KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI – GHANA

DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

COLLEGE OF SCIENCE

IMPACT OF ANTHROPOGENIC ACTIVITIES ON CHANGES IN FOREST COVER, DIVERSITY AND STRUCTURE IN THE BOBRI AND OBOYOW FOREST RESERVES IN GHANA

by

FRANK ANKOMAH

JULY, 2012

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A Thesis submitted to the Department of Theoretical and Applied Biology

in partial fulfillment of the requirement for the award of the

Master of Science degree in Environmental Science

by

FRANK ANKOMAH

JULY, 2012

DECLARATION

I declare that this thesis work entitled "**impact of anthropogenic activities on changes in forest cover, diversity and structure in the Bobri and Oboyow forest reserves in Ghana** "is as a result of my own research findings, prepared and submitted to the Kwame Nkrumah University of Science and Technology, Kumasi - Ghana, Department of Theoretical and Applied Biology in partial fulfillment of the requirement for the award of Master of Science Degree in Environmental Science, except for the references which have duly been acknowledged.

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DEDICATION

All thanks and praise belong to GOD the creator of us all, for His kind and loving hands have kept me safe that I did not tremble on the road to achieving this academic feat and it is for this reason that I sincerely dedicate my work to Him.

This thesis work is also dedicated lovingly to the most important people in my educational career: Mrs. Lydia Opoku and Mr. Oduro Barnie both Regional Managers of the Forest Services Division of the Forestry Commission. I could not have agreed more with Napoleon Hill who once said that "more gold has been mined from the thoughts of men than has ever been taken from the earth" because it is for your encouragement and advice that has brought me this far.

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ABSTRACT

Forests are essential for human survival and well-being. During the past millennium, humans have taken an increasingly large role in the modification of the global environment. Globally, land cover today is altered primarily by direct human use. The study therefore used GIS based technique, to determine the land cover change for the two forest reserves. Satellite images spanning 1990-2010 on a ten year interval were acquired using Landsat Enhance Transverse Mecator (ETM) and data analyzed using Erdas Imagine and ArcGIS software, after performing supervised classification to validate these images. The study showed that Closed Canopy areas for Bobri and Oboyow Forest Reserves had reduced from 3292.2 ha and 3345.9 ha in 1990 to 1588.6 ha and 1370.2 ha in 2010 respectively. Correspondingly, Open Canopy areas for Bobri and Oboyow increased from 1556.3 ha and 3333.4 ha in 1990 to 2741.3 ha and 3091.1 ha in 2010 respectively. The shrub layer increased considerable by 13 % over the period for Oboyow F/R, an indication of loss of forest cover. Field inventory conducted showed mean basal area for Bobri and Oboyow as 32.93^{a} and 13.75^{b} respectively with $P < 0.001$. Bobri was significantly higher than Oboyow. Using Shannon Wiener diversity index, closed canopy for Bobri was $2.124^{a,}$ open canopy was 1.247^{b}; Oboyow recorded closed canopy 1.634^{c} and open canopy 1.073^{d} with $P < 0.001$. Closed canopies for the two reserves were significantly higher. Overexploitation of timber, improper logging practices, constant revision of the harvesting schedule etc. accounted for the loss of forest cover. Results indicates that the Forestry Commission (FC) should stop the constant revision of the harvesting schedule and put in place mechanisms to induce political will from governments whilst mainstreaming community participation in forest management.

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LIST OF ACRONYMS

dbh	Diameter at breast height
ETM	Enhance Transverse Mecator
FAO	Food and Agricultural Organization
FC	Forestry Commission
FORIG	Forest Research Institute of Ghana
FSD	Forest Services Division
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Position System
HFZ	High Forest Zone
ITTO	International Tropical and Timber Organization
CERSGIS	Center for Remote Sensing and Geographic Information Systems
LMCC	Log Measurement and Conveyance Certificate
MoP	Manual of Procedure
NRMP	Natural Resource Management Programme
NTFP's	Non Timber Forest Products
REDD	Reduced Emission from Forest Degradation and Deforestation
SFM	Sustainable Forest Management
SPSS	Statistical Package for Social Sciences
SRA	Social Responsibility Agreement
TUC	Timber Utilization Contract
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UTM	Universal Transverse Mecator
VPA	Voluntary Partnership Agreement
WGS	World Geodetic System

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

The total land area of Ghana is about 23.85 million hectares with forest areas confined to two vegetation zones, each with different forest types: the high forest zone (HFZ) constitutes 34 % and the savannah zone forms the remaining 66 % (Marfo, 2010). Forests designated for the production of timber are mainly concentrated in the southwestern part of the country; forest types range from wet evergreen to semi-deciduous. Forest lands are owned by local communities and stools (chiefs and families). However, timber resources, whether inside forest reserves or outside them, are managed by the Forestry Commission. Thus, even though traditional authorities are recognized as "land–owners" and receive benefits as such, they do not have any management rights over "their" forests. Approximately, 20 % of the High Forest Zone is gazette as forest reserves (Marfo, 2010). These areas are to be managed for timber production, biodiversity and environmental conservation. About 0.39 million hectares of forest reserves have been categorized as degraded while 0.35 million hectares have protected status (including hill and swamp sanctuaries, areas of high biodiversity and fire protection sites) and the remainder is suitable for timber production (Marfo, 2010).

Forests provide numerous goods and services to support human life—timber and materials, firewood, food, medicines, fodder for livestock, and a variety of sources of income. Many forests are rich stores of valuable biodiversity stocks. They protect the fertility and stability of soils, play a key role in watershed management, are the habitats

of countless species of wildlife, and homes for many cultures and communities. Forests help to regulate the global climate and to mitigate climate change by absorbing carbon dioxide, which would otherwise enter the atmosphere as a greenhouse gas. In short, forests are natural assets of enormous importance (SCBD, 2009).

In terms of economic contribution, forestry and logging accounted for 3 per cent GDP in 2009 and contributed US$240.9 million (representing 7.6 per cent) to total export value. It is estimated that about 120,000 people are formally employed by the forest and wildlife sector, and it serves as a source of livelihood for about 2 million people (MLNR, 2011).

In order to maintain the economic benefits the forest provides for nations, man has made unprecedented changes to the forest ecosystems. According to Boakye *et al*. (2008), vegetation changes are often the result of anthropogenic pressure (e.g. population growth) and natural factors such as variability in climate. They reported that tropical forests are exploited for varied purposes such as timber, slash-and-burn cultivation and pasture development. They further explained that degradation of forest or woodland has impact on catchment processes and biochemical cycles and leads to soil erosion and water shortage not only in the regions immediately affected by deforestation, but also in reasonably distant areas. Due to increasing population growth rates, there have been increasing rates of conversion of forest and woodlands in developing economies all over the world, mainly for the slash-and-burn farming practice (Groten *et al*., 1999).

Consequently, the past two decades has witnessed increased attention of the world community to the issue of conservation and wise use of natural resources. In an effort to halt the deleterious effects of deforestation, global warming and climatic change, certain

European countries unilaterally moved to restrict importation of tropical timbers. In response, the International Tropical Timber Organization (ITTO), of which Ghana is an active member, launched its Target 2000, aimed at ensuring that trade in tropical timber will be sourced from sustainably managed forests by the year 2000 (MLF, 1994).

However, with increasing demand for wood and forest land for agricultural purposes due to population pressure, advances in science and technology, growing ecological importance of the forest in terms of genetic biodiversity and wildlife, institutional changes, and the increasing need for popular participation in resource management, Ghana responded by enacting the Forest and wildlife policy of 1994 to reflect and address the challenges of forest loss and land cover change.

The aim of the 1994 Forest and Wildlife Policy was "to sustainably develop and conserve the nation's forest and wildlife resources for maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society" (MLF, 1994). Forest and wildlife resources have long been major contributors to Ghana's economic development, formal and informal employment, livelihoods and export earnings. The forest and savannah ecosystems provide rich biodiversity of national and global significance and form the backbone of the economic and productive sectors of the Ghanaian economy. Unfortunately, the exploitations of these resources for national development have not been sustainable over the years.

1.2 Problem Statement

After drafting the 1994 Forest and Wildlife Policy, the Ministry of Lands and Forestry developed a Forestry Sector Development Master Plan (MLF, 1994). The Forestry Department Master Plan has therefore been prepared as a sound basis for attainment of

the aims of the Forest and Wildlife Policy, and its successful implementation is intended to maximize the rate of social and economic development of the country and secure optimum welfare and adequate means of livelihood for all Ghanaians (MLF, 1994).

A number of strategic initiatives were introduced to improve and develop the forest and wildlife resource base; integrate good governance, transparency, equity and poverty reduction into the forest and wildlife sector. The 1994 policy introduced equitable sharing of management responsibilities; increased benefit flows to local stakeholders, especially the rural poor; and increased participation, transparency and accountability in the sector activities. However, there is a paradox. The implementation of the 1994 policy with all the associated reforms could not halt the degradation in the forest resource base. Illegal chainsaw and mining (*galamsey*) operations in forest areas have thrived over the years despite conscious national efforts to curb the situation in collaboration with the security agencies (MLNR, 2011).

Forests in Ghana have suffered a serious decline because of over-exploitation to meet the growing socio-economic needs of the population (EPA, 2004). Today forest estates continue to dwindle at an estimated annual deforestation rate of 2 % (65,000 ha) valued at annual degradation cost of 10 % of Gross Domestic Product (GDP), (MLNR, 2011). However, the changes in the forest cover show the quantitative figures and trends of the forest loss but little seems to have been done qualitatively on how much in terms of tree species diversity, composition and structure have changed. Finding answers to these problems have therefore informed this study.

1.3 General Objective

The main aim of the study was to determine changes in plant diversity, forest cover and structure over a period of time (20 years) in the Bobri and Oboyow Forest Reserves.

1.3.1 Specific Objectives

The specific objectives were;

- to determine the land cover change for the two Forest Reserves through the use of Geographic Information System (GIS),
- to identify tree species in the two forests, to determine the abundance and basal area of trees,
- to examine methods of timber exploitation if they are in line with Forest Stewardship Council (FSC) certification standards,
- to assess the effects of timber exploitation on the livelihood of the fringe communities through an open ended questionnaires.

1.4 Research Questions

To gain a better understanding, the following questions were formulated in order to gain more empirical information about the situation in Ghana:

- Has forest cover of these forests changed over the past three decades?
- How has timber exploitation affected the livelihood of fringe communities?
- How have forest management practices influenced plant diversity, forest cover and structure?

1.5 Justification

The Sustainable Forest Management (SFM) concept has been initiated to address many problems relating to deforestation, especially those in developing countries. International Tropical Timber Organization (ITTO) pioneered in defining criteria and indicators of natural tropical forest for sustainable forest management in the early 1990's. ITTO is still aiming at achieving SFM by reviewing, assessing and monitoring forest lands (ITTO, 2004).

Many studies have been performed to identify factors that cause deforestation in developing countries. However, the most important factor that causes deforestation comes from Illegal logging and trade (Atmopawiro, 2004; Zaitunah, 2004). According to Casson and Obidzinski (2002), illegal logging is defined as the harvesting of logs in contravention of laws and regulations that were designed to prevent the overexploitation of forest resources and to promote sustainable forest management. It is estimated that logging is generating between US$10 billion and $15 billion of forest losses globally every year (FAO, 2004).

Even though Ghana continues to operate based on sustainable forest management principles and procedures since the adoption of the 1994 Forest and Wildlife Policy, it as well have a number of laws and several pieces of legislation introduced in the forest sector including the Forestry Commission Act of 2005 (Act 543), the Plantations Development Fund Amendment of 2002 (Act 623) and the Timber Resource Management Act (as amended) (Act 547 of 1997 and Act 617 of 2002) — and their

legislative instruments (LI 1649 and LI 1715). The Forest Protection (Amendment) Act 2002 (Act 624). Trees and Timber (Amendment) Act, 1994 (Act 493). Essentially, the laws outline the functions of the Forestry Commission (FC) in managing the forest resources of Ghana and prescribe the qualifications and procedures for the allocation of timber rights and participation in plantation development. The laws also prescribe the rights of local communities and the payment of forest fees by forest users.

In spite of the aforementioned legal framework and the Master Plan governing the use and management of Ghana's forest resources, Marfo (2010), reports that about 80 percent of Ghana's forests have been destroyed by illegal logging. The Ghana Forestry Commission estimates that US$256 million in illegal timber leaves the country each year, most of which enters Europe, Ghana's biggest timber consumer (Forestry Commission, 2007).

In recent times, biodiversity has become easy targets for human over-exploitation due to burgeoning human populations and the quest for a "better life" through improvements in science and technology. Biodiversity, therefore, is being exploited at much faster rates than ever before with negative implications for sustainable human livelihood (Turner *et al.*, 1990). Wilson (1992) has stated that biodiversity is facing a decline of crisis proportions which could ultimately lead to mass extinctions in the very near future. In Ghana, increasing evidence indicates that the rate of environmental degradation has increased in recent times (Gyasi *et al.*, 1995), with previously rich forests being converted to savanna woodland and existing savanna woodlands converted into near desert (Hawthorne and Abu-Juam, 1995). It has been estimated that Ghana's high forest

area of 8.2 million hectares at the turn of last century had dwindled to about 1.7 million hectares by the mid-1980s (Hall, 1987), and about one million hectares by the mid-1990s (Forest Services Division, 1996).

In the light of this dwindling trends, the Forestry Sector in Ghana have lost its major role and influence in the National economy. The timber industry used to be the third largest export earner after gold and cocoa, contributing 6 % to GDP and 18 % of total export earnings in 1994 (MLF, 2010). Today, reports from the sector ministry indicates that, forestry only accounts for about 4 % of the Gross Domestic Product (GDP) and 11 % of national export revenue, a decline of 2 % and 7 % respectively over the past five years.

One thing which has become evident is that the Forestry Commission is good in monitoring activities to achieve the objectives of the Master Plan than evaluating outcomes or impacts of the plan, so there was no surprise when further checks on the sector ministry and the Agency mandated with the policy implementation (Forestry Commission) revealed that since the adoption of the concept of SFM and the Forest and Wildlife policy and its Master Plan in 1994 and 1996 respectively to date, about two decades ago not much work seems to have been done to evaluate the impact of anthropogenic activities on changes in Ghana's forest cover, tree species diversity and composition. Therefore the need for the research work to be carried out to assess these impacts on sustainable forest management (SFM).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 World's Forest Resources

Forests are essential for human survival and well-being. They harbor two thirds of all terrestrial animal and plant species. They provide us with food, oxygen, shelter, recreation, and spiritual sustenance, and they are the source for over 5,000 commercially-traded products, ranging from pharmaceuticals to timber and clothing. The biodiversity of forests—*the variety of genes, species, and forest ecosystems*—underpins these goods and services, and is the basis for long-term forest health and stability (SCBD, 2009).

According to Ahmed (2008), about one half of the forests that covered the Earth are gone. Each year, another 16 million hectares disappear. The World Resources Institute estimates that only about 22% of the world's (old growth) original forest cover remains "intact" - most of this is in three large areas: the Canadian and Alaskan boreal forest, the boreal forest of Russia, and the tropical forest of the northwestern Amazon Basin and the Guyana Shield (Guyana, Suriname, Venezuela, Columbia, etc.).

2.2 Ghana's Forest Resource

Ghana has two predominant ecological zones: the high forest zone mainly in the south-western part constituting a third of the country (about 35 percent of the country) and the savannah zone occupying the rest of the country. The forests are classified as *on-reserved* and *off-reserved* and there are 282 Protected Areas covering a total area of 23,729 km² with 216 of them located within the high forest zone. Forest and wildlife conservation areas constitute about 16.2 percent of the total land area (MLNR, 2011). Two types of

Protected Areas exist - Production reserves exploited for timber (75 per cent) and Protected forests (25 per cent) established for conservation purposes (MLNR, 2011).

The biological diversity of the high forest ecological zone is considerable and accounts for most of the biological diversity of the country. For example, out of 3,725 higher plants known to be in Ghana, about 2,300 are found in the high forest zone, including 730 tree species. Similarly, 185 of the 222 mammals of Ghana and about 200 of the 494 resident birds in Ghana are present in the high forest zone. Amphibians, reptiles and fishes have not yet been systematically surveyed in the forest zone but it is assumed that this zone harbours most of the diversity of these groups. (National Biodiversity Strategy for Ghana, 2002 as cited in MLNR, 2011).

2.3 Forests and Wildlife Contributions to Ghana's Economy

In terms of economic contribution, forestry and logging accounted for 3 per cent GDP in 2009 and contributed US$240.9 million (representing 7.6 per cent) to total export value. It is estimated that about 120,000 people are formally employed by the forest and wildlife sector, and it serves as a source of livelihood for about 2 million people. There are 84 sawmills and 12 companies with plywood capacity in the formal sector, directly employing about 120,000 people. (Country Environmental Analysis, 2007 as cited in MLNR, 2011).

In the informal sector, however, a wide mix of actors and rural households depend on forest resources for their livelihoods, ranging from micro/small scale carpentry, hunting, illegal chain-saw operations, and wood fuel collection to the gathering and commercialization of diverse non-timber forest products (NTFPs). About 11 million people live in forest areas of which about 67 per cent of their livelihoods are supported by

forest activities. It is estimated that there are about 5,000 to 6,000 people engaged in regular hunting, with an average income from hunting of around $1,000 per year. Even though they are of very high importance to the national economy, the extent of the contribution of non-timber forest products (NTFPs) are not formally recorded, and remains inadequately represented in policy analysis. Wild animal and wild plant exports were valued at US$18.0 million in 2003 (World Bank, 2006 as cited in MLNR, 2011). Bush-meat is of high dietary importance as a protein source in Ghana, but there is no consistency in national statistics on the annual trade in bush meat. The primary indigenous energy sources in Ghana are from the forestry sector comprising of 94.5 percent wood fuel (Strategic National Energy Plan, 2006). Biomass in the form of firewood and charcoal dominates the total energy consumed in the country (averaging 67 per cent in 2008; MLNR, 2011).

2.4 State of Ghana's Forest Cover

Ghana, like many tropical countries, continues to lose its remaining closed forests at an alarming rate. At the beginning of the last century, about one-third (i.e. 8.2 million hectares) of the total land area was covered by high forest while the remaining two-third (15.7 million hectares) was savannah woodland (Owusu *et al*., 1999). The area of high forest (off reserve) has drastically reduced and the only remaining portions today are mainly in remnant or sacred grooves. Records show that at the turn of the last century, Ghana had about 8.2 million ha of primary forest. By 1950, the area had been reduced to 4.2 million hectares and further to about 1.5 million ha by 1999 (Owusu *et al*., 1999). This implies that from 1900 to 1950, the nation lost 50 % of its primary forest cover and also lost about 60 % of the remaining forest cover between 1950 and 1999.

From (1900 to 2000), the nation lost over 80 % of the closed forest (a reduction from 8.2 million ha to 1.5 million hectares). Farrhead and Leach (1998) estimated the deforestation rate to be a massive 22,000 hectares per year around the late 90's. From some more recent trends, Mongabay.com reported that, between 1990 and 2000, the average annual deforestation rate was 1.82 %. Also, between 2000 and 2005, the rate of forest change increased from 1.89 % to 4.2 % per annum. The recent FAO (2010) Country report on Ghana's forest has estimated Ghana's deforestation at 135,395 ha per year.

According to Tropenbos (2005), the crisis in the forestry sector is deepening rapidly. Satellite imagery suggests that the forest resource is depleting faster than at any time in our history and that state managed forest reserves are now also under siege. As forest resources dwindle and industry competes fiercely for what remains, the vicious cycle of state capture, over-logging, rural stakeholder marginalization and conflict has speeded up considerably.

2.5 Forest Condition Score

The condition of each of the 214 reserves has been assessed drawing attention to the general trends and forest quality within the reserve boundaries. A single score has been applied to each forest reserve to summarize the general condition (Hawthorne and Abu Juam, 1993). The condition score runs from 1 to 6, with condition 1 forest reserves showing minimal signs of disturbance and condition 5 forest being seriously degraded with few upper canopy trees. Condition 6 reserves have no significant forest at all. Condition scores 1-3 refer to low to moderate disturbance, with healthy vital parts of the forest mosaic in the ascendance and regeneration of timber trees and other forest plants usually abundant. Well-managed, selective logging should generate condition 2-3 forest

by the end of a felling cycle. Scores 4-6 are applied to forests that have suffered slight degradation over more than half the reserve or heavy degradation over more than 25 per cent of it. Very often there is poor regeneration. In summary, about half of the reserved forest, some 900,000 ha, is in "reasonable condition" and the remainder is "mostly degraded" or worse (Hawthorne and Abu-Juam, 1993).

2.6 Causes of Deforestation and Forest Degradation

Deforestation has been practiced by humans since the beginning of civilization. Fire was the first tool that allowed humans to modify the landscape. Fire was also probably used to drive game into more accessible areas. With the advent of agriculture, fire became the prime tool to clear land for crops (Ahmed, 2008).

Degradation takes different forms particularly in open forest formations deriving mainly from human activities such as overgrazing, overexploitation (for fuel wood or timber), repeated fires, or due to attacks by insects, diseases, plant parasites or other natural source. In most cases, degradation does not show as a decrease in the area of woody vegetation but rather as a gradual reduction of biomass, changes in species composition and soil degradation. Unsustainable logging practices can contribute to degradation if the extraction of mature trees is not accompanied with their regeneration or if the use of heavy machinery causes soil compaction or loss of productive forest area (FAO, 2006). The misuse of forest resources due to the centralization of forest management policy is considered as another factor for deforestation (Rosyadi *et al*., 2003). Moreover, Boltz (2003) mentioned that conventional logging operation with unplanned-selective logging method also becomes one factor of deforestation. However, the most important factor that

causes deforestation comes from Illegal logging and trade (Atmopawiro, 2004; Zaitunah, 2004). According to Casson and Obidzinski (2002), illegal logging is defined as the harvesting of logs in contravention of laws and regulations that were designed to prevent the overexploitation of forest resources and to promote sustainable forest management. It is estimated that logging is generating between US$10 billion and $15 billion of forest losses every year (FAO, 2004).

