SOCIO-ECONOMIC FACTORS INFLUENCING LAND USE AND VEGETATION COVER CHANGES IN AND AROUND KAGOMA FOREST RESERVE KAGERA REGION, TANZANIA

BY

NANJIVA GEOFREY NZUNDA

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ABSTRACT

The Miombo woodland ecosystem has been and continues to face conservation threats. Understanding of changes happening in such ecosystem overtime is important for establishing management baseline data. This study assessed the extent of land use/cover change and the socio-economic drivers of land use and vegetation cover changes in and around Kagoma Forest Reserve north western Tanzania. Remote sensing and GIS techniques were used to analyze land use and vegetation cover changes over the past 23 years. Landsat imagery of 1988, 1999 and 2010 were used in this study. Household survey, field observations and focus group discussions were used to obtain socio-economic data that influence land use and vegetation cover changes and logistic regression model was used to establish the relationship between socioeconomic drivers and land degradation/vegetation cover change. It was revealed that there has been significant land use and vegetation cover transformation from one class to another. In the period of 12 years (1988-1999) woodlands increased by 5.8%, cultivated land increased by 5.9%, settlements increased by 0.52%, grassland decreased by 2.7%, bushland decreased by 3.87% and forests decreased by 5.64%. During 1999-2010 period woodland decreased by 22.97%, cultivated land increased by 6.07%, settlements increased by 9.14%, grassland increased by 1.50%, bushland increased by 8.76%, and forest decreased by 2.5%. There has been a substantial change in land use and vegetation cover with resultant land degradation over the Kagoma area where the vegetation cover is decreasing at the rate of 45.0845 ha (0.27%) per year. The perceived drivers for the changes include; overgrazing, demand for forest products (mainly timber, charcoal, firewood and poles), shifting cultivation, agricultural expansion, increasing crop prices and lack of land tenure. Enforcement of different laws and regulations relating to natural resources and land use

planning to improve land tenure and resource use in villages bordering the forest can substantially reduce the problem of land degradation.

DECLARATION

I, NANJIVA GEOFREY NZUNDA, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

Nanjiva Geofrey Nzunda — Date

(MSc. Candidate)

The above declaration confirmed

Prof. Munishi, P.K.T. — Date

Supervisor

Dr. Kashaigili, J.J. — Date

Supervisor

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DEDICATION

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LIST OF ABBREAVIATIONS AND SYMBOLS

EMR	Electromagnetic Ration
ETM+	Enhanced Thematic Mapper Plus
FAO	Food Agriculture Organization of the United Nations
Fig	Figure
GIS	Geographic Information Systems
GPS	Global Positioning System
ha	Hectare
LCCS	Land Cover Classification System
LUCID	Land Use Change Impacts and Dynamics
MLHUD	Ministry of Land, Hosing and Urban Development
MNRT	Ministry of Natural Resources and Tourism
MSS	Multispectoral Scanner
NEMC	National Environment Management Council
TM	Thematic Mapper
URT	United Republic of Tanzania
USGS	United States Geological Survey
UTM	Universal Transverse Mercater
WCED	World Commission on Environment and Development

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Expansion of cultivation in many parts of the world has changed land cover to more agro-ecosystems and less cover of natural vegetation (Lyaruu, 2002; Tiffen, 2003). These changes are fuelled by a growing demand for agricultural products that are important for improving food security and generate income, not only for the rural poor but also for the large-scale investors in commercial farming sector. Food production in Kenya, for example, is reported to have increased steadily between 1980 and 1990, but because of population increase, the food supply in calories per head fell slightly during the same period (Reid, 2004). Historically, humans have increased agricultural outputs mainly by bringing more land into production (Lambin *et al*., 2003). Indeed, land conversion to agriculture in East Africa has outpaced the proportional human population growth in recent decades (Reid, 2004). Natural vegetation cover has given way not only to cropland but also to native or planted pasture (Lambin *et al.,* 2003). Also, considerable importance to land use change in East Africa, is the expansion of urban centres.

During the last few decades, the area under cultivation has more than doubled in Kenya and Tanzania, but in Uganda the change has been moderate due to enhancement of land policy protecting large parts of Uganda as wetlands (Olson *et al.*, 2004). In Kenya, Olson *et al.* (2004) reported that cultivation expanded by 70% between 1958 and 2001, leaving only isolated pockets of forest and bush. Similarly, in Tanzania, (Misana *et al.*, 2003) reported a significant expansion of cultivation in Moshi area over the same period. However, in Uganda, Mugisha (2002) reported that agriculture only expanded in the drier rangelands, not in the wetter highlands. Land scarcity in the highlands caused farmers to intensify their land use (increase inputs per hectare) because there was little land available for extension of their farms. Globally, concerns about the changes in land use/cover emerged due to realization that land surface processes influence climate and that change in these processes impact on ecosystem goods and services (Lambin *et al.*, 2003). The impacts that have been of primary concern, are the negative effects of land use change on biological diversity, soil degradation and the ability of biological systems to support human needs. Crop yields have declined, forcing people to cultivate more land to meet their needs (Kaihura and Stocking, 2003). Grazing areas have become less productive resulting from over stocking of livestock. Conflicts over the use of land have increased due to increased demand for land by different sectors of the economy. One of the particular concern are the conflicts among cultivators, livestock keepers, wildlife conservationists, individual land users and governments due to encroachment of humans into the protected areas (Hoare, 1999; Campbell *et al.*, 2003).

1.2 Problem Statement and Justification

Anthropogenic alterations of the natural landscape through urbanization, agriculture and forestry have been continuous and increasing process for the past millennium (Vanacker, 2002). Areas of the natural vegetation and land cover are removed and replaced with the human managed systems of altered structure (Lundgren, 1978). During the last century, land use has changed drastically in the tropics due to changing economy and growing population (Meyer and Turner, 1992). This has caused significant and adverse effects on physical and ecological process (Briassoulis, 2002), on soil and water (Center for Earth and Planetary Studies, 2001; Munishi *et al*., 2006) on local and global climate (Turner *et al.*, 1993) and on biodiversity (Association of American Geographers, 1996). Studies by

Meyer and Turner (1996) showed that land use both deliberately and inadivertly alters land cover such as vegetation by changing it into different state like building materials, medicinal, wood and fuel, hence deforestation. Recently, efforts have been made to quantify the nature and extent of land use/land cover changes including vegetation at global scale (e.g. Zhou *et al*., 2008; Kashaigili, 2008; Dewan and Yamaguchi, 2009). Richards (1990) estimated that, over the last 300 years, the total global area of forest and woodland diminished by 19%, while grasslands increased by 46.6%. Despite the recognition on the magnitude and impact of global changes in land use and land cover, there have been relatively few comprehensive studies on land use changes and their impacts (Strategic Plan for the climatic change Science programme, 2003).

Kaoneka (1993) reported on the analysis of land use changes based on sequential aerial photographs in the Usambara Mountains, Tanzania. The report revealed declining area of natural forest reserve at a fairly high rate of 3.8% per year on the expense of farmlands and settlements which increased dramatically by 83% per year. Also, reported that this change was mainly due to population increase which resulted into more pressure on land and forest resources. Misana *et al.* (2003) on the other hand reported a significant expansion of cultivation in Moshi area, as well as other north-western regions, including Kagera.

Despite the studies conducted in the north-western Tanzania, little is known about the factors influencing land use and vegetation cover change in and around Kagoma Forest Reserve and other Forests in the world. It is widely acknowledged that increased population as a result of refugees’ influx including local population increase have had impact on forest resources in the study area. While that has been said, no quantifications have been done and it is not explicitly clear whether population increase is the only cause for the changes. Therefore, the research done through this study identified and assessed various socio-economic factors influencing land use and vegetation cover change in and around Kagoma Forest Reserve, and established the magnitude of changes. The findings from this study are expected to be very useful in informing the policy makers and also will assist in land use planning and management of Kagoma Forest Reserve.

1.3 Objectives

1.3.1 General objective

The overall objective was to assess the socio-economic factors influencing the spatial and temporal land use and vegetation cover change, in and around Kagoma Forest Reserve.

1.3.2 Specific objectives

The specific objectives were to;

(i) Examine the land use and vegetation cover change from 1988 to 2010 in and around Kagoma Forest Reserve

(ii) To identify the socio-economic factors that influence the land use and vegetation cover change around Kagoma Forest Reserve

1.4 Research Questions

i) What changes in land use and vegetation cover have occurred between 1988 to 2010?

ii) What are the socio-economic factors influencing land use and vegetation cover change?

iii) Which factors have more influence on land use and vegetation cover change?

1.5 The Conceptual and Theoretical Framework

The research concentrated on influence of human interaction with the environment and subsequent effects. According to Mbonile *et al.* (2003) land use and land cover change form a complex and interactive system linking human action to land use and land cover change to environmental feedbacks to their impacts and human responses. Explanation of land use and land cover pattern has to do with a number of factors including natural and man made casualties like socio-economic forces that occur at national and international levels. The decisions arrived at any level affect the use and management of natural resources at local level (Munishi *et al.*, 2003). For instance trade liberalization has direct impact to suppliers and consumers of goods and services produced in a country.

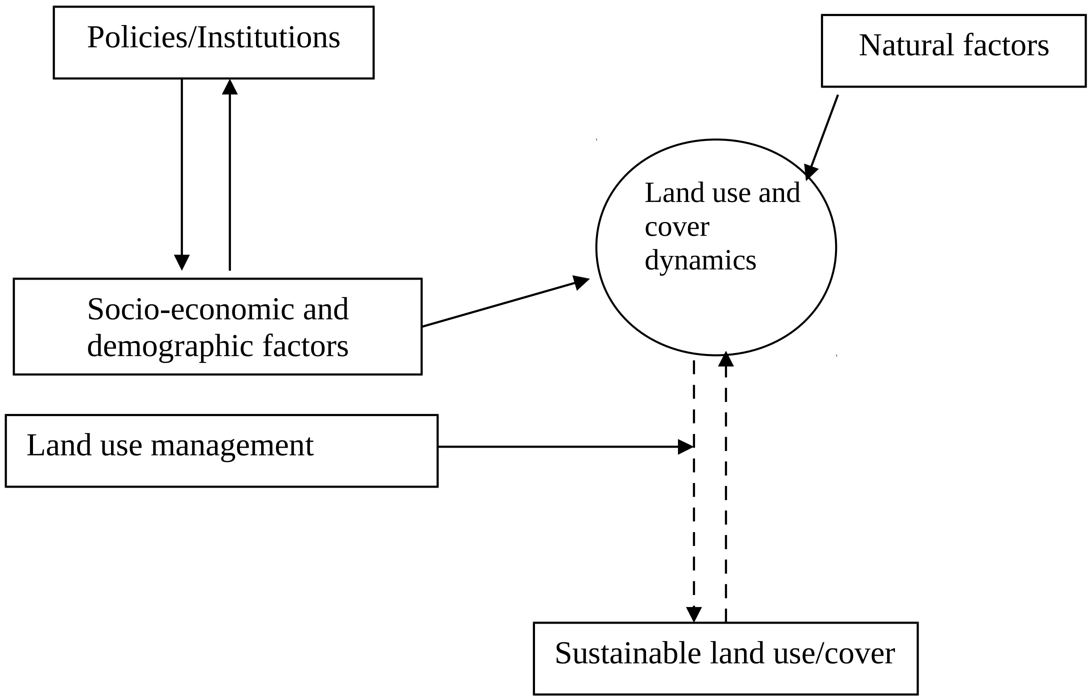

Figure 1: The Conceptual and Theoretical Framework

The socio-economic factors thought under this conceptual frame work include national economic policies and other public policies which have influence on social and economic status of the community like use and ownership of resources basically land and its associated natural resources like forests, population changes and social cultural behaviors of communities. On the other hand, enacted laws like land acts and forest act have also implications on natural resource use. Furthermore, according to Turner *et al.* (1995) and Mbonile *et al.* (2003) cultural practices are important ingredients responsible for variations in land management at the unit of production and may endure over long periods of time, transcending shorter term historical periods.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition and Basic Concepts on Land Use

2.1.1 Land use

According to FAO (1995), land is a delineable area of the Earths' terrestrial surface, encompasses the attributes of biosphere immediately above or below the Earths' surface including those of near the surface, climate, the soil landforms and the surface hydrology (shallow lakes, rivers, marshes, and swamps). The near surface sedentary layers in associated ground water reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activities.

