DEFORESTATION IN CHIPURIRO LANDS (GURUVE), SOCIO-ECONOMIC FACTORS AND PATTERNS

By

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submitted in accordance with the requirements for the degree of

MASTER OF SCIENCE

in the subject

ENVIRONMENTAL MANAGEMENT

at the

UNIVERSITY OF SOUTH AFRICA

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February 2013

DECLARATION

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I, AGREEMENT HLANGANAYI, declare that this dissertation entitled: 'DEFORESTATION IN CHIPURIRO LANDS (GURUVE), SOCIO-ECONOMIC FACTORS AND PATTERNS' is my own work, and has not been submitted before for any degree or examination and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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ACKNOWLEDGEMENTS

I am greatly indebted to my supervisors, Professors WAJ Nel and RM Hendrick for selflessly and tirelessly guiding me through all the stages of writing this dissertation. Without their comments and suggestions, the completion of this thesis would have been difficult. I am also indebted to Ms L Adriaanse the librian at UNISA Florida Campus, and my language editor Dr Peter Merrington.

I also want to thank Emely Mhlanga and Godfrey Mutowo from the University of Zimbabwe for agreeing to read and comment on my thesis draft. I also want to thank the research assistants Susan Njagu and Linda Sibethukile Mhlanga.

I would also like to thank the Guruve District Administrator, Chief Chipuriro, the headsmen and all the households who participated in this research.

Last but not least, to David, Mary, Phanuel, Charles-Deon, Ruvarashe-Sasha for their support, and to God almighty for his strength.

ABSTRACT

Information on deforestation and forest management is limited due to lack of understanding as to how socioeconomic factors affect deforestation. Without adequate data, it is difficult to manage deforestation; particularly in Chipuriro where deforestation is occurring at a rapid rate. This research was carried out to address the problem. Surveys and landsat images were used to collect data. To quantify deforestation, images were processed using Geographical Information System. Pearson's Correlation Coefficient was used to deduce the relationship between socioeconomic factors and deforestation. Socioeconomic factors were obtained through household surveys and focus group discussions. Results indicated high rates of deforestation in Ward 18 (4.7% per annum) while in Ward 16 woodland cover increased throughout the study period (7.7% per annum). Population growth with its demand on fuel wood, settlement and agricultural land caused a significant decrease in woodland cover in Ward 18. Plantations increased the area under woodlands in Ward 16.

KEY WORDS: deforestation; Landsat Thematic Mapper images; plantations; woodlands, Socioeconomic, population growth

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GLOSSARY

Afforestation

The establishment of forest stands in an area that has not been forested for a long time, for example for at least 50 years, or an area that is believed never to have been forested (FAO, 2001b).

Communal area

It is an area where farmers who grow crops for subsistence reside. The farmers use the land, but do not own the land (retrieved November 7, 2011 from (http://www.ess.co.at/GAIA/CASES/Zim/Communalhtml). In this study Ward 18 was interchangeably used with the Chipuriro communal area

Debt-for-nature swaps

It is when countries protect their forests in exchange for foreign aid or debt relief (Miller, 2007: 207).

Deforestation

The clearing of forests to put the land to another land use or the long-term reduction of the tree canopy cover below the minimum 10% threshold (FAO, 2001).

Digital Elevation Model

A DEM is a raster or grid-based terrain model with each cell in the DEM having a value to represent the elevation of the area (Ministry of Natural Resources, Environment and Meteorology, 2005).

Direct driver of deforestation

This is a factor that directly causes the decline in forest cover, eg clearing land for agriculture.

Economic factors

Economic factors of deforestation are the activities done to generate money at the expense of forests (Rademaekers et al., 2010).

Extensive farming

A system of farming that uses less labour and capital as compared with the size of land being farmed [big farm land], (retrieved May 19, 2013 from http://www.Scalloway.org .uk/farm6a).

Focus group

A group of people assembled by a researcher to discuss and comment on the subject of the research drawing on their personal experience (Powell et al., 1996:499).

Forest

An area of about 0.05 to 1 hectare with tree crown cover of more than 10-30% and the trees are of minimum height of 2-5 meters (FAO, 2005).

Forest degradation

The reduction in tree structure or density (Grainger, 1993).

Forest land

An area covered with forests or lands under agro-forestry and shifting cultivation, and not only closed canopy primary forests (FAO/UNEP, 1982).

Food security

When individuals or a group of people have access to a safe and nutritious balanced diet (FAO, 2010).

Grassland

In this class the trees are very scattered or are absent. The canopy cover of the existing trees is plus or minus 2% (Kusangaya & Sithole, 2006).

Household

A group of people who live together and share meals from a common kitchen.

Household food security

The access to adequate basic food by a group of people living together as a family (FAO, 2010).

Intensive farming

A system of farming that utilizes huge amounts of capital and labour as compared with the size of the land [small piece of land], (http://www.scalloway.org.uk/farm6a.html).

Kappa statistics

The measure of the difference between the actual agreement between the reference data and an automated classifier and the chance agreement between the reference data and the classified image (Congalton & Green, 1999).

Large-scale commercial farms (LSCF)

These are privately owned commercial farming areas. LSCF in this study was used interchangeably with Ward 16 (retrieved November 7, 2011, from http://www.ess.co.at/GAIA/CASES/Zim/Communalhtm dated 7/11/2010).

Overgrazing

Overgrazing occurs when too many animals graze on a piece of land for a long time and exceed the carrying capacity of the grazing area (Miller, 2007:209).

Plantations

Forest stands established either through afforestation or reforestation (FAO, 2001b).

Population growth

Population growth is the increase in number of people over a period of time (Miller, 2007:172).

Population pressure

Population pressure occurs when there are more people than the resources can provide for (Bhattarai & Hammig, 2001).

Poverty

Lack of choice, lack of dignity, living in marginal environments and lack of access to clean water, being vulnerable to violence, being insecure, having no power to participate, being excluded, lack of access to credit, lack of access to land to grow crops, not having a school or clinic to attend, not having enough to feed the family (United Nations, 2005). In this research poverty was defined as lack of access to basic needs as well as earning below the

Zimbabwe poverty line (US$500) (retrieved December 13, 2011, from http://allafrica.com/stories/201201110137.html).

Poverty alleviation

Short-term poverty relief. In developing countries this could be as a result of aid from donors, non-governmental organisations and community help groups (Dewdney, 1996:64).

Reforestation

The growing of trees on an area that used to be covered by forests or where the area is under-stocked (FAO, 2001b).

Secure rights to land

Having title to the land or owning the land that you use (Moyo, 1998a).

Social factors

Social factors are the factors that affect or direct our lifestyle (Rademaekers et al.,2010).

Survey

The study of a situation, beliefs or attitudes using questionnaires or interview guides from a known or sampled group of people (Maree, 2007:155).