Many studies have cited different agents as causes of forest depletion. According to Hermosilla (2000), forest depletion is the result of actions by a number of agents. Agents are individuals, groups of individuals or institutions that directly convert forested lands to other uses or that intervene in forests without necessarily causing deforestation but substantially reducing their productive capacity. Agents include shifted cultivators, private and government logging companies, mining and oil and farming corporations, forest concessionaires and ranchers. These agents clear forest lands or selectively exploit forests for agricultural expansion, for mining, to obtain forest products and fuel wood, etc. The construction of access roads and the penetration of forest areas by other agents compound this effect.

2.7 Effects of Forest Degradation and Deforestation on Species Dominance

Forest degradation refers to any activity that affects the quality of the forest (Guuroh, 2010). According to FAO (2006), forest degradation is the changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services. Very often degradation does not show up so much in decrease of woody vegetation but rather as a gradual reduction in biomass, changes in species composition and soil degradation (FAO, 2000).

According to Fiset (2008), consequences of degradation are; loss of biodiversity, non-suitability of deforested areas for conversion, flooding and soil erosion.

Land-use change is thought to have the greatest impact on biodiversity in tropical forests (Sala *et al*., 2000). Forest clearance destroys the habitat and generally causes a decline in forest species abundance and diversity, particularly for species that are restricted in range. Diverse taxon show different and often variable responses (Lawton *et al*., 1998; Barlow *et al*., 2007).

2.8 Invasive species and its effect on Forest structure and composition

Invasive species are non-native species that have established outside their natural range, while introduced species have been established outside their natural range by human action. Both invasive and introduced species can cause extinctions, alter abiotic environments, become pests, or introduce diseases (Bradshaw *et al*., 2009), particularly targeting species with a lower reproductive potential or those that are naive to competitors or predators (Purvis *et al*., 2000). Much of the evidence for the detrimental effects of invasive species is based on correlations between invasive species dominance and native species decline in degraded habitats (Didham *et al*., 2005). In these cases, invasive species could be driving the native species loss or could simply be taking advantage of habitat modification or another ecosystem change that is itself driving the native species loss (MacDougall and Turkington, 2005). Invasive species may cause biotic homogenization, where species assemblages become dominated by a small number of widespread species that thrive in human-altered environments (McKinney and Lockwood, 1999). Tropical forest communities that have been substantially altered by

invasive or introduced species occur predominantly on heavily disturbed islands (Ghazoul and Sheil, 2010). Intact continental rainforest may be more resistant to invasion because of the high species and functional group richness, high competitive exclusion rates and high pest loads (Denslow and DeWalt, 2008). Invasive species can, however, dominate disturbed or open tropical forest areas, impacting their recovery (Ghazoul and Sheil, 2010).

2.9 Impact of Logging on Forest Structure and Composition

Forest structure and composition and their implications for biodiversity are difficult to evaluate at broad geographic scales and may vary widely depending on (among other factors) the kinds and intensity of human activity and local ecological conditions. It is well-documented, for example, that logging increases the probability of recurrent fire in Amazonian rain forests (Uhl *et al.*, 1991; Nepstad *et al*., 1998), and that this in turn will lead to long term changes in species composition (Cochrane and Schulze 1998, 1999). Logging also affects animal community composition and ecological relationships (Johns 1996; Lambert 1992; Ochoa, 2000). Hunting activity near settlements substantially reduces the abundance of mammal species (Muchaal and Ngandjui, 1999) and the construction of roads facilitates logging and hunting as well as land conversion and colonization.

2.10 Impact of Forest Degradation and Deforestation on VPA and REDD+

Forest depletion constitutes a threat to forest sustainability and loss of potential forestry revenues, the situation posses a big challenge to implementation of Ghana's Voluntary Partnership Agreement (VPA) with the European Union. Though VPA is primarily concerned with legality of timber being exported to Europe, a component seeks to

promote legality of domestic lumber supply. This is because if legality of domestic lumber is not ensured, illegally sourced lumber for the domestic market could find its way as legal lumber for export. Besides, leaving out legality of domestic lumber supply would constitute a threat to forest sustainability, the ultimate goal the VPA seeks to contribute to.

Illegal chainsaw lumbering also constitutes a threat to Ghana's REDD plus agenda by which Ghana seeks to reduce the loss and degradation of her forests (Nutakor *et al.*, 2009).

The REDD+ concept as defined in the Bali Action Plan (UNFCCC Dec 1/CP.13) and subsequent COP decisions relates to reducing emissions from deforestation and degradation, the role of conservation, sustainable management of forests and enhancement of forest carbon stocks all within developing countries. REDD+ actions are sustainable development policies and measures to reduce emissions and/or enhance removals, knowing that these measures may well extend to the agriculture and bio-energy sectors, insofar as they impact forests. A REDD+ strategy can involve market or non market based instruments, and be based on performance according to established criteria or based on greenhouse gas quantification (FC, 2012).

2.11 Implementation of Forestry Legislation and its Challenges

Forest law enforcement is difficult in weak nations like Ghana in the face of conflicting interests and competing claims to forest resources. One area of interest in Ghana is the enforcement of a ban on chainsaw operation. Since 1998, chainsaw milling is legally

prohibited in Ghana. However, today, there is enormous evidence to show that the practice is on the increase, exploiting about 2.5 million cubic meters of trees annually and employing about 100,000 people. This high level of illegality presents a big challenge to implementation of Ghana's Voluntary Partnership Agreement with the European Union (EU) and also to Ghana's REDD+ (Reducing Emissions from Deforestation and Forest Degradation)-plus agenda. Nutakor *et al*. (2009) observes that high levels of rural unemployment, corruption among law enforcement agencies including the Forest Services Division (FSD) and the police, low political motivation and high elite influence in the forestry sector are some of the socio-political factors constraining effective enforcement.

2.12 Sustainable Forest Management Defined

The concept of Sustainable Forest Management (SFM) arose from the UN Conference on Environment and Development (UNCED) in 1992, and included social and environmental dimensions besides the economic aspects of forest use. The concept defines SFM as: "The process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the continuous flow of desired forest products and services without undue reduction in its inherent values and future productivity and without undue undesirable effects on the physical and social environment" (ITTO, 2006).

On the other hand, according to Shifley (2006), defining sustainability and sustainable forest management has been difficult because of complexity in relevant scientific concepts and the state of current technical progress that might have practical application for land managers. It's therefore necessary to improve the ability of the natural resource

community to interpret a variety of performance indicator measurements with regard to sustainability. Definitions related to sustainability have also eluded precise clarity and consensus because of the highly politically charged atmosphere that characterizes ongoing debates about forest management practices and land tenure involving landowners, forest industry, environmental conservation organizations, aboriginal peoples, the general public, and public agencies at local to national and international levels.

2.12.1 Ghana's Forest Policies and Sustainable Forest Management (SFM)

This policy of 1948 directed forestry activities in Ghana over a long period of time. The direction of this policy led to increasing emphasis on central government administration, control and ownership of the country's forests. Local people's involvement in forest management was not pursued as the policy had stated. According to (Owusu, 1999), Smith *et al*. (1995) and Tuffour (1996), there were an increasing marginalization and even alienation, of local communities in the administration of forests; a trend towards forestry being practiced only by foresters for the nation's benefit; and a trend towards what some early forest researchers have called the "timberisation" of forestry. This was the state of Ghana's forests from the post-independence period to the late 1980s.

In 1994, Ghana enunciated a forest and wildlife policy to replace the first formal forest policy of 1948, which was formulated for the conservation and protection of the forest reserve estates. The aim of the 1994 Forest and Wildlife Policy was "to sustainably develop and conserve the nation's forest and wildlife resources for maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society" (MLF, 1994). The main policy thrusts of the 1994 policy were environmental protection,

sustainable production and use of forest and wildlife resources, involvement of local people in management and benefit sharing, institutional restructuring and promotion of research and human resource development. A Forestry Development Master Plan was formulated in 1996 to implement the policy via a comprehensive donor funded sector development programme- the Natural Resource Management Programme [NRMP], (MLNR, 2011).

2.12.2 Sustainable Forest Management in Practice

Adoption and implementation of sustainable forestry practices are essential for sustaining forest resources, yet development of effective policies and strategies to achieve them are problematic. Part of the difficulty stems from a limited understanding of the interaction between obtrusive forest policies and indigenous tenure systems and how this affects sustainable forest management. Owubah *et al*. (2001) in their study used a market framework to analyze the relationships between individual components of forest tenure and sustainable forestry practices in Ghana, and concluded that the number of farmers engaged in sustainable forestry practices is small. This is because farmers, in their role as potential producers, perceive preservation of indigenous economically valuable trees and conservation of forests as having a net cost to them, especially if compensation is not paid for damage to crops resulting from logging operations by concessionaires. Current statistics in Ghana provide few incentives for farmers to engage in sustainable practices. The study also provided recommendations for forest tenure systems to function effectively.

2.12.3 Sustainable Forest Management and Public Participation

One of the core principles of Sustainable Forest Management (SFM) is that it reflects a diverse range of societal values in reference to forest conservation and use. For this reason, the active and informed participation of communities and stakeholders affected by forest management decisions is critical to the credibility and sustainability of management processes. Public awareness creation and communication activities play a critical role in informing and educating the public, thereby allowing them to more effectively participate in SFM decision-making (IUCN, 2010).

2.12.4 Sustainable Forest Management and Timber Harvesting

Timber harvesting is the removal of financially or technically matured trees from the forest for utilization. Timber harvesting therefore constitutes an integral part of silviculture and forest management systems. Generally, all wood based industries are dependent on the output of timber harvest for their supply of raw materials (Ford-Robertson, 1983 as cited in Abeney, 1996). Notwithstanding this function, timber harvesting causes various forms of damage resulting in deforestation, soil degradation, wood waste, and damage to the residual stand.

In Ghana, "the resource life" of *Pericopsis elata* which was introduced to the market after the Second World War was found to be threatened together with some of the traditional species (*Milicia excelsa* and *Entandrophragma spp*.) following the massive timber exploitation for export earnings (Alder 1989; Park 1992; Grainger, 1993 as cited in Abeney, 1996). Control for the sustainability of the timber resource base depends on the

frequency of harvesting. The felling cycle varies between 25 years in Liberia to 40 years in Ghana.

In order to protect immature timber species from felling, forest legislation has prescribed minimum felling limits for timber harvesting throughout the West African sub-region. Felling limits prescriptions are species specific and vary from country to country.

2.13 Forest Certification Standards

Forest certification was launched since 2002 to help protect forests from destructive logging practices. Like the "organically grown" sticker on produce, forest certification was intended as a seal of approval -- a means of notifying consumers that a wood or paper product comes from forests managed in accordance with strict environmental and social standards. There are a number of standards in used, but Ghana adopted the Forest Stewardship Council's (FSC) Certification Standard. The FSC was established in 1993 as one of the world's forest certification schemes (Gulbrandsen, 2004). The goal of the FSC is to promote environmentally responsible, socially beneficial and economically viable management of the world's forests, by establishing a worldwide standard of recognized and respected Principles of Forest Stewardship (FSC, 2007). To achieve this goal, the FSC provides global performance standards for well-managed forests in the form of prescriptive principles and criteria, including tenure and use rights, indigenous peoples' rights, community relations and workers' rights, environmental impact, management plan, monitoring and assessment, maintenance of high conservation value forests, and plantations (Gulbrandsen, 2004).

2.14 Land Cover Change Detection

Change detection according to Bruzzone and Cossu (2003), is the process of identifying differences in the state of an object or phenomenon by observing it at different times. Lambin and Strahler (1994), listed five categories of causes that influenced land-cover change: a) long-term natural changes in climate conditions, b) geomorphologic and ecological processes such as soil erosion and vegetation succession, c) human-induced alterations of vegetation cover and landscapes such as deforestation and land degradation, d) inter-annual climate variability and e) the greenhouse effect caused by human activities.

According to Ringrose *et al*. (1997), land cover change in Africa is currently accelerating and causing widespread environmental problems and thus needs to be mapped. This is important because the changing pattern reflects changing economic and social conditions. Monitoring such changes is important for coordinated actions at the national and international levels (Bernard and Wilkinson, 1997). Modern technologies such as Remote Sensing and Geographic Information System (GIS) provide some of the most accurate means of measuring the extent and pattern of changes in landscape conditions over a period of time (Miller *et al*., 1998). Damizadeh *et al*. (2000) used satellite images, as an effective technique to study how changes in vegetation cover is growing. Satellite data have become a major application in change detection because of the repetitive coverage of the satellites at short intervals (Mas, 1999). According to the IGBP/IHDP (1999), change detection studies seek to know (i) pattern of land cover change, (ii) processes of land use change, and (iii) human response to land cover change.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study area

The study was conducted in two Forest Districts in two regions of Ghana; Akim-Oda Forest District (Oboyow Forest Reserve) in the Eastern Region and Juaso Forest District (Bobri Forest Reserve) in the Ashanti Region.

Bobri Forest Reserve in the south-east sub-type of moist semi-deciduous (MSSE) forest in Ghana (Hall and Swaine, 1981), covering an area of approximately 5,445 ha, Bobri forest was demarcated in 1936 and reserved in its pristine, unexploited state in 1939 (Foggie, 1947, Alder, 1993). It lies between latitudes 6^{o} 39' and 6 o 44'N and longitudes 1^{o} 15' and 1^{o} 23'W. The mean annual rainfall is about 1,500 mm.

Oboyow Forest Reserve on the other hand covers an area of approximately 6,371 ha (Figure 1). The Forest Reserve is located at the latitude and longitude coordinates of 5.766667 and -.916667, with an average temperature of 25°C / 77°F, windy condition recorded showing 5.8km/ West/Southwest with clouds of a few at 1600ft. Within these reserves, the forest is luxuriant and exhibits the three-tier layer.

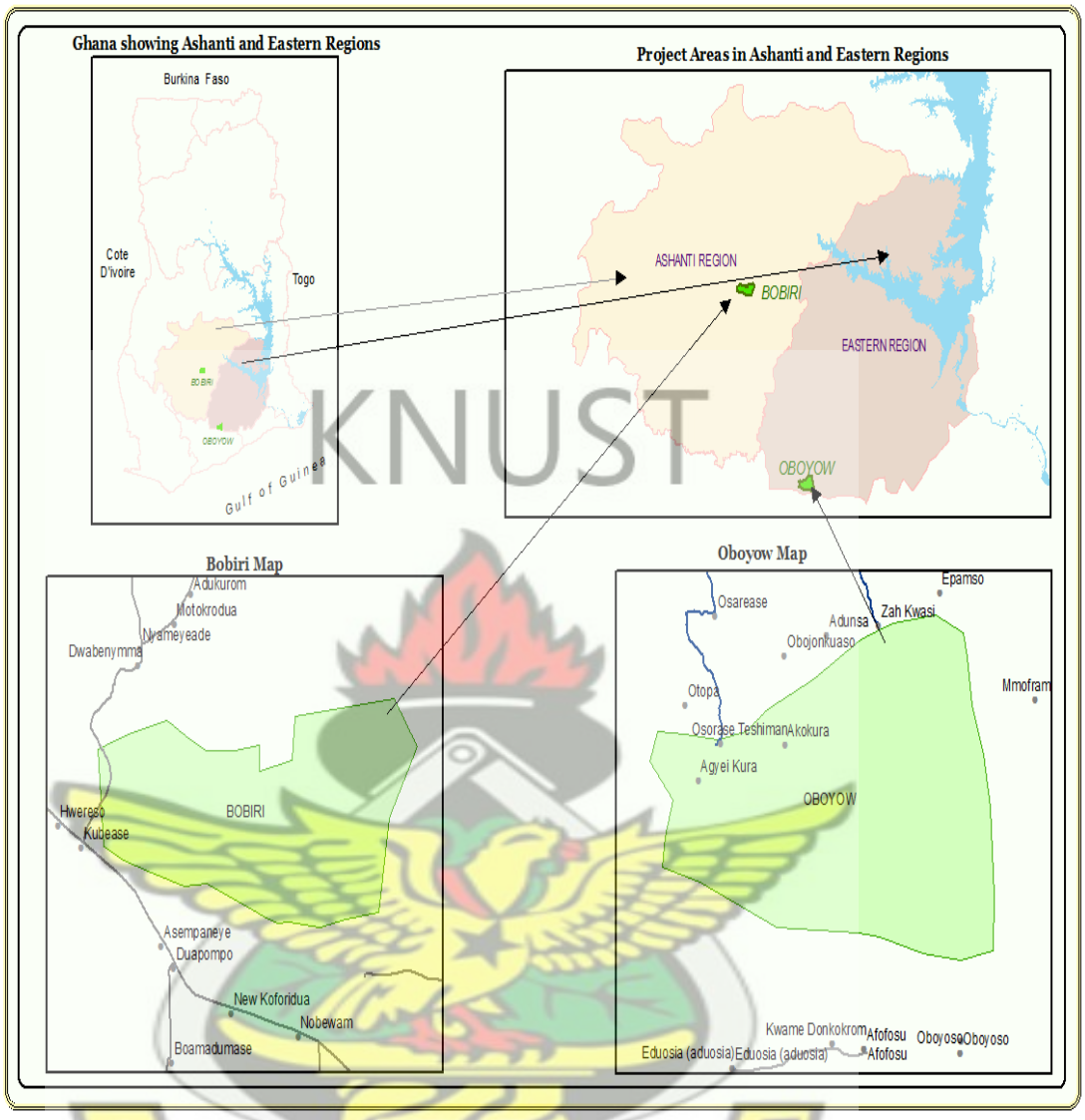


Figure 1: Map of the study area

3.2 Data collection

3.2.1 Detection of Land Cover Change

Using Geographic Information System (GIS) and data sources from Center for Remote Sensing and GIS (CERSGIS) from Legon, images were undertaken to determine the

change in the forest cover using a ten year interval period from 1990 to 2010. The following steps were followed.

- Raw satellite Image was acquired using Lansat Enhanced Transverse Mecator (ETM) image. This raw data showing the world was yet to be geo-referenced to Ghana, as shown below in Fig. 2

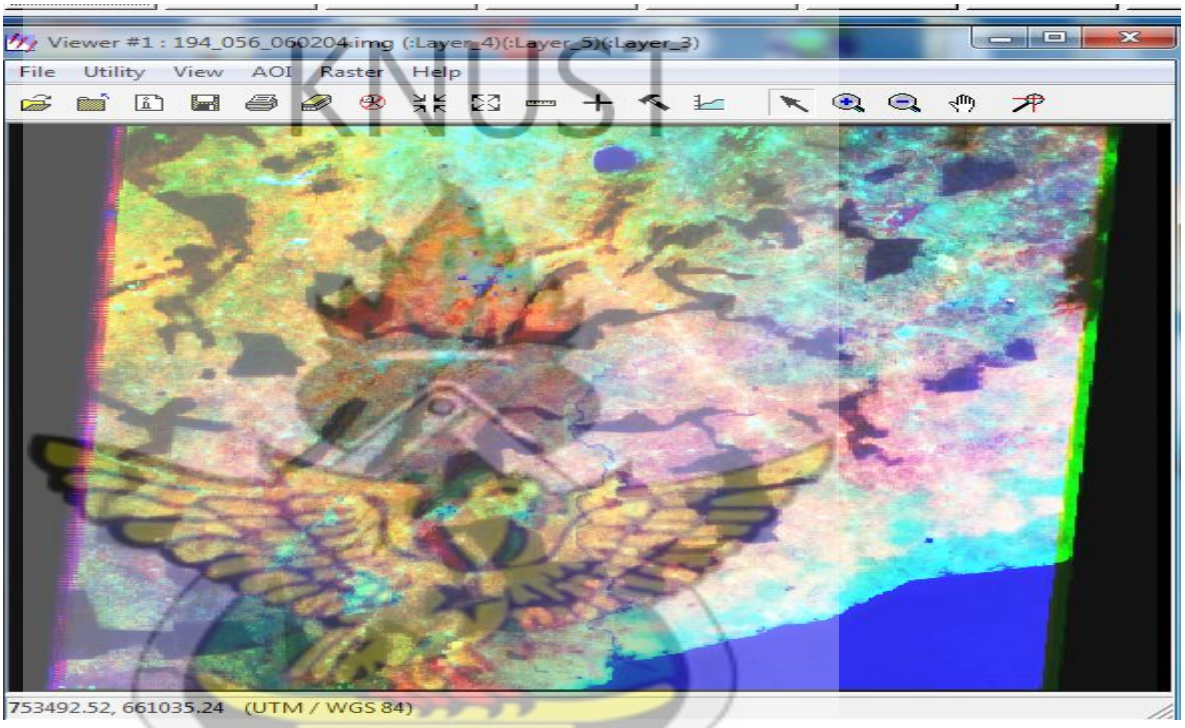


Figure 2: Raw satellite image not yet geo-referenced to Ghana's projection system

- Universal Transverse Mecator (UTM) World Geodetic System (WGS) UTM/WGS 84 was acquired as shown in Fig. 2. This was geo-referenced to Ghana's Projection System by assigning Ghana's coordinates to the image using ERDAS IMAGINE processing Software, as shown below in Fig. 3.