Land use, has been referred to as the human purposes that are associated with land cover, which may include raising cattle, recreation, or urban living (Veldcamp and Fresic, 1995). In more detail, land use is the total arrangement of activities and inputs that people undertake in a certain land cover type (FAO, 1999). On the other hand, land cover is the observed physical and observed biological cover of the earth's surface such as vegetation or manmade features (FAO, 1997).

2.1.2 Remote sensing technology and land use and vegetation cover change

Remote sensing principally involves two main processes namely data acquisition and data analysis where earth resource data are acquired using various electromagnetic energy sensor systems operated from airborne and space borne platform which are finally made available in digital format for image interpretation. Remote sensing technology determines the cover changes from Landsat Thematic Mapper scenes for given years which is used in determining the land cover rate of change, where cover change is computed by the respective equation (Kashaigili, 2006).

2.1.3 Land use and vegetation cover changes

According to Briassoulis (2000), land use and vegetation cover change has been defined as quantitatively changes in the real extent (increase or decrease) of a given type of land use or vegetation, respectively. Such changes have been occurring rapidly and involve large areas, especially in developing countries, and their influence on environmental conditions may easily be as large as the effects of climate change (Vanacker, 2002). Most of land use and vegetation cover changes of present and recent past are due to human actions, resulting from uses of land for production or settlement (Veldkamp and Fresco, 1995). Land use and vegetation cover change is largely driven by the need to meet the increasing resource consumption (energy and food) of the expanding human population (Houghton *et al.,* 1991). Land use alters land cover such as vegetation by changing it into different state (Meyer and Turner, 1996). Many studies (Mbilinyi, 2000; Vanacker, 2002; Rugenga, 2002; Ngalande, 2002; Kashaigili, 2006; Kashaigili, 2008) have revealed the effect of human activities or arrangements on land use and land cover or vegetation change. Kaoneka (1993) analysed land use changes based on sequential aerial photographs in the Usambara Mountains, Tanzania. The report revealed declining area of natural forest reserve at a fairly high rate of 3.8% per year on the expense of farmlands and settlements which increased dramatically by 83% per year. He also reported that this change was mainly due to population increase which resulted into more pressure on forest resources.

Change in land use and vegetation cover can have far reaching consequences to farmer’s welfare as well as the environment (Bergeron and Pender, 1999). For instance conversion of forest or pasture into irrigated cropland may increase farmer’s incomes, but may also increase soil erosion, reduce plant biodiversity, or lead to environmental pollution (FAO, 1998; Kimaro, 2003). A study conducted by Rugenga (2002) at Ruaha Mbuyuni in Iringa Region Tanzania, revealed that within temporal periods of 1976-1999, land use/cover experienced a profound transformation due to irrigated agriculture, mainly for onion production. A depletion of about 2131 ha of riverine vegetation was noted, of which 64% was contributed by increased irrigated agriculture alone. Despite this, the report shows that the onions were sold at good price hence contributed much to the improvement of people’s income (Rugenga, 2002).

According to Veldkamp and Fresco (1995), land use and land cover change is largely driven by the need to meet the increasing resource consumption of the expanding human population. Changes in population density may affect land use choices by increasing the scarcity of land relative to labour, which creates pressure to reduce fallow periods (Bergeron and Pender, 1999; Kimaro, 2003). The increased population in Uluguru Mountains, Tanzania has stimulated wide utilization of natural resources including land for cultivation and settlements, and forest products such as wood for fuel, building materials, and medicinal purposes (Kilasara and Rutatora, 1993; Lulandala *et al*., 1995).

2.2 Land Use and Land Cover Classification Systems

The analysis of land use and land cover change depends on the used system of land use and land cover classification (Briassoulis, 2000). The used classification system must fulfil the primary needs of project, fit the technology and resources available, and simplify all further processings (USDA, 1996). Several land use and land cover classification systems have been developed that can readily incorporate land use and land cover data obtained by interpreting remotely sensed data (Jensen, 1996). Some have been developed at global and others at sub-global or mostly national level (Michael and Vicksburg, 2006). Major points of difference between various classification systems are their emphasis and ability to incorporate information using remote sensing.

At global level, the FAO/UNEP land cover classification system (LCCS) is the only universally applicable classification system in operational use at present (Lathman, 2001). It enables a comparison of land cover regardless of data source, economic sector or country. The LCCS has the best potential to become standard accepted international land cover classification system because of its ability to allow production of many different spatial maps based on data classification scheme. It has the ability to respond to changing needs and definitions in all climatic zones and environmental conditions and is also compatible with the existing classification systems such as the United States Geological Survey (USGS) classification system, the United States Fish and Wildlife Service Wetland Classification system, and coordinated Information on the European Environment (CORINE), (FAO, 2001; Environmental and Natural Resources services (SDRN) and FAO, 2004).

At sub-global or national level, the most commonly used system is the United States Geological survey (USGS classification system). The USGS classification system is the hierarchical system developed by Anderson *et al.* (1976) at the United States Geological survey (Lillesand and Kiefer, 1987; Short, 1999). The system was developed as a national system for land use and land cover classification that would use data from conventional sources and remote sensors on high altitude aircraft and satellite platforms (Anderson *et al.*, 2001). This multi-system has been designed because different degrees of detail can be obtained from different data sources depending on the sensor system and image resolution (Anoroff, 1998; Lillesand and Kiefer, 2000). The USGS classification system is aimed at complete standardization at levels 1 and 11 only (Avery and Berlin, 1985). Land use and land cover classifications at levels 1 and 11 are usually adaptable for evaluation of past changes in land use. Problems arise when more detailed break downs are desired, because reliable ground checks cannot be made for older sets of imagery. The USGS system attempts to meet the need for current overview of land use and land cover studies on the basis that it is uniform in categorization at the generalized first and second levels. The categories of land use and land cover in this classification system can also be related to other land use and land cover classification systems such as FAO land suitability classification system, vulnerability of certain management practices, potential for any particular activity, or land value, either intrinsic or speculative (Anoroff, 1998).

The standard land use coding (SLUC) manual is another land use classification system developed in the United States. The system is land use activity oriented and is primarily dependent on *in situ* observation to obtain remarkably specific land information, even to the contents of building (Rhind and Hudson, 1980). Whereas the USGS land use and land cover classification system is resource oriented (land cover) the SLUC manual or activity (land use) oriented system (Anderson *et al.*, 1976; USGS, 1992). Another classification is the United States Fish and Wildlife Service Wetland classification system. The system is responsible for mapping all the wetlands in the United States. It incorporates information extracted from remote sensing data and *in situ* measurement. The system describes ecological taxa, arranges them in a system useful to resource managers and provides uniformity of concept and terms. Wetlands are classified based on plant characteristics, soils and frequency of flooding.

Other authors (Mbilinyi, 2000; Vanacker, 2000; Rugenga, 2002) have not adopted any of the already established classification systems but have described different land use and land cover classes using general terms and based on field observations outlined by Dent and Young (1981). This was done to meet the primary needs of the respective projects. The description of the land use and land cover classes was done following the complexity and multiplicity of the landscape in the study area. Hence the FAO/UNEP land cover classification system (LCCS) is the only universally applicable classification system in operational use at present (Lathman, 2001) since it enables a comparison of land cover regardless of data source, economic sector or country.

2.3 Remote sensing usefulness in understanding land use/cover change

Remote sensing is the acquisition of data concerning objects or features on earths' surfaces or in the atmosphere through the use of imaging devices (Avery *et al.,* 1985; Rugenga, 2002). The sensors record electromagnetic ratio (EMR) that is reflected or emitted from these objects or features. Remote sensing includes the collection of data, their display, their analysis or interpretation and their subsequent use for purpose of inventory, survey, monitoring, planning and management Cochrane (1986). Remote sensing can readily show aspects like arable land and maintained pasture, natural forest, plantations, the pattern of the field and the extent of urban or village use of land.

Studies using remotely sensed data have been done by various natural resources professionals. Mulongo (1993) used remote sensing to assess the rate of natural resources exploitation and the implication of existing land policy in the reserved lands of Mboele-Muyonzi in Zambia. In this study it was found that due to uncoordinated nature of resource utilization and localized population pressure, resources degradation in terms of forest depletion due to bush clearing for cultivation had increased which later caused serious decline of soil productivity (Kashaigili, 2006).

Slayback (2003) studied land cover change in the Takamanda forest reserve in Cameroon. The study revealed that most of the areas of forest conversion into other land uses were located on the periphery of existing villages and areas of pre-existing secondary forest and the rates of forest clearing increased as the expanding patterns of forest conversion indicated.

Kummer (1992) investigated population pressure, expansion of small agriculture and shifting cultivation contribution to deforestation in the uplands of Philippines between 1948 and 1980. The study revealed that small scale agriculture converted secondary forest to farmland while logging accelerated deforestation. Deforestation and expansion of subsistence agriculture were signs of failure of development standards in Philippines. Shreier *et al.* (1994) used remotely sensed data and historic land use/land cover dynamics to study resources status in the Himalaya, Nepal watershed using geographical information system. In this study forest, cropping system and socio-economic factors were investigated. Observations showed that between 1947 and 1990, forest, shrubs and agriculture were the only land uses. Deforestation was significant from years 1972 to 1990 and was more critical in the middle mountains of Nepal. It was reported that geographical information systems when integrated with remotely sensed data could be useful in identifying impact of deforestation due to increased agricultural activities and grazing. Land use and land cover transformation studies have also been done in Tanzania by using remote sensing. Monela and Solberg (1998) studied the land use and cover change and deforestation rates of the Nguru Mountains rain forests in Morogoro between 1949 and 1993. The findings showed that the continuous rainforest outside the forest reserve declined by about 1.3% per year since 1949 while continuous rainforest boundary was moved up the slopes and shortened by 37%. The encroachments for subsistence agriculture as well as establishment of settlements by indigenous people were found to be the main causes of rainforest degradation pressure.

Nindi (2004) studied the dynamics of land use in Matengo highlands southern Tanzania using remote sensing for the periods of 1984, 1989, 1991, 1994 and 2000. The study revealed that vegetation cover change in miombo woodland of Kitanda village changed from 84% coverage in 1984 to 20% in year 2000 due to human induced activities. Luoga *et al.* (2005) used remote sensing to investigate the potentials of local communities to sustainably manage miombo woodland resources. Results revealed that woodlands of Kitulanghalo Forest Reserve and surrounding public land covered 82.3% in 1964. However, woodland declined by 50% representing a decline of an overall mean of 1.6% per year for the period between 1964 and 1996. This situation was due to existed relationship of people and their local environmental which shaped the landscape of the area, creating a mosaic of woodland, bushland, cropland, settlements, home garden and forests.

Rugenga (2002) used remote sensing to study land use changes due to traditional irrigation activities for the of periods 1955, 1976, and 1999 in Ruaha River, Tanzania. The study identified seven main land use classes including riverside vegetation, forest woodland, scrub, settlements and abandoned fields. The land use change was mainly observed along the Great Ruaha River and its distributaries. It was found that overpopulation, grazing and charcoal making were among socio-economic factors leading to land use/land cover changes. The above reviewed studies indicate a thorough feasibility of the methodology for the study of land use and land cover changes and its driving forces, which prompted to use this methodology in the study site.

2.4 Land Use and Vegetation Change Detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Lillesand and Kiefer, 2000). Land use is necessary for better management of natural resources. The change is usually detected by comparison between two multidate images, or sometimes between an old map and an update remote sensing image (Anoroff, 1996). The land use/vegetation cover change can also be done by comparing seasonal changes and annual changes (Japan Association of Remote sensing, 1996). For example, Mbilinyi (2000) used pancromatic aerial photographs, (1993 and 1978), Landsat TM and satellite imagery incorporated into GIS environment to assess land degradation. A large part of rain forests was converted from woody vegetation to cultivated land and wooded grassland annually in Morogoro region.

2.5 Drivers of Land Use/Vegetation Cover Change

Lambin *et al.* (1999) reported that, the monitoring of land use changes would be most relevant and useful when it is accompanied by the understanding of the driving factors, which are Natural factors, Biophysical and Socio-economic factors. This study mainly focused on the Socio-economic factors/ Drivers.