Tree

A woody perennial plant with a single stem or several stems in the case of a coppice. The tree can grow up to a height of 15m (FAO**,** 2005).

Underlying factors

The underlying factors of deforestation are those factors which may also create an environment for destruction of forests (Rademaekers et al., 2010).

Usufruct rights

The rights allocated to an individual, especially a male by the chief to use the arable and grazing land without title deeds (Chenje et al., 1998).

Woodlands

A habitat where trees are the main plants and the trees are 5-15m tall and close together so that the branches often meet overhead forming a more or less continuous canopy (Kusangaya & Sithole, 2006).

Wooded grassland

This is characterised by scattered trees or bushes of 1-15m high and with a canopy cover of 2 – 20% (Kusangaya & Sithole, 2006).

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ABBREVIATIONS

AREX	Agricultural Research and Extension
CA	Communal area
CIFR	Centre for International Forestry Research
CMB	Cotton Marketing Board
CSO	Central Statistics Office
DA	District Administrator
DEM	Digital Elevation Model
DMO	Department of Meteorology Office
FAO	Food and Agricultural Organisation of the United Nations
FCZ	Forestry Commission of Zimbabwe
GIS	Geographical Information System
GMB	Grain Marketing Board
GPS	Global Positioning System
IDS	Institute of Developmental Studies
IIED	International Institute for Environment and Development
ILWIS	Integrated land and Water Software
IPCC	Intergovernmental Panel on Climate Change
LSCF	Large-scale commercial farm
MDC	Movement for Democratic Change
MMET	Ministry of Mines, Environment and Tourism.
MNREM	Ministry of Natural Resources, Environment and Meteorology.
MTNRE	Ministry of Tourism, Natural Resources and Environment
NASA	National Aeronautics and Space Administration
NCAR	National Centre for Atmospheric Research
NIAS	Nordic Institute of Asian Studies
PDL	Poverty datum line
PPMCC	Pearson's Product Moment Correlation Coefficient
P-value	Probability value
REDD	Reduced emissions from deforestation and degradation
SADC	Southern Africa Development Community

S.A.M	Sahabat Alam Malaysia
SNEA	Sudan National Energy Administration
SRTM	Shuttle Radar Topography Mission
UN	United Nations
US$	United States Dollar
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Conference on Climate Change
UTM	Universal Transverse Mercator
WRI	World Resource Institute
ZAOGA	Zimbabwe Assemblies of God Africa
ZAR	South African Rand

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ABSTRACT

Information on deforestation and forest management is limited due to lack of understanding as to how socioeconomic factors affect deforestation. Without adequate data, it is difficult to manage deforestation; particularly in Chipuriro where deforestation is occurring at a rapid rate. This research was carried out to address the problem. Surveys and landsat images were used to collect data. To quantify deforestation, images were processed using Geographical Information System. Pearson's Correlation Coefficient was used to deduce the relationship between socioeconomic factors and deforestation. Socioeconomic factors were obtained through household surveys and focus group discussions. Results indicated high rates of deforestation in Ward 18 (4.7% per annum) while in Ward 16 woodland cover increased throughout the study period (7.7% per annum). Population growth with its demand on fuel wood, settlement and agricultural land caused a significant decrease in woodland cover in Ward 18. Plantations increased the area under woodlands in Ward 16.

KEY WORDS: deforestation; Landsat Thematic Mapper images; plantations; woodlands, Socioeconomic, population growth

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter starts by highlighting the importance of forests to our social, economic and physical environment. Some background is given on the factors affecting deforestation and the extent of deforestation in both developed and developing countries. The chapter also discusses the objectives of the research, the characteristics of the study area and the research methods employed to collect data. The chapter ends with a description of the organisation of the study.

1.2 Importance of forests

Forests play a vital role in the social and economic development of a country. Economically, forests create employment and generate foreign currency and socially they enable people to live healthy lives with forests absorbing pollutants and carbon dioxide, and hence helping to control the temperature of the earth **(**Rock, 1996; Chamshama & Nduwayezu, 2002). Forests also play an important role in the cultural and religious values of some societies. Environmentally, forests cover the watersheds that supply fresh water to rivers (FAO, 1993) and hold soil in place to control runoff and soil erosion (Sharma, 1992; Schwab, Fanmeier & Elliot, 1996; Kwaramba, 2011). However, the rapid population increase experienced globally since the turn of the nineteenth century has led to an increase in the use of forests and forest products. This has subsequently led to the increased disappearance of forests - a phenomenon called deforestation.

Deforestation, which is the clearing of forests to put the land to other use (Food and Agricultural Organisation [FAO], 2001), is a product of interrelated factors to be explained in chapter two. The degradation of forests concerns the world as a whole as evidenced by the number of researches carried out on the subject (Whitlow, 1980; Bajracharya, 1983; Repetto & Holmes, 1983; Repetto, 1985; Whitlow, 1988; Myers, 1989; World Resource Institute [WRI], 1990; Fearnside, 1993; Grainger, 1993, 1996; Kwaramba, 2011). Deforestation is also associated with land degradation, a phenomenon that affects the very source of human survival (crop production) through a reduction in soil fertility. With the decline in crop production it is almost impossible to eliminate poverty in the rural areas of Zimbabwe, where the majority of Zimbabweans reside and who depend almost wholly on agriculture for their survival. This research therefore aims at determining the socio-

economic drivers of deforestation and the patterns of deforestation in Wards 16 and 18 of the Chipuriro communal lands, Zimbabwe.

1.3 Background

Deforestation has been top on the environmental agenda for a long time and continues to be a leading issue of concern in the world. It is a serious land use problem in developing countries, and Zimbabwe is no exception. Kahn and MacDonald (1994) reported that the destruction of forests especially in the tropics is occurring at a fast rate, making it a matter of concern to environmentalists and economists. The World Resources Institute (WRI), the United Nations Environmental Programme (UNEP), United Nations Development Programme (UNDP) and World Bank (1996) reported that by the early 1990s, about 40% of the earth's surface was transformed into crop cultivation and grazing lands. The WRI further reported that the earth has already lost 80% of its forest cover to deforestation – a figure very near to complete clearance of forest cover (retrieved March 11, 2011, from http://www.buzzle.com/articles/causes-and-effects-of-deforestation.html). Despite this rate of forest loss, more than 1.6 billion people in the world depend on forests for their survival (Kwaramba, 2011).

Studies have shown that the rate of deforestation is not the same for all countries. Between 1990 and 2010 Indonesia lost 20.3% (around 24,113,000 hectares) of its forest cover (retrieved May 19, 2013, from http://rainforests.mongabay.com/deforestation/2000/ Indonesia.htm). Papua New Guinea during the same period lost around 2,797,000 hectares (8.9%) of forest cover (retrieved May 19, 2013, from http://rainforests.mongabay.com/ deforestation/2000/ Papua_New_Guinea.htm). Research reveals that deforestation is most extensive in developing countries where the majority of the population depends on agriculture for both food and income generation. A research carried on 121 tropical countries, showed that about 9.34 million hectares of forest cover was lost between 2000 and 2010 (FAO, 2010).