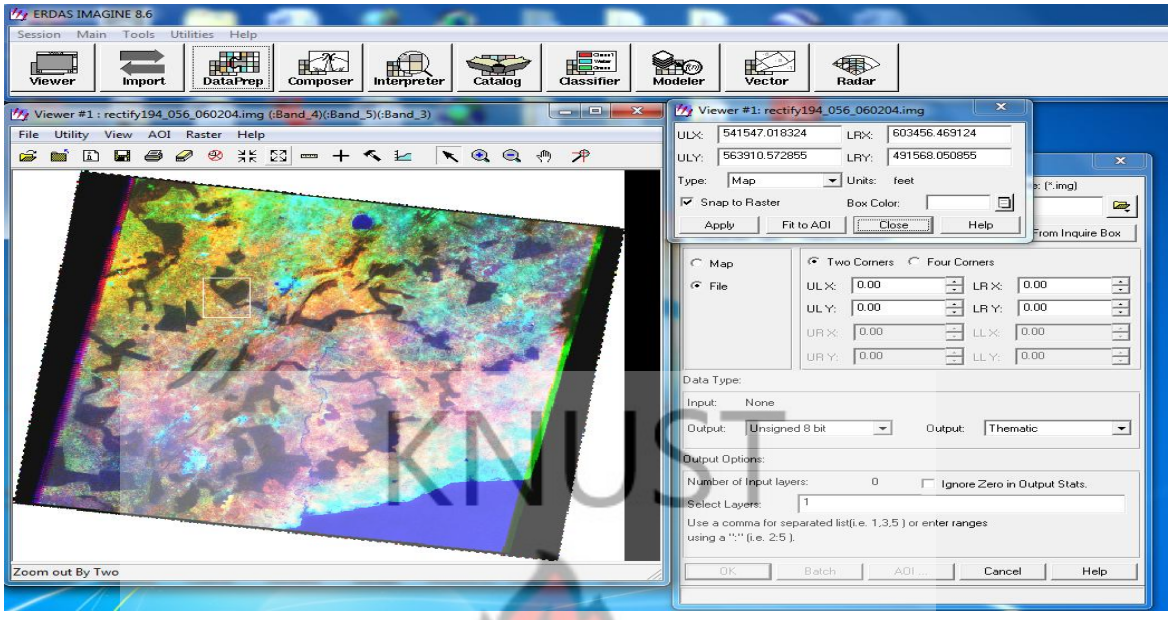


Figure 3: Geo-referenced map, showing the referenced map of Ghana.

- The project area of interest, for example Bobri Forest Reserve was subset using the forest reserve boundary coordinates. Sub setting is the process of breaking up a portion of a larger image into smaller one. Fig. 4. below shows Bobri F/R.

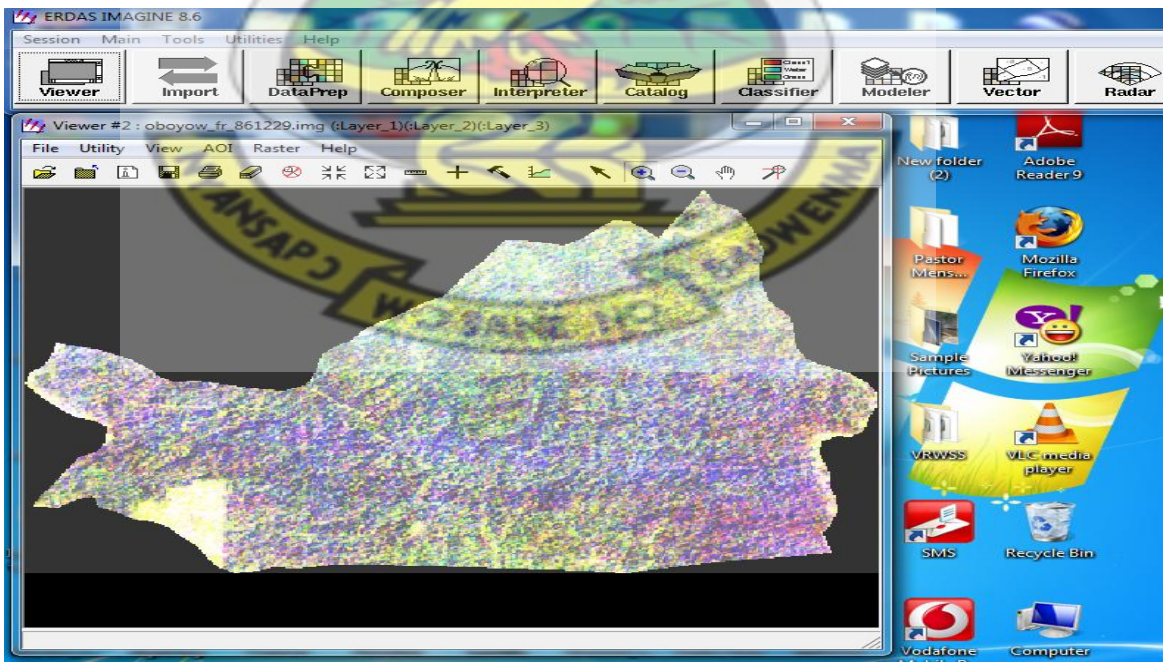


Figure 4: Bobri Forest Reserve image after sub setting

The Forest Reserve image above was then classified. Classification is the process of sorting pixels into a finite number of individual classes, or categories of data based on their data file values. If a pixel satisfies a certain set of criteria, then the pixel is assigned to the class that corresponds to that criterion. There are two ways by which pixels can be classified into the various categories, namely Supervised and Unsupervised.

Supervised classification is more closely controlled by you than unsupervised classification. In this process, you select pixels that represent patterns you recognize or that you can identify with help from other sources. Knowledge of the data, the classes desired, and the algorithm to be used is required before you begin selecting training samples. By identifying patterns in the imagery, you can train the computer system to identify pixels with similar characteristics. By setting priorities to these classes, you supervise the classification of pixels as they are assigned to a class value. If the classification is accurate, then each resulting class should correspond to a pattern that you originally identified.

Unsupervised classification is more computer-automated. It allows you to specify parameters that the computer uses as guidelines to uncover statistical patterns in the data. In this tour guide, you perform both a supervised and an unsupervised classification of the same image file. This allows you to create a thematic raster layer by letting the software identify statistical patterns in the data without using any ground truth data.

- The images were therefore classified using the unsupervised classification option and then validated the classified images using GPS for the purpose of orientation in the field. Later the classes were updated. Image below shows the classifications.

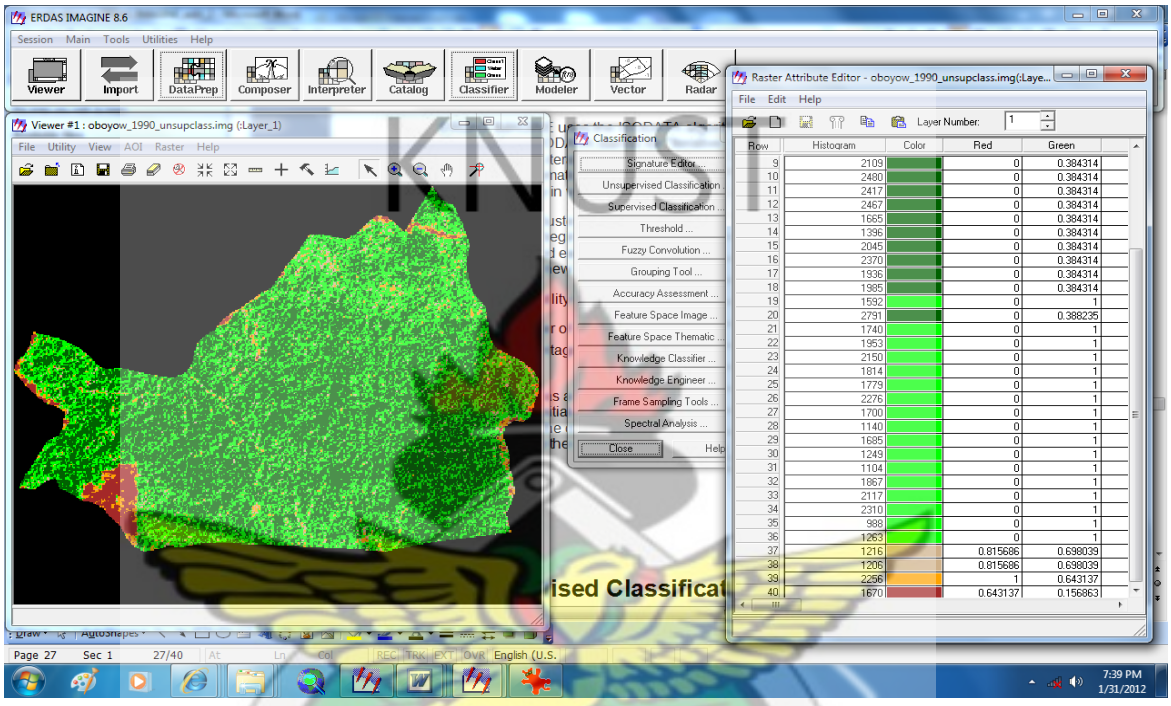


Figure 5: Classified Image of Bobri as shown above.

- The next step after the classification was recoding, by assigning a new class value number to all classes using ERDAS IMAGINE Software, creating a new thematic raster layer using the new class numbers. Some of the classes were combined through this process, using ERDAS IMAGINE software, as shown below in Fig. 6.

Raster attribute data sets, which has a cell (which is also known as a pixel) has a value. The cell values represent the phenomenon portrayed by the raster data set such as a category, magnitude, height, or spectral value. The category could be a land-use class

such as grassland, forest, or road. Spectral values are used in satellite imagery and aerial photography to represent light reflectance and color.

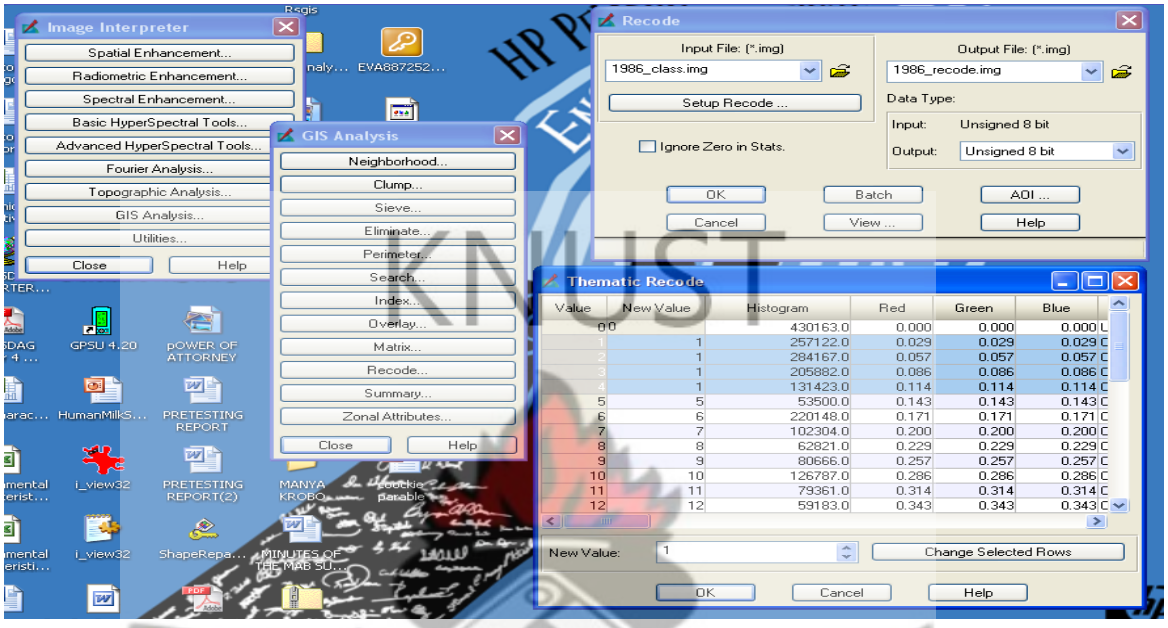


Figure 6: Rasta Attribute Data using ERDAS IMAGINE software

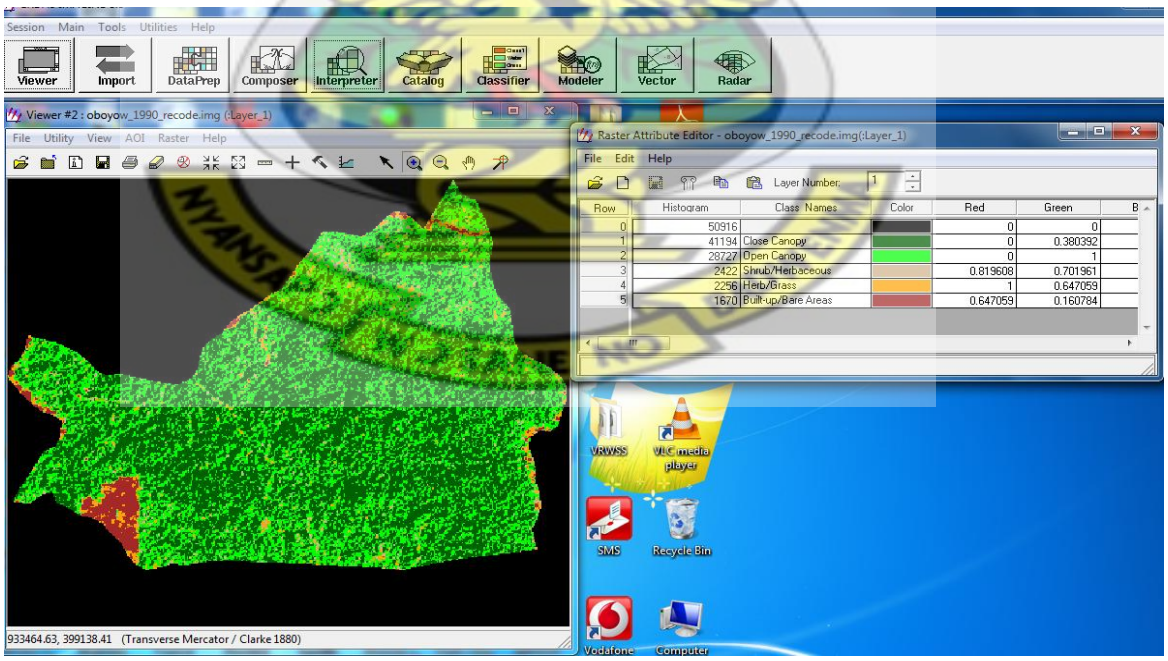
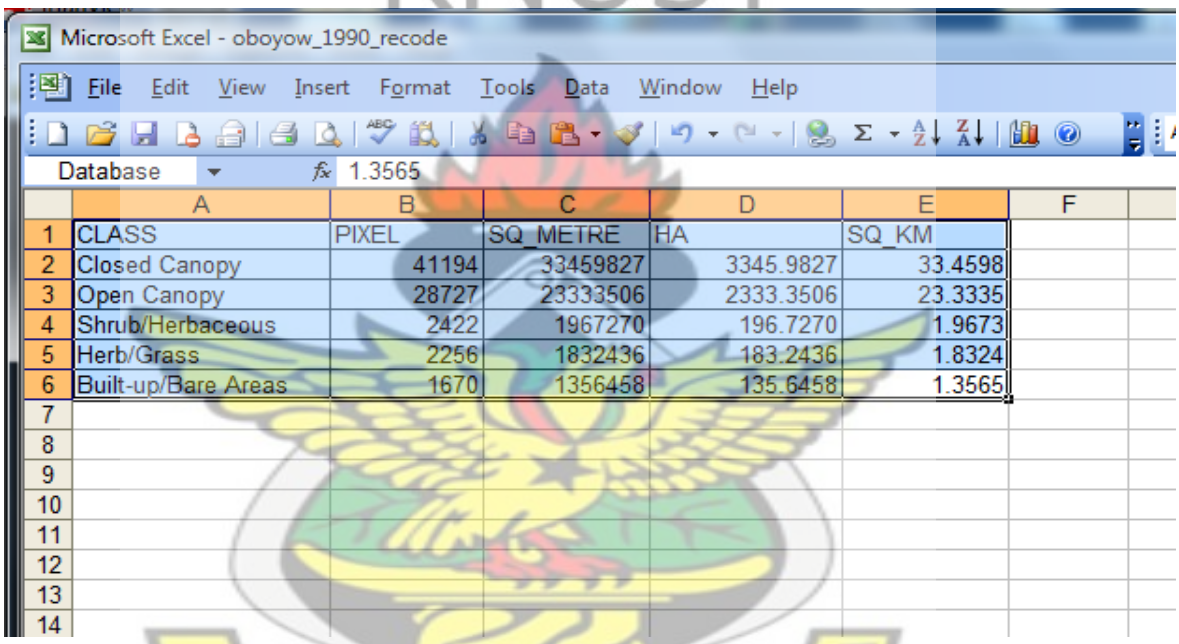


Figure 7: Map after recoding, and raster attribute data exported as .dat

- This was opened in Microsoft Excel and statistics for all various classes was generated. The area was determined knowing the size of a pixel for the Landsat ETM as 30m x 30m = 900m^2

The pixels per class were multiplied by 900m^2 to get the total area in Square meters per class. This was thereafter divided by 10000 to get hectares, and then divided by 100 to obtain a square kilometers value as shown below:



	A	B	C	D	E	F
1	CLASS	PIXEL	SQ_METRE	HA	SQ_KM	
2	Closed Canopy	41194	33459827	3345.9827	33.4598	
3	Open Canopy	28727	23333506	2333.3506	23.3335	
4	Shrub/Herbaceous	2422	1967270	196.7270	1.9673	
5	Herb/Grass	2256	1832436	183.2436	1.8324	
6	Built-up/Bare Areas	1670	1356458	135.6458	1.3565	
7						
8						
9						
10						
11						
12						
13						
14						

Figure 8: Microsoft Excel spreadsheet shown above used in the area determination.

- Maps were composed using ArcGis to show various classes, Closed Canopy, Open Canopy, Shrubs, Grass and Bare Areas etc.

3.2.2 Vegetation Sampling

Within each forest, two (2) hectare plots, one (1) each in Closed and Open canopy areas were demarcated for the study. Each plot was divided into 25 subplots using 20m × 20m,

out of which 10 were randomly selected for the enumeration of tree species. All tree species with diameter at breast height (dbh) above 10cm were identified and counted. Plant species were identified with the help of a botanist. At each site, the state of the forest was determined using the forest condition score of 1-6 as shown below.

Table 1: Forest Reserve Condition Score

SCORE	DESCRIPTION
1	EXCELLENT: with few signs (< 2 %) human disturbance, with good canopy and virgin or late secondary forest throughout
2	GOOD: with < 10 % heavily disturbed. Logging damage restricted or light and well dispersed. Fire damage none or peripheral.
3	SLIGHTLY DEGRADED: Obviously disturbed or degraded and usually patchy, but with good forest predominant; maximum 25 % with serious scars and poor regeneration; maximum 50 % slightly disturbed, with broken upper canopy.
4	MOSTLY DEGRADED: Obviously disturbed and patchy, with poor quality forest predominant; 25-50 % with serious scars; maximum 75 % disrupted canopy or forest slightly burned throughout.
5	VERY POOR: forest with coherent canopy < 25 % or more with half the forest with serious scars and poor forest regeneration; or almost all heavily burned with conspicuous pioneer species throughout.
6	NO SIGNIFICANT FOREST LEFT: Almost all deforested with savanna, plantation, or farm; < 2 % good forest

Source: Hawthorne and Abu-Juam (1995)

Plate 1: A wawa tree been identified and measured at (dbh) 1.3m above ground at Bobri Forest Reserve

3.2.3 Questionnaires Administration

3.2.3.1 Local Level (Forest Management Unit)

- Administration of structured questionnaires using both simple random and selective sampling techniques was employed.
- Administration of questionnaires was used in this sub-survey and it involved 100 respondents sampled from; Timber Utilization Contract (TUC) holders, traditional authority areas, forest fringe communities (community members and farmers), District Assemblies, Forest Districts, and Companies within the study area to reflect the influence of anthropogenic activities on sustainable forest management.

This was assessed in terms of level of education, benefit sharing and sustainable forest management (Appendix II).

Structured questionnaires were administered to elicit information from the following categories of stakeholders:

- TUC holders – 5 Companies with 2 respondents each.
- Traditional authorities – 2 traditional areas with 2 respondents each.
- Forest fringed community members – 10 communities with 5 respondents each.
- Local Government Authority (District Assemblies) – 2 District Assemblies with 2 respondents each.
- Forestry Commission (Government Agency) – 4 Forest Districts/Regional Offices with 3 respondents each.
- Total number of respondents: 80 (Appendix III).

3.2.3.2 National Level

Structured questionnaires administered to collect data from the following stakeholders:

- Ministry of Lands and Natural Resources – (4 respondents)
- Forestry Commission (Corporate Headquarters) – (5 respondents)
- Forest Services Division – (5 respondents)
- Timber Industry Development Division - (3 respondents)
- Wildlife Division – (3 respondents)

Total number of respondents: 20 (Appendix I).

3.2.3.3 Informal Interviews

Apart from the use of structured questionnaire to solicit for relevant information, informal interviews were also conducted alongside to seek for other answers which were not originally planned for during the data collection exercise. This procedure was used for all the three categories of respondents in the research survey.

3.2.4 Sampling Method

The selective and simple random sampling methods was employed in the data collection exercise, where for example at the National level and local levels some agencies by their level of interest were selected ahead of others while at the local level some communities and TUC holders by their proximity to the study area were selected and simple random sampling technique applied accordingly.

3.2.5 Forest Field Verification

Field verification exercise was undertaken in the two forest reserves to ascertain whether timber companies operating in these forest reserves were working in line with the conditions spelt out in the Draft Forest Stewardship Council's Certification (FSC) standards. This is the standard adopted by Ghana in achieving sustainable forest management. Therefore the Timber companies logging operations were examined.

3.2.6 Data Analysis

Results with reference to the Experimental design and questionnaire were analyzed using Statistical Package for the Social Sciences (SPSS) and presented into tables/graphs of frequencies and percentages.

Sustainability of forest management and conservation was also assessed based on the current conditions of forest reserves by analyzing gaps between field timber operations and that of Ghana's Sustainability Standards (Forest Stewardship Council certification standards).

