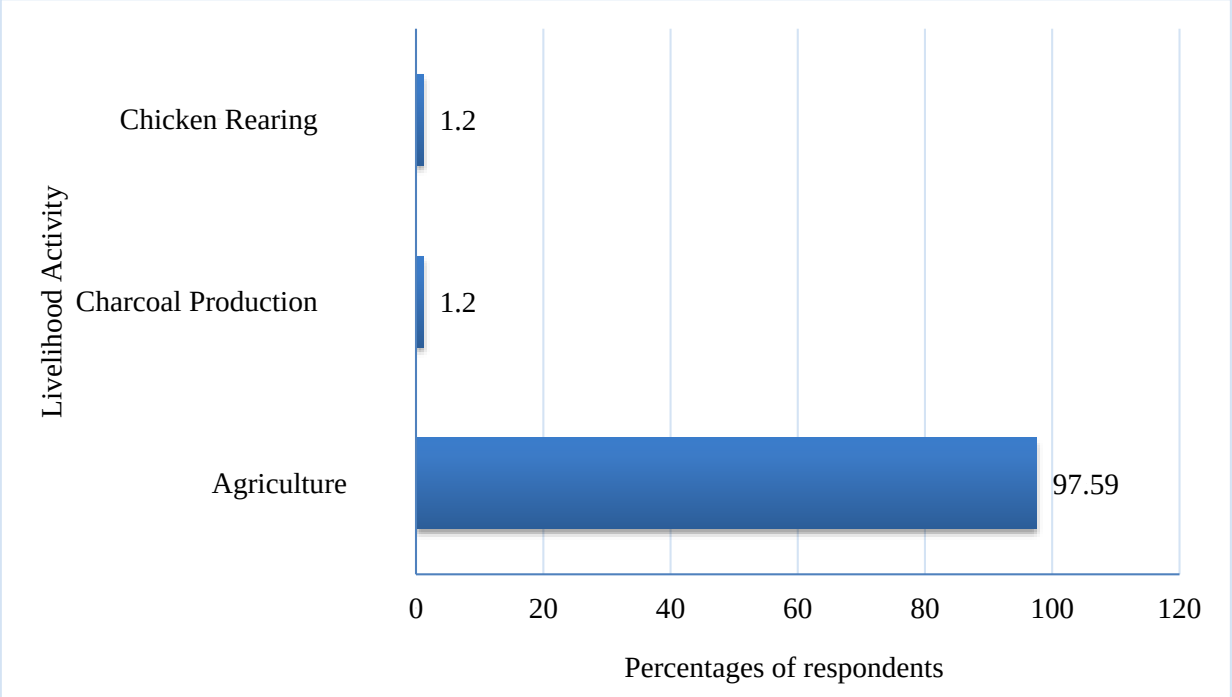

Figure 5.3: Livelihood activities for the respondents.
Source: Field Data, 2016

Figure 5.4 shows a piece of land used for maize growing and Figure 5.5 shows a field prepared for sweet potato planting.

Additionally, Table 5.1 shows the types of crops grown by the respondents as the majority (97.6 percent) of the respondents were maize growers. This can be due to the fact that the government through Ministry of Agriculture has a Farmer Support Input Programme (FISP) which is aimed at providing small scale farmers agriculture inputs (seeds and fertilizers) at a subsidized cost. Furthermore, guaranteed market for the maize product through the Food Reserve Agency (FRA) has pushed a lot of these small scale farmers to major in maize growing such as the respondents of KFR (Zorya, *et al*., 2011). Soya beans was the second most grown crop among the respondents possibly due to the guaranteed market from FRA and other businesses such as Cargill Zambia and other "briefcase" businesses.

Table 5.1: Types of crops grown within the Forest.

Crops grown	**% of Respondents**
Maize	97.6
Soya beans	37.3
Common beans	31.3
Sweet potatoes	21.7
Cotton	4.8
Millet	2.4
Cowpeas	1.2
Sunflower	6.0
No crops grown	2.4

(Source: Field Data, 2016)

Table 5.1 shows the type of crops grown among the respondents of Kalulu Forest Reserve. Majority of the respondents were growing maize largely because of government incentives associated with maize growing. Additional crops grown included soya beans, commons beans, sweet potatoes, cotton, millet, cowpeas, and sunflower. A small percent (2.4) of the respondents did not grow any crops.

Figure 5.4: Maize crop being grown in the forest
(Source: Field Data, 2016)

Figure 5.5 shows a field being prepared for the growing of sweet potatoes in Kalulu Forest Reserve.

Figure 5.5: Fields being prepared for sweet potato planting
(Source: Field Data, 2016)

The respondents were asked if they had other alternative livelihood strategies. The majority (66 percent) had no alternative livelihood strategies and solely depended on agricultural activities (both crop and livestock production). Of the 34 percent who had alternative livelihood source, 16 percent were casual/ part-time works, 6 percent were store owners, 5 percent were traders, and 4percent were in fulltime employment (teachers at the school in the forest and a plumber in the Lukanga Water Sewerage Company). The rest were craftsmen (3 percent).

The situation highlighted by FAO is similar to what was obtaining in KFR as agriculture on a subsistence level had an inverse effect on the forest cover.

Among the livestock farmers, the majority owned chickens because they were not difficult

to rear as they are local chickens' breeds. 8 percent did not own livestock. As shown in Table 5.2, livestock rearing is a significant livelihood activity in KFR as there is readily available grazing land for cattle, goats and pigs. Figure 5.6 shows a pastoral farmer herding cattle.

Table 5.2: Livestock types owned in Kalulu Forest.

Animal Type	**% of Respondents**
Cattle	25.3
Goats	56.6
Ducks	1.2
Pigs	22.9
Chickens	69.9
Guinea fowls	7.2
Others	8.4

(Source: Field Data, 2016)

Table 5.2 shows the livestock owned by respondents in Kalulu Forest Reserve. Majority of the respondents reared chickens and goats. Cattle, ducks, pigs and guinea fowls were among the livestock reared in Kalulu Forest Reserve.

Figure 5.6: Pastoral farmer herding cattle within the Kalulu Forest Reserve
(Source: Field Data, 2016)

5.3 Forest cover changes in Kalulu Forest Reserve between 2000 and 2015.

This section highlights the forest changes based on the observations and perceptions of the respondents. Respondents were asked about their perceptions and analysis on the observed forest cover changes in Kalulu Forest Reserve.

The respondents who had been in the forest reserve for at least 10 years had noted that there had been some changes in the forest reserve since they became settlers in the forest reserve. The major perceived changes fall within the deforestation category (Table 5.3). A few respondents however, believed that the notable significant changes they experienced were the reduction in the water levels and soil fertility.

Table 5.3 Perceptions of forest cover changes

Forest Changes view	**% of Respondents**
Loss of forest cover	48.19
Loss of trees	37.35
Loss of trees due to population increase	7.23
Loss of trees due to agriculture and charcoal production	3.61
Low water levels	2.41
Poor soil fertility	1.20
Total	**100**

The respondents were able to give justification on why the perceived changes in the forest cover since settling in and around the forest reserve. The majority of the respondents attribute the changes to the fact that there has been an influx in the human population. The increase in population had a negative impact on the forest because it meant clearing of land for agricultural purposes and settlements. Furthermore, it was to support other livelihood such as charcoal production and livestock rearing. Furthermore, the respondents believed that there had been a significant loss in biodiversity as some tree species which had been cut down by the settlers whose main livelihood was charcoal production. Among species which were lost *Pterocarpus* species, *Pericopsos* species, *Mpundu* (*Paranari caratellifolia*), *Makole* (*Dombeya Rotunditolia*), *Masuku* (*Uapaca kirkiana*) and *Albizia* tree species. Some respondents were of the view that trees were not growing as before due to the reduction in water levels and poor soil fertility.

Table 5.4 Perceptions on climate change in KFR.

Climatic Changes	**% of Respondents**
Reduced rainfall	79.5
Increased Temperature	81.9
Extreme temperatures changes	8.4
No observed changes	4.8
Changed rainfall patterns	14.5

(Source: Field Data, 2016)

Findings from Table 5.4 show that most (82 percent) residents perceived increase in temperature, while only a few (5 percent) did not perceive any changes. These perceptions which could neither be confirmed nor refuted by the researcher because they were residents' experiences. The key informants indicated from the Forestry Department, both from the District and Provincial Office, had no comment on the changes in the forest as they were not necessarily in the forest to experience any changes happening in the Forest Reserve.

5.3.1 Land cover change dynamics in KFR.

This section presents land cover change dynamics in the KFR based on analysis using remote sensing techniques. Figure 5.7 shows land cover maps generated.