2.5.1 Socioeconomic factors/drivers

2.5.1.1 Population Growth

Historical land use change has occurred primarily in response to population growth, technological advances, economical opportunities and public policies (Strategic plan for Climate change science Programme, 2002). Hence land cover, like vegetation modification and conversion are driven by human use. Overpopulation leads to over utilization of land resources, excessive deforestation and water related problems hence land degradation and vegetation change. In Uganda (Zwick and Smith, 2001) in the 1940s and 1950s many Banyarwanda and Bahutu farmers and Batutsi pastoralists from Rwanda, immigrated to Rakai District, Uganda in search for arable and grazing land, where being there they not only increased the population size but also they started grazing and cultivation activities, where crops like bananas and coffees were cultivated. Also Bantu cultivators and Nilotic pastoralists migrated in Haya land and created the settlement in different Forests whereby being there they started cultivating different crops by slashing the forest parts for their cattle and crops like yams, finger millet, and Sorghum, whereby by doing that Forests and land were highly converted into agricultural land hence severe destruction (Ogot, 1984).

2.5.1.2 Land tenure system

Land tenure system include terms and conditions whether stipulated in a land legislation and regulations or implied terms upon which land is acquired, owned, used and disposed in a given country (ODI, 1999). In the sub-Saharan Africa, land tenure systems vary from one country to another depending on natural differences in ecology that shape greatly the kind of land use and land cover in that locality over a particular time and space (Yoshinda, 2002). Land acquisition has a great role in determining agricultural systems which finally influence the land use and land cover change. For example, a study which was carried out in the Bolta Basin in Ghana revealed that traditional ownership under common property system allowed re-distribution of fallowed land to arable land use due to land scarcity (Codjoe, 2004; Braimoh, 2004).

Furthermore, Olson *et al.* (2004) established that the land tenure arrangements were the most shocking driving force of the land use change in Tanzania, Uganda and Kenya. Land tenure dynamics in these countries altered who conducts management of land and who has the right to use land and the way how the land should be used. Most of these changes influenced land use in agriculture and pastoral lands.

The structure of land tenure in Tanzania for example has evolved from traditional ownership before the Germans and the British rules. Before 1885 landholding was based on traditional law and culture of each respective tribe in an area MLHUD (1995). An individual as a member of a family, clan or tribe acquired rights of use in the arable land he and his family could clear, cultivate and manage. However, when the land showed signs of exhaustion, then shifting cultivation was practiced. In many of these areas, there was and there is still communal land for grazing and forestlands for cutting firewood. This type of extensive cultivation was acceptable and viable under conditions of low population densities, abundance of land and agriculture.

The German rule introduced new land tenure system in the country by passing the Imperial Decree in 1895, which declared all lands in Tanzania as crown land vested in the German Empire (MLHUD, 1995). This was the beginning of the land nationalization. Under the British administration, the system of land holding continued to change.

The Land Ordinance Chapter 113 of 1923 was passed. All land in Tanzania whether occupied or unoccupied was declared as public land. The Ordinance introduced the concept of rights of occupancy in the country. Under this new land tenure system, rights over or in land were placed under control of the Governor to be held, used or disposed of as rights of occupancy for the benefit of indigenous people of Tanzania, Although the granted right of occupancy was introduced in the country, customary ownership continued to exist and communities in rural areas continued to hold land under traditional ownership (MLHUD, 1995).

After independence the country maintained the Land ordinance cap 113 of 1923 with some reforms. The introduction of villagelization programme in early 1970s did not consider land tenure system and available resources in resettlement of people, which later resulted into resource degradation around village centers where woodlands were degraded for fuel woods, building materials, agriculture and grazing (Mbilinyi, 2000). Some villages in this period were surveyed and were given certificate of occupancy, which means that no individual household could be granted right of occupancy. This situation caused insecurity of land tenure in rural areas and was one of the causes of rural household’s reluctance to invest in land improvements. It encouraged extensions of field farms and shifting cultivation (Kikula, 1997). May be the introduced Land Act No.4 and Village Land Act No.5 of 1999 will regulate land tenure in the future if implemented properly.

2.5.1.3 Market conditions of agricultural products

Marketability and price fluctuations of agriculture produces are important ingredients responsible for land use and land over change. Duraiappah *et al.* (2000) put clear that good prices play an incentive role to commercial farmers who decide to acquire large tracts of land for agriculture. Kasperson *et al.* (2001) observed that capital investments involved in unsustainable production levels for the world market create livelihood systems dependendent on those market yet vulnerable to their fluctuations. Markets systems allow households who are farmers to decide how many agricultural commodities should be produced. Noe (2003) argues that before market liberalization in Tanzania, the government played a great role in controlling market prices through rural co-operative societies. However after trade liberalization in early 1990s, individual farmers had free market access and market forces influenced commodity prices. Thus farmers started to compete to produce crops, which have higher return in terms of income, which means demand of more land for cultivation and natural resources increased. According to Msambichaka *et al.* (1995), liberalization of markets, removal of subsidies on farm inputs and price reforms had significant impact on land and resource use. Bagachwa and Limbu (1995), argued that a removal of subsidies on farm inputs in the case of Kilimanjaro Region made farmers to resort to traditional system of extensive agriculture, which led to high land cover change.

2.5.1.4 Income levels

The injudicious ecosystems management is a consequence of poverty, which finds roots in the Tanzania's poor economic base. The average of rural household annual income in Tanzania is far below the expenditure poverty line (URT, 2005). The poor economic environment is likely to increase hardship in the livelihood systems of people and is bound to pose more pressure on natural resources and ultimate loss of existing ecosystems. Therefore, poor socio-economic base cause poor societies to depend on biological resources for construction, food energy and other related products (Kajembe and Luoga, 1996). This dependence on natural resources affect land cover through which human utilize the resources which in turn shift land use patterns hence land degradation.

2.5.1.5 Education level

Education is an important ingredient for sustainable natural resources management and development. Education tends to create self awareness, positive altitude, values and motivation (Kajembe and Luoga, 1996). It is also argued that education stimulates self confidence and self-reliance, which promote human development. Educated rural households are more productive in agriculture and are likely to have more off farm income earning opportunities than the non educated (Kajembe and Luoga, 1996). Under such circumstances, education helps better management of resources at a household level, which reduces human pressure over existing natural resources. Ngalande (2002) did a study in Zambia and revealed that low education level of most local people was among the reasons causing difficulty in understanding relationship between clearing vegetation for cultivation without taking measures of conservation. Furthermore it was noted that low level of technology reflected in slash and burn with lack of conservation farming practices like non-terracing the land on slopes caused land deterioration.

2.5.1.6 Beliefs and attitudes

In many third world countries including Tanzania, social and economic pressure have forced communities to remain with the same land use practices and social values that are no longer conducive under present land use systems (Lyaruu, 2002; Tiffen, 2003). For example, some tribes in Tanzania such as Gogo, Sukuma and Maasai, continue to measure their social and economic status in terms of size of cattle herds they own. This belief encourages keeping large herds of livestock beyond their carrying capacity of grazing lands (Mwalyosi, 1990). Overgrazing and drought are among the factors that have contributed to degradation of environment by speeding up land degradation most in areas with high population density, fragile land and low rainfall. Kikula (1997) pointed out that clearing of land for cultivation, without proper soil management practices has accelerated loss of vegetation cover.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description and Location of the Study Area

Kagoma Forest Reserve is found in Bukoba Rural District, Kagera Region in Tanzania (fig 2) and is located at Kagoma Forest Reserve is found in Bukoba Rural District, Kagera Region in Tanzania (fig 2) and lies within longitudes 1°29'49"S - 1°39'18"S and latitudes 31°18'27"E - 31°19'20"E. The forest has the size of 16697.92ha and is at about 1245m above sea level, situated at the center of Bukoba Rural District in the north-western Tanzania. Bukoba Rural District is one of the six districts of the Kagera Region occupied by different tribes but mainly Haya tribe. It is bordered to the north by the Bukoba Urban District, to the south by Biharamulo and Muleba Districts, to the east by Lake Victoria and to the west by the Ngara and Karagwe districts. The geographical coverage of the District is 5282 km² of land and 7925 km² of water, mostly Lake Victoria and including more than 20 islands in the Lake.

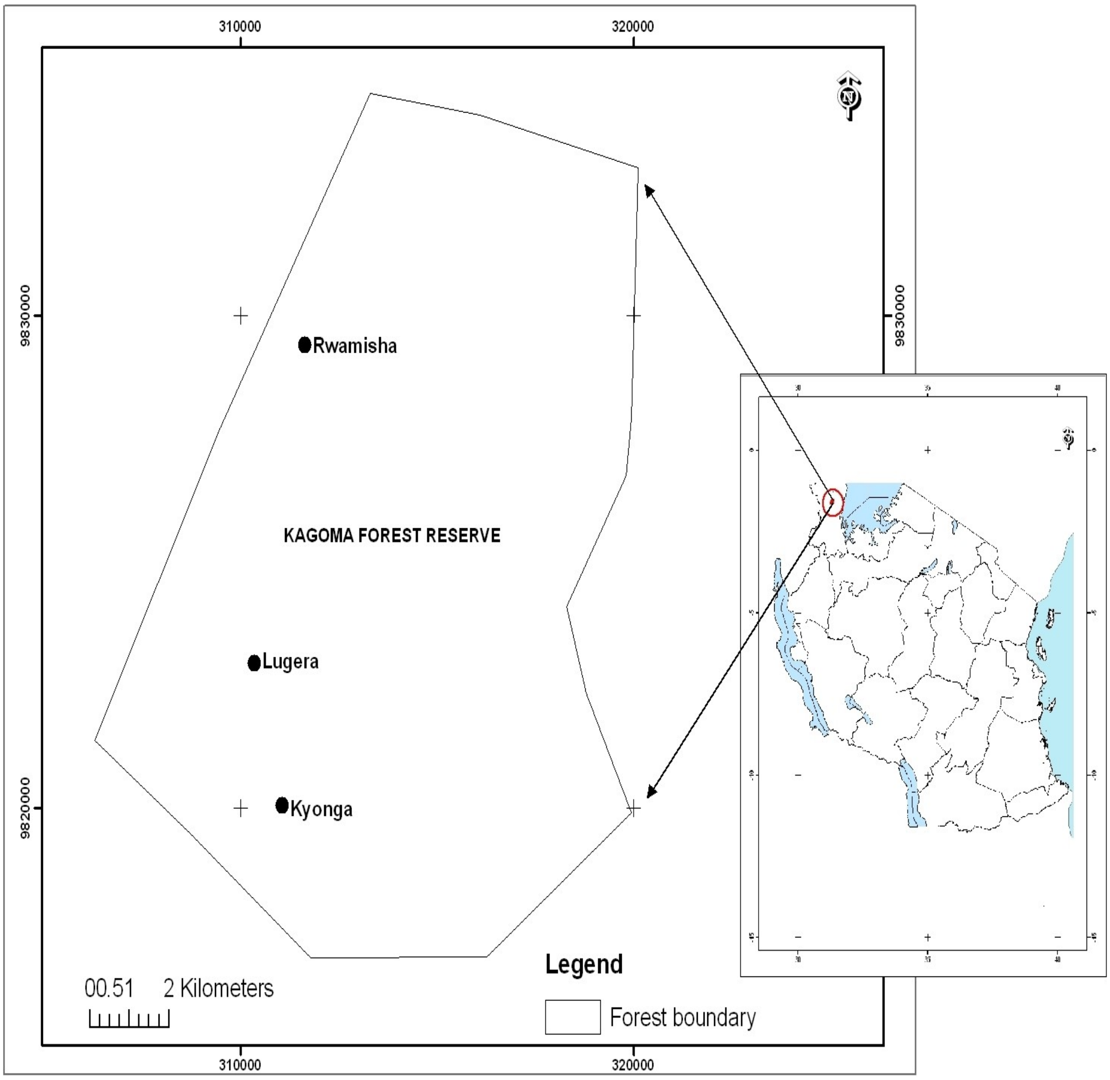

Figure 2: Location of Kagoma Forest Reserve, Tanzania

3.1.1 Soil

Major landforms are hills and ridges with a north south orientation, valleys, uplands and plains. Soil types vary according to location, and the common ones were described by Touber and Kanani (1994) as Ferralsols, Fluvisols, Arenosols and Gleysols (UN Habitat, 2009).

3.1.2 Climate

Rainfall is very much influenced by topography and the presence of Lake Victoria. A rather steep gradient in total annual rainfall is observed, from 2100 mm along the coast to less than 700 mm towards the interior (Touber and Kanani, 1994). The daily temperatures are relatively low and fluctuate between 15°C and 28°C, with an average of 20°C (Tolman, 1990).