CHAPTER FOUR

4.0 RESULTS

4.1 Land Cover Change in the Bobri and Oboyow Forest Reserves

4.1.1 Bobri Forest Reserve

The image below shows satellite image for Bobri Forest Reserve for the year 1990. The detailed area in hectares and square kilometers are spelt out below:

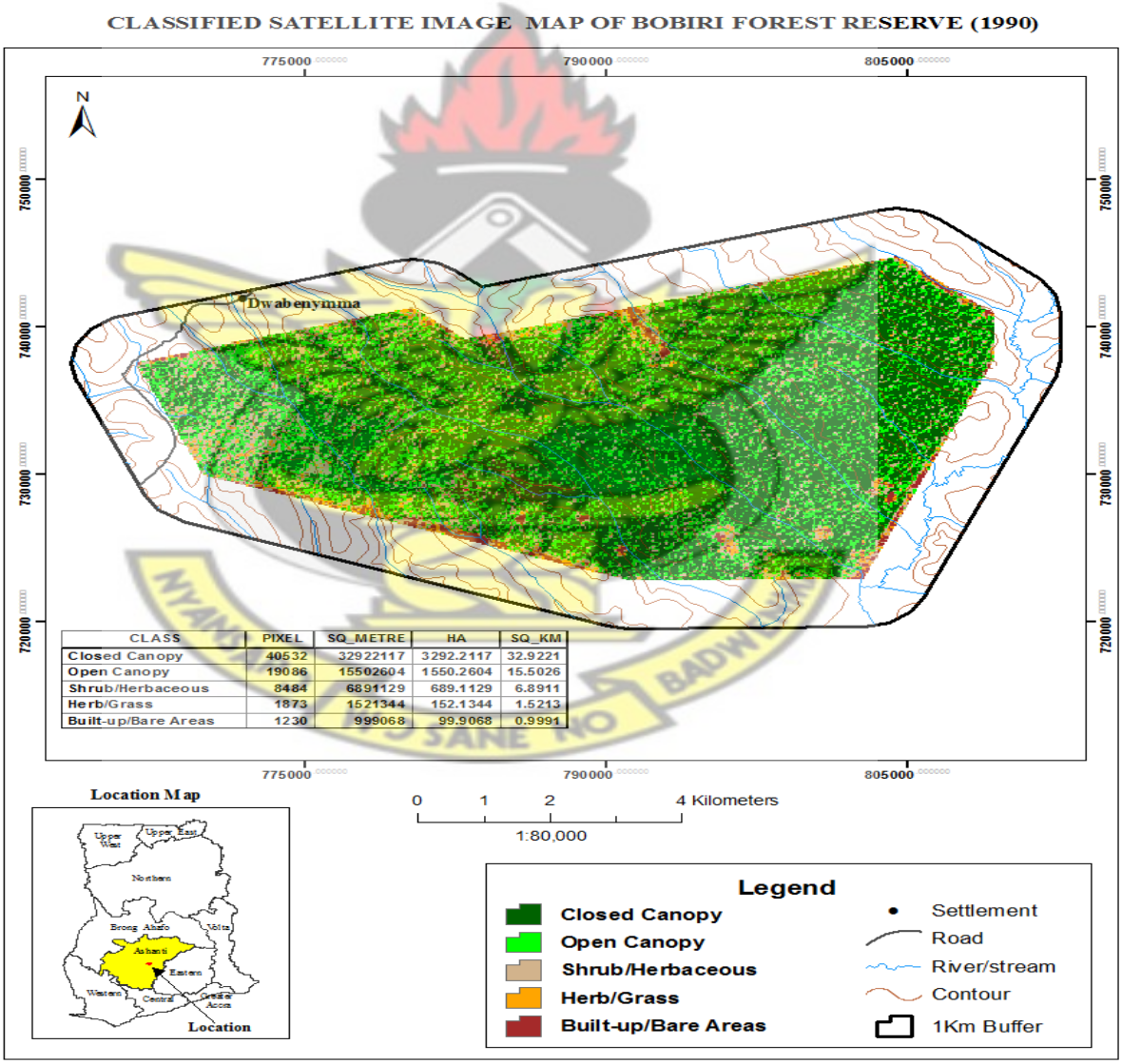


Figure 9: Classified image for Bobri Forest Reserve in 1990

The captured satellite image in 1990 showed high density of close canopy covering about 56.92 % of the total land area with few grasses and marginal bare areas (Table 2) and (Fig. 9). Open canopy occupied an area of 1556.2604 ha representing 26.8 % of the entire land cover (Table 2).

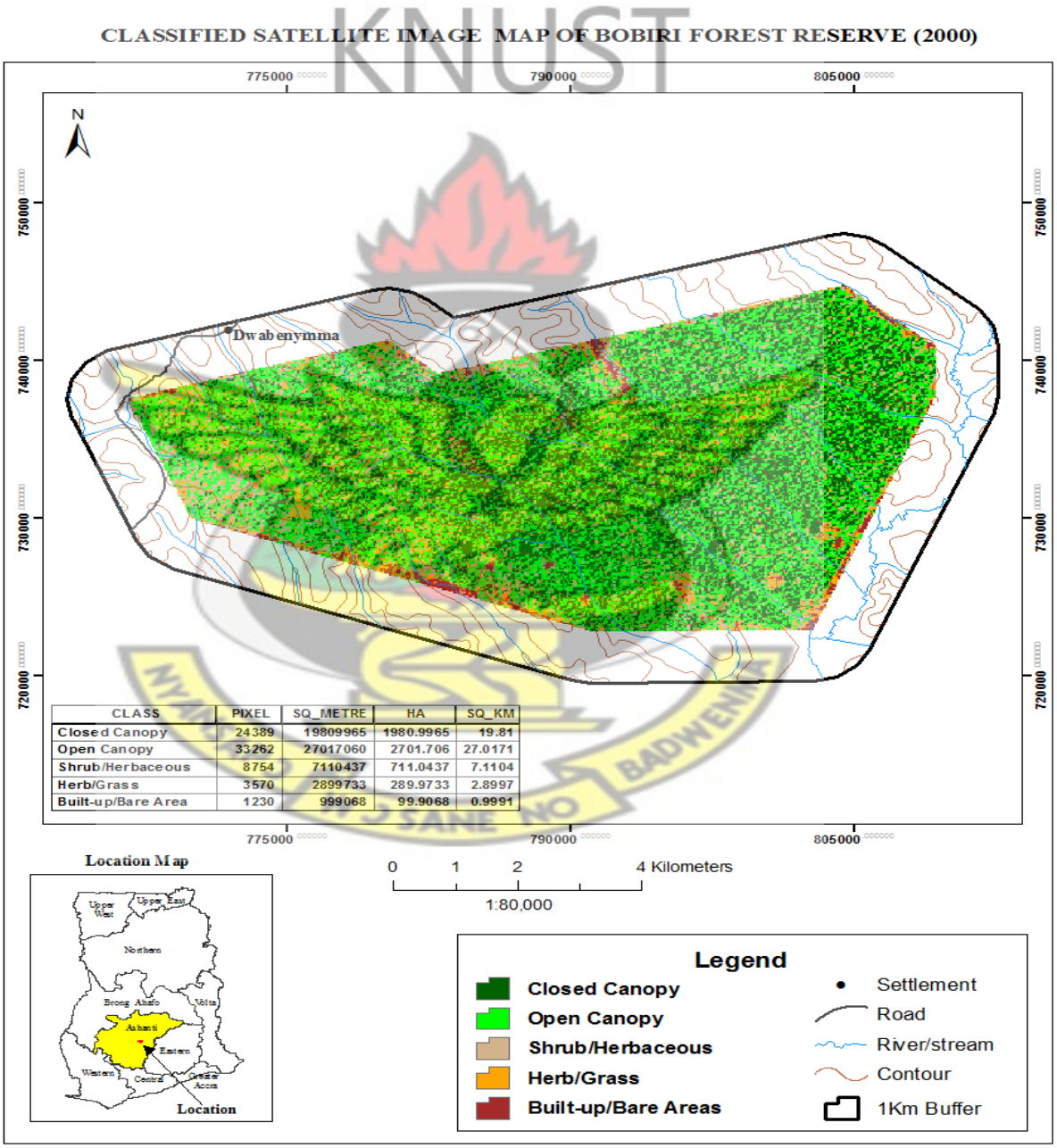


Figure 10: Classified Image of Bobri Forest Reserve in the year 2000

The deep green in the captured satellite image comparatively shows a decline from 56.9 % in 1990 to 34.2 % in 2000, thus making way for the dominance of the light green with high density of open canopy spreading across the entire land area increasing from 26.8 % to 46.7 % within a decade (Table 2). Shrubs and grasses covered an area of about 12.29408 ha and 5.013684 ha respectively with few bare grasses (Figs. 9, and 10; Table 2).

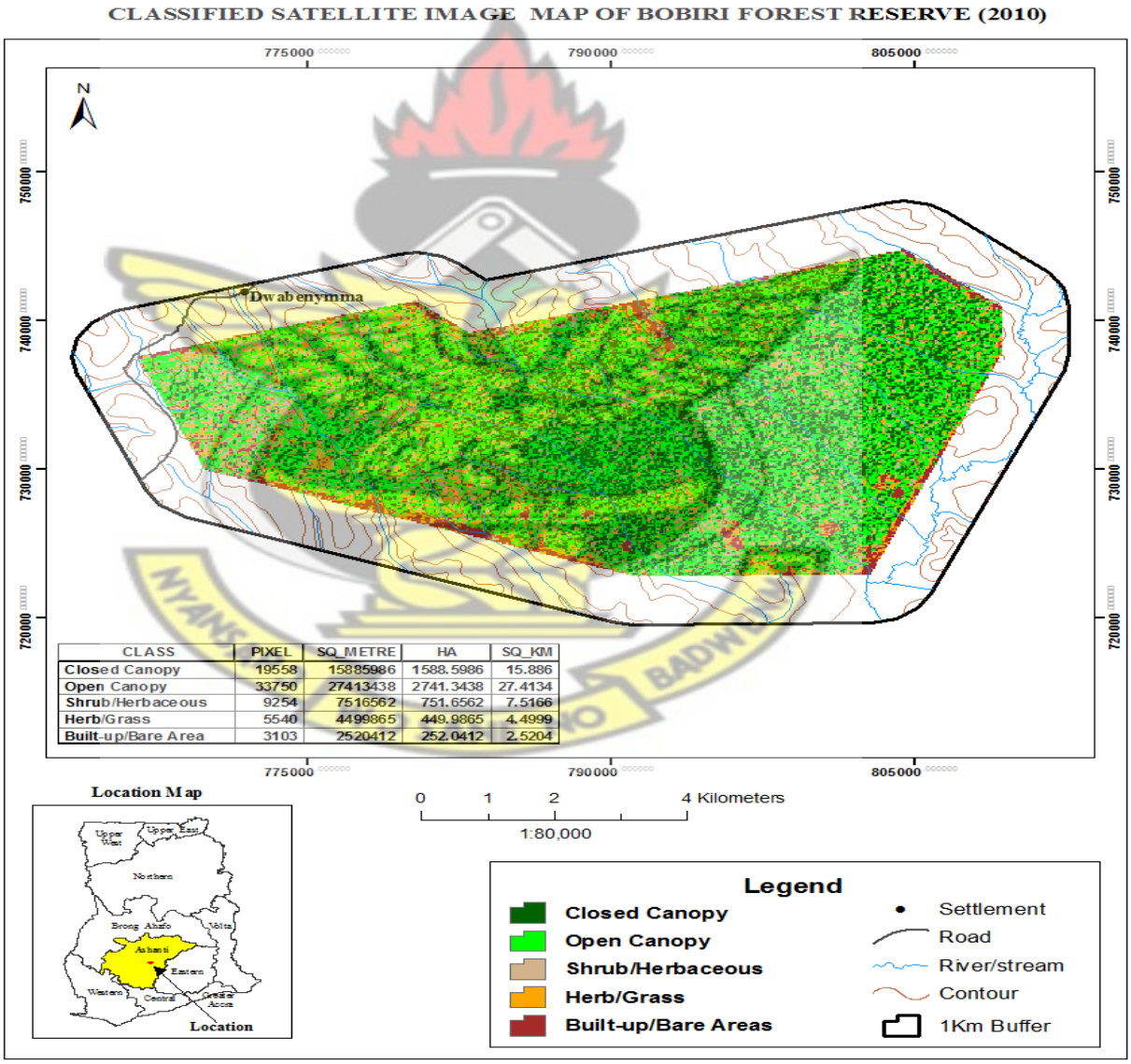


Figure 11: Classified Image of Bobri Forest Reserve in the year 2010

The satellite image for Bobri forest reserve in 2010 depicted marginal build-up areas and grasses (252.0412 ha and 449.9862 ha) respectively (Fig 11, Table 2). Open canopies dominated across the Bobri Forest Reserve, covering 47.39 % of the total land mark. There was a reduction in closed canopy area from 2000 to 2010 (from 34.25 % to 27.5 %).

Approximately 57 % of the forest composed of closed canopy in 1990 but has reduced considerably about half of this value within the last two decades to 27 %. On the other hand, open canopy area increased from 1990 to 2010 (27 % - 47 %). Though the shrub layer also increased, the changes were marginal.

Table 2: Proportion of Bobri Forest Reserve

Class	**Area (ha)**			**Area (%)**		
	1990	**2000**	**2010**	**1990**	**2000**	**2010**
Close Canopy	3292.2117	1980.9964	1588.5986	56.92297	34.25181	27.46717
Open Canopy	1556.2604	2701.7060	2741.3438	26.8043	46.71301	47.39836
Shrubs/Herbs	680.1129	711.0437	751.6562	11.91489	12.29408	12.99628
Grass	155.1344	289.9733	449.9862	2.630433	5.013694	7.780347
Built-up/Bare Areas	99.9068	99.9068	252.0412	1.727408	1.727408	4.357841
Total	5783.6262	5783.6262	5783.6262	100	100	100

Classified image of Oboyow Forest Reserve in 1990 indicated high density of close canopies (3345.9827 ha), which constituted 54 % of the area (Fig. 12, Table 3). Few build-up and grass areas were sparsely distributed in the South (135.6458 ha and 183.2436 ha) respectively (Table 3).

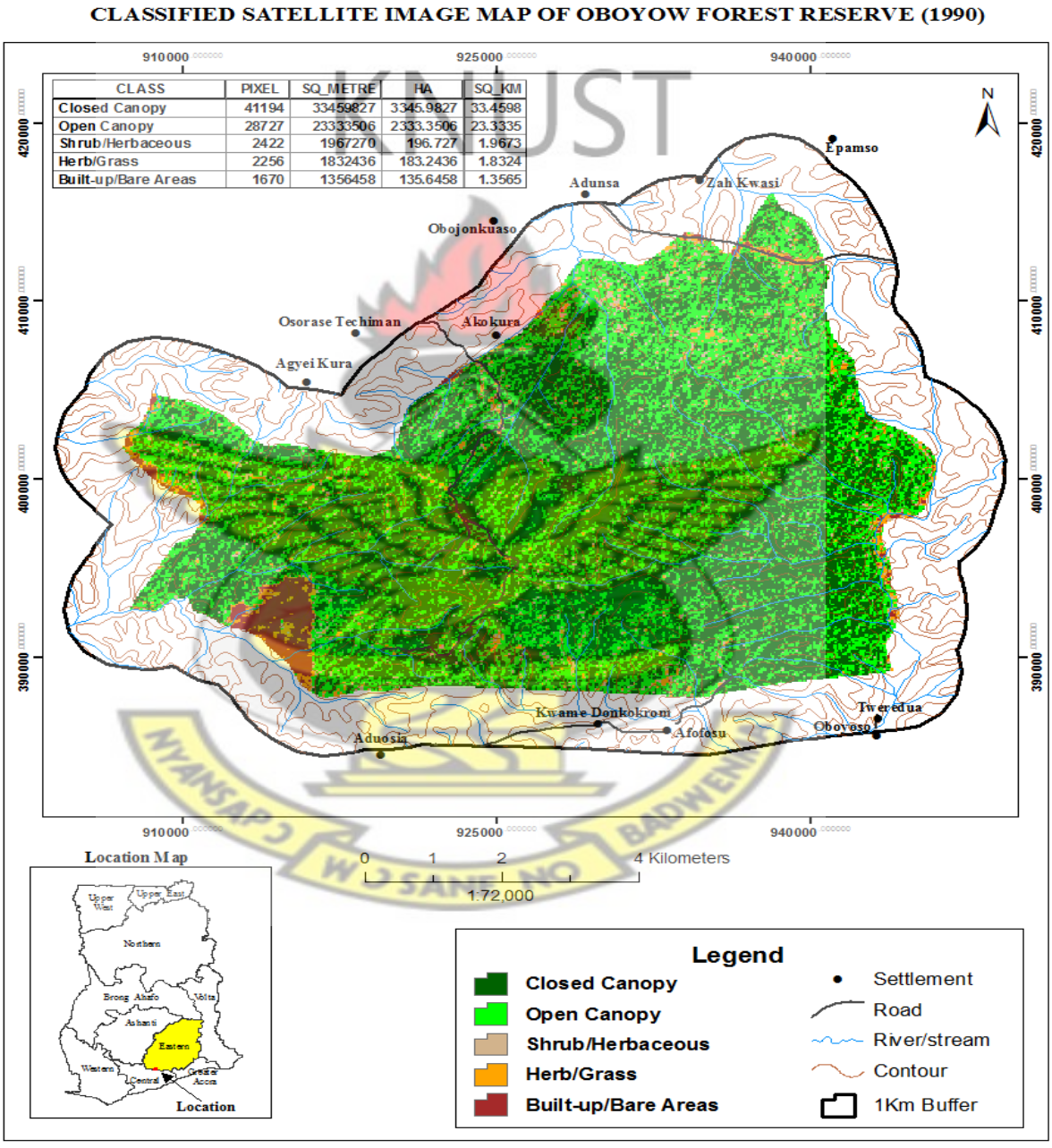


Figure 12: Classified Image of Oboyow Forest Reserve in 1990

Total open canopy area 3489.9946 ha was twice as much as that of closed canopy area (1747.4747 ha) in 2000 (Fig. 13; Table 3). Few grasses occurred in many parts of the reserve, while bare areas were concentrated in the South-Western part of the reserve. The grasses occupy an area of about 196.727 ha while the bare areas cover 135.6458 ha of land.

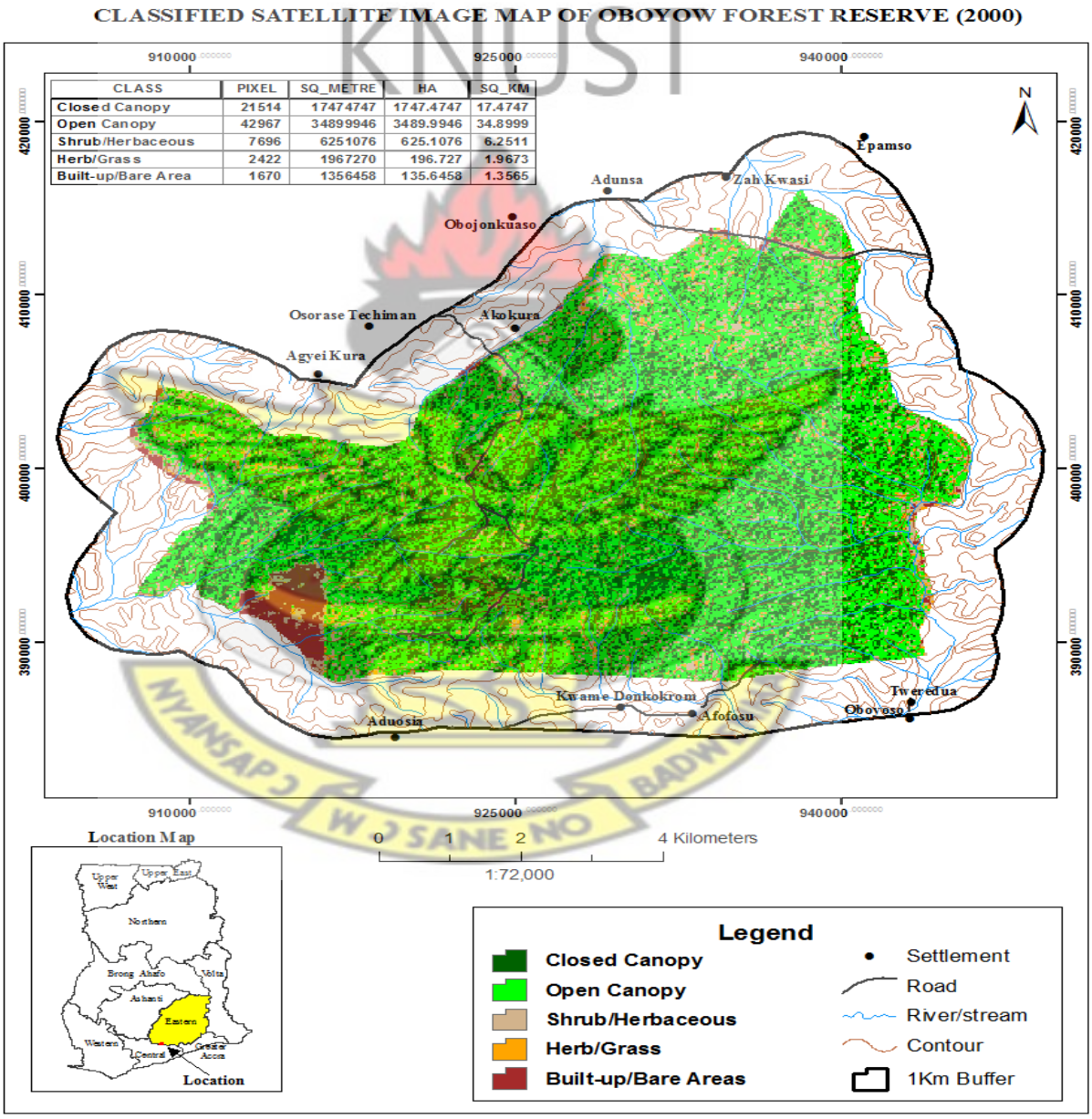


Figure 13: Classified Image of Oboyow Forest Reserve in the year 2000

There was a high density of open canopies, (3091.14 ha) in the central part of the reserve in 2010 (Fig. 14; Table 3). Sparsely bare areas are recorded along the boundaries with few grasses scattered along the coast. The bare and grass areas occupied 364.14 ha and 325.71 ha of land respectively.