Land cover maps and classification accuracy assessment

The land cover maps generated from satellite imagery were used to analyse land cover change in KFR. The overall accuracy for 2000, 2005, 2010 and 2015 land cover maps were 88.72 percent, 79.03 percent, 94.14 percent and 87.96 percent, respectively. Regarding the user and producer's accuracy, the bareland land cover class had consistently high accuracy in all the four years sampled. This is because bareland had

very high reflectance property than the other land cover classes considering the period when the image was taken. These images were taken in the dry seasons (September) for the year 2000 and 2005, and winter (May and June) for the year 2010 and 2015, respectively. This spectral difference allowed bareland to be readily identified and thus resulted in higher accuracy values for the bare land class.

For vegetation (open and closed vegetation), user's accuracy was 87.95 percent and above except for the 2005 image which was 39.13 percent. The producer accuracy was 56.25 percent and above. The disparity in user's accuracy and producer's accuracy indicates a tendency to overestimate the number of vegetation pixels in all images.

Accuracy values for crop field displayed the largest variance. User's accuracy ranged from 53.85 percent to 87.50 percent while producer's accuracy ranged from 31.82 percent to 100 percent. The wide range of accuracy indicated an inconsistency of crop field with other land cover classes (Appendix D, E, F and G).

The lowest user's accuracy for water was 83.33 percent for the year 2000 while the accuracy of the water class was 100 percent for 2010 and 2015. The producer's accuracy for water were all 100 percent in all the years analyzed. Water has radically different spectral properties than the other land cover classes. This spectral difference allowed water to be readily identified and thus resulted in higher accuracy values.

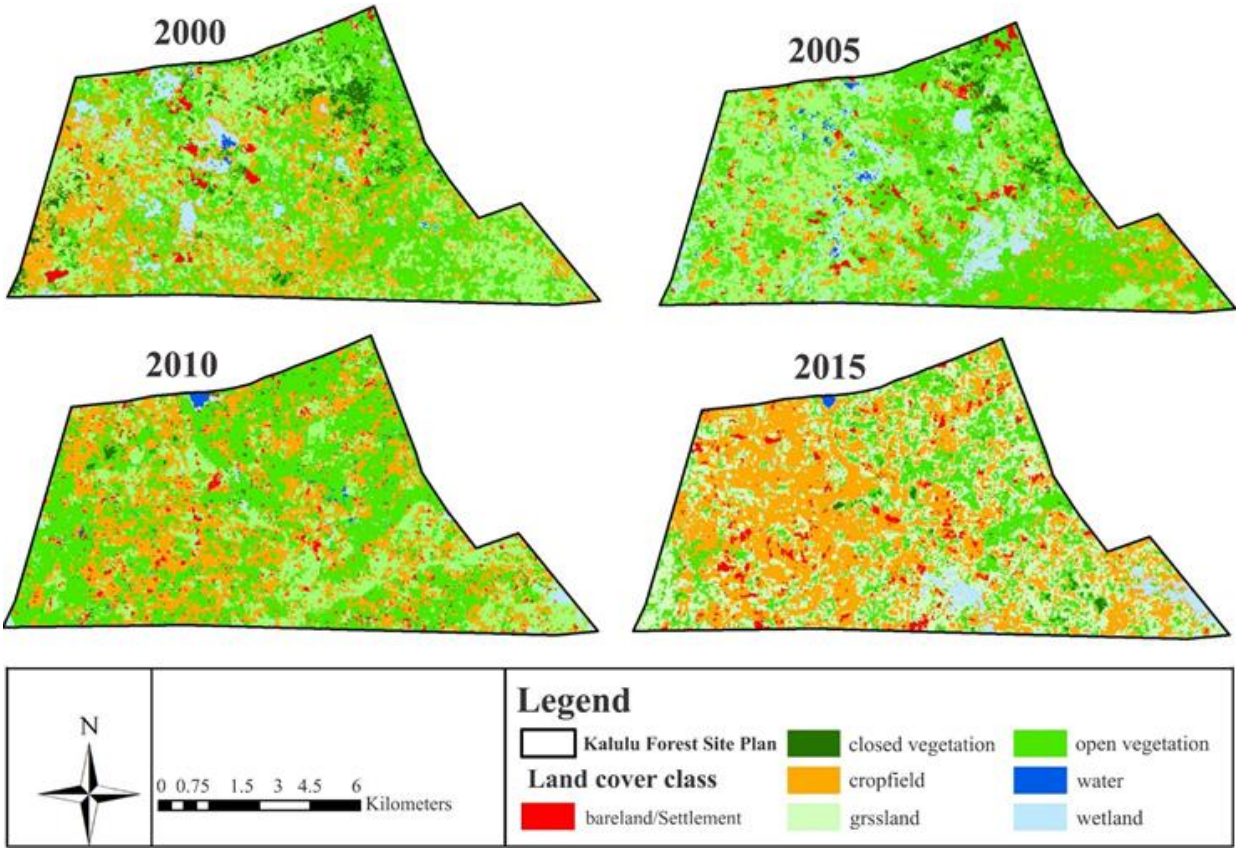

Figure 5.7 shows areal land cover changes between 2000 and 2015.
Source: NRSC, 2017

Figure 5.7 shows the spatial changes that have occurred in Kalulu Forest Reserve between 2000 and 2015. It demonstrates the kind of land cover changes, namely from bareland/settlement to wetland information, that occurred between 2000 and 2015. If the land cover changes for each class turned up as follows: the majority of the open and closed vegetation was converted to cropfield. The class bare land includes the largest changes. The water class showed fewer changes. Wetland had also undergone significant changes as shown in Table 5.5.

Land cover in KFR between 2000 and 2015

In the years 2000 and 2005, KFR was dominated by forest cover in form of open vegetation. Grassland constituted another major land cover, followed by agriculture and wetlands. However, by 2015, crop land and grassland had become the major land cover

types in the forest reserve (Table 5.5).

Table 5.5. Land cover by area in KFR from 2000 - 2015

	Area In 2000		**Area In 2005**		**Area In 2010**		**Area In 2015**	
Land cover type	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
Bareland/ Settlemen	98.55	2.11	119.07	2.55	132.03	2.8	152.82	3.2
Closed Vegetation	155.49	3.33	71.64	1.53	54.77	1.17	33.21	0.711
Cropfield	1,082.34	23.17	1,131.81	24.2	1,442.88	30.8	1,923.57	41.17
Grassland	1,352.88	28.96	1,434.39	30.7	1,514.21	32.4	1,582.89	33.88
Open vegetation	1,642.86	35.16	1,589.32	34.0	1,353.94	28.9	839.79	17.97
Water	20.09	0.43	25.83	0.55	26.73	0.57	26.76	0.57
Wetland	319.87	6.85	300.02	6.42	147.52	3.16	113.04	2.42
Total	**4672.08**	**100**	**4672.08**	**100**	**4672.08**	**100**	**4672.08**	**100**

Source: Field data, 2016

Trends in Land cover in KFR from 2000 to 2015

The findings in Table 5.5 show that there had been changes in the land cover in Kalulu forest reserve between 2000 and 2005. Notably, there had been an increase in bareland. The rapid increase in population as attributed to by the 44percent of the respondents may have led to the increase in the bareland due to the need for shelter and agricultural land. According to Chivian and Bernstein (2008), people had a tendency to cut down trees from forests for a myriad purposes but mostly for survival. Thus, the increase in cropfield and grassland in KFR corresponds to the period of increased human encroachment into the reserve (Figure 5.2). The need for food could have been the major driver of deforestation in this State owned forest of KFR. Chivian and Bernstein (2008) added that rural residents cleared land for crops and for livestock grazing. Cattle rearing has also been noted as one of the leading causes of deforestation and forest degradation (FAO, 2003). Kalulu forest reserve had cattle ranchers who could be contributing to deforestation and forest degradation. Furthermore, as cropland was depleted of nutrients through overuse, new

land must be cleared to provide fertile farmland. Marcoux (1999) initially stated that "population growth was a major determinant of land clearing, through then growth in requirements for food and other agricultural products." Subsequently, the increase in population and the demand for agricultural land, a significant reduction in the area of both closed and open vegetation was observed. Muller *et al* (2011) suggests a broader spectrum as to why, agricultural expansion in forested areas could increase, among them citing; geophysical factors (rainfall), soil fertility, access to market and lack of land policies on land access. The highlighted are among the proximate drivers of forest cover loss in Kalulu Forest Reserve as it meets all the suggested factors.

GRZ (2020) indicates that in Zambia, it was recorded that there was a loss of 1.1 million hectares 2000 to 2015 due to deforestation and unsustainable forest use in the forested areas of the country. Among the reasons cited were that in the same period, there was an increase in cropland and settlements. The findings do agree with what was obtaining in Kalulu Forest Reserve, however, the forest cover loss and the establishment of cropfield and settlements was at a much higher rate as compared to the overall picture in Zambia.