The continent of Africa records the highest rate of deforestation. During the early 1980s, forests in Africa were being destroyed 29 times faster than the rate of replacement, compared with 10.5 times in tropical America and 4.5 times in tropical Asia (Holmberg, Bass & Timberlake, 1991). Current results report Africa as losing forests at double the world rate (Doyle, 2008).

In Tanzania, about 10,000 hectares of closed forest were destroyed annually between 1981 and 1985, representing an average deforestation rate of 0.4% (WRI and the International Institute for Environment and Development [IIED], 1986). Between 1976 and 1980, deforestation in Tanzania was estimated to have proceeded at an average annual rate of 0.5% (Allen & Barnes, 1985). Although these rates seem low compared to the rates registered in other African countries such as Nigeria, the rates are high considering the limited forest resources in Tanzania. Between 1990 and 2010 the country was reported to have lost 19.4% of its forest cover. Togo and Nigeria are among countries with the highest rate of deforestation. They are losing forests at 5.75% per annum and 4% per annum respectively (Morales, 2011).

Zimbabwe between 1990 and 2005 lost 21.1% of its forest cover which was equivalent to 4,694,000 hectares. The Forestry Commission of Zimbabwe (2011), cited by Kwaramba (2011), found that the country was losing about 330,000 hectares of forest per annum. At that rate of forest loss, Phillip Mataranyika of the Friends of the Environment, cited by Kwaramba (2011), reports that Zimbabwe can lose all its forests within 52 years.

Although forest cover dwindles every day, many people still do not clearly understand the factors affecting deforestation. Several people believe population growth to be the main driving force behind deforestation (Allen & Barnes, 1985). This belief has, however, been opposed by other researchers. These authors argue that deforestation is a result of various interlinked factors that include subsistence farming practices, lack of land security rights, uneven land distribution, greedy multinational companies, poverty, and poor government management (Myers, 1984; Gillis & Repetto, 1988; Bilsborrow & Ogendo, 1992; Palloni, 1994). Of these factors, the United Nations Framework Convention on Climate Change (UNFCCC) secretariat points to agriculture as the most significant in its effect on deforestation. Subsistence farming was pointed out as accounting for 46% of total deforestation while commercial farming and logging account for 32% and 14% respectively. Fuel wood requirements, which are highly prevalent in Zimbabwe's communal areas, was found to account for 5% (UNFCCC, 2007:81). In Zimbabwe 90% of households rely on biomass for energy, with fuel wood providing 49% of the energy requirements (Kwaramba, 2011). Kwaramba states that 7.7 cubic meters of wood are used per year for domestic purposes.

Poverty which is endemic in most rural areas of the country is also thought to exacerbate the problem of deforestation (Chomitz, Buys, Thomas & Wertz-Kanounnioff, 2007*)*. In Zimbabwe the high rate of unemployment has left people with no option but to sell fuel wood in order to earn an income, in both rural and urban areas of the country (Kwaramba, 2011). There is, therefore, concern that increased poverty levels (especially in rural areas) may lead to high levels of deforestation. According to Chomitz et al. (2007), forest-dense areas are often associated with poverty as these areas are inaccessible and the people staying in these areas rely solely on agriculture. The people clear the forests to make way for subsistence agriculture and they leave the plots they cultivate as soon as the yields decline, moving on to clear new land, as they often lack the finances to improve the soil (Myers, 1991). To reinforce these points, Angelsen (1999) stated that farmers living in forested areas depend wholly on agriculture for all of their needs.

Despite the heavy impacts of deforestation on our social and economic environment, research has shown that there is inadequate data on the extent and rates of deforestation for various countries. This has led to the use of estimates for the rates and extent of deforestation (FAO, 1992). However, it is known that differences in the rates of deforestation exist in different areas because of differences in the types of land use, economic activities, nature of the vegetation, and varying kinds of social need.

In Zimbabwe a number of research projects have been conducted to examine the extent of deforestation (Whitlow, 1980; Forestry Commission of Zimbabwe, 1996; Kwaramba, 2011). These research projects were carried out on a national basis and therefore less attention was placed on Wards 16 and 18 of Chipuriro, which remain under-researched areas. Furthermore, the research failed to compare the factors affecting deforestation and the comparative patterns of deforestation between these wards. Against the above background this study will assess the factors affecting deforestation within these two rural wards. In addition, a comparison of the rates of deforestation between the two wards shall also be done. It is hoped that the results will aid policy makers and other stakeholders in making informed and relevant decisions to manage deforestation.

1.4 Motivation, Value and Benefit of the study

Much has been documented about the factors affecting deforestation the world over. However, little seems to be known about the extent of deforestation and the socio-economic factors affecting it in Wards 16 and 18 of the Chipuriro communal lands.

The researcher grew up in Chipuriro and has seen how her mother struggled each day to prepare a meal for the family. From the researcher's experience, it was evident that there is a need to research the factors affecting deforestation in her ward as well as in the adjacent ward (Ward 16) which lies within a large-scale commercial farming region.

There are many social and economic factors affecting deforestation. These factors include population growth, settlement, overgrazing, fuel wood demand and demand for land for cultivation, craft work, domestic policies, and fencing, to mention but a few. From years of residence in Ward 18 the researcher has noticed that some people build their houses using a mixture of loam soil and water locally referred to as *dagga*, grass and wooden poles. For cooking people have been using fuel wood which at times they supplement with de-husked maize cobs, cow dung and freshly pruned branches from fruit trees in people's yards. Some elders are, at times, seen chopping tree stumps which barely reach knee height. Some youths on the other hand are found selling wood which they transport on scotch carts, but not everyone in the rural areas has money so this (transport of fuel wood for sale) is an income-generating solution to only a limited number of people.

The researcher is of the opinion that deforestation in Chipuriro is caused mainly by poverty. This belief is confirmed by Adeleke (1998) who states that poverty worsens and increases the pressure on natural resources. The people of the Chipuriro communal area rely solely on agriculture, and their type of farming is dependent on natural rainfall. Therefore if the rains are poor, the yields will be low and this in turn affects their income.

Trees in Chipuriro, as in any other place, provide many functions that people cannot do without. It is therefore important to understand the factors leading to their disappearance. It is hoped that the results of this research will enlighten Chipuriro residents about the factors affecting deforestation in their respective wards. The wards will benefit as the researcher will give the District Administrator as well as the Chief a copy of the dissertation after

completion of the study. The researcher, by conducting this research, will gain and share knowledge on how to manage deforestation in her ward of residence.