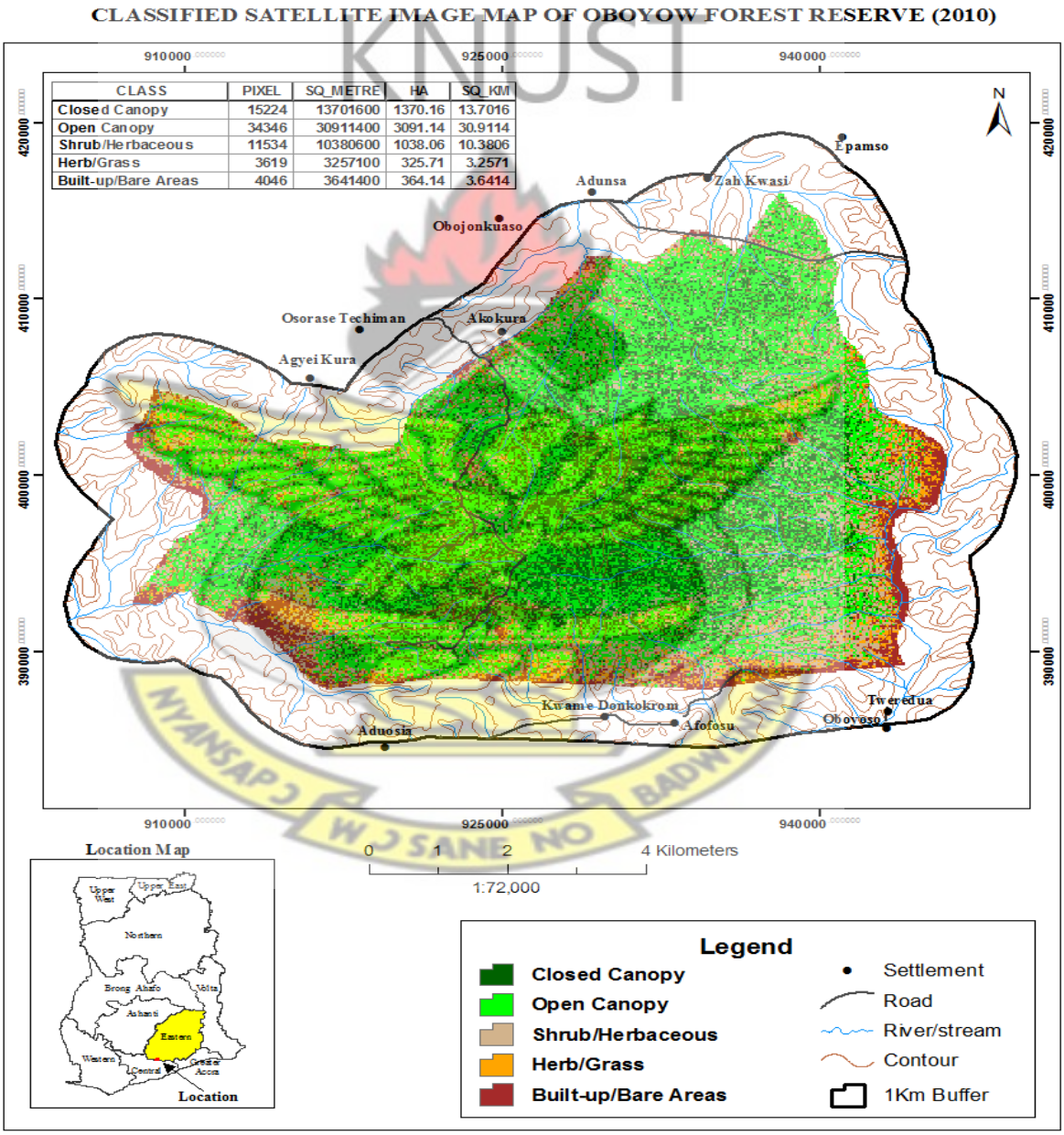


Figure 14: Classified Image of Oboyow Forest Reserve in the year 2010

There was a decrease in the open canopy area from 1990 to 2000 (from 56 % to 28 % of the land area) (Table 3). The open canopy area increased considerably from 1990 to 2000 (37.67 % to 56.34 %). There was a high increase in shrub cover from 1990 to 2010.

Table 3: Proportion of Oboyow Forest Reserve

Class	Area (ha)			Area (%)		
	1990	2000	2010	1990	2000	2010
Close Canopy	3345.9827	1747.4747	1370.16	54.01153	28.20809	22.117399
Open Canopy	2333.3428	3489.9866	3096.8717	37.66529	56.33607	49.990328
Shrubs/Herbs	196.7270	625.1076	1038.06	3.175607	10.09061	16.756574
Grass	183.2436	196.727	325.71	2.957955	3.175607	5.257677
Built-up/Bare Areas	135.6456	135.6458	364.14	2.189619	2.189622	5.878021
Total	6194.9417	6194.9417	6194.9417	100	100	100

4.2 Diversity and Structure

4.2.1 Bobri Forest Reserve

In all trees belonging to 16 genera and 9 families were identified in the Bobri forest reserve (Table 4). There were more species diversity (15) and number of individual plants (136) in the closed canopy areas than the open canopy area as shown in the table below.

Table 4: List of tree species identified at Bobri Forest Reserve

Species Canopy	Family	Abundance (Numbers)	
		Closed Canopy	Open Canopy
Afzelia africana	Fabaceae	9	-
Amphimas pterocarpoides	Fabaceae	4	-
Pouteria aningeri "aningeria robusta"	Sapotaceae	8	-
Antiaris toxicaria	Moraceae	-	5
Antrocaryon micraster	Sterculiaceae	3	6
Bombax buonpozense	Bombacaceae	3	-
Ceiba pentandra	Bombacaceae	-	4
Celtis zenkiri	Ulmaceae	14	21
Chrysophyllum albidum	Sapotaceae	1	-
Cola gigantea	Sterculiaceae	8	-
Daniellia ogea	Fabaceae	7	3
Entandrophragma angolense	Meliaceae	5	-
Entandrophragma cylindricum	Meliaceae	6	-
Pterygota macrocarpa	Sterculiaceae	12	-
Pycnanthus angolensis	Myristicaceae	12	16
Terminalia superba	Combretaceae	18	7
Triplochiton scleroxylon	Sterculiaceae	26	6
Species diversity		**15**	**8**

Basal area of tree species in the closed canopy was significantly higher compared to that in the open canopy area as depicted by (Table 5).

Table 5: Mean basal area of trees in the canopies of the forests.

Forest	Basal area (m^2/ha)	
	Closed canopy	Open canopy
Bobri	**127**[a]	**37.65**[b]
Oboyow	**49.9**[c]	**18.85**[d]

Means in the same row that have different superscripts are significantly different at 5 % significance level

Shannon Diversity index for Bobri Forest Reserve showed that, tree species in the closed canopy areas were significantly higher compared to that in the open canopy areas (Table 6), an indication that there were more species communities in the closed canopies than in the open canopy areas.

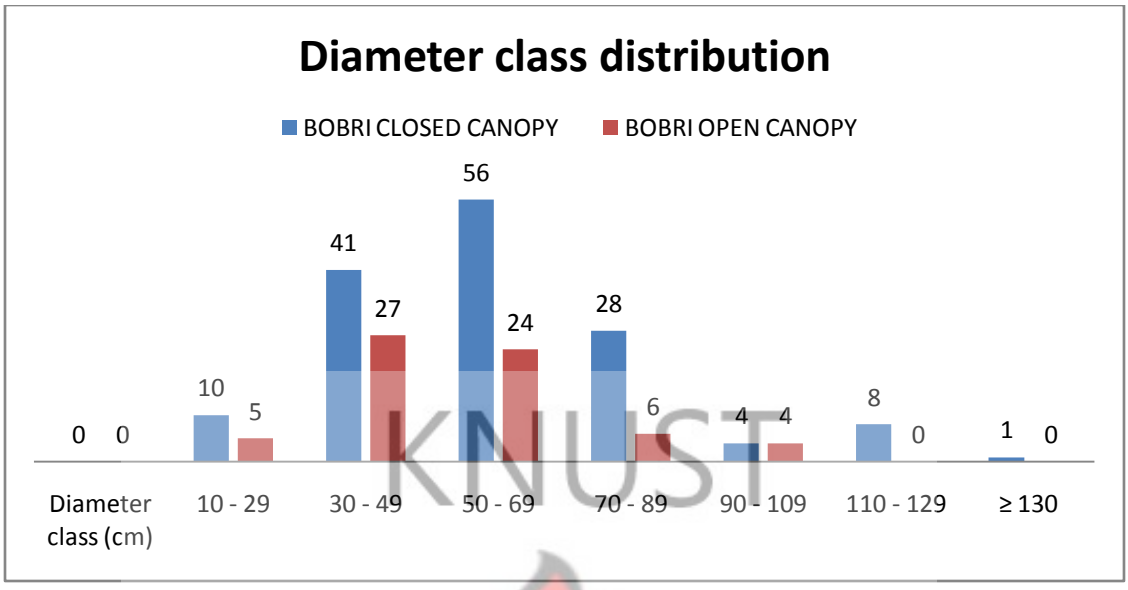


Figure 15: Size class distribution for Bobri Forest Reserve

Diameters taken at dbh indicated that the closed canopy had abundant tree species with higher diameter class within 110-129cm while the open canopy had none. Peak abundance for closed canopy was within the diameter class of 50-69cm while open canopy was within 30-49cm (Fig 15). Lower number of trees at higher diameter class is an indication of over exploitation.

Despite the high numbers of young trees, regeneration will be insufficient to maintain and sustain the occurrence of older age class size in the future.

Table 6: Mean Shannon Diversity index of trees in the canopies of the forests.

	Shannon Wiener Index (m^2/ha)	
Forest	**Closed canopy**	**Open canopy**
Bobri	**2.124[a]**	**1.247[b]**
Oboyow	**1.634[c]**	**1.073[d]**

Means in the same column that have different superscripts are significantly different at 5 % significance level

4.2.2 Oboyow Forest Reserve

In all 108 individual trees belonging to 16 plant species, 16 genera and 9 families were identified in the Oboyow forest reserve (Table 7). There were more plant species (11) and number of individuals (66) in the closed canopy areas than the open canopy area (6 and 42 respectively).

Table 7: List of tree species identified at Oboyow Forest Reserve

		Abundance (Numbers)	
Species	**Family**	**Closed Canopy**	**Open Canopy**
Antiaris toxicaria	Moraceae	6	-
Amphimas pterocarpoides	Fabaceae	12	-
Celtis zenkeri	Ulmaceae	13	-
Cylicodiscus gabunensis	Fabaceae	-	8
Daniellia ogea	Fabaceae	5	-
Distemonanthus benthamianus	Ebenaceae	-	2
Entandrophragma cylindricum	Meliaceae	1	-
Ficus sur	Moraceae	-	6
Hannoa klaineana	Simaroubaceae	-	5
Khaya ivorensis	Meliaceae	3	-
Nauclea diderrichii	Rubiaceae	2	-
Nesogordonia papaverifera	Sterculiaceae	-	12
Piptadeniastrum africanum	Fabaceae	6	-
Sterculia oblonga	Sterculiaceae	8	-
Terminalia superba	Combretaceae	2	-
Turraeanthus africanus	Meliaceae	8	9
Total 16	**9**	**66**	**42**

Basal area of tree species in the closed canopy was significantly higher compared to that in the open canopy area (Table 5).

Shannon Wiener Diversity index for Oboyow Forest Reserve showed that, tree species in the closed canopy areas were significantly higher compared to that in the open canopy areas (Table 6). This infers that there was high tree species community diversity in the closed canopy areas than in the open canopy areas.

4.2.3 Comparative Analysis of Bobri and Oboyow Forest Reserves

Mean basal area of tree species in Bobri forest reserve was significantly higher compared to that in Oboyow forest reserve (Table 8).

Table 8: Mean basal area of trees in the indicated forests.

Forest	Basal area (m^2/ha)
Bobri	**32.93[a]**
Oboyow	**13.75[b]**

Means in the same column that have different superscripts are significantly different at 5 % significance level

Comparatively, Shannon Wiener Diversity index (Table 6) showed that, tree species were significantly higher in terms of abundance in the Bobri forest reserve than in Oboyow forest reserve for both closed and open canopy areas.

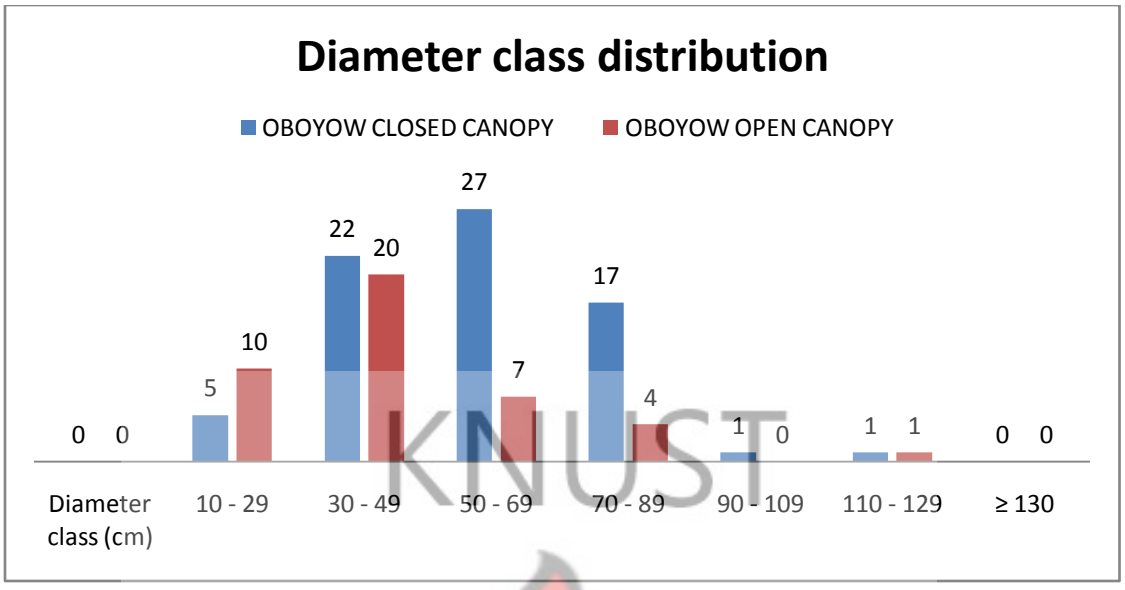


Figure 16: Size class distribution for Oboyow Forest Reserve

Diameters taken at dbh showed that there was a massive exploitation of trees within and above the felling limit as higher class diameters ≥ 90cm are only three (3). The open canopy area showed that there are smaller trees with minimal number of individuals (Fig. 16).

Although, the closed canopy though has younger trees, regeneration is not sufficient to sustain future occurrence of older age class diameters.

Table 9: Summary characteristics of the two forests

Forest Reserve	Class	Species Diversity	Total No. of Trees	Average Diameter (cm)	Condition Score
Bobri	Close Canopy	15	136	57	3
Oboyow	Close Canopy	11	66	52	4
Bobri	Open Canopy	8	68	51	4
Oboyow	Open Canopy	6	42	36	5

4.3 Causes of change in forest cover

About 50 % of respondents from the communities revealed that the major causes of forest destruction were chainsaw lumbering of the resource, with 15 % and 10 % been insufficient penalties to offenders and illegal farming respectively (Fig. 17). On the contrary, 50 % of respondents from the Forestry Commission revealed that the major cause of forest destruction was chainsaw lumbering (Fig. 17).

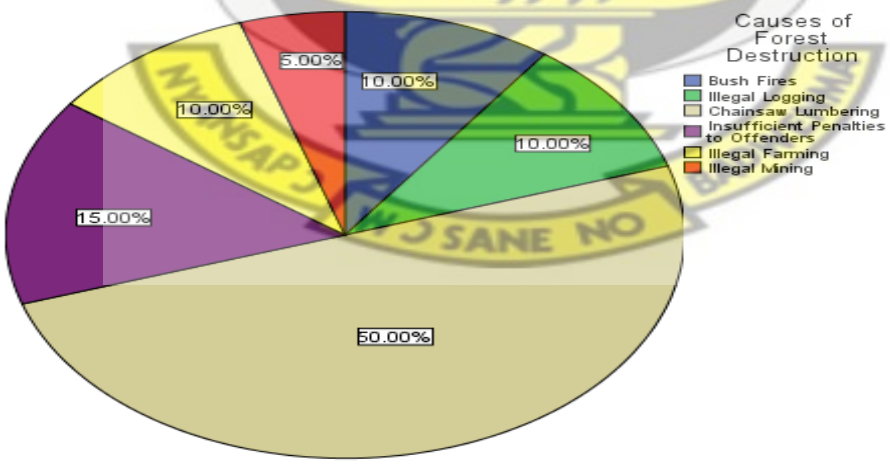


Figure 17: Causes of forest destruction

4.3.1 Community participation in forest protection

The study showed that, forest fringe communities have been contributing in diverse ways towards the protection of the forest estates (Fig. 18).

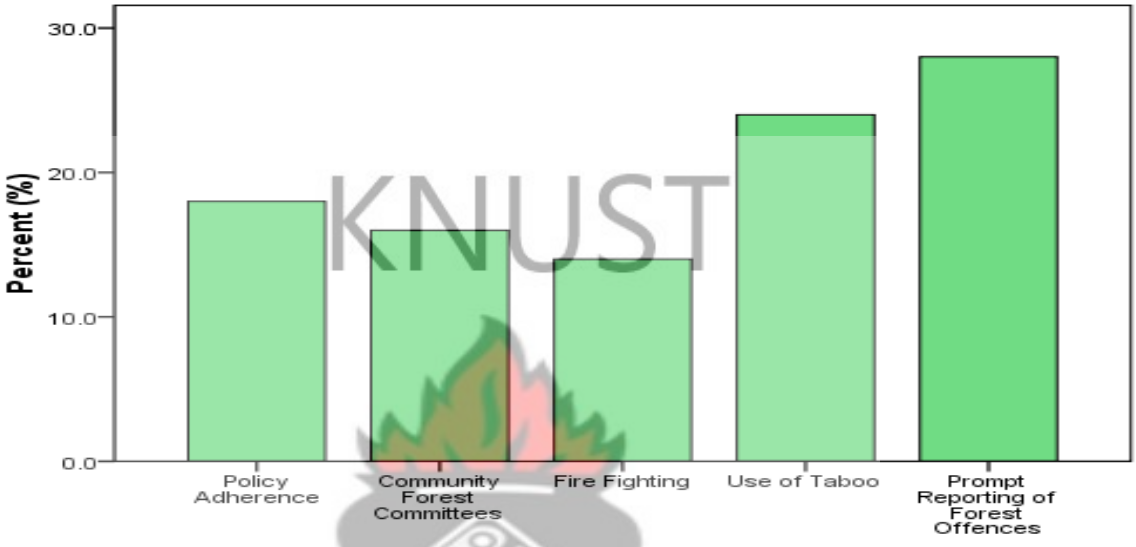


Figure 18: Various ways of community involvement in forest protection

Furthermore, although 70 % of the respondents from the Forestry Commission admitted that community participation had contributed to effective forest protection, 62 % of respondents from the selected communities stated that it had not been adequate and therefore needed to be improved, citing various ways in which it could be improved (Table 10).

Table 10: Ways of Improving Community Participation in Forest Conservation

Activity	Frequency	Percent (%)	Valid Percent (%)
Provision of Incentives	7	13.7	14
Community Empowerment	4	7.8	8.0
Adhering to Community Benefit Rights	15	29.4	30.0
Awareness Creation	19	37.3	38.0
Putting in Place Reward System	5	9.8	10.0
Total	50	98.0	100

4.3.2 Forest Contributions to Community Livelihoods

About 50 % of respondents from the Forestry Commission intimated that fringe community benefits from the forest through the gathering of Non Timber Forest Products (NTFP's) while 25 % of respondents stated that the communities have been benefitting from Social Responsibilities (SRA's) from Timber firms; minority 15 % and 10 % of respondents said communities have benefitted from the share of Royalties and Tree Ownership respectively.

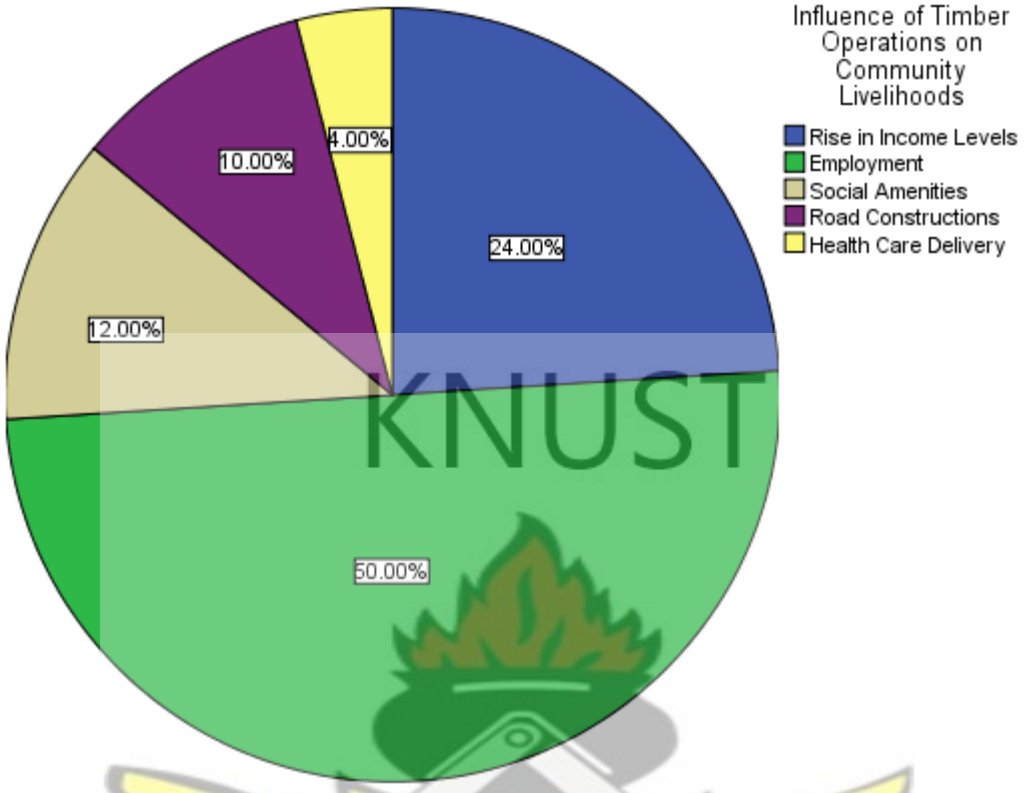


Figure 19: Timber contributions to communal livelihoods

In addition, (Fig. 19) showed that 74 % of respondents from the fringe communities revealed during the study that timber operations in their localities have contributed to poverty alleviation through direct employment and rise in their income levels by boosting their trade.