Land cover trends in KFR between 2000 and 2015

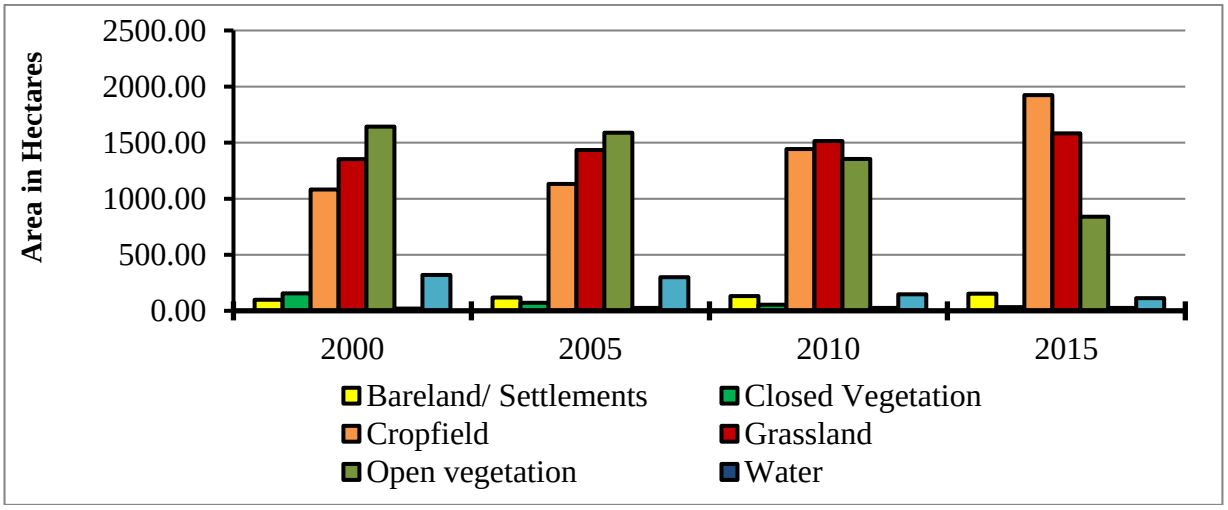

Figure 5.8. Land cover change trends in KFR from 2000 – 2015.
(Source: Field data, 2016)

The trends in land cover changes in KFR are given in Figure 5.8.

The findings from Figure 5.8 show that there had been an increase in bareland/settlement, cropfield and grassland between 2000 and 2015. The more there was need for land for agricultural land and creation of settlements due to the perception of an increase in the population, the decline in the forest cover.

Thus, Figure 5.8 shows an increase in farmland whilst there had been decrease in forest cover between 2000 and 2015. According to FAO, 2016:20

> *Local subsistence agriculture accounts for an estimated 33 percent of deforestation, urban expansion for 10 percent, and infrastructure for 10 percent and mining for 7 percent. Land-use change was preceded by forest degradation, for example caused by unsustainable or illegal wood removal.*

The situation highlighted by FAO is similar to that obtaining in KFR as agriculture expansion on a subsistence level had an inverse effect on the forest cover. However, in Kalulu Forest Reserve, the agricultural and infrastructure expansion (as shown in Table 5.5) in the period under review was more than the estimated figures in the FAO, 2016 report.

Alig *et al.,* (2010) indicate that forests are vulnerable to conversion to other land uses. An increase in the number of houses and other buildings in and near forests foreshadow growing costs and complications in forest cover. Additionally, FAO (2016) showed that in Africa, high population density have had a negative impact on forest cover because

growing populations mean increased demand for food, and a corresponding need to convert forests to agricultural land. Countries with a middle and low income, the annual forest cover was lost largely due to creation of agricultural areas (FAO, 2016). This also applies to KFR as much of the forest area had been converted from open and closed forest vegetation into bareland/settlements and largely cropfield.

Magnitude and direction of land cover changes in KFR

Table 5.6 shows the magnitudes and directions of land cover change in the KFR for the period 2000-2015. The change matrix results (Table 5.6) reaffirm that the largest changes between 2000 and 2015 were in the form of increasing crop land and barelands and settlements, and declining forest cover (closed vegetation and open vegetation) and wetlands. This indicates that forest cover loss in KFR was largely due to human pressures in the form of settlements and agriculture.

Table 5.6. Land cover change matrix in KFR from 2000 - 2015

	Percentage changes in land cover						
	Bareland/ Settlements	**Closed Vegetation**	**Cropfield**	**Grassland**	**Open vegetation**	**Water**	**Wetland**
2000-2005	20.82	-53.93	4.57	6.02	-3.26	28.57	-6.21
2005-2010	10.88	-23.55	27.48	5.56	-14.81	3.48	-50.83
2010-2015	15.75	-39.36	33.31	4.54	-37.97	0.11	-23.37
2000-2015	55.07	-78.64	77.72	17.00	-48.88	33.20	-64.66

Source: Field data, 2016

5.3.2 Forest Cover Changes in KFR from the Key Informants' point of view

Kalulu Forest Reserve has experienced deforestation as the forest management approaches are perceived not and have not been working since 2000. From Table 5.7, the crop field and bareland/settlement have increased by78 percent and 55 percent

respectively, whereas closed and open vegetation has reduced by 49 percent and 78 percent respectively, between the years 2000 and 2015. The Forestry Department both at the provincial and the district level all indicated their major concerns with regards the management of Kalulu Forest reserve. According to the Key Informant from the District Forestry Department (2016), "Kalulu Forest Reserve has been under the fortress management approach in order to preserve the aquifer but currently no forest management approach seems to be effective especially due to 'political' issues around this". The majority of the settlers were of the view that the forest was managed by traditional and political leaders as opposed to the Forestry Department. The key informant from the District Forestry Department reiterated that the fences and fines approach worked perfectly to conserve gazetted areas such as Kalulu Forest Reserve. From the early 2000 up to the year 2015, forests were still managed under the Forest Act of 1973.

Shauma (2008) highlights that the Act replaced the 1941 Forest Act that had allowed local and traditional authorities to use forests for them to have a direct financial benefit. It can be assumed that due to the institutional restructuring of the Forest Department (Vinya *et al.*, 2011) which led to less manpower and funding for the implementation of the fortress system, there was an increase in forest encroachment resulting in deforestation and forest degradation. Attempts to improve forest management thereafter have proved futile, even after the introduction of the Zambia Forestry Action Plan (ZFAP) of 1994 which subsequently in the 1998 Forest Policy and the Forest Act No. 7 of 1999 led to the establishment of the Zambia Forestry Commission (ZAFCOM) an institutional structure to replace the Forestry Department, these did not change things significantly. Among the challenges in managing Kalulu Forest Reserve, the District Forestry Officer cited lack of political will from the Government to remove the illegal settlers from Kalulu Forest

Reserve as it is now part of the electoral areas of Muwowo ward which had over 1,792 people (CSO, 2010). Shauma (2008) also pointed out that lack of political will to foster protection and sustainable management of the environmental resources had made it difficult to formulate sound environmental policies. Other challenges the Key Informant from the District Forestry Department stated included the inadequate budget allocation to Forest Department. This made it difficult to conduct any operations of monitoring resource depletion and education based programs. The Key Informant said "the allocation to the Forest Sector is so small that we can barely manage administrative requirements. This puts us in a very difficult position especially when we are asked about Kalulu forest reserve". He further stated that "it has been difficult to work with the settler as they perceive the Forestry department as their enemies and do not want them seen within the forest. Lastly, when asked about what opportunities may exist in order for Kalulu to be managed more efficiently, he highlighted that initiatives such as the REDD+ should be championed to help in resuscitating of the forest reserve. The Key Informant from the Provincial Forestry Department shared the same sentiments as those of Key informant from District Forestry Department. He however, believed that Kalulu Forest Reserve is beyond redemption as there has been less Forest Department involvement and more of the traditional and political leaders being in charge of the affairs of Kalulu Forest. He believes that it should be degazetted as it just makes the Forest Department look ineffective considering the amount of damage the forest reserve has experienced. Keenan *et al* (2015) suggest that increased investment over an extended period of time can improve national forest monitoring capacity especially in developing countries and as such even allows for opportunities such as REDD+ mechanism to be easily implemented in the quest to manage forests sustainably. Additionally, Kleinschmit *et al* (2017) did indicate

that forest resources only play an essential role in the areas where forest resources are assumed as unlimited. Further indicating that in countries where there is fewer forest resources, they are more likely to be careful in how they manage the forest resource. Indicating that that the likelihood of these countries to fund the Forestry Department in higher than in those countries with a perceived abundance of the forest resource as is the case in Zambia. The Key Informant from Lukanga Water and Sewerage Company shared his observations about Kalulu Forest stating that the encroachment of the reserve by the illegal settlers had disturbed the municipal supply from the aquifer as they had to shut down the pump stations due to faecal contamination from the poorly constructed pit latrines. He lamented to the fact that the company now have to pump water from a much further area, the Mulungushi Dam, roughly 26 Kilometers away from Kabwe. The implication is that the cost of water will rise in Kabwe. He stated that as a company, they are unable to conduct any awareness campaigns on ground water pollution and promoting ecological sanitation, in the reserve without the forest department because the forest department is incapacitated.