3.2 Biodiversity Features

3.2.1 Fauna

Kagoma Forest Reserve host different wildlife species like elephants (*Loxodonta Africana*), where a very large group of 200 elephants shifted from neighboring Game Reserves of Burigi and Ibanda Rumanyika and moved to Kagoma Forest Reserve for refuge. Also impala (*Aepyceros melampus*), waterbucks (*Kobus ellipsiprymnus*), roan antelope *(Hippotragus equinus*), birds and other wildlife species are hosted there (Hofer et al., 2004).

3.2.2 Flora

There is a large community of Miombo woodlands. The site is rich in tree species of conservation significance including African Blackwood (*Dalbergia melanoxylon*) , (*Milicia excelsa*) and (*Pterocarpus angolensis*) thickets, and several streams intersect the woodland.

3.3 Demography of Bukoba Rural District

According to the 2002 Tanzania National Census, the population of Bukoba Rural District was 450 000 with an annual growth rate of 2.4% (URT, 2002). Bukoba Rural District is occupied by different ethnic groups; Haya, Nyankole, Nyambo, Nyarwanda, Waganda, Shubi, Zinza, and Waha.

3.4 Economic Activities

Bukoba Rural District is made up of undulating hills and valleys. It receives sufficient rainfall, which is conducive to continuous agricultural activities throughout the year. Land lies at the heart of social, political, and economic life in most African societies, thus, land in the study area is used for agriculture, settlements, forest conservation and grazing. In the forest reserve, the principal land uses are nature conservation, timber harvesting, firewood and honey gathering. Agriculture is the main economic activity. Production of food and cash crops accounts for more than 90% of the gross domestic product, and over 95% of population are employed in this sector (URT, 2004). The main food crops are bananas, sweet potatoes, cassava, maize, beans, yams, bambara nuts, groundnuts, finger millet and sorghum. Others are horticultural crops like tomatoes, cabbage, sweet pepper, carrots, cinnamon and cauliflower. Cash crops are mainly coffee and tea.

3.5 Social Services

The district has a number of social services. Education institutions include primary schools, secondary schools, teachers training college and vacation training. There are health services, district hospitals, one health centre and dispensaries though they are not enough compared to the population size which is found in the District**.** Although there are such facilities in the district there is a very big number of illiterate people in the study area, where only 2.2% has secondary education, where 40.9% have primary education, 55.9% have got formal education and 1.1% have adult education (URT, 2004).

3.6 Water and Sanitation

There is a HESAWA Project operating in the district along with the water Department. It is estimated that 40% of the population has access to clean and safe water. However, the water schemes lack maintenance and operational funds. The main problem has been lack of sustainability of the water schemes. The recent construction of a major line from Uganda has improved the rate of power supply in the district. The district has passable earth roads and most parts of the district area not accessible throughout the year.

3.7 Methodology

Both primary and secondary information were used. Qualitative data were collected by interviews using questionnaires; focus group discussion and direct observation while secondary data were gathered in documented books and journals.

3.7.1 Collection of Secondary Data

Secondary data were obtained through literature review. The information was gathered from other research findings and experience from different case studies relating to land use and vegetation cover change in other countries and in Tanzania. Most of the secondary information was obtained from libraries and internet.

3.7.2 Determination of socio-economic factors influencing land use change

3.7.2.1 Sampling procedure and questionnaire administration

Three villages (Rwamisha, Lugera and Kyonga) in the study site were randomly selected based on accessibility and proximity to Kagoma Forest Reserve, and thereafter a random sample of households were selected from village registers, which were considered to be the sampling population. A range7.9% to 7.1% of total households in the selected villages were randomly picked for interview. Rwamisha, Lugera and Kyonga villages had a total of 1251 households, where 31 households were sampled from Rwamisha village, 32 household from Lugera village and 30 households from Kyonga village (Table 1). This was a reasonable sample size according to (Bailey, 1994; Mbeyale, 2007) that a sample of at least 30 units is sufficient irrespective of the population size. A total of 45 women (48.4%) and 48 men (51.6%) were interviewed.

Table 1: The Sample Size of Rwamisha, Lugera and Kyonga villages

Village	Number of household	Number of sampled household	Sample size (%)
Rwamisha	392	31	7.9
Lugera	434	32	7.4
Kyonga	425	30	7.1
Total	**1395**	**93**	

Questionnaire surveys used had both closed and open ended questions. The questionnaires were addressed to extract information on the expansion of livestock keeping activities, demand of forest resources to the community in and around Kagoma Forest Reserve, farm expansion, price of agricultural products, households' size, and immigration, land rights, knowledge of land cover change, farm productivity, Government restrictions on the use of Kagoma Forest Reserve and others.

3.7.2.2 Focus group discussion

In the focus group discussion, government officers and long time residents were involved. The government officers included forest officer, agricultural officer, water officer, livestock officer, land officer, ward executive officer and village executive officer. Also, the discussion involved old people with long time knowledge about villages under study.

A checklist of questions or issues of interest was used to guide the discussion. Focus group discussion availed information that could not be picked by using structured questionnaire. Such information included probing questions to capture the historical trends over time with regards to land cover dynamics like vegetation cover change, settlements patterns, water availability especially river streams, farms and grasslands. It also intended to obtain information on institutional arrangements regulating resource use, population dynamics and community awareness about the land use and vegetation cover change. The observation acted as a cross checking mechanism for the extent of settlement and farm expansion towards the forest, pit sawing for sale, charcoal harvest for sale, and honey hunting in the study area.

3.7.2.3 Key informant interviews

While the group meetings can provide details on the broad context for local circumstances and practices, there are frequently particular individuals who for whatever reason have acquired significant knowledge about specific issues. These individuals come from a variety of segments of society, including farmers, bureaucrats, elders, priests, and local “historians” What sets them apart as key informants is that they are recognized by others in their community as being particularly knowledgeable about the area, or facets of it. For the purposes of the study, District Forest Officer, District Wildlife Officer and Ranch Manager were interviewed at District level while three elders with good knowledge and two farmers from each village were involved in group discussions using a guiding checklist.

3.8 Analysis of Land Use and Cover Changes

Materials used in the study were Landsat 5 TM of 5th June, 1988, Landsat 7 ETM + imagery of 5th June, 1999 and Landsat 7 ETM + of 5th June, 2010. Topographical maps with scale of 1:50,000 were used for geo-referencing Landsat scenes. Global Positioning System (GPS) was used in land use and cover map verification and updating land use and land cover map to include land use pattern up to year 2010. The images were selected based on seasonality of the imageries, spatial resolution 28.5m, study location, and availability of imageries.

3.8.1 Analysis of land use/cover changes

The land use/cover was captured on the basis of Landsat 5 TM p172r061 scene of August, 1988, Landsat 7 ETM + p172r061 of June, 1999 and Landsat7 – ETM + p172r061 of June, 2010. The imageries were obtained from archive of the Geo Network Limited, Dar es Salaam Tanzania, and Sokoine University of Agriculture GIS Laboratory. Topographical sheets with scale of 1:50 000 of 1967 were acquired from the Surveys and Mapping Division of the Ministry of Lands, Housing and Human Settlements Development for geo-referencing Landsat images and during the preparation of land use/cover interpretation key. The sub scenes covering the Kagoma Forest Reserve and the neighboring villages were extracted from mentioned images. The land cover maps produced by Africover project in 1995 were also obtained from Institute of Resource assessment (IRA) of University of Dar es Salaam. These land use maps were used as base maps during land use and vegetation cover interpretation.

3.8.2 Pre-processing of Landsat data

The 2010 image was geo-referenced using ERDAS IMAGINE 9.1 Software with reference to topographical map of scale 1:50 000 of the study site. Easily identifiable ground control points on permanent features were used. Thus, image coordinates were transformed into map coordinates as per 36 UTM zone, projected to Universal Transverse

Mercator, spheroid Clark 1880 and Datum Arc 1960. Images of 1988 and 1999 were geo-referenced using the already geo-referenced image of 2010. Three rectified images were reduced to the size of the study site by using subset command in ERDAS imagine software.

3.8.3 Interpretation of landsat images

The enhanced images in ERDAS IMAGINE 9.1 Software were interpreted in ArcGIS 9.3 for interpretation since ArcGIS 9.3 is suitable for spatial data analysis and interpretation, also is suitable for creation of Thematic maps compared to ERDAS IMAGINE 9.1. In General, ERDAS IMAGINE 9.1 is the best for image processing while ArcGIS 9.3 is the best in spatial data analysis and Thematic maps creation. The image analysis extension in ArcGIS 9.3 helped to sharpen more features for better visual identification of features of greatest interest in the study area. Different land cover categories were extracted using photo texture. False colour composite was formed using Red, Green and Blue (RGB) for band 4, 3 and 2. On screen digitization procedure was used in identifying land covers. The analysis of land cover in Kagoma Forest Reserve was done in an area covering a total of 16 663 hectares and the area was stretched to include bigger area to cover village land bordering the forest in order to relate human factors influencing land cover changes within the forest. The cover classes were determined based on ground truthing data which were used as reference points for each land cover collected from the field by using GPS.

3.8.4 Ground truthing

Land use types identified from the image scenes of 1988, 1999 and 2010 were counterchecked by carrying out a fieldwork in the study area in order to update data interpreted from the image. Geographical Position System (GPS) was used to record ground coordinates for different land cover types on the map in order to have correct reference points. The recorded coordinates were then used to transform former land use and vegetation cover types before performing land use vegetation cover change detection for generating final results.

3.8.5 Land use and vegetation cover change detection

Change detection was performed through the overlay method based on generated vector themes of different years. Change detection was done between datasets of 1988-1999 and 1999-2010 years. The overlay was performed by intersecting of feature themes so that the boundaries and attributes of themes were combined to form the derivative output theme. The attribute tables of the output themes were summarized in definition tables and results were exported in MS-Excel Package to compile areas of change for each information category.

Change detection analysis entails finding the type, amount and location of land use changes that are taking place (Yeh *et al.*, 1996). Various algorithms are available for change detection analysis and they can be grouped into two categories namely (a) pixel-to-pixel comparison of multi-temporal images before image classification, and (b) post-classification comparison (Jensen, 1996). In this study, a post-classification comparison method was used to assess land use and cover changes. It is the most common approach for comparing data from different sources and dates (Jensen, 1996). The advantage of post-classification comparison is that it bypasses the difficulties associated with the analysis of images acquired at different times of the year and/or by different sensors (Alphan, 2003). The method has been found to be the most suitable for detecting land cover changes (Wickware and Howarth, 1981); as this enables estimation of the amount, location, and nature of change. The only pitfall is that the accuracy of the change maps depends on the accuracy of individual classifications and subject to error propagation (Zhang *et al.,* 2002). The approach identifies changes by comparing independently classified multi-date images on pixel-by-pixel basis using a change detection matrix (Yuan and Elvidge, 1998).

3.8.6 Assessment of the rate of cover change

The estimation for the rate of change for the different covers was computed based on the following formulae (Kashaigili, 2006):

$$\%\ Cover\ change = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{\sum_{i=1}^{n} Area_{i\ year\ x}}\ x\ 100 \qquad [1]$$

$$Annual\ rate\ of\ change = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{t_{years}} \qquad [2]$$

$$\%\ Annual\ rate\ of\ change = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{Area_{i\ year\ x}\ x\ t_{years}}\ x\ 100 \qquad [3]$$

Where: $Area_{i\ year\ x}$ = area of cover i at the first date,

$Area_{i\ year\ x+1}$ = area of cover i at the second date,

$\sum_{i=1}^{n} Area_{i\ year\ x}$ = total cover area at the first and

t_{years} = period in years between the first and second scene acquisition data

3.9 Analysis of Socio-Economic Factors Influencing Vegetation Cover Changes

The analysis was done by using both qualitative and quantitative methods.

3.9.1 Qualitative data analysis

The information collected using participatory rural appraisal was analyzed by the help of the participants through focus group discussions and the results were communicated back to them for confirmation and verifications. Content and structural-functional analysis approaches were used to analyze qualitative information. According to Singleton *et al*. (1993) and Mayeta (2004), content analysis is a set of techniques for analyzing the symbolic content of any communication. The basic idea is to reduce the total content of communication to some set of categories that represent some characteristics of research interest. Through this approach, the information gathered using verbal discussion with the key informants were recorded and broken down into small meaningful units of information. Kajembe (1994) recommends this technique in explaining the way how social facts relate each other in a social system and the way they relate to the natural physical environment.