4.3.3 Threats of Timber Operations on Communal Lives

The study revealed that though, timber operations contribute immensely to communal livelihood, it also poses serious threats to the surrounding communities in the form of dust pollution, farmland destruction etc (Fig. 20).

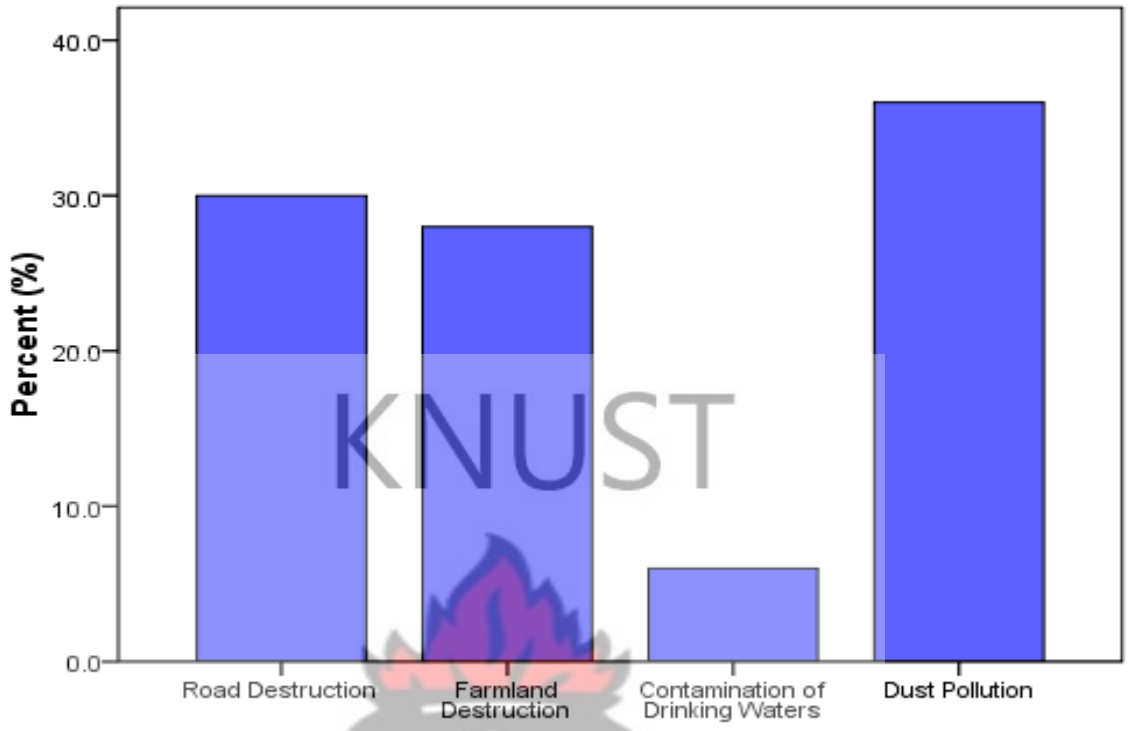


Figure 20: Threats posed by Timber Operations in the Reserved Forests.

4.3.4 Level of Education among Timber Company's Field Operators

It became evident during the study that the level of education amongst field staff of timber firms was very low. About 83 % had Primary and Middle School education. This was therefore making it difficult for them to read and understand the logging manual. About 10 % and 7 % had attained Senior Secondary School and Tertiary level of education respectively (Fig. 21).

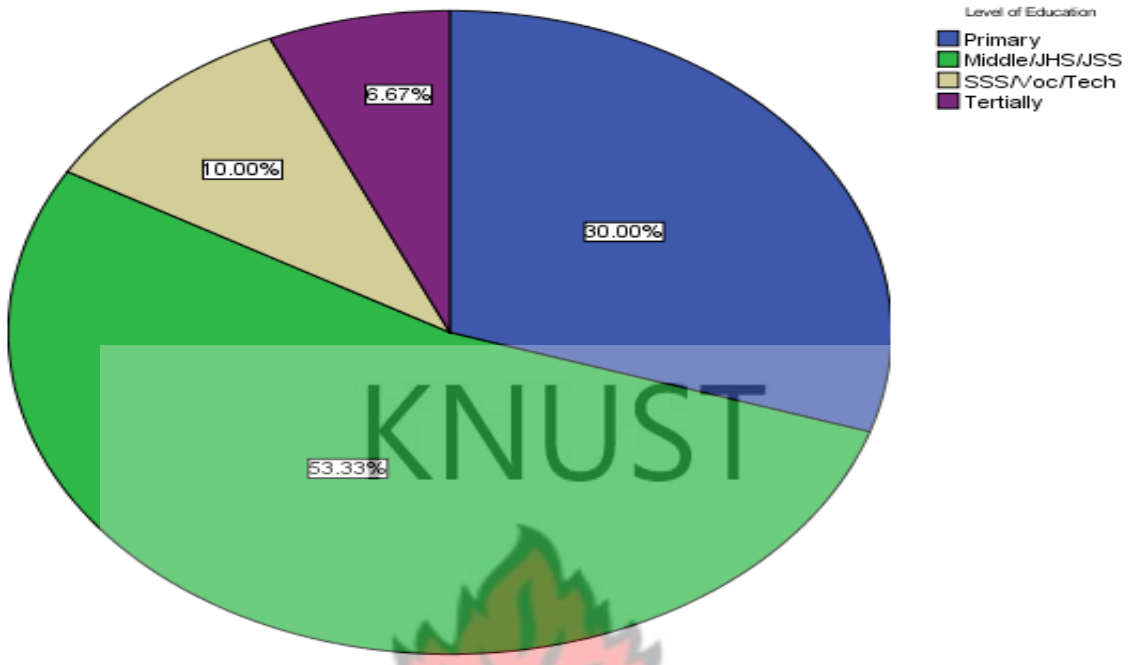


Figure 21: Level of Education amongst staff of Timber Firms

4.3.5 Knowledge of the Logging Manual

Exactly 70 % of respondents from the Field Operators have no knowledge or have not even heard of the Logging Manual. Of the remaining who claimed to have knowledge of the manual only 20 % were familiar with its contents. In contrast, 25 % of respondents from the Forestry Commission who are supposed to supervise the work of these Field Operators had no knowledge or were unfamiliar with the contents in the logging manual. Only 20 % of field operators used the prescribed logging manual; the remaining 80 % operated outside the code of practice of the manual (Fig. 22).

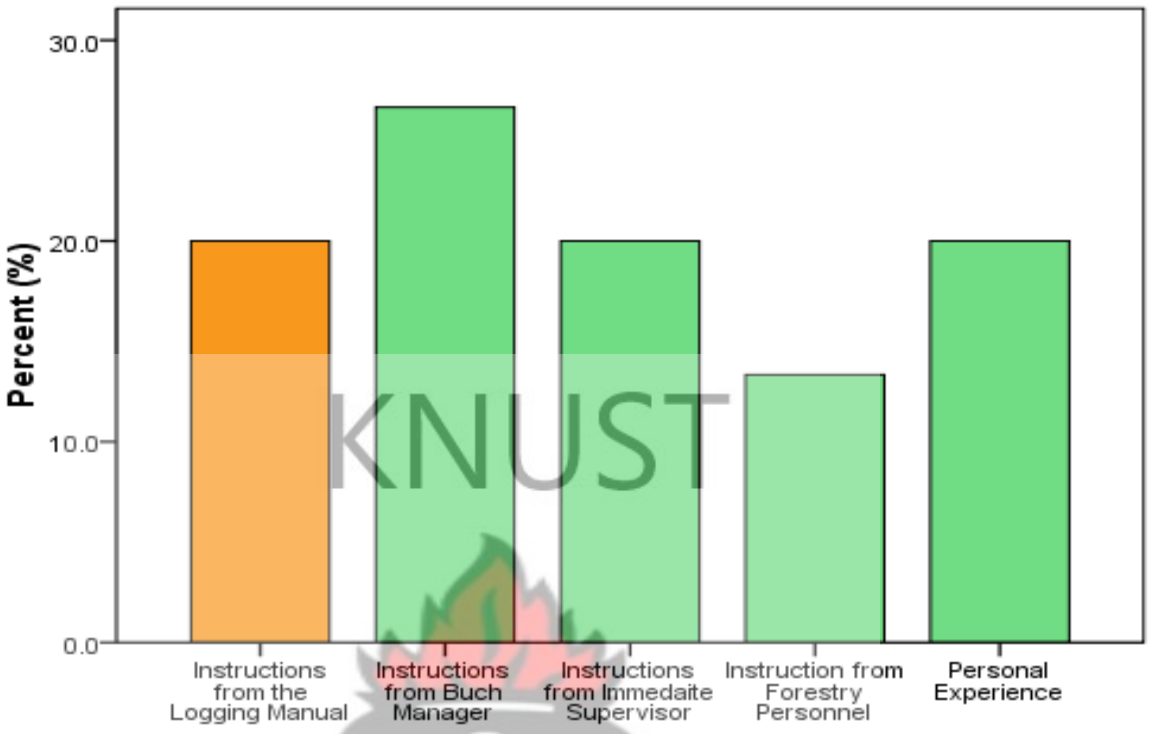


Figure 22: Operational procedures adopted by Field Operators

4.3.6 Kind and nature of forest offences by timber companies

The nature and kind of forest offences are many but the most common amongst these from the study as collaborated by the Forestry Commission and the Timber Companies were, felling trees outside the approved yield (Fig. 23).

On the other hand, when asked if having adequate knowledge on the Logging Manual could have reduced or avoided the offences in (Fig. 23), 90 % of respondents from the Timber Industries agreed and therefore made suggestions that copies of the manual should be made available to them.

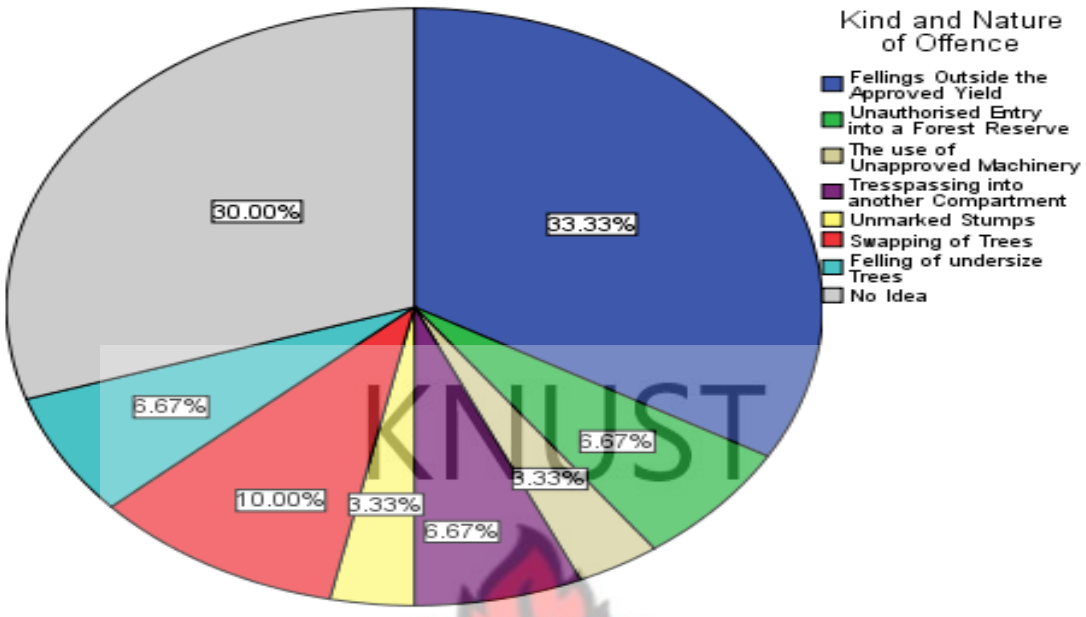


Figure 23: Familiar Forest Offences Committed by Timber Companies

4.3.7 Knowledge on management plans and harvesting schedule

The study revealed that 90 % and 75 % amongst respondents from the Forestry Commission and the Timber Companies had knowledge in the management plans and harvesting schedules respectively for the two reserves under study. The study further showed that, 50 % of respondents from the Commission stated that the two Forest Reserves has had its Management Plans revised twice, while the Harvesting Schedules of the two reserves had been revised thrice (3 times). Even though 55 % of respondents from both the Forestry Commission and Timber Companies believe that it might have affected the Forest Reserves Negatively. Reasons behind the constant revision of the Harvesting Schedule are spelt out in (Fig. 24).

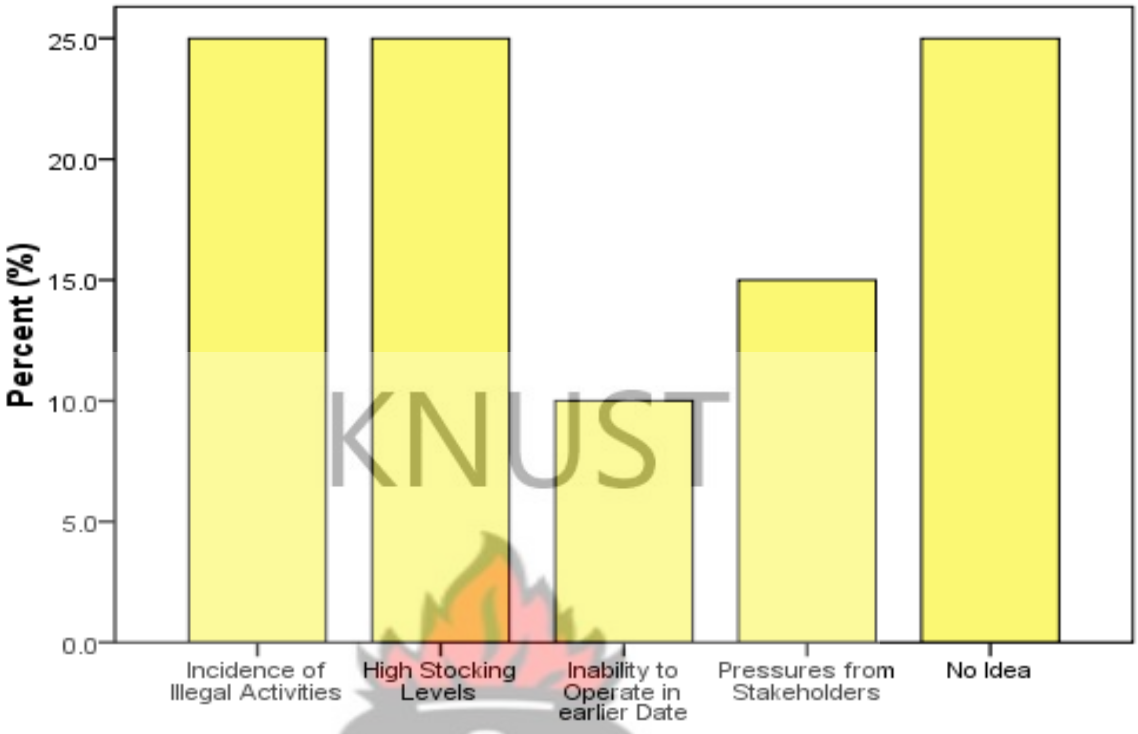


Figure 24: Reasons for the Frequent Revision of the Harvesting Schedule

4.3.8 Knowledge in Forest and Wildlife Policy of 1994

The Forest and Wildlife Policy of 1994, is a working document for staff of the Forestry Commission. There was little surprise when the study demonstrated that 80 % of respondents had knowledge of the document. However it was surprising that 20 % of workers were still not familiar with its contents; 75 % did not still having any idea as to whether the implementation of the policy has a correlation with the dwindling trends in the forest cover. This might have arisen from the fact that, 75 % of the respondents believe that there has not been any scientific research to evaluate the 1994 Forest and Wildlife Policy in relation to recorded deforestation in the country.

In spite of these, 40 % of respondents from the Commission believe that the Policies aim of sustainably managing the country's forest and wildlife resources might have partially been achieved whilst a majority 50 % have contrary opinion by citing the following reasons presented in (Fig. 25) for the policy failure.

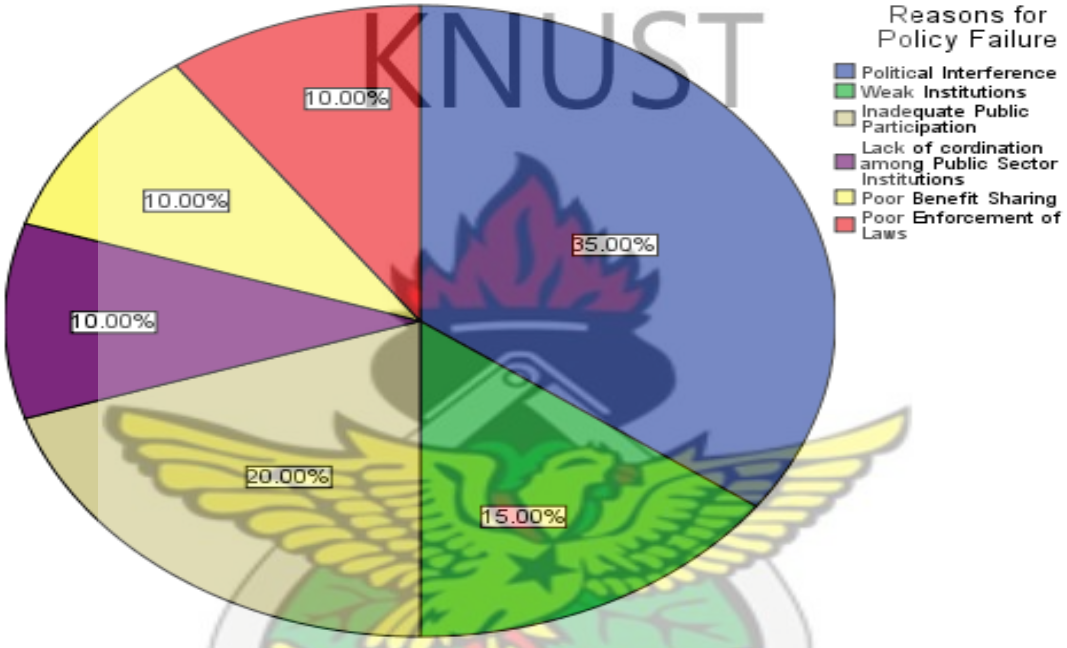


Figure 25: Reasons for failure of the Forest and Wildlife Policy (1994)

4.3.9 Challenges to Sustainable Forest Management (SFM)

Despite the dwindling trends in the Nations forest cover and biodiversity, 75 % of respondents from the Forestry Commission believe that the country can achieve sustainable development, even though the study unearthed some challenges confronting the Forestry Commission which are summarized in Fig. 26.

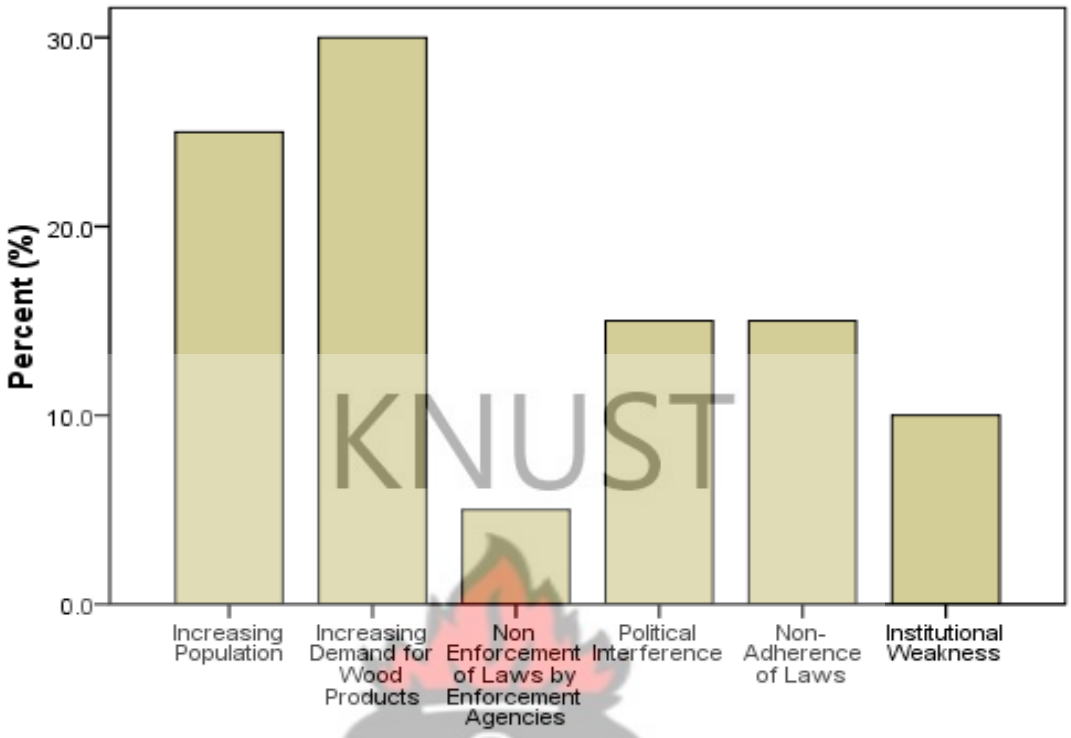


Figure 26: **Challenges to Sustainable Forest Management in Ghana**

4.3.10 The Way Forward

4.3.10.1 Forestry Commission

One-quarter of the respondents indicated the need to strengthen forest regulations. About 20 % (one-fifth) each believes that there is the need for community sensitization on the relevance of protecting the nation's forest estates; similarly 20 % believe that governments should have a strong political will and also provide incentives to the workforce if effective policy implementation is to be achieved. It was evidently clear from the study that, most forestry field supervisors were not on top of their jobs. Consequently, 15 % of respondents were of the view that there should be capacity building for staff so as to upgrade them to meet the challenges the job brings. This

notwithstanding, 10 % intimated the essence of involving fringe communities in forest protection whiles further 10 % suggested the provision of logistics to help ensure effective forest protection and management.