The common concern from key informants about KFR, is that there is no presence of the Forestry Department in the reserve, hence the unregulated levels of encroachment being experienced in the forest reserve. This can be supported by an existing "conflict" between the Forestry Department and the squatters. Shitima (2005) points out that forests are a source of both socio-economic and environmental benefits and as such there is bound to exist friction between the Forest Department and the people accessing these benefits especially if the forest provides a livelihood activity. However, the situation in Kalulu is special as the settlers had the political and traditional leaders were in support of the illegal settlers and actually were the ones that allocate the land resource within the

forest. Martin *et al* (2013) points out that there existed conflict between the community members, traditional leaders and the forest sector. Furthermore, there were more conflicts between the marginalized and those that were close to chiefdom. He also indicated that conflicts were also accelerated by lack of communication and a distrust between the State (Forest Department) and the traditional leaders and the community members. Martin *et al* (2013) further stated that, the State through the forestry section was there to conserve and manage forest resources in the community forest. Based on this the study, it was concluded that, there was lack of involvement by any organization in managing the natural forest whilst both community and natural forests were not managed by any outside organizations. This was contrary to the observation made by Ostrom (2001) that in some countries, community-based forest management institutions had received increasing attention from governments, donors and Non-Governmental Organisations in the past. These organisations saw themselves as stakeholders in community managed forests and wanted to understand how community-based institutions worked and how they could be supported, reoriented or recreated to advance particular environment and development goals. Therefore, the conflict had weakened the management structure of the forest and subsequently had driven to the excessive depletion of the forest resource.

5.4 Knowledge and perceptions of stakeholders on the current forest management approaches used.

Most of the respondents (64.30 percent) stated that they did not have formal knowledge of any forest management approach. This could be attributed to the educational levels of the respondents of which the majority had only attained primary education.

Figure 5.9 shows types of the forest management approaches known by the respondents in KFR. Almost two-thirds (64.30 percent) of the respondents had no knowledge of

any type of forest management approach, whereas, the rest knew about the fortress, CFM and plantation forest management approaches (Figure 5.9). Kalulu Forest Reserve is commonly known as "*kuma coupu*" which comes from the word COUPE, a form of approaches mentioned as part of the fortress management. Initially, there was a section within Kalulu Forest Reserve which practiced the coupe system as a Silvicultural system. However, with time and unregulated exploitation of the forest resource, the system failed. Secondly, the respondents who knew about the fortress management approach and lived around the forest reserve for longer than 18 years stated that Kalulu Forest Reserve used to be in a fence and anyone found loitering in the reserve would be fined or prosecuted by the then "*kapenda mabula*" (literal translation as People who count leaves). These respondents further stated that the Forestry Department was mandated to "police" forests and would penalize any non-compliant individuals. Lastly, the respondents who stated they knew CFM, were those who had been encouraged by the traditional and political leaders to exploit the forest resource within their allocated portion of land but left some trees for the purposes of water retention. The CFM is not a strange phenomenon to the residents as most of them were familiar with the forest's "guidelines" in terms of resources use by other community members and the traditional leaders.

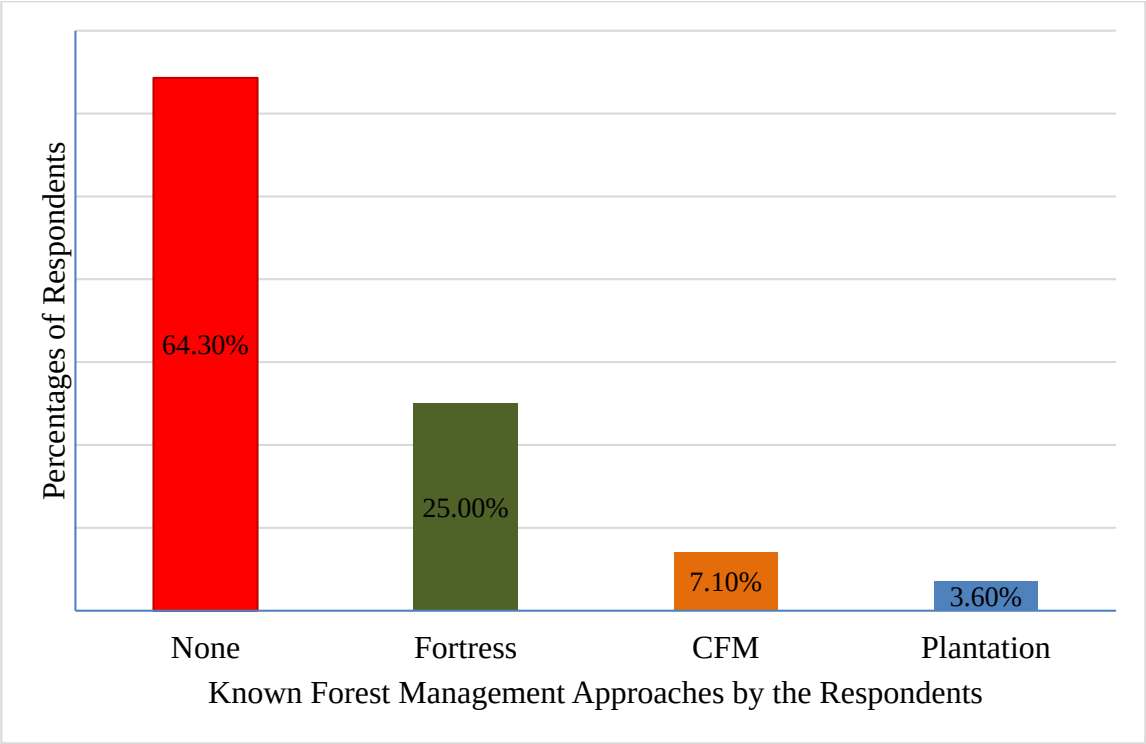

Figure 5.9. Types of forest management approaches known.
(Source: Field Data, 2016)

Knowledge of the reserve

The majority (81.90 percent) of the respondents had knowledge of Kalulu Forest Reserve being a forest reserve, and only 18.10 percent of the respondents were unaware of it being a protected area. Furthermore, 89.20 percent of the respondents acknowledge that Kalulu Forest Reserve is a protected area and has been designated as a water catchment area. The rest of the respondents did not know that the reserve was a water catchment area.

Being aware of the status of Kalulu Forest Reserve, firstly, that it was a protected area and secondly, that it was a water catchment area, the settlers were not allowed to reside in the confinements of the forest reserve. This was because of the classic '*fences and fines*' which promoted high excludability and low access to forest resources.

However, this current study reveals that the current management approach or lack of it in Kalulu Forest Reserve promoted low excludability and high access to the forest reserve for as long as the traditional leaders are involved in land allocation.

Respondents were asked on who they thought managed Kalulu Forest Reserve and who they thought would be the best manager of the forest reserve. Regardless of the fact that close to half of the respondents know that the forest reserve is under the care of the Forestry Department and thus a protected area in which no human should reside in or do any activities which have an adverse effect on the area, they still have remained residents of the reserve due to a number of reasons:

1. The Forestry Department is an "*absentee landlord*", implying the lack of an active presence in the forest reserve. The respondents felt the only time they saw the Forestry Department occasionally was when confiscating charcoal bags from traders. The Forest Act No. 4 of 2015 part II and section 5, clearly gives authority to the Forest Department to control, manage, conserve and administer National Forests, Local Forests and botanical reserves. The management of the forest remains within the mandate of the Director of Forestry and Forestry Department "except that the Minister may, by statutory instrument, after consultation with a local community in the area, assign the control and management of a Local Forest to a local community or joint forest management committee on such terms and conditions as the Minister may determine" which has not been the case with Kalulu Forest Reserve. Lastly, section 23 (1) (*b*) plainly states that "a person shall not … without a license or permit; squat, camp, reside, build or excavate, construct or use any enclosure, re-open or use any road other than a public road, or erect or operate any plant, machinery or

equipment;" and therefore, the Forestry Department is within their rights of operation to get the illegal squatters out of the forest.

2. The interference by political and traditional leaders make it difficult for the Forestry Department to execute their duties because of constant intimidation from the political leaders. A key informant stated that "Kalulu Forest is a hostile ground especially for the Forestry Department in that, as much as we would want to go in and promote forest conservation, we are perceived as enemies to the settlers.

Table 5.7: Responses on who manages Kalulu forest reserve.

Forest Manager	**% of Respondents**
Forestry Department	44.6
Community leaders	55.4

(Source: Field Data, 2016).

Table 5.7 shows the responses on who the respondents were certain manages Kalulu Forest Reserve. Over half of the respondents indicated that the forest was managed by Community Leaders (Traditional and Political leaders) and the other respondents knew that the Forestry Department managed the forest. Additionally, respondents were also asked about who they thought would best manage Kalulu Forest Reserve. Over 80 percent of the respondents believed that the community leaders should manage the forest. While 81.9 percent stated that the community ought to manage the forest reserve. Only about 15.60 percent of the respondents felt that the Forestry Department should continue to manage the forest. The respondents that thought that traditional leaders and the community should manage the forest maintained this position because they believed that they were close to the resource and that they knew their needs and how best to exploit the forest

resources. However, the respondents that believed that the Forest Department should manage the forest reserve observed that the department understands the importance of forests more, has better knowledge on the best management strategies and the best way to ensure sustainability of the resource use.