1.5 Statement of the problem

Deforestation became a major global problem since the turn of the nineteenth century (retrieved March 28, 2011, from website: www.forestproject.com). This prompted governments and non-governmental organisations to formulate policies to fight deforestation. These policies, however, have been received with much reluctance. For example, in the 1970s developed countries asked developing countries to implement sustainable forest management programmes. According to Humphreys (2008) a group of 77 developing countries wanted a global fund to be generated to assist them in the protection of forests, since the developed countries were also receiving the benefits of tropical forest products. This initiative reached a deadlock as the developed countries refused to make the contributions. Other policies include the Dept-for-Nature Swaps by the World Wildlife Foundation and the Reduced Emissions from Deforestation and Degradation (REDD) concept (Leplay & Thoyer, 2009). These policies were formulated to try to fight deforestation, which is a threat to the source of human survival.

Scientists have produced pictures of the earth without trees and economists have developed theories of deforestation. Such theories include the Forest Transition Theory, which states that 'deforestation cannot be maintained over a long period of time as the negative effects of deforestation will increase with the scarcity of forests,' (Ewers, 2006; Damette & Delacote, 2008; Karsenty, 2008). The need to comprehend the subject evolved from the fact that the removal of forests not only leads to biodiversity loss (Harris, 1988; Leplay & Thoyer, 2009), but can also affect economic development and local livelihoods (Leisz, Tottrup, Rasmussen, & Vien, unpublished article). Moreover, according to Leplay and Thoyer (2009), deforestation is now the second leading aggravation of greenhouse gas emissions which directly affect our global climate through ozone depletion.

From time immemorial, trees have provided invaluable services to the people. They serve as habitat for a variety of animal species. Trees control erosion by holding the soil together. Forests provide shading to stream flows and therefore reduce evaporation, and people obtain fruits, medicine and clean air from forests. Despite these many and varied benefits provided by forests, the researcher notes that people continue to cut down trees

indiscriminately – and particularly so in the communal lands in Zimbabwe, where the present research is focused.

In Zimbabwe a number of research projects have been conducted to examine the extent of deforestation (Whitlow 1980, 1988; Forestry Commission Of Zimbabwe, 1996, 2011). These research studies were done out of the realisation of how important the trees are to our social, economic and physical environment. The findings were however reported at a national level and therefore did not necessarily reflect what was happening in specific locations, such as at ward level. Furthermore, no comparisons or distinctions were made between land use on individually-owned large-scale commercial farms (LSCF) and land use in communally-owned (CA) farming areas. Against the above background this study will assess the factors affecting deforestation within the two farming systems. Furthermore, a comparison of the rates of deforestation between the two wards will be carried out. It is hoped that the results will aid policy makers and other stakeholders in making informed and relevant decisions to manage deforestation for the resources under contrasting management patterns (communal and privately owned).

1.6 Aims and Objectives

1.6.1 Aims

The aim of research has been described by De Vos (2005) as the desired outcome from a research project. The aim of this present study is to understand the patterns and socio-economic factors of deforestation in the Chipuriro lands, Zimbabwe.

1.6.2 Objectives

Objectives according to Fouché (2005) are steps taken to achieve the desired aim. In order to achieve the above aim the following objectives were set:

1) To examine the socio-economic drivers of deforestation in the Chipuriro lands;
2) To apply a quantitative assessment of woodland cover change between 1989 and 2008 for assessing the patterns of forest condition on a landscape scale;
3) To analyse which ward suffered the highest rate of deforestation; and
4) To make recommendations for managing deforestation in the Chipuriro lands.

1.7 Hypothesis

Research is carried out to solve a problem, and because of that a hypothesis is set. The hypothesis, however, usually follows quantitative research as stated by Fouché (2002). This research will use both qualitative and quantitative approaches. The hypotheses set for this research are as follows:

H_0: Level of poverty has no effect on deforestation.
H_1: Level of poverty has an effect on deforestation.

H_0: There is no significant change in woodland cover between 1989 and 2008.
H_1: There is a significant change in woodland cover between 1989 and 2008.

H_0: There is no significant difference in woodland cover loss between Wards 16 and 18 of the Chipuriro lands.
H_1: There is a significant difference in woodland cover loss between Wards 16 and 18 of the Chipuriro lands.

H_0: Deforestation in the Chipuriro lands cannot be managed.
H_1: Deforestation in the Chipuriro lands can be managed.

1.8 Research questions

Research questions are the questions which the research is to answer or follow in order to achieve the desired outcome. For the purpose of this study the following have been formulated:

1.7.1 What are the social factors affecting deforestation?
1.7.2 What are the economic factors affecting deforestation?
1.7.3 In which ward is deforestation most prominent?
1.7.4 What methods are being employed to manage deforestation?
1.7.5 How successful are the methods?
1.7.6 What other methods can be employed to manage deforestation?
1.7.7 At what percentage per annum is deforestation proceeding in each ward?

1.9 Research approach

This research will utilise both the qualitative and the quantitative methods, as a mixed mode. The use of both quantitative and qualitative data gathering methods will improve the process of data collection and enhance the validity and quality of the results.

1.9.1 Qualitative approach

The qualitative approach will help the researcher to collect data which cannot be gathered using the quantitative data gathering method. Moreover, the qualitative data collected will help to explain identified trends noted to be significant through the quantitative data gathering process.

1.9.2 Quantitative approach

Quantitative study is based on gathering information composed of variables, measured with numbers and analysed using statistical procedures in order to determine the significance of the variables. The quantitative data in this research will enable the researcher to identify trends in population size, changes in area under cultivation and those areas that were under woodland, wooded grassland, and grassland.

1.10 Type of research

This research will use the applied research philosophy, which is aimed at solving specific problems in practise (Fouché & De Vos, 2005). The type of applied research used in this case is exploratory research which aims at gaining insight into the given situation. The researcher has observed how people struggle to get fuel wood, so she wants to have a better understanding of the factors affecting woodland cover in her community. This study therefore aims to provide insight into the socio-economic factors that affect deforestation in the Chipuriro lands.

1.11 Justification for the research project

Deforestation has been redefined from primarily an environmental problem to a social problem. The effects of deforestation on our socio-economic and physical environment have fuelled numerous studies on the subject (FAO, 1982; Eckholm, Foley, Barnard & Timberlake, 1984; Allen & Barnes, 1985; Fearnside, 1986; WRI & IIED, 1986; Holmberg et al., 1991; Cropper & Griffiths, 1994; Khan & MacDonald 1994, 1995; Douglas, 1999; Bhattarai & Hammig, 2001, 2004; Koop & Tole, 2001; Rudel, Coomes, Moran, Archard,

Angelsen, Xu & Lambin, 2005; Ewers, 2006; Mena, Bilsborrow & McClain, 2006; Culas, 2007; Damette & Delacote, 2008; Karsenty, 2008; Shandra, Shor, Maynard & London, 2008; Combes Motel, Pirard & Combes, 2009; Leplay & Thoyer, 2009; Kwaramba, 2011). Most of these studies, however, focus mainly on factors affecting deforestation in the tropics, as these are the zones where deforestation has been most prominent. According to Takeda (1992), deforestation became a concern in the nineteenth century when tropical teak forests failed to regenerate. This tree species was used by the British to built naval vessels in Burma (Myanmar). The issue later became a major global concern after World War II when populations increased and more land was cleared for agriculture.