4.3.10.2 Forest fringe communities

About 42 % of respondents thought that, community participation should be encouraged if SFM is to be achieved. Failure to honor Social Responsibility Agreement on the part of timber firms was revealed and therefore 36 % of respondents called for its improvement. About 8 % suggested that a reward system should be put in place to encourage communities into forest protection; further 8 % of them recommended that, there should be strict implementation of the logging manual, while 6 % suggested the employment of local community members as forest guards.

4.3.10.3 Timber companies

Interestingly, whiles the Forestry Commission was in support of strengthening forest regulations, about 47 % of respondents from the timber firms believed that the way forward to Sustainable Forest Management is to increase the yield allocation of removable trees to timber firms for extraction. About 37 % of respondents suggested that there should be Prompt issuance of Conveyance Certificate (LMCC) to their trucks to avoid the usual delay. A further 10 % called for capacity building among field operators to be abreast with the changing trends in the changing environment. About 6 % suggested the removal of Institutional Bureaucracy within the Forestry Commission.

4.4 Field Observation

Forest Managers and Field Supervisors interviewed responded showing adequate knowledge and understanding of the logging manual. However, field activities supervised and managed by them proved otherwise. Plate 2 shows unauthorized machinery in use at the forest floor under a wet condition.

Plate 2: Unauthorized machine (caterpillar D8) in use at the forest floor

This was a caterpillar D8 machine, which was been allowed to operate and access a hill of a gradient above 30 % in a wet area. This therefore is likely to cause compaction, apart from deliberately opening the canopy widely.

Plate 3: Excessive opening of a log yard at Oboyow Forest Reserve

The forest canopy was widely opened to be used as a log yard (Plate 3), even though they had not completed to their prescribed standard it was measured at 0.52 ha far more than the approved standard of 0.25 ha in the logging manual.

Plate 4: Abandoned undersize ceiba logs allowed to rot at the forest floor

Plate 4 shows abandoned undersize logs which have been left to rot in one of the closed compartments at Bobri Forest Reserve. This was in contravention to the code of practice spelt out in the logging manual of cleaning the forest floor of waste.

Plate 5: A properly constructed bridge at Oboyow Forest Reserve

In line with the logging manual, bridges should be constructed perpendicular to courses of streams and rivers. The picture in plate 5 shows a product of a properly supervised logging operation at Oboyow Forest Reserve. This is one of the few areas where respondents clearly demonstrated that they were working with guidelines based on the prescription spelled out in the logging manual.

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Land Cover Change Analysis for 1990, 2000 and 2010

Bobri Forest Reserve is one of the well managed reserves in Ghana. In 1990, it had most of its forest cover intact with its closed canopy area representing 56.9 % while the opened canopy area was 26.8 %. Similarly, conditions at Oboyow Forest Reserve were not different with its closed canopy and open canopy representing 54 % and 37.7 % respectively. However, in 2000, both reserves witnessed a drastic change in the forest cover with closed canopies of Bobri and Oboyow being reduced drastically to 34.3 % and 28.2 % respectively (Tables 2 and 3). This therefore made way for the forest reserves to be well opened up.

Even though drastic changes were recorded in both reserves, it was clear that the reduction comparatively was more evident in Oboyow than Bobri Forest Reserve. The changing trends from 1990-2010, may probably be attributed to the high exploitation over the last two decades. However, the increases in Grasses and Built up areas are indication of a vast degradation of the forest estate resulting from human induced activities such as chain sawing, illegal farming, intensive logging etc.

Respondents from the social survey attributed this change to the sudden revision of the harvesting schedules for these reserves to favor timber exploitation as well as illegal

chain saw lumbering. In spite of these massive reductions, the grass and bare areas remained intact.

The findings from the satellite images which demonstrated the continuous destruction of forest cover in the two (2) forests was consistent with the work of Tropenbos (2005). This brings to the fore the question of how effective the various management interventions that have been instituted in these forest reserves over the years had been? The findings of this present study calls for a critical assessment of how forests are managed in Ghana.

5.2 Diversity and Structure

Vegetation sampling conducted in the two forest reserves not only confirmed the changes in land cover but also changes in tree community, diversity and structure. In the Bobri Forest Reserve, the average tree diversity, abundance, diameter and basal area were significantly higher in the closed canopy areas in relation to the open canopy areas (Tables 5 and 6). The difference in diversity and structure between the two areas could largely be attributed to the various anthropogenic activities. A comparison with FORIG Permanent Sample Plots adjacent to the closed and open canopy areas revealed that the studied areas under the management of the government agency the Forestry Commission had lost most of the Economic trees species. With regards to Oboyow Forest Reserve, a similar trend in tree diversity and structure was observed (Tables 4 and 7).

Comparatively, although Bobri Forest Reserve has shown signs of depletion of its economic tree species like; *Milicia excelsa*, (Odum), *Tieghmella hekilli* (Baku/Makore),

Entandrophragma cylindricum (Sapele), *Khaya* (Mahogany's) etc. from the study, it became apparent that it was richer than Oboyow Forest Reserve, in terms of species diversity, forest structure, as well as the health of the forest, using the forest condition score system of Hawthorne and Abu Juam (1993). The study further confirmed that most of these economic tree species were being threatened of possible extinction as a result of overexploitation. This confirms a similar report by MLNR (2011).

5.3 Causes of Change in Forest Cover

Forest depletion constitutes a threat to forest sustainability and loss of potential forestry revenues even though a number of causes have been assigned for the depletion and subsequent deforestation of Ghana's forest resources. The present study showed that the major causes of land degradation in the two forest reserves were the use of chainsaw machine to convert logs into lumber (Fig. 17). Inadequate punitive measures to offenders as well as illegal logging were among the reasons cited by respondents for the loss of forest cover in this study. This confirms the findings of other workers (Hermosilla, 2000; Atmopawiro, 2004; Zaitunah, 2004; Marfo, 2010).

The current study further underscores the fact that, the depletion of the two forest reserves was partly due to constant revision of the harvesting schedule for some compartments to be harvested before their actual time.

5.4 Community Participation in Forest Protection

One of the core principles of Sustainable Forest Management (SFM) is that it reflects a diverse range of societal values in reference to forest conservation and use. For this reason, the active and informed participation of communities and stakeholders affected by forest management decisions is critical to the credibility and sustainability of management processes (IUCN, 2010). Even though the study reiterated that fringe communities have contributed in diverse ways to ensure the integrity of the forest estates, it was not enough to safeguard the forest from degradation. The question is, to what extent and at what stage should communities be called upon to participate in forest management and decision making? The main policy thrusts of 1994 Forest and wildlife Policy revolves around the involvement of local people in management and benefit sharing (MLNR, 2011). However, the current study shows that community involvement in forest management was not adequate. A similar finding was reported by Tropenbos International-Ghana (2007).

5.5 Forests Contributions to Community Livelihoods

Forests play a vital role in the economy of Ghana and a great number of people continue to depend on forest resources for subsistence and to satisfy their socio-cultural needs. The study revealed that the forest provided direct employment through working in some timber firms, gathering of NTFP's, and chain saw lumber business. Social amenities were also provided through the SRA's, though they were not timely and in some cases not even honoured. This agrees with the findings of Myers (1985) and ITTO/IUCN (2005)

who indicated that the forest serves as a source of livelihood for millions of people in the world.

The study further shows that, unequal sharing of benefits from products of forest resources was of great concern to most traditional rulers and opinion leaders. District Assemblies benefits more than the other stakeholders such as the Stool Lands and the real land owners. The mechanism used in sharing benefits does not cater for the actual land owners. The allocation of 25 % for Stool Lands; 55 % for District Assembly and 20 % for Traditional Council simply ignores individual landowners and their families. They therefore expressed concern for government intervention.

However, despite this contribution of the forest through timber operations, most fringe communities continue to live in fear for their lives because of likely threats to their health as a result of the dust pollution, contamination of drinking waters, destruction of their farms as well as the deplorable state in which timber activities always leave their roads (Fig. 20).

5.6 Educational Level and Knowledge in Logging Manual of Timber Operators

Logging manual is a guiding principle, spelling out a step by step approach within which all logging activities are to be used as guidance. Therefore Logging Manuals prescribes a Code of Practice to be adhered to by all contractors. Due to the low level of education of most operators, they could not use the logging manual. As a result, they depended on

instructions from their supervisors and their personal experiences. Consequently the operations of most operators were contrary to the principles of the manual (Fig. 22).

Interestingly Forestry Commission's field or Range Supervisor's mandated to oversee the operations of the companies said they had enough knowledge in the Manual, but could not demonstrate it on the ground as it became evident that they had no or little idea on the subject. No wonder activities in the areas visited did not conform to sustainable forest management principles as undersize trees have been felled; felling was outside the approved yield and the use of unauthorized machinery etc. were the order of the day.

5.7 Knowledge on Management Plans and the Harvesting Schedule

Harvesting schedules set the order, in which compartments are to be logged on the basis of their suitability or readiness for logging (FSD, 1998). Ideally the Forestry Commission's Manual of Procedure (MoP) Section C stipulates that no compartment should be scheduled for re-entry following logging prior to the standard rotation of 40 years. MoP Section E provides guidance on how the best compromise can be reached where this is not possible and the additional factors that need to be taken into account to minimize the practical problems of logging. For example, grouping compartments where possible, in order to minimize road construction and extraction damage. According to the manual, in some cases, the period of re-entry can be reduced if it is known that the previous exploitation was particularly light (i.e. less than 2 trees/ha). However since logging damage is directly proportional to the number of entries, the 40 year rule should be adhered as closely as possible. Under no circumstances should re-entry be allowed in

less than 25 years - no matter how minimal previous logging had been, as this would have extremely deleterious effect on regeneration (FSD, 1998).

However, this was not the case for the two forest reserves, as within the past two (2) decades the harvesting schedule for Bobri Forest Reserve has been revised twice, whereas Oboyow Forest Reserve is awaiting its fourth revision forward to allow certain compartments that are not due for harvesting to be logged. As at the time of compiling this report an approval has been given for its revision in this critical stage of the dwindling forest cover. Pushing the harvesting schedule of these compartments forward is not the problem but the reasons or rational behind these revisions. It was a clear deviation from the standard procedure (MoP). It was without doubt that the forest managers who knew the consequences of this action pretended they had no idea behind the revisions. Should pressure from stakeholders, particularly, timber contractors and political leaders as well as illegal activities compel the Commission to abandon its standards? What then will be the fate of the country's forest estates? Interestingly, most respondents from the Forestry Commission agreed that the revision has impacted negatively on these reserves.

5.8 Field Observations

Field throttling and investigations revealed that, forest managers and bush managers who are to supervise to ensure that logging in these forest reserves are done according to the logging manual and agree to have in-depth knowledge on the logging manual, it became evident than its contents were not known to majority of them. The use of high level

equipment like caterpillar D8 should not have been allowed especially in the wet environment (Plate 2). There was therefore the opening up of the canopy and the widening of the hauling roads contrary to the road specification of 10m and 3.5m of cleared width and carriage width respectively. This has impacted negatively on the soil through compaction and excessive damage to residual trees and regeneration flora. This finding is supported by the work of ITTO (1990).

Log yard is a cleared area where logs are dumped during skidding. They must be kept as small as practicable and should not be more than one quarter of a hectare in area. There should not be more than four log yards constructed per compartment (130 hectares), (FC, 2003). The study found a complete deviation from the approved specifications when measured log yards were estimated around 0.52 ha. Reasons may be varied, but it is centered on the fact that there is weak law enforcement or supervisors not abreast with the rules of engagement.

It can be said that the right to harvest timber resources requires that certain rules and regulations are observed to reduce all forms of negative impacts and ensure maximum benefits. Field investigations and a further check with the logging manual as well as the FSC certification checklist revealed that undersize tree, felling outside the approved yield, felling and hauling on slopes above 30 % gradient were undertaken, whiles logs were also seen abandoned in a closed compartment at Bobri Forest Reserve (Plate 4). These activities were in contravention with the logging manual.

Though the logging manual and the Timber Resource Management Act 547 of 1997, entreats all timber firms to have a competent forestry officer as a logging supervisor, only one company adhered to this directive, and a visit to their area of operation at Oboyow showed that they were working in accordance with set standards. (Plate 5). The question therefore was how is it that Technical Forestry Officers allow the laws and directives to be flouted? They attributed the lapses to lack of motivation and logistics, political interference and to some extend corruption amongst the field officers. This is collaborated by Marfo (2009), who adduced six major factors which contribute to the ineffective enforcement of forest laws as: corruption among FSD officials; corruption among law enforcement agencies; a high rate of rural unemployment; a lack of political will to enforce the laws; market demand (i.e. the relatively cheap price of illegally produced wood); and political interference, particularly by chiefs and local politicians.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Satellite image today, suggests that Ghana's forest are depleting faster than we have replenished. Land cover change detection for the two forest reserves showed a trend of decline in forest cover. From 1990 to 2010, Bobri Forest Reserve lost its closed canopy area by 1703.6 ha representing 52 % of its total land area whiles Oboyow Forest Reserve also saw a decline in its closed canopy area by 1975.8 ha representing 59 % of its total land area. This situation led to an increase in the corresponding open canopies, shrubs, grasses and built up areas for the two forest reserves. This, the study elucidated had been caused by human activities such as; intensive and illegal logging, Chain saw lumbering, illegal charcoal burning, illegal farming, illegal mining and farming amongst others.

Even though the significant forest loss, coupled with bad forest management practices, has impacted negatively on tree diversity, basal area for tree species and their Shannon Winner diversity index were significantly higher in closed canopy areas than in open canopy areas for Bobri and Oboyow Forest Reserves. In addition, Bobri Forest Reserve was seen to have a significantly higher tree diversity, abundance and basal area than Oboyow Forest Reserve.

In supervising timber exploitation, Forest Field Technicians or Range Supervisors demonstrated during the survey that their knowledge on forest management principles and practices were inadequate as well as lack of logistics for the execution of their duties.

The study brought to light that community participation in decision making helped to control and reduced forest offences although community involvement was minimal. This study further revealed that communities are ever willing to contribute to forest protection and management if they are sensitized and encouraged with a reward system.

If the current trend of forest loss persists, the country risks losing its forest cover completely in the next three decades. Therefore for sustainable forest management to be achieved, the under listed are recommended for effective implementation.

6.2 Recommendations

- There is the need to revise the 1994 Forest and Wildlife Policy to incorporate in it monitoring and evaluation, so that apart from reflecting on current trends, it can also allow for constant evaluation to determine how far it is meeting its objectives set out in achieving the mandate of sustainable forest management.
- One of the factors affecting enforceability of laws is deterrence, and this can better be achieved when there is the probability that violations will be detected, expectations that response to violations will be swift and predictable and expectation that response will include an appropriate sanction. Therefore the Forestry Commission should put in place mechanisms for early offence detection and act promptly in meting out justice to offenders.
- The issue of benefit sharing which places the landowners at a disadvantage position by given District Assemblies a majority share of benefits should be reviewed to the satisfaction of landowners.

- Enhance the capacity of staff of the Forestry Commission's Field or Range Supervisors as well as Timber Companies to update their knowledge and level of education on the logging manual as well in forest management so as to meet the changing trends and become abreast with the complexity of managing a tropical high forest.
- Mainstreaming rural community's involvement in forest decision making and forest protection.
- The Forestry Commission should establish mechanisms to solicit political will for effective policy implementation.
- Forestry Commission should take keen interest in Social Responsibility Agreements (SRA) signed between timber companies and the fringe communities so as to ensure that it is honoured.
- Dealing with sector corruption, particularly within the FSD district-level staff and the police, is a fundamental requirement if sustainable forest management is to be achieved, and finally,
- Constant revision of the Harvesting Schedule forward to allow certain compartments to be logged before their time should be stopped, in order to allow the forest to fully recover from its shock from anthropogenic effects.

REFERENCES

Abeney, E. A. (2006). Harvesting controls in some West African countries Institute Of Renewable Natural Resources University Of Science And Technology, Kumasi, Ghana. Ghana Journal of Forestry Vol. 3: 19-29.

Ahmed, M. U. A. I. (2008). Underlying Causes of Deforestation and Forest Degradation in Bangladesh. A report submitted to Global Forest Coalition (GFC), the Netherlands p.4.

Alder, D. (1989). Natural Forest Increment, Growth and Yield Ghana Forest Inventory Project, Seminar Proceedings, ODA/GHANA Forestry. Dept. Accra, p. 47-58

Alder, D. (1993). Growth and Yield Research in Bobri Forest Reserve. ODA/Forestry Research Institute of Ghana. Unpublished Consultancy report, 71 pp.

Atmopawiro, V. P. (2004). Detection of Single Tree Felling in the Tropical Forest Using Optical Satellite Data and Image Classification Techniques (a Case Study in the Labanan Concession, East Kalimantan, Indonesia). MSc Thesis, ITC. The Netherlands Enschede, 91 pp.

Barlow, J. Gardner, T. A. Araujo, I. S. Avila-Pires, T. C. Bonaldo, A. B. Costa, J. E. Esposito, M. C. and Ferreira, L. V. (2007). Quantifying the biodiversity value of tropical primary, secondary, and plantation forests. Proc. Natl Acad. Sci. USA 104, 18 555–18 560.

Bernard, A. C. and Wilkinson, G. G. (1997). Training strategies for neural network soft classification of remotely-sensed imagery. International Journal of Remote Sensing, vol. 18, issue 8, pp. 1851-1856

Boakye, E. Odai, S. N. Adjei, K. A. and Annor, F. O. (2008). Landsat Images for Assessment of the Impact of Land Use and Land Cover Changes on the Barekese Catchment in Ghana. Department of Civil Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. European Journal of Scientific Research. ISSN 1450-216X Vol.22 No.2 (2008), pp.269-278. © EuroJournals Publishing, Inc. 2008. http://www.eurojournals.com/ejsr.htm and www.knust.edu.gh/downloads/22/221784.pdf

Boltz, F. Holmes, T. P. and Cater, D. R. (2003). Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America: a comparative review. Forest Policy and Economics, 5(1): 69-81

Bradshaw, C. J. A. Sodhi, N. S. and Brook, B. W. (2009). Tropical turmoil: a biodiversity tragedy in progress. Front. Ecol. Environ. 7, 79–87.

Bruzzone, L. and Cossu, R. (2003). An Adaptive Approach for Reducing Registration Noise Effects in Unsupervised Change Detection, IEEE Transactions on Geoscience and Remote Sensing, Vol. 41, No. 11, 2003, 2455-2465.

Casson, A. and Obidzinski, (2002). From New Order to Regional Autonomy: Shifting Dynamics of "Illegal" Logging in Kalimantan, Indonesia. World Development, 30(12): 2133-2151.

Cochrane, M. A. and Schulze, M. D. (1998). Forest fires in the Brazilian Amazon. Conservation Biology 12:498-450.

Cochrane, M. A. and Schulze, M. D. (1999). Fire as a recurrent event in tropical forests of the eastern Amazon: effects on forest structure, biomass and species composition. Bio tropical 31: 2-16.

Contreras-Hermosilla, A. (2000). The Underlying Causes of Forest Decline. Occasional Paper No. 30, Pg 8-9.

Damizadeh, M. Saghafian, B. and Greske, A. (2000). Studying vegetation responses and rainfall relationship based on NOAA-AVHRR images.

Denslow, J. S. and DeWalt, S. J. (2008). Exotic plant invasions in tropical forests: Patterns and hypotheses. In: Carson, W.P.; Schnitzer, S.A., eds. Tropical forest community ecology. University of Chicago: pp. 409-426.

Didham, R. K. Tylianakis, J. M. Hutchison, M. A. Ewers, R. M. and Gemmell, N. J. (2005). Are invasive species the drivers of ecological change? Trends Ecol. Evol. 20, 470–474.

Environmental Protection Agency (2004). Ghana State of the Environment Report, EPA Ghana, Accra. Pp 11-51.

Farrhead, J. and Leach, M. (1998). Reframing deforestation. Global analyses and local realities: studies in West Africa, Routledge, London.

Fiset, N. (2008). Positive and Negative Consequences of Deforestation. http://ezinearticles.com/?The-Positive-and-Negative-Consequences-of-Deforestation&id=525336. Accessed 30th May 2012.

Foggie, A. (1947). Some ecological observations on a tropical forest type in the Gold Coast. Journal of Ecology, 34 (1): 88-106.

Food and Agricultural Organization (2000). Forest Resources of Bangladesh. Country Report, (Rome: FAO) www.fao.org/docrep/007/ad104e/AD104E08.htm. Accessed 30th May 2012.

Food and Agriculture Organisation (2004). Illegal Activities in Forestry, http://www.fao.org/forestry/site/1844/en. Date Accessed: 24 June 2004.

Food and Agriculture Organization (2006). Forest and Water Forests and water, FAO, Unasylva No. 229 Vol. 58, 2007/4, Rome, 2007.

Food and Agricultural Organization (2006). Degradation. http://www.foa.org/docrep/009/j9345e/j9345e08.htm. Accessed 30th May 2012.

Food and Agriculture Organization (2010). Country Report-Ghana, Forestry Sector Outlook Studies-FOSA, Working Paper /WP/12.

Forest Services Division (1996). Annual Report. Ministry of Lands and Forestry, Accra, Ghana. Pp 2-5.

Forest Services Division (1998). Annual Report. Ministry of Lands and Forestry, Accra, Ghana. Pp 12-16.

Forest Stewardship Council (2007). 1155 30th Street NW, Suite 300 Washington, DC **www.fscus.org**.

Forestry Commission of Ghana (1997). Forest and Wildlife Policy, 1994, Forestry Commission, Accra, Pp 1-7.

Forestry Commission of Ghana (2003). Manual of procedures, Forestry Commission, Accra, Pp 1-66.

Forestry Commission of Ghana (2007). Validation of legal timber programme, Forestry Commission, Accra, Pp 11-14.