To understand why the respondents would prefer traditional and political leaders to manage the forest, it is imperative to know that their stance emanates from the fact that these settlers have been granted permission to settle in this forest reserve by the traditional and political leaders (See Figure 5.10). Figure 5.10 clearly shows that the respondents were granted permission largely by the traditional leaders or the political leaders (considered as Government as per the figure). The majority (90 percent) of the respondents exclusively mentioned that they were granted permission by the traditional leaders (Chief and Headmen). Only 8 percent respondents state they have been given permission by the Government (political leaders), and lastly, the 2 percent of the respondents have just squatted illegally without permission either from the political leaders or the traditional leaders. The granting of permission to the settler by the traditional leaders is supposedly because the land exists under customary land tenure. However, the law states that all land that is gazetted as protected area is no longer under customary tenure. Section 11 of the Zambia Wildlife Act No. 14 of 2015 states that "Whenever the President considers that the conservation or protection and enhancement of wildlife, eco-systems, biological diversity and natural beauty so demands, the President may, after consultation with the Minister and the local community in the area, by statutory order, declare an area of land within the Republic to be a National Park for the purposes of this Act and may, in like manner, declare that a National Park shall cease to be a National Park or that the boundaries of a National Park shall be altered or extended." The political leaders on the other hand grant permission

because they are more interested in having the people's votes come re-election time and they reassure the illegal settlers that will not be relocated if they elect the candidate (Key Informant from Forestry Department, 2016). Kajoba and Chidumayo (1999) concluded that when encroachment has occurred in a protected forest reserve, there usually arises a conflict between forest conservation and meeting the demands and needs of the squatters and as such, a gradual transformation of the land use begins to take shape. As in the case of Kalulu Forest Reserve, observable trends indicated that due to the community leaders allowing the squatters access to the forest reserve, settlements and cropfield had increased and as such the conservation needs were superseded by the needs of the squatters. Gabay and Rekola (2019) suggest that enhancing participatory and transparent forest management and land use decision-making can work in areas where stakeholders do not have such a system. Gabay and Rekola (2019:49) indicated that "effective participation also requires public access to information allowing to grasp the multiple dimensions involved to make knowledgeable forest management and land use decisions".

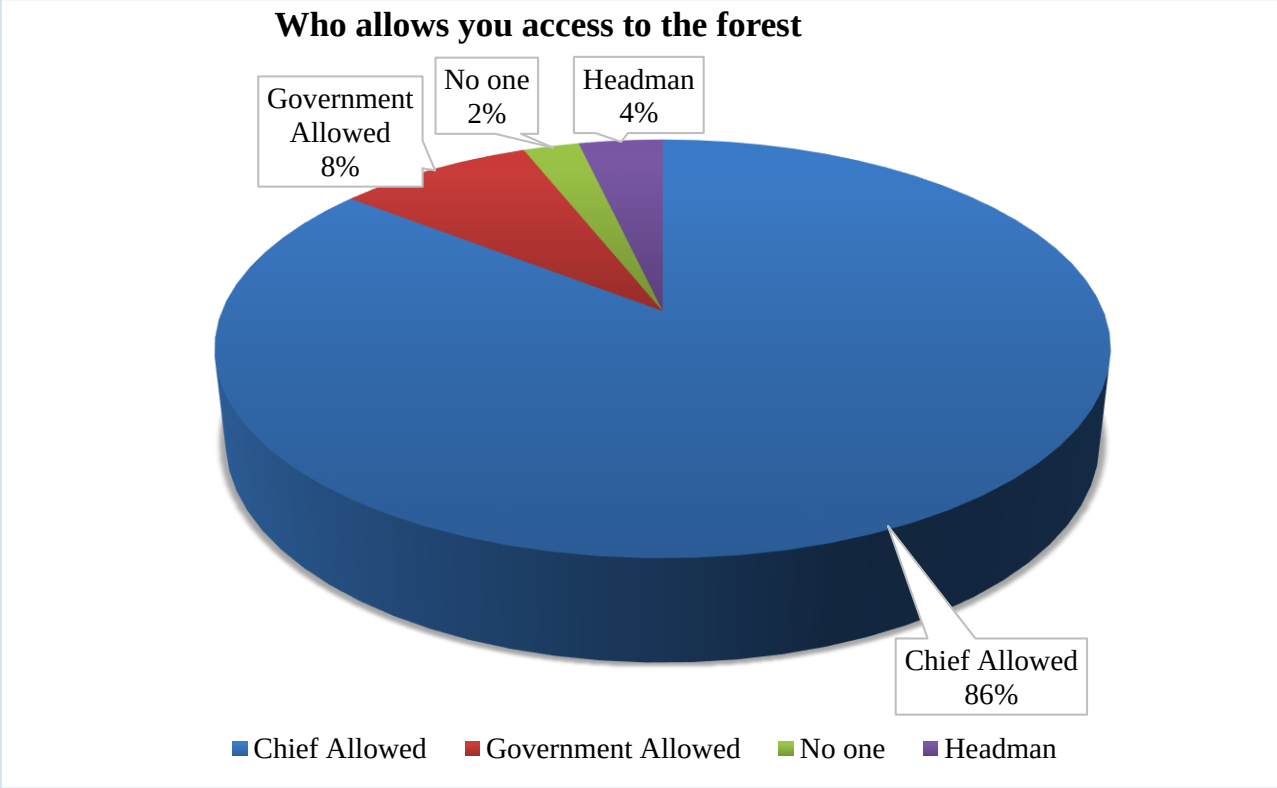

Figure 5.10. Who allows you access to the forest?
(Source: Field Data, 2016).

Awareness campaigns on forest management in the reserve

The respondents were asked if they had participated in any learning programmes on the importance of forest management. The majority of the respondents stated that during their time of residing in the forest reserve, they had never received any teachings on forest management. The rest stated they received some sensitization. However, these were not given by the Forestry Department but by Ministry of Agriculture. Figure 5.11 further shows the frequency of these sensitization meetings. All responses with an affirmative response as to the frequency of the teachings stated that these teachings were by Ministry of Agriculture and traditional leaders. In a sense, the Forestry Department has had no influence in behavioral change on forest management and how the settlers perceive the importance of the forest resource.

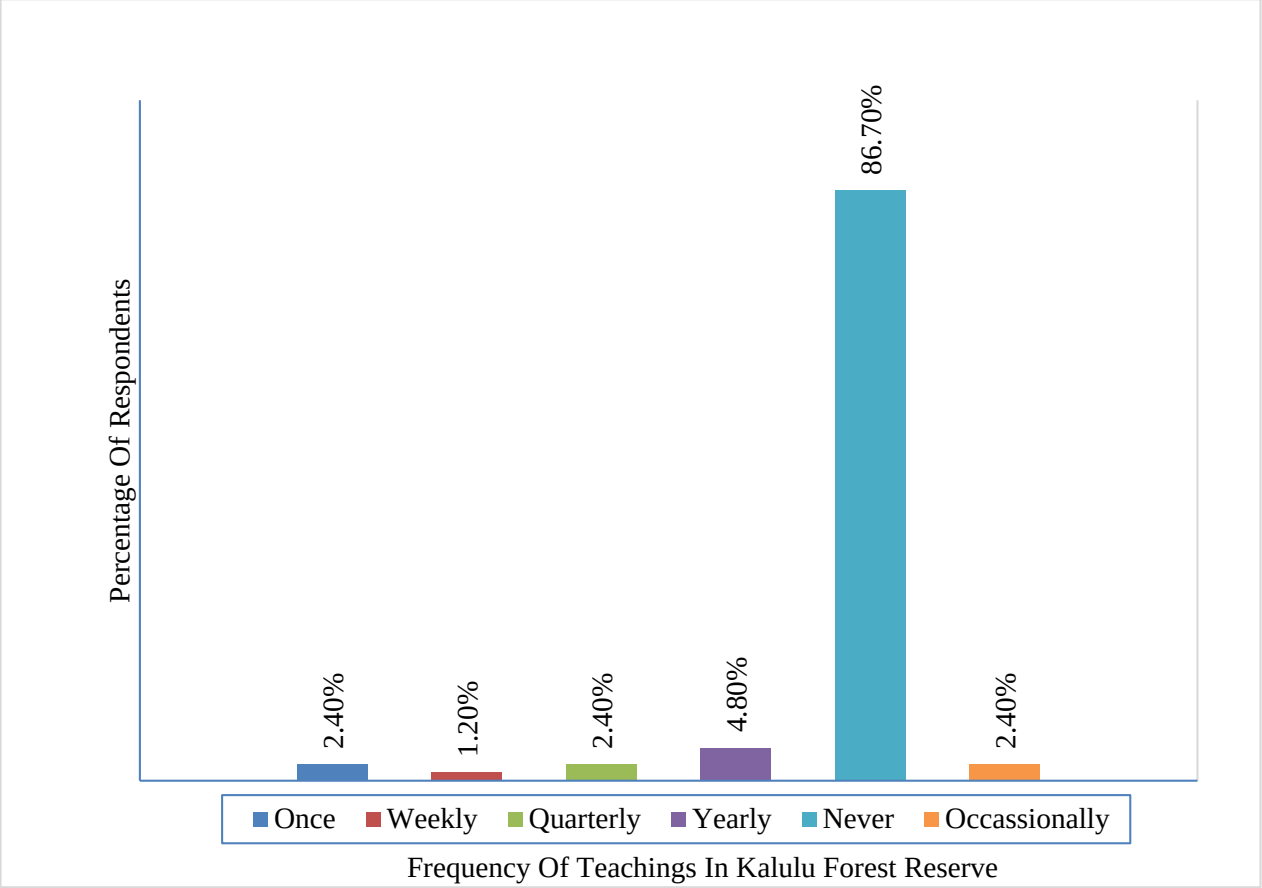

Figure 5.11 Frequency of the forest teachings on forest management.
(Source: Field Data, 2016)