Cantor (1994) describes how Europeans around 1200 AD were living in huge areas of forest cover. They had access to forest wild life which provided them with the bulk of their protein requirement. As these people became more and more experienced in cutting down trees, they cleared a lot of forests. As the trees were dwindling the Europeans started to run short of wood for cooking and heating, circa 1500 AD. Since wild game also resides in the forests the disappearance of forests meant the loss of sources of animal protein. The shortage of animal protein and wood, led to more attention being placed on deforestation.

In Zimbabwe, although much has been documented on the factors affecting deforestation (Whitlow 1980, 1988; Forestry Commission of Zimbabwe, 1996, 2011; Kwaramba, 2011) no attempts have been made to compare the factors and patterns of deforestation between Wards 16 and 18 of the Chipuriro lands. The research carried out by Whitlow (1980) on deforestation was nationally based, and hence some places (including the Chipuriro lands) were left out. Whitlow used aerial photographs taken in the early 1960s and 1970s. The Forestry Commission of Zimbabwe in 2011 used satellite images to determine the extent of deforestation in the country. But as noted, this was carried out at a national level and did not compare the rates at ward level. Another factor hindering the study of the subject is the current economic and political situation of the country.

Up to now, as a result, the view that deforestation is both an environmental as well as a socio-economic problem has not yet changed. However, less effort has been done to analyze the socio-economic drivers of deforestation in the two subsectors or wards of Chipuriro. Therefore, while a major challenge facing the Chipuriro lands is the alarming

rate of deforestation, the factors that lie behind this – and the extent of the problem – are still debatable, due to lack of information.

This study is considered to be an important step towards bridging this information gap. The findings of this study will enlighten the Chipuriro residents about the socio-economic factors affecting deforestation and the pattern of deforestation in their ward. With adequate information, households will be in a better position to fight against the threats to both the forest and their own livelihoods.

1.12 Theoretical framework

The factors affecting deforestation have been grouped into direct (proximate) and indirect (underlying) factors (Rowe & Sharma, 1992). The direct factors include fuel wood collection, clearing land for agriculture, logging and timber production and human settlement. Underlying factors include poverty, unequal land distribution, low agricultural productivity, rapid population growth and poor government policies (Repetto & Holmes, 1983; Repetto, 1985; Myers, 1986; Livitnoff, 1990; Holmberg et al., 1991).

Many people believe that population growth is the main factor affecting deforestation in developing countries (Allen & Barnes, 1985; Holmberg et al., 1991; Green, 1992). This fact cannot be denied as the increase in population in most developing countries has led to the opening up of cultivated lands in forests and marginal lands. Population increase also leads to an increase in demand for settlement and fuel wood, hence causing more forest cover loss. However, deforestation is a complex problem and cannot be explained by population growth alone.

In the communal areas of most developing countries, poverty contributes a significant role to natural resource depletion. Communal farmers or peasants who are smallholder farmers are often poor, hence their condition pushes them into destructive patterns of land-use to meet the basic needs for food and fuel (Holmes & Repetto, 1983; Repetto, 1985; Myers, 1986; Burgess & Makandya, 1990; Livitnoff, 1990; Holmberg et al., 1991; Chomitz et al., 2007). Considering this, it is misleading if people regard population growth with its demand on settlement, fuel wood and any other forest resource as the only factor affecting deforestation. If policy makers design policies based solely on population growth there is a

danger that the problem of deforestation may not be solved. Solving the problem of deforestation demands a holistic approach.

Palmer (1992) views deforestation as a result of developmental projects that over-exploit forest resources with the aim of generating money to pay off debts (IIED, 1987). Utting (1991) reinforces Palmer's view by stating that most developing countries during the late 1800s and early 1900s had to rely on agricultural production. Crops like tobacco, cotton and coffee were grown mainly for the export market and to get foreign currency in order to develop the country. Zimbabwe during the early 1980s was regarded as the 'bread basket' of the Southern African Development Community (SADC) region. Crops like tobacco and tea were extensively grown for export. In the same country the growing of tobacco is still being carried out in some districts of the country, including Guruve District. The crop is still fetching a high price on the auction floors. One disadvantage of growing this crop is that tobacco requires a lot of fuel wood during the curing process which may lead to severe forest loss if the farmers do not have plantations or other alternative sources of energy to cure tobacco, such as coal.

Unequal land distribution in Zimbabwe has left most peasants in less productive lands with limited access to land, credit, essential goods and services. As a result most peasants are poor. Their desperate need to survive forces them to extend land for cultivation into forests and fragile lands, causing forest cover loss and soil erosion. Some peasants in an effort to survive cut wood to sell to the community. This practise causes more and more forest cover loss.

In the communal areas of Zimbabwe, some households have large families. The children are believed to help in a number of ways which include fetching water, tending livestock, collecting fuel wood and dung, and taking care of the elders when they are too old to work (Miller, 2007). According to these households' understanding, the bigger the family, the more the economic or security benefits received.

From the preceding discussion, it is evident that the causes of deforestation (population growth, extension of cultivated lands, fuel wood collection for sale) are driven by the effort to make or earn a living. The destruction of tree resources may be viewed as a survival strategy given the scenario that in rural areas there are limited employment opportunities.

This research will thus be conducted within the school of thought that regards impoverishment as the major factor behind deforestation. This school of thought believes that deforestation is a consequence of the growing number of poor people (retrieved March 3, 2012, from http://www.experiencefestival.com/a/Deforestation_-_Causes_of_deforestation/id/1314747).