3.9.2 Quantitative data analysis

Both descriptive and inferential statistics were used in this study. Inferential statistics provide an idea on whether the patterns explained in the sample population are likely to apply to the population from which the samples were taken (Kajembe, 1994). In this study, logistic regression model was used in analyzing inferential statistics.

Regression model;

$$Yi = \frac{1}{1 + e^{-z}} \qquad \ldots\ldots\ldots\ldots(4)$$

Where; Yi = i^{th} probability of event to occur for the dependent variable (land cover change as aggregate of households land sizes in the study area), binary variable of 1 if there is a change and 0 other wise

The linear combination:

$Zi = ß_0 + ßX_1 + ßX_2 + \ldots\ldots\ldots.+ß_kX_k + e$

Z_i = the 1^{st} observed value of the independent variables

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

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

e = a natural logarithm base approximately 2.718

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

X_1 to X_k = independent variables (socio-economic factors and population factors)

The probability of not to occur was estimated as; Probability of no event = 1- probability of event. The hypotheses in this study were;

(Ho): ß=0 Implied that the regression coefficients are equal to zero and thus no correlations between dependent (household land size/land use change) and independent variables (socio- economic factors).

(Hi): ß=0 implied that the regression coefficients are not equal to zero and thus there is either a positive or negative correlation between dependent (household land size/land use change) and independent variables

3.9.3 The Interpretation of logistic model results

Pampel (2000) and Mayeta (2004) reported that to test whether the regression coefficients are significantly different from zero, the Wald statistic is always used. The Wald statistic has asymptotic character following a chi-square distribution in large samples. Usually the Wald statistic is distributed as chi-square with degree of freedom (*df*) equal to the number of constrained parameters (r). In single parameter, Wald statistic is expressed to imply the square of the t-ratio (Gujarat, 1995). Thus, the Wald statistic was used to test the statistical significance of the effect of a particular variable. The odds ratios represented by Exp (*ß*) from logistic regression analysis were used to explain possible occurrence or no-occurrence of land cover dynamics as influenced by socio-economic factors in the study area, for example; how much an increase of one unit in X_k would change the odds of success. The assessment of goodness of fit of the regression model to variables tested was done by using the model chi-square at 5% probability level of significance. Chi-square indicates how good independent variables influenced the outcome of dependent variable while the -2log likelihood shows whether the model fits reasonably good and at the same time the higher overall percentage of correct predictions imply the better the model. The parameters above were observed in testing and concluding the hypothesis and goodness of fit of the model to tested variables.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Land Use and Land Cover Class Distribution 1988-2010

The land cover maps for 1988, 1999 and 2010 are presented in Figs 1, 2 and 3 respectively. Generally, the maps show the variation in cover between the three time periods under consideration. Fig. 4 shows that in year 1988, bushland dominated the area by covering 27.37% (4570.43 ha) followed by grassland 24.35% (4065.50 ha), then woodlands 23.12% (3860.16 ha), settlements 15.46% (2 581.10 ha), forest 9.56% (1 593.20 ha), while cultivated land occupied 0.16% (27.53 ha).