A large majority of the respondents stated that the teachings did not impact forest conservation. The respondents believed the teachings had resulted in less deforestation and a growth of trees respectively. The respondents also lamented that if the Forestry Department had invested much time and effort in educating the residents on the importance of forest conservation and its management the forest cover may not have been depleted as was the case during the time of the study. Mwanamuchende (2016) indicated that the role of environmental education in addressing deforestation as it teaches a broader level of concern with regards managing forests and thus reducing deforestation. Ishola *et al* (2019) stressed that "…through the introduction of environmental education, the rate of deforestation can be reduced and education on afforestation practices can be disseminated".

This however is not the case in Kalulu Forest Reserve, and it could be argued that the state of the forest is as is because of the lack of education on forest conservation.

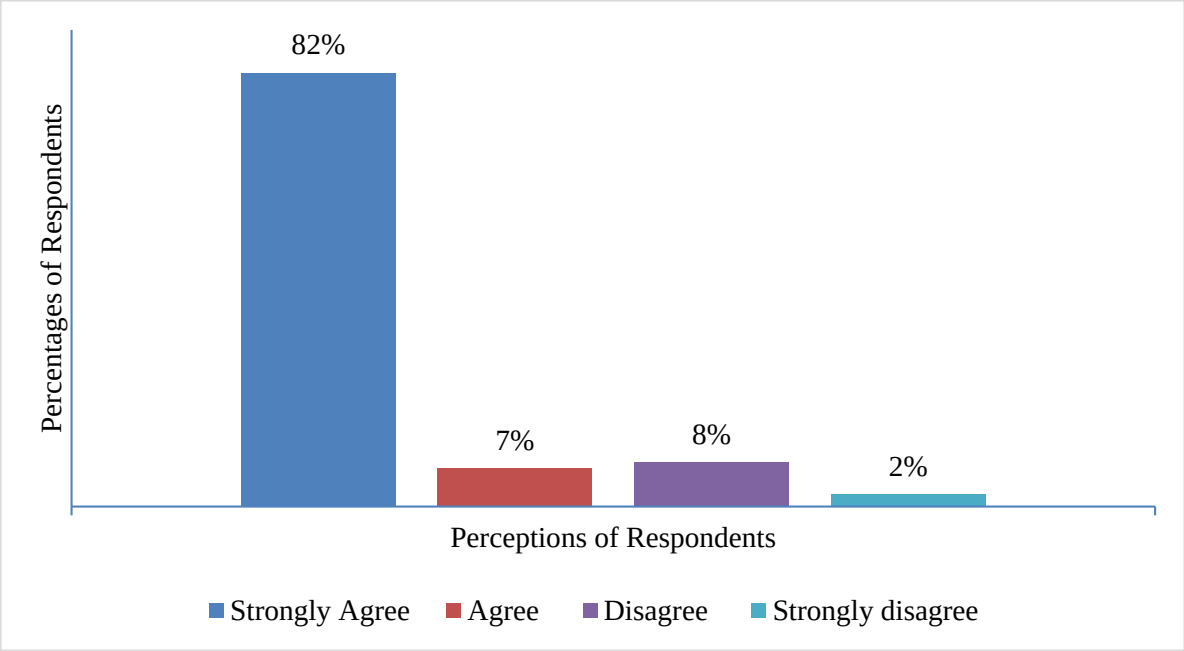

Figure 5.12: Respondents' perceptions on the importance of teachings and their impact on the forest.
(Source: Field Data, 2016)

Findings from Figure 5.12 show that the majority of the respondents believed that the teachings on forest management would have been good in relation to preserving KFR. However, the rest of the respondents were of the perception that nothing would have changed from the teachings. The respondents also supposed that if the Forestry Department had invested much time and effort in educating the residences on the importance of forest preservation and its management the forest cover may not have been depleted as was the case during the time of the study.

This critically shows the significance of educating communities on the critical role the forest play other than just immediate physical benefits.

It is increasingly becoming clear that indigenous people possess extensive knowledge

about their environment. They also have interpretations of reality which are radically different from the conventional scientific paradigm.

Resident's view on relocating from the reserve

The respondents were asked if they would relocate from the forest reserve given alternative land to resettle.

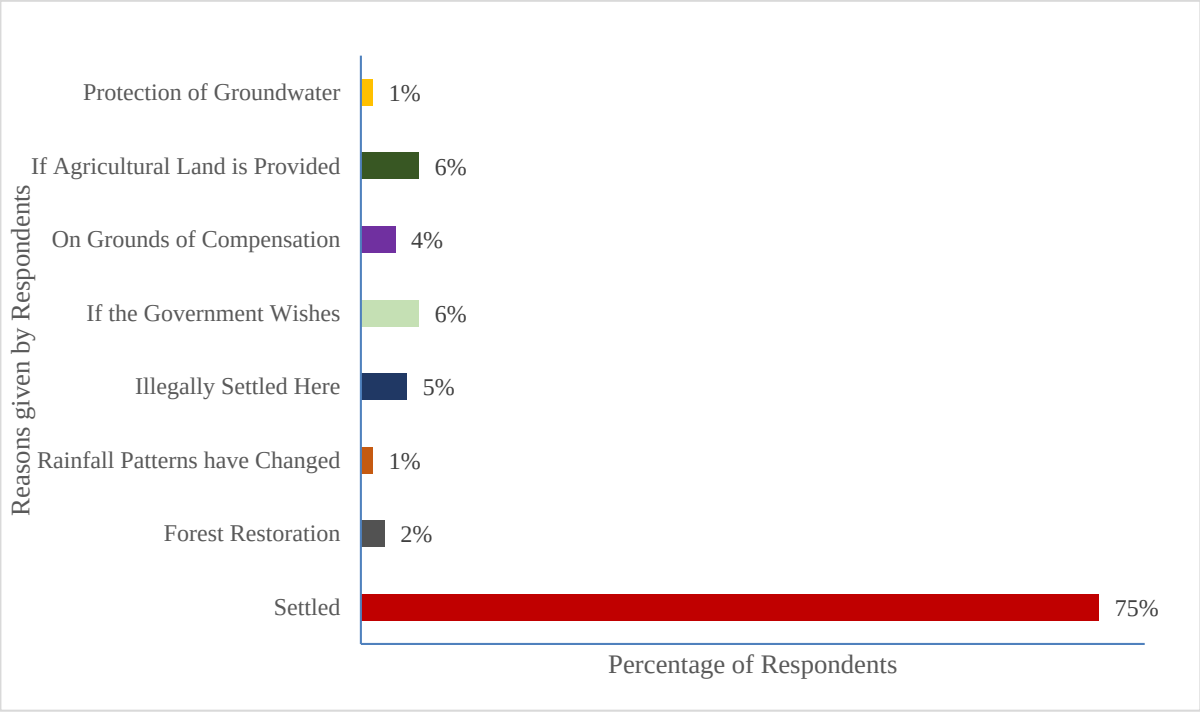

Figure 5.13: Reasons for residents' view on relocating from Kalulu Forest (Source: Field Data, 2016).

Figure 5.13 shows that only 5 percent of the respondents were interested in forest restoration. The majority of the respondents were of the view that they cannot move out of KFR no.32 if they were given alternative land to relocate because they had fully settled. The other respondents were of the view that they would move if they were provided with alternative agricultural land, if they were compensated for how much they had invested in terms of infrastructure and cropfield established, if the government so wished and especially that they were illegally settled there (4 percent) and to have the

forest restored. Hansilo and Tiki (2015) state that educated respondents supported protected areas more than those with no formal education, further indicating that conservation may be quite difficult in areas like KFR with people who are more illiterate on forest management approaches. Support for conservation was positively correlated with the level of education of the wildlife in Kenya. As the case is with KFR no. 32, the majority of the respondents were illiterate and that in a sense makes it difficult to promote conservation. Gadd (2005) also observed a similar situation in a study of people's attitudes towards sustainable forest management. Few respondents showed a negative attitude towards the park. Lastly, fear of displacement from the area by government is the major cause. They suggested that the park has to be free from human intervention.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter provides the conclusions and the recommendations of this study.