1.13 Conceptual framework

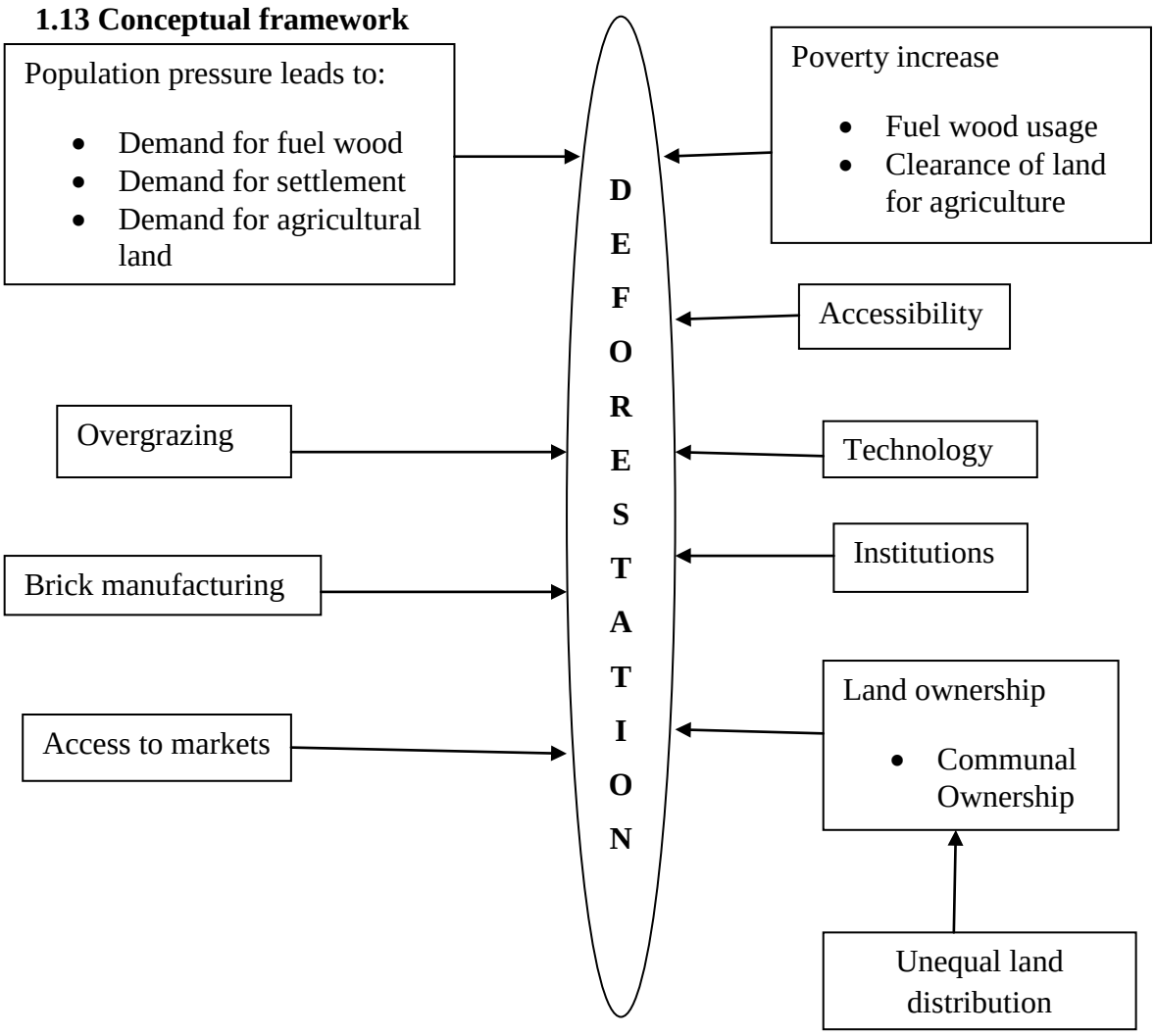


Figure 1.1: conceptual framework (source: researcher's own construction)

The conceptual framework presented in Figure 1.1 illustrates the various factors affecting deforestation. People clear forests because of the demand for either forest land or forest resources. Figure 1.1 reveals that population pressure contributes directly to the loss of woodland cover. As the population increases, the demand for fuel wood also increases and this puts pressure on the existing natural forest. In the Chipuriro communal areas, just as in any communal area in Zimbabwe, very few households build their houses with brick walls

and asbestos or tin roofs. Rather, they use wood for the walls and frame, and grass to thatch the roofs. Woodlands are therefore cleared to prepare land for settlement as well as for house construction. The most targeted species is the Mopani tree due to its resistance to termite attack. *Brachystegia spiciformis* bark is also used to tie poles, as households use bark fibre as well as nails to join poles during house construction.

The Chipuriro communal area is an agrarian community. The increase in population leads directly to an increase in demand for land for cultivation. Households in Chipuriro practise subsistence farming, with some excess produce for sale. Selling agricultural produce is therefore one of their major sources of income. Apart from selling agricultural produce some households manufacture bricks for sale. During the process of brick manufacturing a lot of heat is needed to fire clay bricks. Trees that produce a lot of charcoal such as Mopani trees are therefore at the mercy of brick manufacturers.

In most communal areas of Zimbabwe, wealth is measured in terms of how many cattle a person possesses. Cattle are viewed as a form of financial security. Thus every farmer aspires to have more cattle, and this leads to overgrazing as the cattle numbers will exceed the carrying capacity of the land. Another factor affecting grazing lands in the communal areas is the land ownership type. In the Chipuriro communal area, no-one owns the land as the land belongs to the state. Forest resources are therefore regarded as open access resources, since no individual owns them. This type of land ownership has been found to lead to over-exploitation and very poor management (Hardin, 1968). With open access resources, each and every individual will use the resource to his or her maximum benefit, to the detriment of the forest. When people have secure rights over forest resources they are in a position to conserve them, as they know that they will directly benefit from the proper management of the resources that they own. Grazing lands in the Chipuriro lands are communally owned, meaning that no-one is responsible for them and this affects the quality of the grazing lands. The grazing of too many cattle in the communal areas without sufficient time to rest the veldt prevents the land-cover from regenerating.

The history of Zimbabwe is viewed as contributing to deforestation in the communal areas of the country. Zimbabwe was a British colony from 1890 to 1980. When the British took over Zimbabwe (former Rhodesia), they made it a policy that all the areas with good soil, good rainfall, favourable temperature and flat to undulating slopes were for colonial

settlement. Zimbabwe is divided into five agro-ecological regions, and favourable agricultural conditions are prevalent in agro-ecological regions I to III. Regions IV and V are arid regions. Figure 1.2 and Table 1.1 show the agro-ecological regions of Zimbabwe.