Forestry Commission of Ghana (2012). Reduced Emissions from Deforestation and Degradation. Pp 1-2.

Ghazoul, J. and Sheil, D. (2010). Tropical rain forest ecology, diversity, and conservation. Oxford, UK: Oxford University Press.

Grainger, A. (1993). Controlling Tropical Deforestation London, Earthscan Publication Ltd., 140p.

Groten, S. M. E. Immerzeel, W. and Leeuwen, L. V. (1999). Monitoring of crops, rangelands and food security at national level. ITC-FAO, Rome.

Gulbrandsen, L. H. (2004). Overlapping Public and Private Governance: Can Forest Certification Fill the Gaps in the Global Forest Regime? Global Environmental Politics, 4(2): 75-99. (Article) Published by The MIT Press.

Guuroh, R. T. (2010). Forest Degradation and Deforestation in Ghana. www.ghananewslink.com/index.php?id=10765 Accessed 30th May 2012.

Gyasi, E. A. Agyepong, G. T. Ardayfio-Schandorf, E. Enu-Kwesi, L. Nabila, J. S. and Owusu-Bennoah, E. (1995). Production pressure and environmental change in the forest-savanna zone of southern Ghana. Global Environmental Change 5 (4): 355–366.

Hall, J. B. (1987). Conservation of forest in Ghana. Universitas 8: 33–42.

Hall, J. B. and Swaine, M. D. (1981). Distribution and ecology of vascular plants in a tropical rain forest: Forest vegetation in Ghana. Geobotany 1.Junk Publishers, The Hague. 383 pp.

Hawthorne, W. D. and Abu-Juam, M. (1993). Forest protection in Ghana with particular reference to vegetation and plant species. Unpublished paper: Forest Inventory and Management Project, ODA and Forestry Department, Kumasi. (Published in 1995 as Forestry Protection in Ghana. Forest Conservation Series No. 14, IUCN, Gland).

Hawthorne, W. D. and **Abu-Juam, A. M. (1995).** Forest protection in Ghana. IUCN/ODA, Cambridge, U.K. pp 3.

International Geosphere–Biosphere Programme and International Human Dimensions Programme on Global Environmental Change (1999). Land use and land cover change implementation strategy. IGBP Report 48 and IHSP Report 10. IGBP Secretariat, Stockholm, Sweden. Pp287. International Journal of Remote Sensing 10(6): 989 - 1003.

International Tropical Timber Organization (1990). ITTO Guidelines for the Sustainable Management of Natural Tropical Forests. ITTO Policy Development Series No 1. **International Tropical Timber Organization (1998).** Criteria and Indicators for Sustainable Management of Natural Tropical Forests. ITTO Policy Development Series 7. 10. ITTO 2001.

International Tropical Timber Organization (2004). ITTO at work : Sustainable Forest Management, http://www.itto.or.jp/PageDisplayHandler?pageId=13 Date Accessed; 11th May, 2011.

International Tropical Timber Organization and the International Union for the Conservation of Nature (2005). ITTO/ IUCN Guidelines for the Conservation and Sustainable Use of Biodiversity in Tropical Timber Production Forests. Second Edition. ITTO Policy Development Series 17. Also available at; http://www.itto.int/en/policypapers_guidelines.

International Tropical Timber Organization (2006). Status of Tropical Forest Management 2005, International Tropical Timber Organisation,Yokohama. http://www.fao.org/forestry/sfm/en/.

International Union for the Conservation of Nature (2010). Protected Areas of the World: A review of national systems. Volume 3: Afro tropical. Prepared by the UNEP World Conservation Monitoring Centre (UNEP-WCMC). IUCN, Gland, Switzerland and Cambridge, UK. Web: www.iucn.org.

Johns, A. G. (1996). Bird population persistence in Sabah logging concessions. Biological Conservation 75:3-10.

Lambert, F. R. (1992). The consequences of selective logging for Bornean lowland forest birds. Philosophical Transactions of the Royal Society (London, Series B) 335: 443-457.

Lambin, E. F. and Strahler, A. (1994). Remotely-sensed indicator of land-cover change for multi-temporal change-vector analysis. International Journal of Remote Sensing. Vol. 15, nr.10, pp.2099-2119.

www.uclouvain.be/cps/ucl/doc/geo/.../Main_publications_Sept09.pdf.

Lawton, J. H. Bignell, D. E. Bolton, B. Bloemers, G. E. Eggleton, P. Hammond, P. M. Hodda, M. Holt, R. D. Larsen, T. B. Mawdsley, N. A. Stork, N. E. Srivastava, D. S. and Watt. A. D. (1998). Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forest. Nature 391, 72–76.

Macdougall, A. S. and Turkington, R. (2005). Are invasive species the drivers or passengers of change in degraded ecosystems? Ecology 86, 42–55.

Marfo, E. (2009). "Chainsaw Milling in Ghana": An Overview of the Issues.Tropenbos International, Wageningen, Netherlands, pp.3.

Marfo, E. (2010). Chainsaw Milling in Ghana: Context, drivers and impacts. Tropenbos International, Wageningen, the Netherlands. xii + 64 pp.

Mas, J. F. (1999). "Monitoring land-cover changes: a comparison of change detection techniques." International Journal of Remote Sensing 20(1): 139 – 152.

Meyers, W. B. (1990). The earth as transformed by human action. Cambridge University Press, Cambridge.

Mckinney, M. L. and Lockwood, J. L. (1999). Biotic homogenization: a few winners replacing many losers in the next mass extinction. Trends Ecol. Evol. 14, 450–453.

Miller, A. B. Bryant, E. S. and Birnie, R. W. (1998). An analysis of land cover changes in the Northern Forest of New England using multitemporal LANDSAT MSS data. Int.J.Remote Sensing, 19 (2): 215-265.

Ministry of Lands and Forestry, (1994). Forest and Wildlife Policy.Republic of Ghana. 24 November 1994. Ministry of Lands and Forestry, Accra. Pp1-10.

Ministry of Lands and Forestry (1996). Forestry Development Master Plan 1996 – 2020. Ministry of Lands and Forestry, Accra – Ghana. Pp 1-65.

Ministry of Lands and Forestry (2010). Analysis of primary stakeholders' participation in forest resources. Ministry of Lands and Forestry, Accra – Ghana. Pp 6.

Ministry of Lands and Natural Resources (2011). Revised Forest and Wildlife Policy of Ghana. Pp 1-38.

Muchaal, P. K. and Ngandjui, G. (1999). Impact of village hunting on wildlife populations in the western Dja Reserve, Cameroon. Conservation Biology 13:385-396.

Myers, N. (1985b). The primary source: Tropical deforestation and Species extinctions: The latest news. Futures. W.W. Norton, London. 17:451-463.

Nepstad, D. Moreira, A. Veríssimo, A. Lefebvre, P. Schlesinger, P. Potter, C. Nobre, C. Setzer, A. Krug, T. Barros, A. C. Alencar, A. and Pereira, J. R. (1998). Forest fire prediction and prevention in the Brazilian Amazon. Conservation Biology 12:951-953.

Nutakor, E. Marfo, E, and Tutu P. O. (2009). socio-political constraints to the enforcement of forest laws: a case study of chainsaw operations in Ghana. CSIR-Forestry Research Institute of Ghana, University Post Office Box 63, KNUST, Kumasi Ghana Email: enutakor@csir-forig.org.gh Tropenbos International – Ghana Programme.

Ochoa, J. (2000). Efectos de la extracción de madera sobre la diversidad de mamíferos pequeños en bosques de tierras bajas de la Guayana Venezolana. Biotropica 32: 146-164.

Owubah, C. E. Le, M. Dennis, C. Bowker, J. Lee, M. and John G. (2001). Forest Tenure Systems and Sustainable Forest Management: The Case of Ghana. Forest Ecology and Management 149 (2001) 253-264.

Owusu-Bennoah, E. (1995). Production pressure and environmental change in the forest-savanna zone of southern Ghana. Global Environmental Change **5** (4): 355–366.

Owusu, J. G. K. (1999). Policies and Legislation Concerning Forests, Forestry and Wildlife.Proceedings, Workshop for Media Personnel on Forestry and Wildlife Reporting. IRNR-UST, 6-11 June 1999.

Owusu, J. G. K. Abeney, E. A. and Frimpong, E. A. (1999). Workshop for media personnel on forestry and wildlife reporting. P 4.

Park, C. C. (1992). Tropical Rain forests New York Routledge, 188pp.

Purvis, A. Gittleman, J. L. Cowlishaw, G. and Mace, G. M. (2000). Predicting extinction risk in declining species. Proc. R. Soc. Lond. B 267, 1947–1952.

Ringrose, S. Vanderpost, C. and Maheson, W. (1997). Use of image processing and GIS technique to determine the extent and possible causes of land management/fenceline induced degradation problems in the Okavango area, northern Botswana.Int.J.Remote Sensing, 18 (11): 2332-2364.

Rosyadi, S. Birner, R. and Zeller, M. (2003). Creating political capital to promote devolution in the forestry sector – a case study of the forest communities in Banyumas district, Central Java, Indonesia. Forest Policy and Economics, In Press, Corrected Proof.

Sala, O. E. Chapin F. S. Armesto, J. J. Berlow, R. Bloomfield, J. Dirzo, R. Huber-Sanwald, E. Huenneke, L. F. Jackson, R. B. Kinzig, A. Leemans, R. Lodge, D. Mooney, H. A. Oesterheld, M. Poff, N. L. Sykes, M. T. Walker, B. H. Walker, M.

and Wall, D. H. (2000). Global biodiversity scenarios for the year 2100. Science 287, 1770–1774.

Secretariat of the Convention on Biological Diversity (2009). Sustainable Forest Management, Biodiversity and Livelihoods: A Good Practice Guide. Montreal, 47 + iii pages.

Shifley, S. R. (2006). Sustainable Forestry in the Balance. Journal of Forestry. 104 (4): 187-195.

Smith, E. K. Aninakwa, B. and Ortsin, G. (1995). Formulating and practising new forest policies - recent experiences from Ghana. Unpublished paper, presented at a seminar on "Making Forest Policy Work", Oxford, 6 July 1995. Ministry of Lands and Forestry, Accra.

Strategic National Energy Plan (2006). Energy Commission Ghana. Strategic National Energy Plan 2006-2020 Volumes 1 & 2, Energy Commission.

Tropenbos International (2005). Reconciling Policy Reforms with Forest Legislation. Proceedings of a workshop held in Elmina, Ghana, on the 4th and 5th of July 2005.

Tropenbos International Ghana (2007). Workshop Proceedings 5, Wageningen, the Netherlands (UN) United Nations (2007). Resolution adopted by the General Assembly 62/98: Non-legally binding instruments on all types of forests.

Tufuor, K. (1996). National report on the forestry policy of Ghana. In: Forestry Policies of Selected Countries in Africa. FAO Forestry Policy Paper No. 132, FAO, Rome.

Turner, B. L. Clark, W. C. Kates, R. W. Richards, J. F. Matthews, J. T. and Meyer, W. B. (1990). The earth as transformed by human action.Cambridge University Press. Cambridge, England.

Uhl, C. Veríssimo, M. Mattos, M. Brandino, Z. and Vieira, I. C. G. (1991). Social, economic, and ecological consequences of selective logging in an Amazonian frontier: the case of Tailândia. Forest Ecology and Management 46:243-273.

Wilson, D. E. (1992). The diversity of life. Belknap, Cambridge, Massachusetts.

www.mongabay.com/ The Rain forest assessed on 12.04.2011.

Zaitunah, A. (2004). Analysis of Physical Factors Affecting Single Tree Felling of Illegal Logging Using Remote Sensing and GIS (A Case Study in Labanan Concession, East Kalimantan, Indonesia). MSc Thesis, ITC The Netherlands, Enschede, 108 pp.

APPENDICES

APPENDIX I:

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI (KNUST) INSTITUTE OF DISTANCE LEARNING (IDL)
QUESTIONNAIRE FOR STAFF OF THE FORESTRY COMMISSION

This questionnaire is prepared to solicit for scientific knowledge on the impact of forest policies on sustainable forest management. This is a student project work and your maximum cooperation is anticipated. Thank you.

A. Socio-Demographic Information

1. Region……District……Community……

2. Name of respondent (optional)……...

3. Gender of respondent (1). Male [ ] (2). Female [ ]

4. Age of respondent (years) (1). 10 – 20 [ ] (2). 21 – 30 [ ] (3). 31 – 40[ ]

(4). 41 – 50 [ ] (5). 51 – 60 [ ] (6). 61+ [ ]

5. Level of education attained (1). Primary [ ] (2). Middle/JSS/JHS [ ]

(3). SSS/Voc. /Tec. [ ] (4). Tertiary [ ]

B. Background of the Forest Reserve

5. How long have you been working as a forester (years)?

(1). 1 - 4 [ ] (2). 5 – 9 [ ] (3). 10 - 14 [ ] (4). 15+ [ ]

6. Are you privy to the management plans for this forest reserve?

(1) Yes [ ] (2) No [ ]

7. If yes, has it been revised, and how many times has it been revised since 1990?

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.8. Do you know of the harvesting schedule for this forest reserve?

(1) Yes [ ] (2) No [ ]

9. Has it been revised, and if it has what was the basis for its revision?

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10. Do you think that the revision of both the management plan and the Harvesting schedule has impacted on the forest reserve? Give reason(s) for your answer

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B. Harvesting in a Forest Reserve

11. Have you supervised logging in this forest reserve or any other reserve before?

(1) Yes [ ] (2) No [ ]

12. If yes, what is the procedure a company goes through before, during and after logging?

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13. Are there situations where the procedure is been abused? (1) Yes [ ] (2) No [ ]

14. If yes what is it and what are its likely consequences on sustainable forest management?

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15. Are the timber Company's field operators well educated, and what are their levels of education?

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16. Do you think that their level of education is a challenge to successful forest operations? Give reason(s) for your answer

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C. Knowledge in Forest Policy and Management

17. Do you know of the forest and wildlife policy of 1994? (1) Yes [ ] (2) No [ ]

18. Are you familiar with its contents? (1) Yes [ ] (2) No [ ]

19. Have you read or heard of any scientific research geared at evaluating the forest and wildlife policy of 1994 against the dwindling trends in forest resources.

(1) Yes [ ] (2) No [ ]

20. If yes, is there any correlation between the Policy and the reduction of forest resources?

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21. If no, in your own estimation, has the Policy's aim of sustainably developing and conserving Ghana's forest and wildlife resources for the maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society been met? Give reason(s)……

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22. In your own opinion, what might have brought about the policy failure in reversing the dwindling trends of our forest, and what do you think should be done or incorporated in the new Revised Draft Policy.

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D. Public Participation and Community Involvement in forest Management

23. What benefit rights do communities have in accessing forest resources?

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24. Are these rights enough for their well being? Give reason(s) for your answer

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25. To what extend are communities involved in forest protection and decision making process?……

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26. Has community participation helped in contributing to effective forest protection and management? Give reason(s) for your answer

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E. The Concept of Sustainable Forest Management

27. What are the challenges being faced as far the concept of sustainable forest management is concerned?

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28. What have been the major causes of forest destruction?

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29. At the backdrop of current forest degradation, can we achieve sustainable development? Give reason(s) for your answer……

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30. Do you have any other comment to share?

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APPENDIX II:

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI (KNUST) – INSTITUTE OF DISTANCE LEARNING
QUESTIONNAIRE: OTHER STAKEHOLDERS (Forest Fringed Communities)

This questionnaire is prepared to solicit for scientific knowledge on the impact of forest policies on sustainable forest management. This is a student project work and your maximum cooperation is anticipated. Thank you.

A. Socio-Demographic Information

1. Region……District…….Community……

2. Name of respondent (optional)……...

3. Gender of respondent (1). Male [ ] (2). Female [ ]

4. Age of respondent (years). (1). 10 – 20 [ ] (2). 21 – 30 [ ] (3). 31 – 40 [ ]
(4). 41 – 50 [ ] (5). 51 – 60 [ ] (6). 61+ [ ]

5. Origin of respondents (1). Native [ ] (2). Migrant [ ] (3). Settler [ ]

6. Level of education attained (1). Primary [ ] (2). Middle/JSS/JHS [ ]
(3). SSS/Voc. /Tec. [ ] (4). Tertiary [ ]

7. Occupation (1). Farmer [ ] (2). Trader [ ] (3). Artisan [ ] (4). Gov't employee [ ]

8. Number of dependants (1). None [ ] (2). 1 – 4 [ ] (3). 5 – 9 [ ] (4). 10+ [ ]

B. Background of the Forest Reserve

9. How long have u been staying here (years)?

(1). 1 - 4 [ ] (2). 5 – 9 [ ] (3). 10 - 14 [ ] (4). 15+ [ ]

10. What was the state of the forest reserve as at that time?

(1). Intact no harvesting [ ] (2). Close canopy with harvesting [ ] (3). Open canopy with harvesting [ ] (4). Shrub/herbaceous [ ] (5). Grass [ ] (5) Bare land [ ]

11. What is the state of the reserve as at now?

(1). Very good [ ] (2). Good [ ] (3). Poor [ ] (4). Very poor [ ]

(5). Other(s) specify……

12. In your own view, what might have been the cause of this change?

(1). Over exploitation [ ] (2). Chain sawing [ ] (3). Illegal mining [ ] (4). Illegal farming [ ] (5). Charcoal burning [ ] (6) other(s) specify……

C. Personal involvement in forest activities

13. Have you ever been involved in any form of activities in the forest reserve?

(1). Yes [ ] (2) No [ ]

If yes specify……..

14. How long were you involved in this activity (in years)?

(1). 1 - 4 [ ] (2). 5 – 9 [ ] (3) 10 – 14 [ ] (4)15 +

15. Was your activity in anyway detrimental to the forest reserve?

Give reasons for your answer……...

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16. Has the forest contributed to your well being or that of others in anyway?

(1). Yes [ ] (2). No [ ]

Give reasons for your answer…….....

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D. Knowledge in forest policy and management

17. Have you heard of the forest and wildlife policy of 1994?

(1). Yes [ ] (2). No [ ]

If yes through what medium specify……..…..

21. Have you or any member of this community been called upon to participate in forest management decision making process?

(1). Yes [ ] (2). No [ ]

22. If yes what form did it take?

(1) Durbar [ ] (2) Focal group discussion [ ] (3). Individual contact [ ]

(4). other(s) specify……

23. Do you think community participation in forest management has been adequate?

(1) Yes [ ] (2) No [ ]

24. If yes in what ways has it contributed to forest protection?

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25. If No, what do you think should be done to improve upon it?

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26. Have you at any point in time contributed to the protection and management of the forest reserve? Give reasons for your answer……

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E. Timber Operations and Community Livelihoods

26. Do you know Timber Company's operating in your community has social obligations to perform in the form of Social Responsibility Agreement (SRA)?

(1) Yes [ ] (2) No [ ]

27. If yes in what ways has the Company honored their part of the agreement?

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28. Has timber operations in the community influence the livelihoods of the people i.e. income levels, employment etc? Give reasons for your answer……..

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29. Has timber operations been a threat to the lives of the people? Give reasons for your answer……

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30. Do you have any other comment to share?

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APPENDIX III:

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI (KNUST) – INSTITUTE OF DISTANCE LEARNING
QUESTIONNAIRE: OTHER STAKEHOLDERS (Forest Fringed Communities)

This questionnaire is prepared to solicit for scientific knowledge on the impact of forest policies on sustainable forest management. This is a student project work and your maximum cooperation is anticipated. Thank you.

A. Socio – Demographic Information

1. Region …… District …….

Community……

2. Name of respondent (optional):

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3. Gender of respondent (1). Male [ ] (2). Female [ ]

4. Age of respondent (years) (1) 10 – 20 [ ] (2). 21 – 30 [ ] (3). 31 – 40 [ ]

(4). 41 – 50 [ ] (5). 51 – 60 [ ] (6). 61+ [ ]

5. Origin of respondents (1). Native [ ] (2). Migrant [ ] (3). Settler [ ]

6. Level of education attained (1). Primary [ ] (2). Middle / JSS/JHS [ ]

(3). SSS/Voc. / Tec. [ ] (4). Tertiary [ ]

7. Number of dependants (1). None [ ] (2). 1 – 4 [ ] (3). 5 – 9 [ ] (4). 10+ [ ]

B. Employment Background

8. How long have you been working in the Timber Industry (years)?

(1). 1 – 4 [ ] (2).[ ] (3). 10 – 14 [ ] (4). 15 + [ ]

9. What was your level of education then, has it changed?

……

10. If it has changed, what kind of training have you had, and if not what kind of training do you think you should be taken through? Give reason(s) for your answer

……

……

C. Knowledge in Forest Management

11. Do you know of the logging manual? (1). Yes [ ] (2) . No [ ]

12. If yes, how conversant are you with its contents?

(1) Excellent [ ] (2) Very good(3) Good (4) Poor [ ] (5) Very poor [ ]

13. If No, per what procedure have you been working? Give reason(s) for your answer

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……

14. Have your Company ever been indulged in any illegal activity while logging in a forest reserve?

(1) Yes [ ] (2) No [ ]

15. If yes, what kind and level of offence is it? Give reason(s) for your answer

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……..

16. Could the offence been avoided if you had adequate knowledge on logging manual or it was deliberate?

……

……

17. What importance of the forest do you know apart from the provision of timber?

……

……

D. Social Responsibility and Community Livelihoods

18. Are you aware of the Company's responsibilities to the communities at their operational areas?

(1) Yes [ ] (2) No [ ]

19. If yes, what has your Company provided for this community?

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……

20. Have you employed any member from this community, and how many are they if you has?

……

21. Have your operations in anyway caused problems to the surrounding communities? And what makes you say so?

……

……

E. Company's Involvement in Forest Activities

22. Have your Company ever been involved in any form of activities to improve the forest reserve?

(1) Yes [ ] (2) No

If yes specify

……

23. How long were they involved in this activity (in years)?

(1) 1 – 4 [ ] (2) 5 – 9 [ ] (3) 10 – 14 [ ] (4) 15+

24. What equipment's are you currently using in forest reserve?

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25. Are you in anyway detrimental to the forest reserve? Give reasons for your answer

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26. Do you have any comments to share?

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