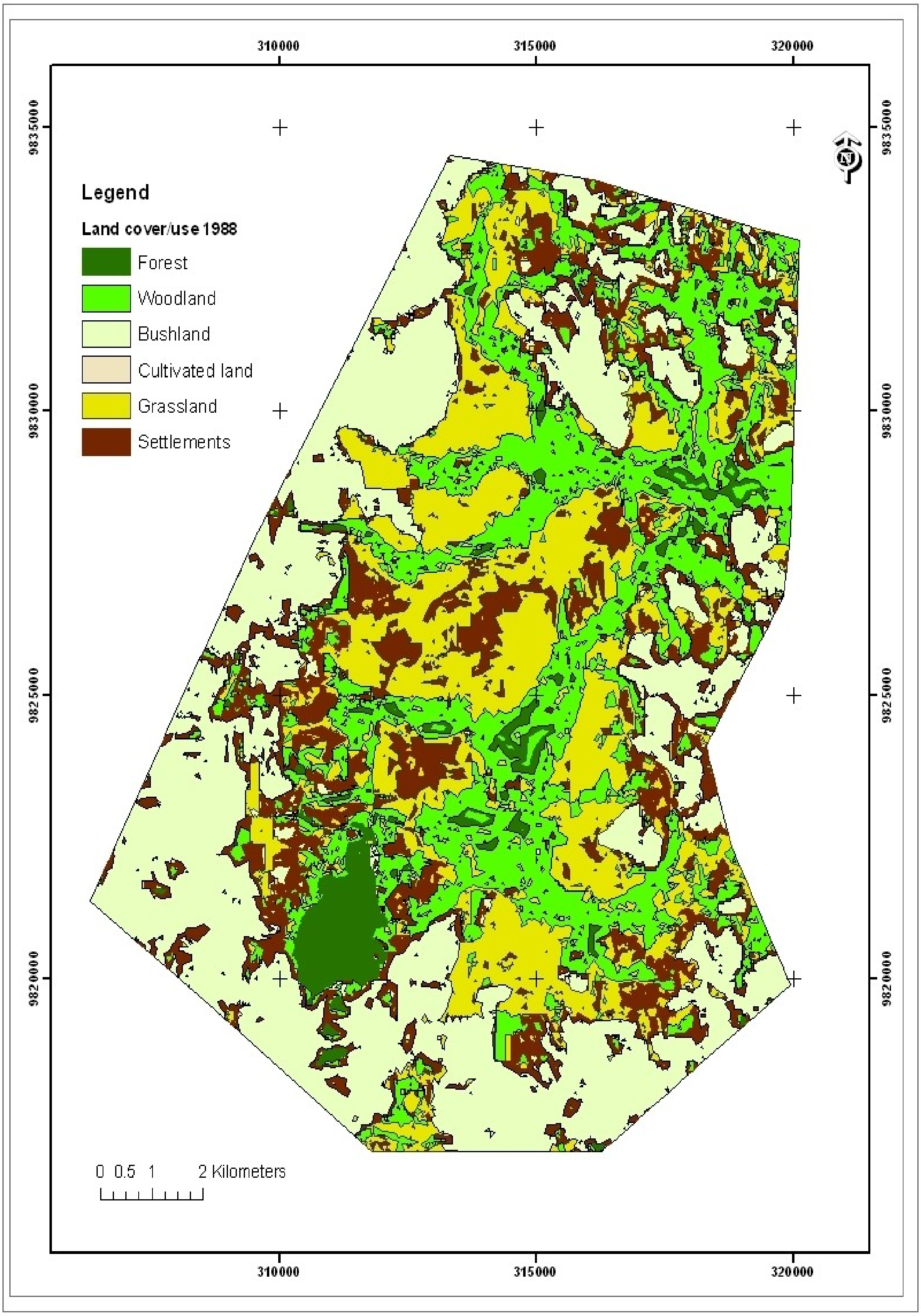

Figure 3: Land Use and Land Cover Map of Image Scene, 1988`

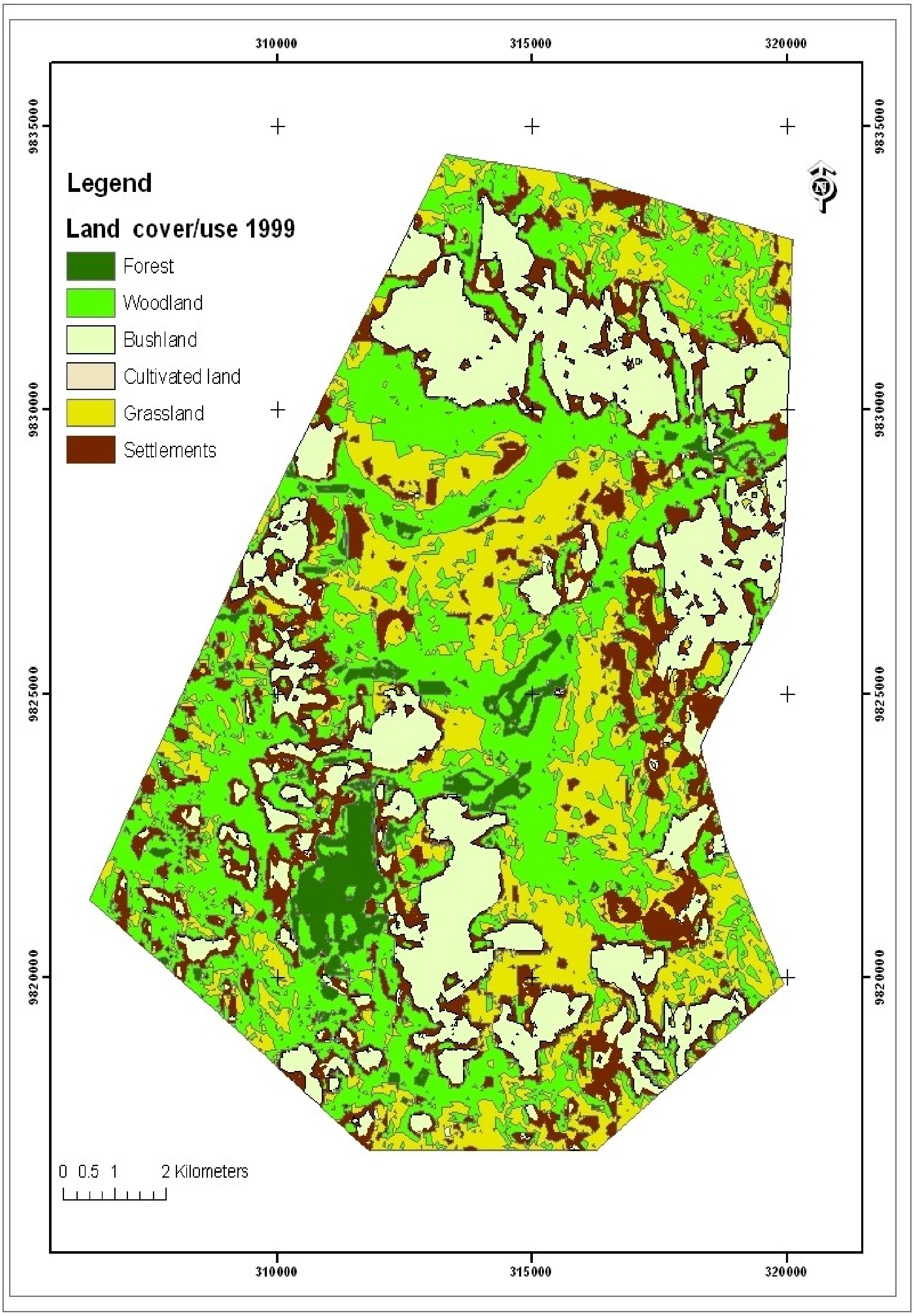

Figure 4: Land Use and Land Cover Map of Image Scene, 1999

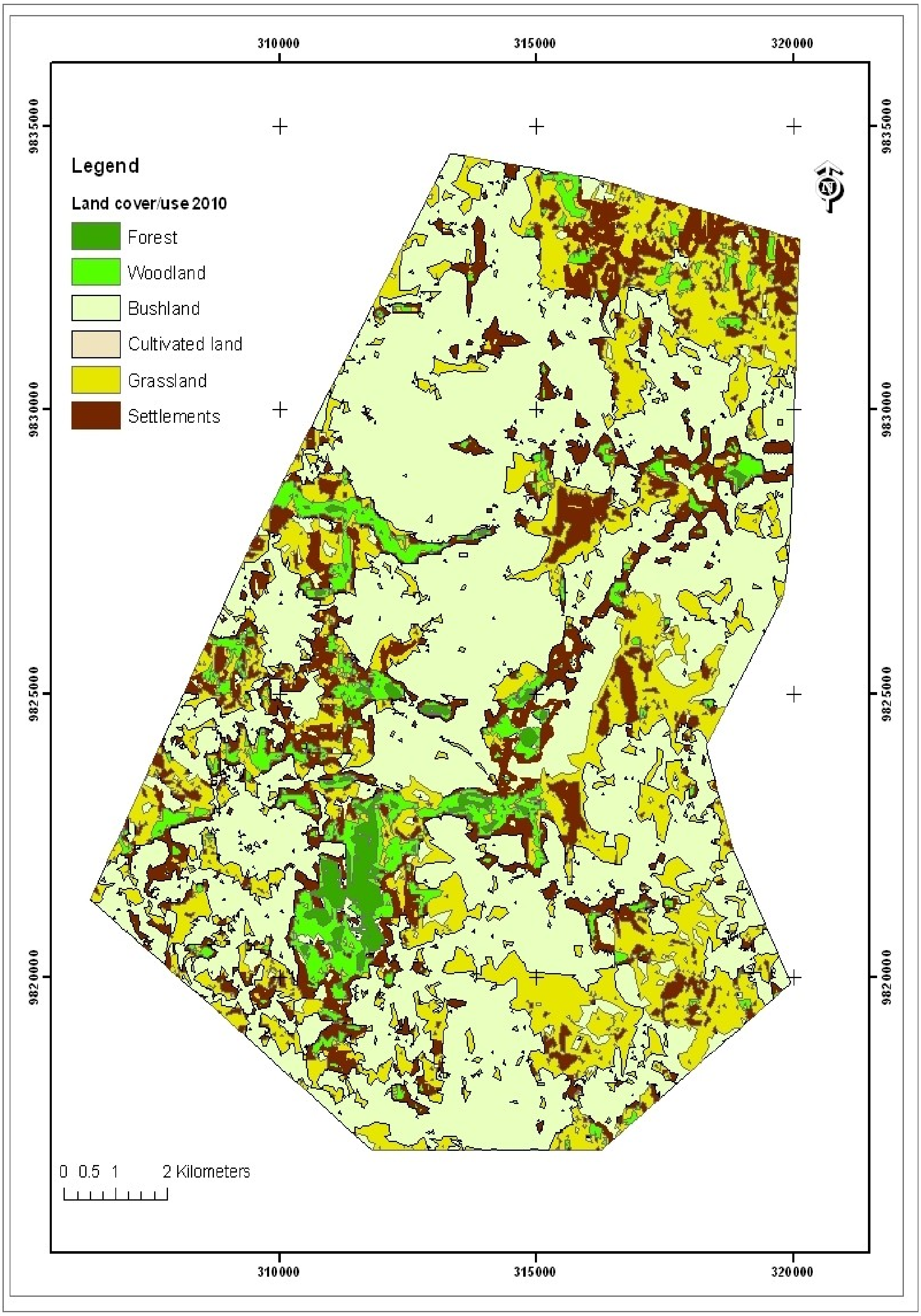

Figure 5: Land Use and Land Cover Map of Image Scene, 2010

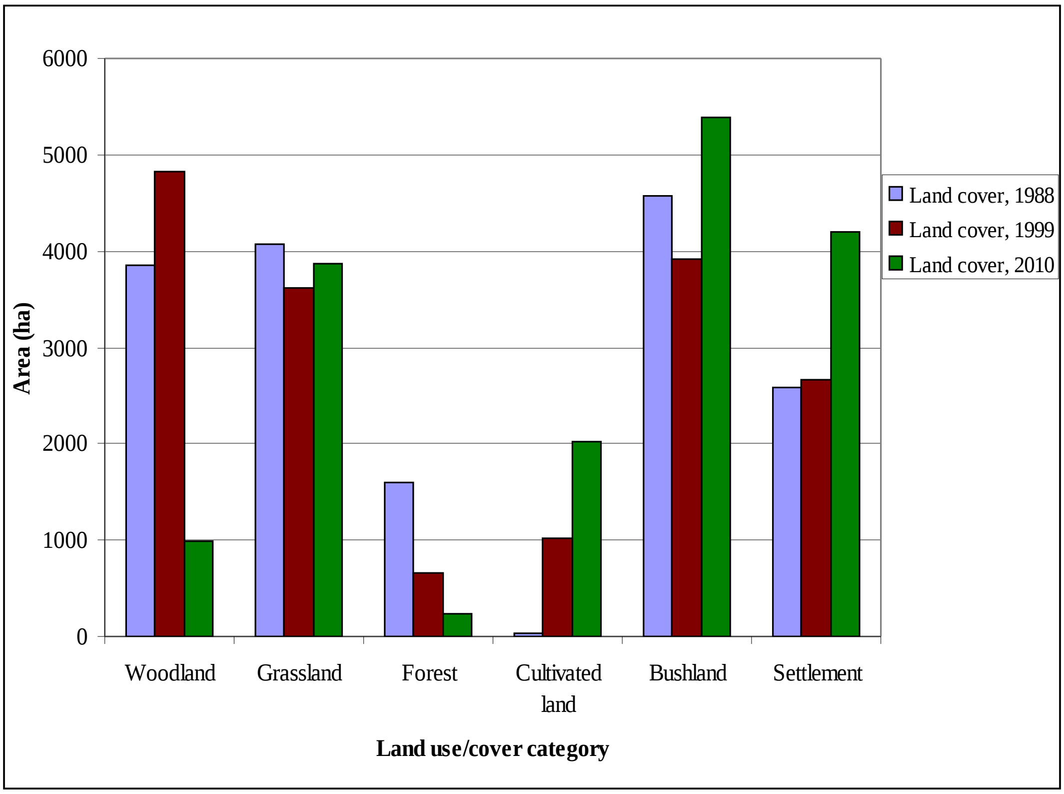

Figure 6: Land Use/Cover Distribution for Kagoma Forest Reserve between 1988 – 2010

Fig. 4 shows that in 1999, woodlands occupied the largest area by 28.92% (4 828.85 ha) due to selective logging of the most preferred timber trees in the closed forest. Bushland occupied 23.5% (3 923.43 ha) followed by grassland which covered 21.64% (3614.16 ha) of the forest, settlement area 15.98% (2667.56 ha), then cultivated land 6.07% (1013.31ha) while forest area covered only 3.9% (650.61 ha of the total area. During this period woodlands, cultivated land and settlement increased by 968.69 ha (5.8%), 985.78 ha (5.9%) and 86.46 ha (0.52%) respectively. The grassland, forest and bushland decreased by 451.34 ha (2.7%), 942.59 ha (5.64%) and 647 ha (3.87%) respectively.

In year 2010, bushland increased in terms of coverage from previous 23.5% (3923.43 ha) to 32.25% (5385.9 ha) of the total area and continued to take the lead in coverage of the area followed by settlement area 25.11% (4193.32 ha), grassland covered 23.15% (3865.39 ha), cultivated land 12.14% (2027.20 ha), followed by woodlands which occupied 5.95% (993.71 ha), while the forested area covered only 1.39% (232.4 ha) of the total area as shown in Fig 4. During this period (1999-2010), the results show a substantial decrease in forest cover from 3.9% (650.61 ha) to 1.39% (232.4 ha), while the woodlands decreased from 28.92% (4828.85 ha) to 5.95% (993.71 ha). The results also show that the grassland, cultivated land, bushland, and settlement increased by 1.5% (251.23 ha), 6.07% (1013.89 ha), 8.76% (1462.47 ha) and 9.14% (1525.76 ha) respectively. The results clearly indicated that cultivated land and settlement areas increased in both temporal periods. This implies that agricultural activities increased in both periods at the expanse of other land cover types like forests and woodlands. Agricultural expansion is among reported activities, which have significant effect on natural vegetation (Ngalande, 2002; Mbonile *et al*., 2003; Noe, 2003). The continuous increase in cultivated land is also reflected in an increased area under settlements (Fig 4). Settlements expansion has an implication on increase in population size as a result demand for more resources and area for cultivation.

Table 2: Cover Area, Changed Area and the Rate of Change between 1988 and 1999

Land cover in 1988			**Land cover in 1999**					
Cover class	*Area (ha)*	*% cover*	*Area (ha)*	*% cover*	*Area change (ha)*	*% Cover change*	*Annual rate of change (ha/yr)*	*% Annual rate of change (%/yr)*
Woodlands	3860.16	23.12	4828.85	28.92	968.69	5.80	88.06	0.53
Grassland	4065.50	24.35	3614.16	21.64	-451.34	-2.70	-41.03	-0.25
Forest	1593.20	9.54	650.61	3.90	-942.59	-5.64	-85.69	-0.51
Cultivated land	27.53	0.16	1013.31	6.07	985.78	5.90	89.62	0.54
Bushland	4570.43	27.37	3923.43	23.50	-647.00	-3.87	-58.82	-0.35
Settlement	2581.10	15.46	2667.56	15.98	86.46	0.52	7.86	0.05
	16697.9		**16697.9**					
Total area	**2**	**100.00**	**2**	**100.00**				

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Table 3: Cover Area, Changed Area and the Rate of Change between 1999 and 2010

Land cover in 1999			**Land cover in 2010**					
Cover class	*Area (ha)*	*% cover*	*Area (ha)*	*% cover*	*Area change (ha)*	*% Cover change*	*Annual rate of change (ha/yr)*	*% Annual rate of change (%/yr)*
Woodland	4828.85	28.92	993.71	5.95	-3835.14	-22.97	-348.65	-2.09
Grassland	3614.16	21.64	3865.39	23.15	251.23	1.50	22.84	0.14
Forest	650.61	3.90	232.40	1.39	-418.21	-2.50	-38.02	-0.23
Cultivated land	1013.31	6.07	2027.20	12.14	1013.89	6.07	92.17	0.55
Bushland	3923.43	23.50	5385.90	32.25	1462.47	8.76	132.95	0.80
Settlement	2667.56	15.98	4193.32	25.11	1525.76	9.14	138.71	0.83
Total area	**16697.92**	**100.00**	**16697.92**	**100.00**				

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As revealed from Table 2, woodlands and settlement increased at a rate of 88.06 ha/year (0.53%/year) and 7.86 ha/year (0.05%/year) respectively over an average period of 11 years (i.e.1988 and 1999) assuming a linear increase. The forest cover decreased consistently at a rate of -85.69 ha/year (-0.51%/year) over an average period of 11 years (i.e.1988 and 1999) assuming a linear decrease. It is possible that the decrease in forest and increase in settlement cover is attributed to increased demand for land. This rapid increase might be due to clear felling of trees for firewood, poles, timber, and increased settlement and agricultural activities (banana farms and subsistence farming). This has also been brought out by local people during the interviews and about 85% of the respondent reported cutting trees. Also, bush fires have been reported to be a serious problem in recent years. It is clear from Table 2 that the forest area decreased consistently over 11 years (i.e. 1988 - 1999) while cultivation increased at a rate of 89.62 ha/year (0.54%/year). Table 3 revealed that grassland, cultivated land, bushland and settlement cover increased between 1999 and 2010. The grassland increased at a rate of 22.84 ha/years (0.14%/year), cultivated land increased at a rate of 92.17 ha/year (0.55%/year), bushland increased at a rate of 132.95 ha/year (0.8%/year) and the settlement cover increased at a rate of 138.71 ha/year (0.83%/year) over an average period of 11 year (i.e.1999 and 2010). The expansion of grassland, bushland, settlement and cultivated areas reflects on the land use transformation in and around Kagoma Forest Reserve. The increasing population as a result of refugees' influx and immigrants from other districts in Tanzania has had impact on the forest resources in the study area.

4.2 Changes Detection Matrix of Different Land Use/Cover

The change detection of land use/covers in Kagoma Forest Reserve is presented in Table 4. During the period–1988 to 1999, forest decreased by 37.7% , 11.2% of forest changed to bushland, 9.9% to settlements, 6.5% bushed grassland, 0.1% of forest was converted to cropland and 34.6% remained unchanged. The woodlands declined the same way where, 24.5% was converted to grassland, 23.1% to bushland, 14.5% converted to settlements, 0.1% were converted to cropland and 33.4% remain unchanged. About 14.7% of the grassland was converted to settlement area, 0.1% converted to cropland, 26.1% remain unchanged (Table 4). About 0.1% of bushland was converted to cropland and 21.2% was converted to settlement areas while 31.2% remained unchanged. The results also suggest that 97.3% of the cultivated land remained unchanged for 11 years. Illegal logging and subsistence agriculture is one of the contributing reasons for observed land cover changes in the area. Monela *et al.* (1998) and Ngalande (2002) found that timber harvesting business in the Miombo woodland has been encouraged by existence of all weather roads from the area to other parts of the district and neighboring countries like Uganda. The analysis of land use and land cover change for the period 1999 - 2010 is provided in Table 5. Forest area changed by 19.9% to bushland, 13.2% to woodlands, 11.0% into settlements, and 6.7% converted to grasslands, 34.1% of forest was converted to cropland and only 13.2% of the forest remained unchanged.