6.2 Conclusion

6.2.1 Examining Forest Cover Changes

Forest cover changes in Kalulu Forest Reserve No.32 were noted. This is due to unmanaged and unchecked forest over a period of time. Forest cover has been lost over the period 2000 and 2015 in KFR and among the reasons cited were that there had been a surge in population over the period of the study. Additionally, the analysis of the Landsat satellite images, provided evidence that there has been an increase in bareland and cropland and a corresponding decrease in both open and closed vegetation in the same period (2000 – 2015). The respondents attributed the forest cover changes to the increase in the population between the period 2000 and 2015. Furthermore, livelihood activities, that is, agriculture and charcoal production, have a negative impact on the forest as there is a serious need for the land resource. Clearing of large portions is a "necessary evil" for the illegal settlers as they have to create areas for cultivation of crops. Though a few respondents stated that they produce charcoal sorely as a main livelihood activity, the bearing they have on the environment is not negligible.

6.2.2 Effectiveness of Forest Management Approaches in Kalulu Forest Reserve

The current forest management approaches employed in Kalulu Forest Reserve are ineffective. Theoretically, Kalulu Forest Reserve being dubbed a protected area should adhere to the 'fences and fines' approach which strictly prohibits for any activity within the forest. The Forestry Department are incapable of removing the settlers because it is

"political". The Forestry Department is adamant that the political leaders as well as the traditional leaders have made it very difficult for the department to enforce the Protected areas forest management approach as they would not want to lose the political mileage gained in that area. Furthermore, the introduction of social services such as a school and clinic within the reserve has made it even impossible to remove the settlers as it signifies the political and traditional leaders' approval of encroachment. There has been a lack of political will to have Kalulu forest reserve restored to a protected area which was gazetted for the purpose of ensuring that the aquifer is preserved. Additionally, it has been difficult for the forestry Department to monitor activities within the forest reserve as they do not have adequate funding to facilitate for such, that is, they do not have adequate manpower to conduct patrols in order to enforce the forest laws. The study also concluded that there was disconnect between the Forestry Department, the traditional and political leaders and the community (squatters) and was observed to show a rift in the management of the forest. The forestry department was convinced that the management approaches being used in Kalulu Forest Reserve are very ineffective.

The loss of forest cover is thus a clear indication of the ineffectiveness of the forest management approaches that exist in Kalulu Forest Reserve. The aim of the protected areas forest management approach is to maintain or improve the state of the forest but this has not been the case as seen in this study. Evidence of deforestation was observed in this study from both the field observation, interviews and from the analysed Landsat images.

6.2.3 Knowledge and Perceptions on the forest management and forest cover changes among stakeholders

The knowledge levels of the respondents were examined and the study revealed that two-thirds of the respondents did not have any formal understanding or knowledge of any

forest management approach. Of course most of these respondents have only attained primary education which may not have covered the basics with regards forest management. The rest have some knowledge of Fortress, CFM and plantation management. The others were more in line with the CFM as they only assumed the forest was managed by communities and community leaders. The study concluded that despite the settlers being aware that Kalulu Forest Reserve being a protected area and a water catchment area, they were unwilling to leave the forest as they were allowed to settle in the forest. The interference of both the political and traditional leaders in the management of forests undermines and belittles the work of the Forest Department and makes the implementation of any forest management approach difficult.

Lastly, there was a clear indication that there was a lack of forest management knowledge among the squatters of Kalulu Forest Reserve. There had not been any teachings on forest management to the squatters due to the Forestry Department's very precarious financial position. Thus, part of the failure of the forest management approach is due to a failure to fully implement it.

6.3 Recommendations

The study makes the following recommendations:

1. Forestry Department should frequently monitor the state of forests by assessing forest cover changes over periods of times.
2. The government should increase its budgetary allocation to the Forestry Department to enable then to execute their duties effectively.
3. There should be more coherence and collaborations created among Forestry Department, political and traditional leaders as well as any other stakeholders in Kalulu Forest Reserve with a focus on all sectors as agriculture, forestry, energy

and land distribution to avoid policy discrepancies and conflicts that currently exist.

4. The extension division of the Forestry Department, which is mandated to engage with forest adjacent communities should commence such engagements. This would allow for easy introduction of Community Forest Management (CFM) groups and Joint Forest Management (JFM) committees in the study area.
5. Heavily encroached protected areas, particularly forest reserves such as Kalulu Forest Reserve, through the Ministry of Lands and Natural Resources, should promote the reforestation of forests with the participation of the squatters.

6.4 Further study recommendations

The following are the recommendations for further research:

1. Sustainable forest management in the face of political and traditional interference.
2. Opportunities and challenges in resuscitating dwindling State managed forest reserves to promote sustainable forest management.

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APPENDIX

Appendix A: Interview Schedule for Settlers

Dear respondent,

My name is Mwenya Mundende. I am a Master of Science student in Environmental and Natural Resource Management at the University of Zambia. I am conducting a research on Deforestation/Forest Cover Changes and Forest Management Approaches in Kalulu Forest Reserve No. 32 in Kabwe District. This questionnaire is intended to collect information from people in and around the forest reserve. This study hopes to contribute to the body of knowledge on effectiveness of Forest Management Approaches in curbing Deforestation and forest cover changes in Kalulu Forest Reserve. Your participation is purely voluntary and all information you provide will be treated in a strictly confidential manner. If you need any clarification or help please feel free to contact my supervisor Dr B. B Umar, School of Natural Sciences Department of Geography and Environmental Studies; University of Zambia, P.O Box 32379, Lusaka.

1.0 Socio-demographic Information

Age [ ]

Sex of household head Male [ ] Female [ ]

Marital Status of household head [ ]

Single [ ] Married [ ] Widowed/Widower [ ] Separated [ ]

What is your level of education?

Primary [ ] Basic [ ] Secondary [ ] Tertiary [ ] None [ ]

Household size…….

How long have you been living in Kalulu Forest……

What activities do you engage in for your livelihood?

[ ] Agricultural [ ] Charcoal Production [ ] Clearing of land for housing [ ] Other …….

a. Crop production

- Crops grown: …….....
- Use of crops grown: Home Consumption [ ] Sale [ ] Given to friends/Relatives [ ] Barter for clothes [ ] Exchange for agricultural labor [ ] Others [ ]

b. Livestock ownership:

Cattle [ ] Goats [ ] Sheep [ ] Donkeys [ ] others …….

c. Charcoal Production: Yes …… No …….
If yes, tree species used: ……., ……., ……,

……., …… ……..……, …….

2.0 FOREST COVER CHANGES

What are your views on how forest cover in Kalulu Forest has changed since you first got here?

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……

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……

……

What activities do you think have led to forest cover changes in Kalulu Forest Reserve?

[ ] Agricultural [ ] Charcoal Production [ ] Clearing of land for housing [ ]

Other ……. a. Other activities

……..

What are some of the alternative livelihood activities you would engage in other than the one (s) you are currently involved in?

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……

……

What are some the products you get from Kalulu Forest Reserve?

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Why do you have access to the above products from Kalulu Forest?

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What are some of the benefits you get from living in or close to Kalulu Forest Reserve?

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……

What some of the things that have changed about Kalulu Forest Reserve since you have been a resident here?

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What are some of the things (animals or trees) you used to see when you came that you can no longer see?

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What are some of the climatic (temperature, rainfall, humidity) changes that you have observed since you settled here?

……

……

……

……

3.0 KNOWLEDGE, PERCEPTIONS AND ATTITUDES TOWARDS FOREST MANAGEMENT APPROACHES

3.1 Are you aware of the forest management approach(s) used in the forest? [ ] Yes [ ] No

3.2 What are the forest management approaches you know?

……

……

……

……

3.3 Do you know that Kalulu Forest is a protected Forest Reserve? Yes [ ] No [ ]

3.4 Are you aware that Kalulu Forest is a Water Catchment Area which provides household water to the residence of Kabwe?
Yes [ ] No [ ]

3.5 Who do you think manages Kalulu Forest Reserve?
[ ] Forest Department [ ] Community Leaders [ ] Ourselves

3.6 What are some of the forest management activities does the community employ to preserve Kalulu Forest?

……

……

……
……

3.7 Have you ever had anyone teach you about forest management approaches and the importance of forest?
[ ] Yes [ ] No

3.8 How often do you get these lessons?

[ ] weekly [ ] monthly [ ] quarterly [ ] yearly

3.9 What impact have the current forest management approaches used for Kalulu Forest Approach had on the forest?

……

……

……

3.10 Give examples of the impact

……

……

……

……

3.11 What management approach do you think is the best approach to manage forest approach for Kalulu Forest?

…….