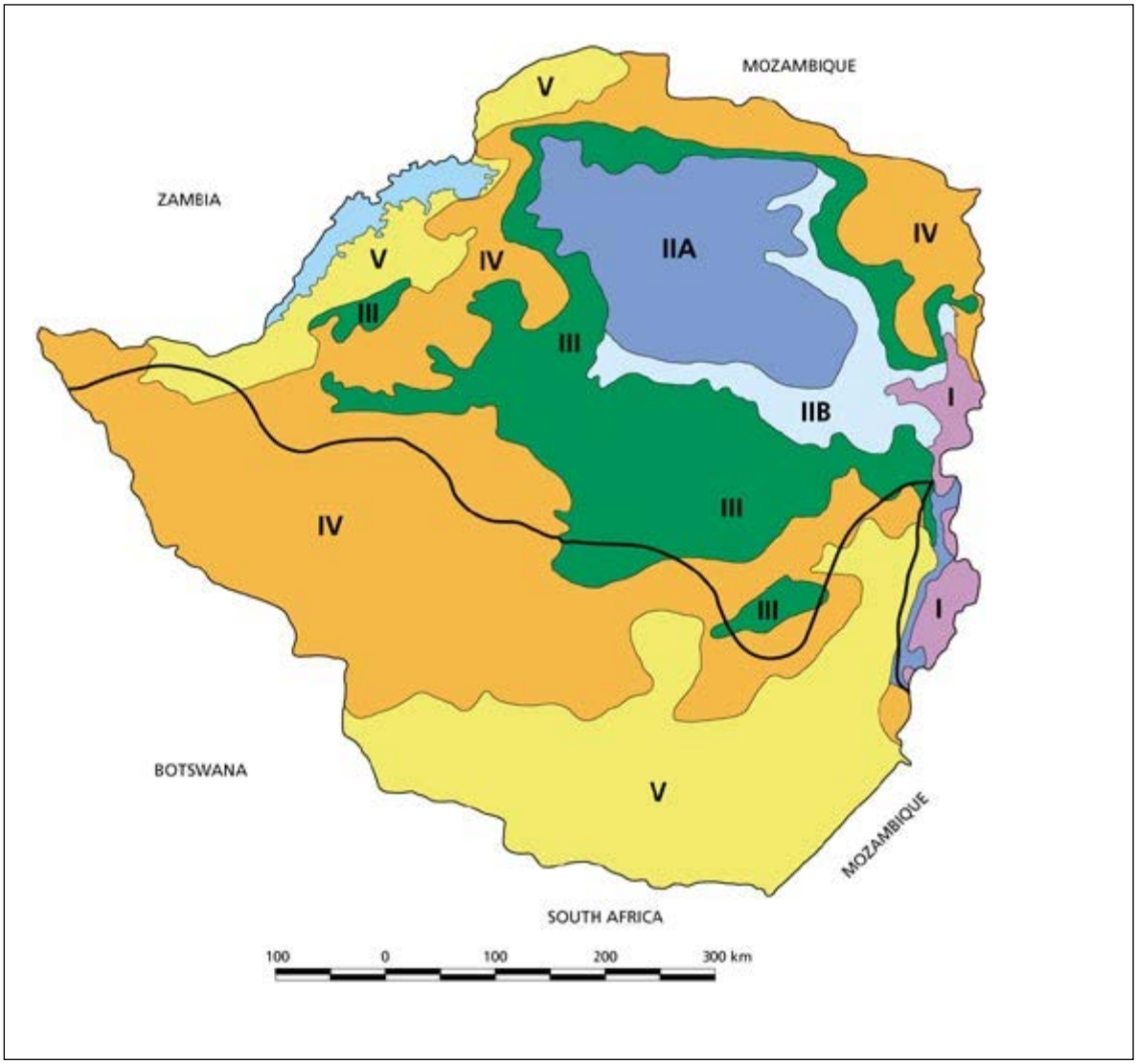


Figure 1.2: agro-ecological regions of Zimbabwe (source: adapted from FAO, 2006)

Table 1.1: agro-ecological regions of Zimbabwe

Natural region	Area (hectares)	% of total land area	Annual rainfall (mm) and climate	Farming systems
1	613	1.56	> 1 000. Rain in all months of the year, relatively low temperatures	Suitable for dairy farming, forestry, tea, coffee, fruit, beef and maize production.
II	7 343	18.68	700-1 050. Rainfall confined to summer	Suitable for intensive farming, based on maize, tobacco, cotton and livestock.
III	6 855	17.43	500-800. Relatively high temperatures and infrequent, heavy falls of rain; subject to seasonal droughts and severe mid-season dry spells.	Semi-intensive farming region. Suitable for livestock production, together with production of fodder crops and cash crops under good farm management.
IV	13 010 036	33.03	450-650. Rainfall is low with periodic seasonal droughts and severe dry spells during the rainy season.	Semi-extensive region. Suitable for farm systems based on livestock and drought-resistant fodder crops.
V	10 288	26.2	< 450. Very erratic rainfall. Northern low veldt may have more rain but the topography and soils are poor.	Suitable for extensive cattle or game ranching.

(Source: adapted from Moyo, 2000; Vincent & Thomas, 1961)

Table 1.1 shows the agro-ecological regions of Zimbabwe. Most whites settled in agro-ecological regions I to III. In these regions, farming is intensive as there is good rainfall. The few blacks left in these regions were settled as communities in the communal areas (former Tribal Trust lands). The majority of the blacks were pushed out to settle in agro-ecological regions IV and V. In most communal areas the slopes are steep and the soils are more vulnerable to soil erosion. Farming in the regions is extensive. The concentration of too many people in the communal areas puts pressure on the existing woodlands as people use forests for their sustenance.

Poverty and deforestation are considered to work hand-in-hand especially in the tropics where most deforestation takes place (WRI, 2000; United Nations [UN], 2002; FAO, 2003, 2005). Poverty, which is the inability to access all the basic needs (Miller, 2007), forces people to over-rely on finite natural forests. From forests people obtain food, energy (fuel wood), poles to built houses and land to cultivate. This factor has meant that most rural areas are left with more bare surfaces than woodlands. Poverty also means a lack of alternative sources of energy, and thus fuel wood becomes the sole source of energy within the communal areas. In the Chipuriro communal area, households use cow dung to substitute for fuel wood especially at gatherings where larger quantities of food have to be prepared.

Technology can have both positive and negative effects on deforestation. On the negative side, with more skills people can learn faster methods of clearing trees, leading to higher rates of deforestation. On the positive side, with the use of high-yield hybrid seeds and intensive farming a small piece of land can be used to produce high yields. Technology can help individuals, communities or the state to protect and manage forest resources, and create energy substitutes for use by households in communal areas.

Deforestation is a consequence of the accessibility of forest resources. When clearing forests, very few people get into the middle of those forests to cut trees. Usually people clear trees along roads for easy transportation of the resource. Most people in the rural areas settle along roads so that they can have easy transport to and from the market. This fact has been supported by Matthews, Payne, Rohweder and Murray (2000), who state that ‘roads open up forests for people to settle along roads and to cut trees for different purposes’.

The clearing of forests can be reduced or increased when a body or group of people work together. The collective can be a small community group, or a state or international body. This group can reduce deforestation if they work together to come up with solutions and put into practise ways of managing deforestation. The stakeholders can on the other hand increase deforestation if their projects are aimed at creating businesses that remove forests, for example mining or dam construction.