About 31.2% of the woodlands were converted to bushlands, 24.9% to grassland, 23.5% to settlement areas, 10.4% to cultivated land, 11.8% remained unchanged. Furthermore, 15.2% of the grassland remained unchanged, while 45.0% was converted to settlements, 24.8% to woodlands, 19.1% to bushlands and 11.3% into cultivated lands. The bushlands lost 32.9% to grassland, 3.8% to agriculture, 12.5% to settlements, 0.7% to settlement and 58.4% remained unchanged. Of the cultivated land, 0.2% changed to bushlands, 0.1% changed to grasslands and 98.3% remained unchanged. About 91.6% of settlement areas remained unchanged, while 8.4% changed to bushlands.

Table 4: Changes Detection Matrix in Different Land Use Coverage between 1988 and 1999

	Cover in 1999 (ha)							
Cover in 1988 (ha)	*WL*	*GL*	*FR*	*FR*	*CL*	*BSL*	*ST*	*Total*
WL	1289.30 (33.4%)	944.38 (24.5%)	171.18 (4.4%)	171.18 (4.4%)	3.86 (0.1%)	892.76 (23.1%)	558.69 (14.5%)	3860.16
GL	1403.50 (34.5%)	1060.52 (26.1%)	150.48 (3.7%)	150.48 (3.7%)	2.40 (0.1%)	848.93 (20.9%)	599.66 (14.7%)	4065.50
FR	223.63 (37.7%)	38.83 (6.5%)	205.01 (34.6%)	205.01 (34.6%)	20.42 (0.1%)	66.70 (11.2%)	58.60 (9.9%)	1593.20
CL	6.50 (0.6%)	7.95 (0.8%)	0.08 (0.0%)	0.08 (0.0%)	1000.02 (97.3%)	9.60 (0.9%)	3.41 (0.3%)	1027.53
BSL	1077.85 (23.6%)	1033.67 (22.6%)	61.93 (1.4%)	61.93 (1.4%)	4.44 (0.1%)	1425.41 (31.2%)	967.12 (21.2%)	4570.43
ST	828.08 (32.1%)	528.80 (20.5%)	61.93 (2.4%)	61.93 (2.4%)	2.19 (0.1%)	680.02 (26.3%)	480.08 (18.6%)	2581.10
Total	**4828.85**	**3614.16**	**650.61**	**650.61**	**1013.31**	**3923.43**	**2667.56**	**16697.92**

Note: WL=Woodland, GL=Grassland, FR= Forest, CL=Cultivated land *nd, ST=Settlement*

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Table 5: Changes detection matrix in different land use coverage between 1999 and 2010

Cover in 1999 (ha)	Cover in 2010 (ha) *WL*	*GL*	*FR*	*CL*	*BSL*	*ST*	*Total*
WL	425.45 (11.8%)	1259.57 (24.9%)	53.02 (1.5%)	13.02 (10.4%)	2230.27 (31.7%)	847.53 (23.5%)	4828.85
GL	161.12 (24.8%)	917.60 (15.2%)	10.11 (1.6%)	8.42 (11.3%)	1024.26 (19.1%)	492.65 (45.0%)	3614.16
FR	134.18 (13.2%)	67.99 (6.7%)	134.63 (13.3%)	344.15 (34.1%)	201.17 (19.9%)	111.81 (11.0%)	650.61
CL	0.46 (0.0%)	2.12 (0.1%)	0.15 (0.0%)	1000.02 (98.3%)	9.03 (0.2%)	1.56 (0.0%)	1013.31
BSL	137.38 (5.1%)	876.89 (32.9%)	17.63 (0.7%)	1002.08 (3.8%)	1557.15 (58.4%)	332.30 (12.5%)	3923.43
ST	135.13 (0.8%)	741.22 (4.4%)	16.87 (0.1%)	2.84 (0.0%)	1364.03 (8.2%)	2407.47 (91.6%)s	2667.56
Total	**993.71**	**3865.39**	**232.40**	**2027.20**	**5385.90**	**4193.32**	**16697.92**

Note: WL=Woodland, GL=Grassland, FR= Forest, CL=Cultivated land, BSL= Bushland, ST=Settlement

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4.3 Socio- economic Factors Influencing Land Use and Vegetation Cover changes

Table 6 shows a summary of the socio-economic factors and the nature of their influence on the land use and vegetation cover change. Land use and vegetation cover change which has occurred in this study is influenced by a number of socio-economic factors. The socio-economic factors which were considered and tested using binary logistic regression model include increase of livestock keeping, education level, population immigration, prices of cash crops, land rights or land tenure, shifting cultivation, demand for forest products and farm increase.

Table 6: Logistic regression model on socio-economic factors influencing land cover dynamics

Variable	ß	S.E.	Wald	df	Sig	Exp(ß)	95% C.I for Exp(ß)	
							Lower	Upper
Education	-1.084	1.324	0.670	1	0.413ns	0.338	0.25	4.533
Livestock keeping	2.123	1.347	2.484	1	0.043s	8.354	1.019	35.568
Population growth	0.992	0.623	1.415	1	0.232ns	2.465	0.554	11.128
Forestry products	2.550	1.356	1.057	1	0.050s	12.805	1.897	182.705
Shifting cultivation	1.876	0.609	9.489	1	0.024s	6.526	0.279	152.909
Cash crop prices	1.962	0.474	17.133	1	0.021s	7.112	1.394	35.132
Farm size	0.724	0.412	2.333	1	0.018s	2.062	0.264	32.853
Land tenure	1.620	0.848	3.649	1	0.042s	5.052	1.132	26.087
Constant	-4.632	0.984	15.394	1	0.000	0.046		

Model chi-square= 34.756, Degree of freedom = 8,-2 Log likelihood = 69.58, Overall percentage = 93% Number of cases = 93, s= statistically significant, and ns = statistically not significant at 0.05 level of significance, ß= Regression coefficients which stand for the odds ratio of probability of success to the probability of failure. S.E. = Standard error of the estimate, Wald statistics= $[ß/S.E.]^2$, df = degree of freedom, Sig = significance level, Ex (ß) = eß where e = 2.718.

4.3.1 Education level

The results show that, there was a negative regression coefficient of education of household head which implied that there was an inverse relationship. This implies that an increase in educated person decreased the odds ratios on land use/vegetation cover change by a factor of 0.341. It is the fact that an increase in the level of education of the community or household reduces the possibility of causing environmental degradation. A person is exposed to the knowledge on wise use of resources including agricultural practices because an educated person will tend to practice more environmental friendly agricultural land use. Furthermore, as forest clearing is driven by economic or income related factors, education tends to improve the economic power of the society thus reducing forest dependence. However, in this study the literacy level of the household was not statistically significant (p = 0.413) in Table 6. This may be due to the fact that 55.9% of the respondents interviewed had no formal education, while 2.2% had secondary education as shown in Table 7. Kajembe and Luoga (1996) argued that, education tends to create awareness, positive attitudes, social values, and motivation which stimulate self reliance. Educated rural households are more productive and likely to use off-farm income earning opportunities than none educated. The disadvantage of low education on resources use was reported by Ngalande (2002) in Zambia where the findings revealed that, local people with low education could not recognize the impact of clearing forests for cultivation while educated people were capable to see the relationship. This implies that education level has a crucial impact on rural households in managing local natural resources thus reducing pressure on the resources.

Table 7: Level of Education of the People in and around Kagoma Forest Reserve

Response Item	Frequency	Percent
No formal education	52	55.9
Adult Education	1	1.1
Primary Education	38	40.9
Secondary Education	2	2.2
Total	**93**	**100.0**

4.3.2 Livestock keeping

There was a positive regression coefficient of livestock keeping in (Table 6), which implies that an increase in one unit of household keeping livestock increased the odds ratio for land use/vegetation cover change by a factor of 8.354. This means that as the number of households keeping livestock in a large number increases in Kagoma Forest Reserve, then search for grazing land will have an impact on the natural forest since people will have to clear forest hence emergence of another land use/vegetation cover. The results indicate that livestock keeping has statistically significant (p = 0.043) influence on land use/vegetation cover change in Kagoma Forest Reserve. This means that the structure of Kagoma Forest Reserve is to a large extent influenced by the increased livestock keeping practices since people keep very large amount of cattle (Plate 1) and graze them in the forest. This study revealed that the community in and around Kagoma Forest Reserve engaged highly in livestock keeping where 93.7% admitted to be involved in livestock keeping, 87% admitted on the increase of the animals in and around the forest and 84.9% admitted to keep more than 50 cattle per household. Kaimowitz (1995) reported that cattle husbandry is one of the major factors influencing deforestation. The report revealed that the role of cattle in deforestation varies, depending upon the type of production system. For example, large-scale "investment ranchers" (urban entrepreneurs with little tradition in cattle ranching) utilize cattle as a financial investment selected from their available alternatives has got more effects than small scale investment ranchers or keepers. Hence this finding concur with the findings found in Kagoma Forest Reserve that, there are small scale livestock keepers and large scale livestock keepers that have got more impact to the forest.

Plate 1: Livestock keeping inside Kagoma Forest Reserve.

4.3.3 Population growth around Kagoma forest reserve

Table 6 shows that population had a positive regression coefficient meaning that an increase in one unit of migrant to the area increased the odds ratio of land use/land cover change by a factor of 2.465. The influence of population growth was statistically insignificant (p = 0.232). Population growth in certain places is normally facilitated by several factors including the availability of land, which provides a room for migrants to establish settlements. It was observed that the community in and around Kagoma Forest Reserve is mainly occupied by migrants by 96.8% especially people from Rwanda, Burundi and Uganda and few others from other parts of Tanzania. Where 89.2% of the respondents revealed that the major driver of immigration was the availability of land. This observation concur with findings by Mbonile *et al.* (2003) who reported that major reasons for in-migration is the peoples movement from their former residence to seek land for cultivation and habitation. Poor productivity in migrants’ former villages is among the basic reasons for farmers to shift from their former land in their villages to new lands in other villages. On the other hand, population immigration has an increasing effect to existing population of a given area and goes hand in hand with an increasing demand for natural resources including areas for settlements, cultivation, and other economic activities like livestock keeping. The study has revealed there was an inflow of people which have added more demand of resources in the study area and consequently more clearance of land for agriculture, livestock keeping, construction of houses and energy. This argument is also supported by Noe (2003) who reported that Maasai population increased by 9.5% due to in-migration population, which caused increased demand of more land for settlement and agriculture in the area between Mountain Kilimanjaro and Amboseli National Park Wildlife corridor and finally led to land use changes in the area. Reid (2004) reported that land conversion for agriculture in East Africa has outpaced by the proportional human population growth in recent decades. Natural vegetation cover has given way not only to cropland but also to planted pasture (Lambin *et al*., 2003).

4.3.4 Demand for forest products

Demand for forest products had positive regression coefficient, meaning that increase of demand of one unit in forest products increased the odds ratio of land use/vegetation cover change by a factor of 12.805. Forest products in this context include all products (firewood, timber, poles and charcoal), which are used by adjacent local communities. It was observed in this study that local communities in and around Kagoma Forest Reserve are depending on these products, for energy, cash and construction. About 98% of the respondents admitted to have access to the forest products, where 76% admitted to clear forest for timber, 85% cleared for charcoal burning while 56% cleared for poles, and firewood. This observation of rural community's dependence on these resources is also reported by Mbonile *et al.* (2003) that, since independence, the government has not yet provided a strategy for providing alternative source of energy for rural communities in Tanzania. The use and demand of forest products were observed during field survey (Plate 2) and trees were cut down for charcoal, timber, and energy source in Kagoma Forest Reserve. Its influence on land use and land cover changes was found to be significant ($p = 0.050$).

Plate 2: A pile of wood for charcoal burning inside Kagoma Forest Reserve.

4.3.5 Shifting cultivation

There was a positive regression coefficient of shifting cultivation in (Table 6), which implied that an increase in one unit of household shifting to new farm area increased the odds ratio for land use/vegetation cover change by a factor of 6.526. This means that the numbers of people shifting around in search of land for cultivation had an impact on natural forest and emergence of another land use/cover. The results indicate shifting cultivation had statistically significant influence on land cover change (p = 0.024). This meant that the structure of Kagoma Forest Reserve was to a large extent influenced by the practice of shifting cultivation. In the study area, 87.1% of respondents admitted to practice shifting cultivation. Shifting cultivation is encouraged by lack of adequate land tenure arrangements encourages self allocation of land without any authority as the land is considered a common property that can be used without control. The influence of shifting cultivation on land use/land cover changes was also reported by Kummer (1992) in upper Philippines that such practices were encouraged by poor land tenure and development standards. These results concur with findings of Opulukwa (2001) who observed that clearance of woodland for cashewnut production is by far the largest destruction of African Black wood, *Dalbergia melanoxylon.* New large areas were observed opened yearly from forestland to agricultural land. The information extracted from the satellite imageries of the study area revealed a sharp decrease of forest land, where about 79.02 ha of the forest has been converted to cultivation and settlement lands during 1988-1999. Also, 112.65 ha of the forested areas were converted to cultivation and settlement lands during 1999- 2010.