……

……

3.12 Who do you think should manage Kalulu Forest Reserve?

[ ] Forest Department [ ] Community Leaders [ ] Ourselves

3.13 Since the education on forest management and importance of forest preservation, has there been any changes in the way you use the resource?

……

……

……

3.14 If you were offered alternative land to relocate from Kalulu Forest Reserve, would you take it?

[ ] Yes [ ] No

3.15 Give a reason to your answer above

……

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……

……

4.0 EFFECTIVENESS OF FOREST MANAGEMENT APPROACHES

4.1 What are some of the challenges faced in managing Kalulu Forest?

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……

……

4.2 What are the solutions to the challenges above?

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4.3 What opportunities can be explored in the way Kalulu Forest is managed?

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……

4.4 Do you think the current forest management approaches are effective in managing Kalulu Forest Reserve?

[ ] Yes [ ] No

4.5 Give reasons for the answer above

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……

4.6 If no, what would be some of your recommended solutions?

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Appendix B: Interview Guide for the Forestry Department Key Informant

INTRODUCTION: *Hello. My name is Mwenya Mundende from the University of Zambia. I am conducting a research on Forest Cover Changes and Forest Management Approaches at Kalulu Forest Reserve No. 32.* ***The aim of this study is to examine forest cover changes and the effectiveness of forest management approaches in Kalulu Forest Reserve No. 32.*** *I would like to talk to you about your experiences in forest management in Kalulu Forest Reserve. I would also like to assure you that everything we discus will remain confidential and will only be used for the purposes of this research. I thank you for accepting to be part of these discussions.*

1. What is/are the forest management approaches the Forest Department uses at Kalulu Forest Reserve? ……
   ……
   ……
   ……
   ……
   ……
2. What have been impacts of the adopted forest management approach(s) on forest cover at Kalulu Forest Reserve?
   ……
   ……
   ……
   ……
   ……
3. What would you say are some of the challenges faced in managing Kalulu Forest Reserve based on the forest management approach?
   ……
   ……
   ……
   ……
   ……
4. What are some of the successes of the forest management approach(s) in Kalulu Forest Reserve?
   ……
   ……
   ……
   ……
   ……
5. What is the Department's position on the illegal settlers in Kalulu Forest?
   ……
   ……
   ……
   ……

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6. Has the Forest Department incorporated the community in Forest Management…….

7. If so, has the department done any forest cover? What have been some of the findings?
……
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……

8. Forest cover loss seems to be on the increase over the years in Kalulu Forest. What are some of the measures the department has put in place to reduce this?
……
……
……
……
……

9. Does the department educate the settlers in and around the forest on forest management approach(s)? …….
   a. If so, how often are these lessons conducted?

   ……
   ……
   ……
   ……
   ……

   b. Have these lessons had any bearing on the way the community perceives the forest resource?

   ……
   ……
   ……
   ……
   ……

   If not, why doesn't the forest department conduct such lessons?

   ……
   ……
   ……
   ……
   …

10. What are your comments on the perceptions and attitudes of the communities in and around Kalulu Forest Reserve on the forest resource?
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11. Do you think the forest management approach(s) used in Kalulu Forest Reserve are effective? …….
    a. If yes, what are the parameters you are basing that on?

    ……
    ……
    ……
    ……
    ……

    b. If not, why are they not effective?

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    ……

12. What are some of the existing opportunities to enable Kalulu Forest to be managed more efficiently?
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    ……
    ……
    ……
    ……

IDENTIFICATION

i) Name: ……..... ii) Contact Phone: .....

iii) Position..... iv) Length in the Position.....

Appendix C: Interview Guide for Lukanga Water and Sewerage Company Key Informant.

INTRODUCTION: *Hello. My name is Mwenya Mundende from the University of Zambia. I am conducting a research on Forest Cover Changes and Forest Management Approaches in State Owned Forests. A case of Kalulu Forest Reserve No. 32.* ***The aim of this study is to examine forest cover changes and the effectiveness of forest management approaches in Kalulu Forest Reserve No. 32.*** *I would like to talk to you about your experiences in Kalulu Forest Reserve. I would also like to assure you that everything we discus will remain confidential and will only be used for the purposes of this research. I thank you for accepting to be part of these discussions*

1. How long has LWSC been pumping water from Kalulu water catchment?

   …….

2. What are some of the observable changes since the inception of the pumping to date?

   ……
   ……
   ……
   ……
   ……
   ……

3. Illegal settlers around the water catchment area in Kalulu have seemingly affected pumping of water. What are some of the effects that can be underlined?

   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

4. Has LWSC tried to conduct any deliberate educational program to teach these illegal settlers on the negative implications of settling there?

   …….

5. If YES to Q4, what was/were the lesson(s) based on? Furthermore, what have been the effects of the same lessons?

   ……

……

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……

6. If NO to Q4, why not?

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7. Kalulu Forest was gazetted as a forest reserve for the sole purpose of protecting the water catchment area for Kabwe, have there been any consolidated efforts between LWSC and the Forest Department in Kabwe to achieve this purpose?

…….

8. If YES to Q7, what efforts can be highlighted and what are the effects of the same?

……
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9. If NO to Q7, why not?

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10. What are some of the challenges can be emphasized in water resource management in Kabwe?

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11. Going forward, what solutions is LWSC considering or recommending with regards to Kalulu water catchment?

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Appendix D: Likert Scale Guide for Settlers

1. The forest cover loss is due to the activities done within and around the forest.

   [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
2. The areas surrounding Kalulu Forest do not benefit as much as the settler in the Forest. [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
3. There is need to adjust how Kalulu Forest is managed

   [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
4. The Forest Department should manage Kalulu Forest Reserve

   [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
5. The community leadership and the community should manage Kalulu Forest Reserve [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
6. If the Forest Department taught the settlers on forest preservation and forest management, the forest would not have been lost to the current state

   [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
7. The current forest management approaches are effective in managing Kalulu Forest Reserve [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree
8. If I was offered alternative land to relocate from Kalulu Forest Reserve, I would you take it. [ ] Strongly disagree [ ] Disagree [ ] No opinion [ ] Agree [ ] strongly agree

Appendix E: Error matrix for supervised classifications of the Kalulu Forest Reserve (2000)

Class	Bareland	Cropfield	Open vegetation	Wetland	Water	Total	User's %
Bareland	26	10	0	0	0	36	**72.22**
Cropfield	1	7	0	0	0	8	**87.50**
Open vegetation	0	1	88	0	0	89	**98.87**
Wetland	0	0	0	17	0	17	**100**
Water	0	0	0	5	25	30	**83.33**
Grassland	4	4	1	0	0	5	**80**
Closed vegetation	0	0	3	0	0	3	**100**
Total	27	22	92	22	25	188	
Producer's %	**96.29**	**31.82**	**95.65**	**77.27**	**100**		

Overall Accuracy= 88.72%

Kappa Coefficient= 0.8566 or 85.66%

Appendix F: Error matrix for supervised classifications of the Kalulu Forest Reserve (2005)

Class	Bareland	Closed vegetation	Open vegetation	Cropfield	Grassland	Total	User's %
Bareland	18	0	0	1	0	19	**94.73**
Closed vegetation	0	9	14	0	0	23	**39.13**
Open vegetation	0	7	73	0	3	83	**87.95**
Cropfield	5	0	0	7	1	13	**53.85**
Grassland	0	0	9	4	33	46	**71.73**
Total	23	16	96	12	37	184	
Producer's %	**78.26**	**56.25**	**76.04**	**58.33**	**0**		

Overall Accuracy = 79.03%

Kappa Coefficient = 0.7339 or 73.39%

Appendix G: Error matrix for supervised classifications of the Kalulu Forest Reserve (2010)

Class	Bareland	Cropfield	Water	Grassland	Closed vegetation	Total	User's %
Bareland	30	2	0	10	0	42	**71.43**
Cropfield	2	17	0	2	0	21	**80.95**
Water	0	0	25	0	0	25	**100**
Grassland	0	0	0	80	0	80	**100**
Open vegetation	0	0	0	0	109	109	**100**
Total	32	19	25	92	109	277	
Producer's %	**93.75**	**89.47**	**100**	**86.95**	**100**		

Overall Accuracy = 94.14%

Kappa Coefficient =0.9249 or 92.49%

Appendix H: Error matrix for supervised classifications of the Kalulu Forest Reserve (2015)

Class	Bareland	Water	Open vegetation	Grassland	Cropfield	Total	User's %
Bareland	30	0	0	0	0	30	**100**
Water	0	29	0	0	0	29	**100**
Open vegetation	0	0	54	0	0	54	**100**
Grassland	0	0	9	8	0	17	**47**
Cropfield	0	0	0	17	30	47	**63.82**
Total	30	29	63	25	30	177	
Producer's %	**100**	**100**	**85.71**	**32**	**0**		

Overall Accuracy = 87.96%

Kappa Coefficient =0.8557 or 85.57%