4.3.6 Agricultural crop prices

The results in Table 6 indicate that there was a positive regression coefficient of cash crop prices. This was to say that an increase of one unit of cash crop price increased the odds ratio from land use/vegetation cover change by a factor of 7.112. This implied that the increase of cash crop prices motivated households to expand their farms in order to harvest more in the following season or year. The results show that, the influence of price increased on land use/cover changes was statistically significant ($p = 0.021$). Attractive cash crop price was one of the factors, which had positive influence on expanding agricultural land because it attracted more number of rural labor forces into agricultural industry. The influence of price on farm expansion was also observed in Kilimanjaro by Noe (2003) due to commercialization and trade liberalization, which caused prices of crops like wheat and maize to rise. The involvement of more people in agriculture will always require new land acquisition where the most vulnerable areas are natural forests. The field survey indicated that coffee, bananas, maize and beans prices have increased since 1980s to date and it has led each household to engage in cultivating such crops, which has inturn created a demand of more land for cultivation.

4.3.7 Expansion of farm sizes

There was a positive regression coefficient of expansion of farm size in (Table 6), which implied that an increase in one unit of household expanding a farm to a new farm area increased the odds ratio for land use/vegetation cover change by a factor of 2.062. This meant that the numbers of people expanding their farms so as to have larger farms for cultivation had impact on the natural forest and emergence of another land use and cover. The results indicated that, the influence of farm sizes expansion on land use/cover changes was statistically significant (p = 0.018). Of the total respondents 67.7% admitted that household's farms were expanding compared to the previous years. Majority of the respondents reported to use poor farming methods without application of fertilizers that increase demand for productive lands. Also, the study revealed that 70% of the farms were located at a distance of less than 1km from the forest edge, this implies that, there is an interference between these farms and the structure of the forest. Lyaruu (2002) and Tiffen (2003) reported that expansion of farms for cultivation in the world has changed land cover to more agro-ecosystems and less cover of natural vegetation. These changes are fuelled by the growing demand for agricultural products that are important for improving food security and generate income, not only for the rural poor but also for the large-scale investors in commercial farming sector.

4.3.8 Land tenure

The results indicated that there was a positive regression coefficient of land tenure insecurity (Table 6), which meant that an increase of one unit of household land tenure insecurity increased the odds ratio for land use/cover change by a factor of 5.052. Land tenure insecurity was statistically significant (p = 0.042). Security of land tenure over land occupied by a household significantly increased the temptation of expanding unplanned farms towards the neighboring forests and woodlands. Usually insecure pieces of land were occupied without title deed or certificate of occupancy. The land which was not demarcated and surveyed was normally not respected by the occupier and is likely to be abandoned and shift to another piece of land in the same neighborhood or anywhere else. This situation might have been the cause of poor land use practices like shifting cultivation and expansion of agricultural farms unnecessarily observed during the field survey in the area. It was revealed that only 8% of the respondents obtained land through inheritance, while 92% acquired land through slashing the bushes and cutting the trees to create own farms. This observation concur with Kikula (1997) findings who reported that security of land tenure had a direct link with sustainable farming practices which in turn enable sustainable natural resources management. Land use and related rights play a key role in determining the use and sustainable management of land resources since they specify accessibility of using resources. Kikula (1997) reported that people were willing to invest their scarce resources if they were sure that they will reap benefits. Insecurity of tenure is one of the cornerstones hindering loan accessibility of rural poor from financing institutions. Title deeds over land could help rural poor to borrow and raise financial ability to purchase farm inputs and improve agricultural productivity and enhance resource use instead of shifting from one piece of land to another looking for fertile soil, thus conservation of local resources and land cover in general.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study socio-economic factors influencing land use and vegetation cover change in and around Kagoma Forest Reserve were investigated. The findings revealed that the study area had undergone notable changes in terms of land use and land cover for the period 1988/1999-1999/2010. The results revealed that bushland, grassland, cultivated land and settlement areas have increased in the last twenty three years, where by forest land and woodland decreased linearly during the same period. This situation has not only reduced wildlife habitat that is rich in plant species but also may result into forest extinction in future if the situation is left unattended. The observed land cover changes have been influenced mainly by socio-economic factors, which are land tenure, cash crop prices, livestock keeping, demand for forest products, increase of farm sizes and shifting cultivation. Other factors that caused changes in land cover include population growth and level of education.

From people’s perspective, livestock keeping ranked the first among the socio-economic factors affecting Kagoma Forest Reserve. Other factors mentioned include ,illegal timber harvesting, charcoal burning, population growth, agricultural encroachment, poles cutting, poor law enforcement, insufficient knowledge on environmental issues and increasing poverty, and firewood collection. The results revealed great changes in land use and vegetation cover hence environmental education is needed to maintain the existing natural vegetation in areas like this in the country since human activities have seriously affected the resources.

5.2 Recommendations

(a) Land use planning in villages bordering the forest is essential in order to reduce human pressure on the natural resources.

(b) Individual land outside the forest should be surveyed and /or issued with title deeds. The issuance of certificates of titles would help as securities to those people interested to borrow from financing institutions. In this case, the rural poor will see this opportunity to get capital for purchasing farm inputs and improve farm productivity.

(c) Together with land use planning enforcement of laws that govern natural resources management and land use are important.

(d) Community sensitization on environmental conservation in villages adjacent to the forest is important in ensuring protection of the forest ecosystem.

(e) To develop an alternative source of energy and enhance energy use efficiency to reduce community dependence on the forest resources.

(f) Resource inventory in the forest and surrounding areas to quantify biodiversity of the forest and identification of conservation approaches as well as biodiversity hotspot areas in the Kagoma Forest Reserve are necessary

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APPENDICES

Appendix 1: Questionnaire for Socio-economic Data Collection

Questionnaire number…………………………………….………………….
Date of interview……………………………………..……………………..
Name of interviewer……………………………………..………………….
Name of interviewee……………………………………………………….
Ward……………………………………………………………………………
Village…………………………………………………………….………….

1.0 BACKGROUND INFORMATION

1.1 Name of respondent (Head of household)………………………………..
…………………

1.2 Sex of respondent…………………………………………………………………….
1. Male 2. Female

1.3 Age………………………… (Years)

1.4 Marital status…………………………………………

1. Single 2.Married 3.Divorced 4. Widowed 5.Other (Specify)…..

Tribe…………………………………………………………………………

1.6 Place of birth…………………………………………………………….

1.7 Years of residence in this village

1.8 Place of usual residence………………………….

1.9 Did you shift to this village? ....

1. Yes 2. No

1.0 If yes in 1.9, what are the reasons for shifting………………………………………

1. Land availability 2. Inheritance of land 3.Farming
4. Residential housing 5. Other (Specify)……………………………………..

1.11 What is your main occupation? ....

1.Farming 2. Business man/woman 3. Teacher 4. Politician
5. Government worker 6. No Occupation 7. Charcoal
8. Other (Specify)…………………………………….

If the main occupation is charcoal where do you get raw materials?.................

1.12 Wealth category ……………………………………………………………………….

1= Rich 2= Intermediate 3= Poor

(From the wealth category data base by key informants)

Category Members (number) how many participate in economic activities works, activity

Adults

Male …………………………………… ……………………………

Female ……………………………………………………………………

Children ………………………………… ………………………………

Dependants ………………………………… ………………………………

Male …………………………………… ……………………………

Female …………………………………… ……………………………

Total …………………………………… …………….……………

2.0 HOUSEHOLDS SOCIO-ECONOMIC STATUS

2.1 What is your highest level of education? ....

1. No formal education
2. Adult education
3. Primary education
4. Secondary education
5. College

Other (specify)………… …………………………………………………..

2.2 What is your social position?

1. Small scale/ Large scale farmer
2. Political leader
3. Traditional leader
4. Employee (specify)

2.3 What is the major source of your income? ………………………………

1. Business (Which business)……………… …… ……………………………………..
2. Farming activities
3. Forest activities

4. Both 1 and 2
5. Other specify……………………………………………………………………

2.4 What is your average monthly income from Agricultural activities (TAS)? ……..
2.5 What is your average monthly income from Forestry activities (TAS)? ………….
2.6 What is your average monthly income from other activities (TAS)…………… …

3.0 LAND USE CATEGORY AND LAND COVER TYPE

3.1 Does your household own land for agriculture use? ....
1. Yes 2. No

3.2. If 2.1 is yes, how did you acquire the land? ....
1. Purchased 2. Rented 3. Inherited 4. Both 1 and 3 5. Both 2 and 3 6. Other (specify)……………………………….

3.3 What is the size of your land (acres)? ………………………………………

How far is your cultivated field (acres) from home? (km)

Table No.1 shows the number of cultivated field and distance from Homestead.

Field No.	Size (acre)	Distance from homestead (km)

3.3.1 Which crops do you cultivate in the duration of five years back from now?

Crop	Last year's yield	Crop	Cash generated
Maize			
Bananas			
Beans			
Coffee			
Cassava			
Other (Specify)			

3.4 Do you keep any livestock? ....

1. Yes 2. No

3.5 If yes which type, breed, quantity and feeding system you are using for the past five years?

Type of livestock	No kept	Year started	Livestock Feeding system 1.Zero grazing 2.Privatepasture 3. Communal pastures 4.Others(specify)	Breed 1. Local 2. Pure 3. Cross

3.5.1 What land use changes in general you have made in the past five years time?.......

3.6. Have you cleared any area of Forest so as to increase the area for cultivation?

1. Yes 2. No

3.6.1 If yes When and how often? ....

3.7 Does your household members have any access to Kagoma Forest Reserve?

1 Yes 2. No

3.7.2 If yes which materials do you take from the forestry and how often per month...

3.7.3 Compared to the previous years, has the opportunity for villager's to clear Kagoma Forest Reserve………………………

1. Increased
2. Decreased

3. Stayed the same
4. You don’t know.

3.7.4 If the opportunity of villager’s to clear forest increased what could be the main reasons?

1…………………………………………………………………………………………
2. …………………………………………………………………………………………

3.7.5 If the opportunity of villager’s to clear forest has decreased what could be the main reasons?

1…………………………………………………………………………………………
2. …………………………………………………………………………………………

3.8. Compared to the previous years, is the size of Kagoma Forest

1. Increased
2. Decreased
3. Stayed the same
4. You don’t know.

3.9 If the answer to question two is 2, do you face any challenges due to the decrease of this forest? Mention the challenges you are facing.

1…………………………………………………………………………
2……………………………………………………………………………
3……………………………………………………………………………

3.10 Is there any Government restriction on the use of Kagoma Forest? ....

4. Households assets and Energy supply.

4.1 Do you own this house or rent? ....

1. Own 2. Rent

4.2. What are the materials used to build the house

Item	Value	Response
House construction material Walls	1. cement 2. Burnt bricks 3.unburnt bricks 4. poles +mud 5.mud 6.grass/straw 7. stones	
Roof	1.Iron sheet 2.grass/straw 3.straw+mud 4.tiles 5. Others	
Floor	1.Cement 2.Earth 3.Others (Specify)	

Does your household own……………………………………………………………

1.Bicycle 2. Motorcycle 3. Car 4. Both 1 and 2 5. Both 2 and 3

6. None of those 7. Others (Specify)………………………..…………………..

4.3. W hat is your primary source of fuel for your household.

Item	Value	Response
Source of energy for cooking and lighting	1.Electricity 2.Charcoal 3.Wood 4.Kerosine 5.Others (specify)	
If 2 and 3 where do you normally get it	1.Cutting down trees 2.Collecting dried straws and tees 3.Other (specify)	

Appendix 2: Checklist for key informants

1. When was the village established
2. What is the total area of land is owned by the village
3. What is the area of forest cover in this village
4. How many villagers are currently live in the village
5. How many are away right now.
6. How many How many different groups (Ethnic groups) are living in the village
7. What is the status of forest from 1980-2008
8. What are the socio-economic factors which leads to land use and vegetation cover change in Kagoma Forest Reserve
9. Are there any effects which occur due to the land use and vegetation cover change to the community around Kagoma Forest Reserve?
10. What should be done to avoid the vegetation cover change?