1.14 The study area

1.14.1 Demarcation of the terrain of study

The research was conducted in Wards 16 and 18 of the Chipuriro lands. Ward 18 is in a communal area while Ward 16 is in a large-scale commercial area. Both wards are in Guruve District (Figure 1.4) in Mashonaland Central Province of Zimbabwe (Figure 1.3).

Figure 1.3 and 1.4 were drawn using the 2002 Ward Map for Zimbabwe which was readily available from the Department of Geography and Environmental Science at the University of Zimbabwe. The maps were drawn using the ArcView software under the Geographical Information System (GIS) environment.

To create the ward maps (Figure 1.8 and 8.1) the 1: 100 000 scale Topographic Map of Guruve, former Sipolilo was scanned and then later imported into Intergrated Land and Water Software (ILWIS) using GIS, where the map was georeferenced in the GIS environment. The boundaries of the two wards were then digitized from the georeferenced topographic map.The topographic map was obtained from the Department of the Surveyor General in Harare.

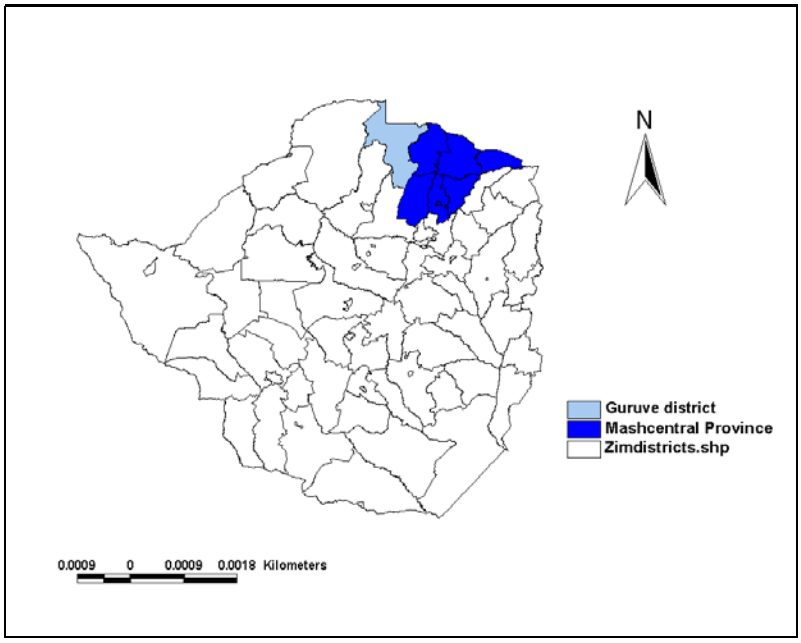


Figure 1.3: the location of Mashonaland Central Province in Zimbabwe (source: extracted from the 2002 Zimbabwean Ward Map)

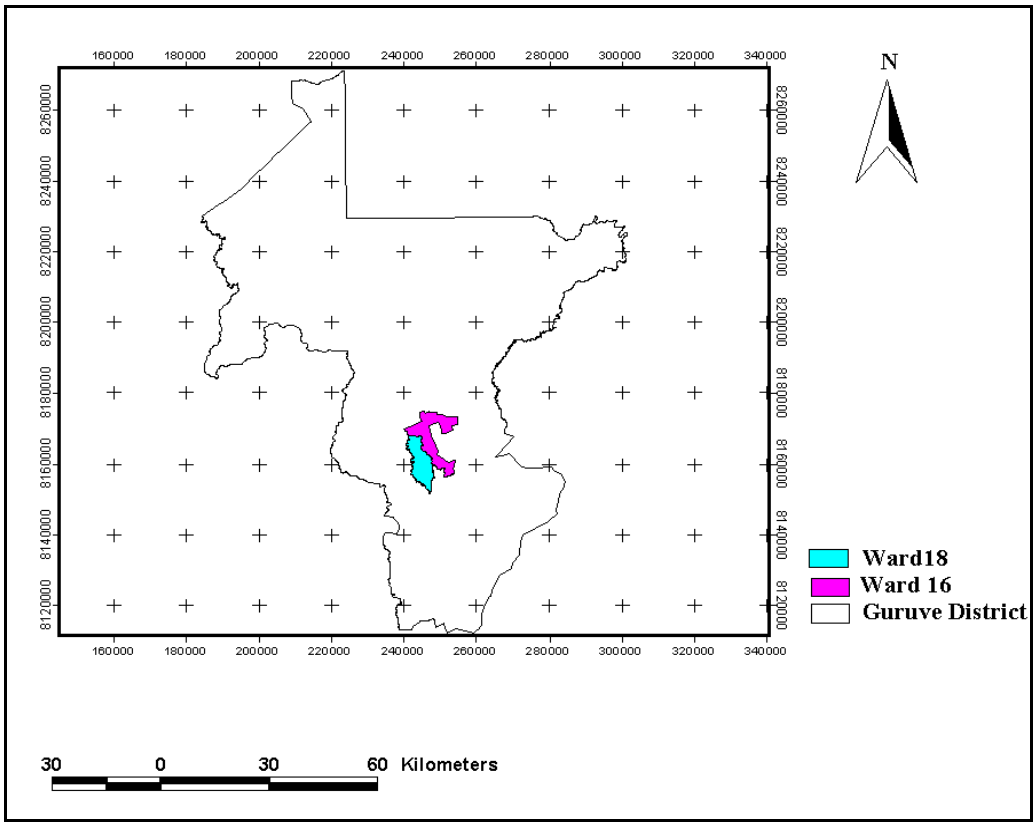


Figure 1.4: the location of Wards 16 and 18 in Guruve District (source: extracted from the 2002 Zimbabwean Ward Map)

1.14.2 Ward 18

1.14.2.1 Physical location

Ward 18 lies between latitudes 239972.54 and 288324.76 and longitudes 8152353.40 and 8168639.64, Universal Transverse Mercator (UTM) Zone 36K (Figure 8.1). The Ward is bounded to the east by Dande River and to the north by Mupingi River.

1.14.2.2 Climate and soils

Ward 18 is located in a semi-intensive agro-ecological region 11a of Zimbabwe (Figure 1.5). The Agro-ecological Region Map was obtained from the Department of the Surveyor General in Harare. The map was scanned and georeferenced using ILWIS in the GIS environment. The map was later imported into Arcview where the Zimbabwean Agro-ecological Region map was overlaid with the ward maps so that the Agro-ecological region for each ward could be identified.

Ward 18 receives rainfall amounts averaging between 750mm to 1200mm per annum and it is unimodal, falling from October to April. The months of May to September experience a dry spell. Figure 1.6 shows the amount of rainfall received from the 1988/9 cropping season to the 2010/11 cropping season. The rainfall data was obtained from the rainfall records kept at the Department of Meterological Office in Guruve.

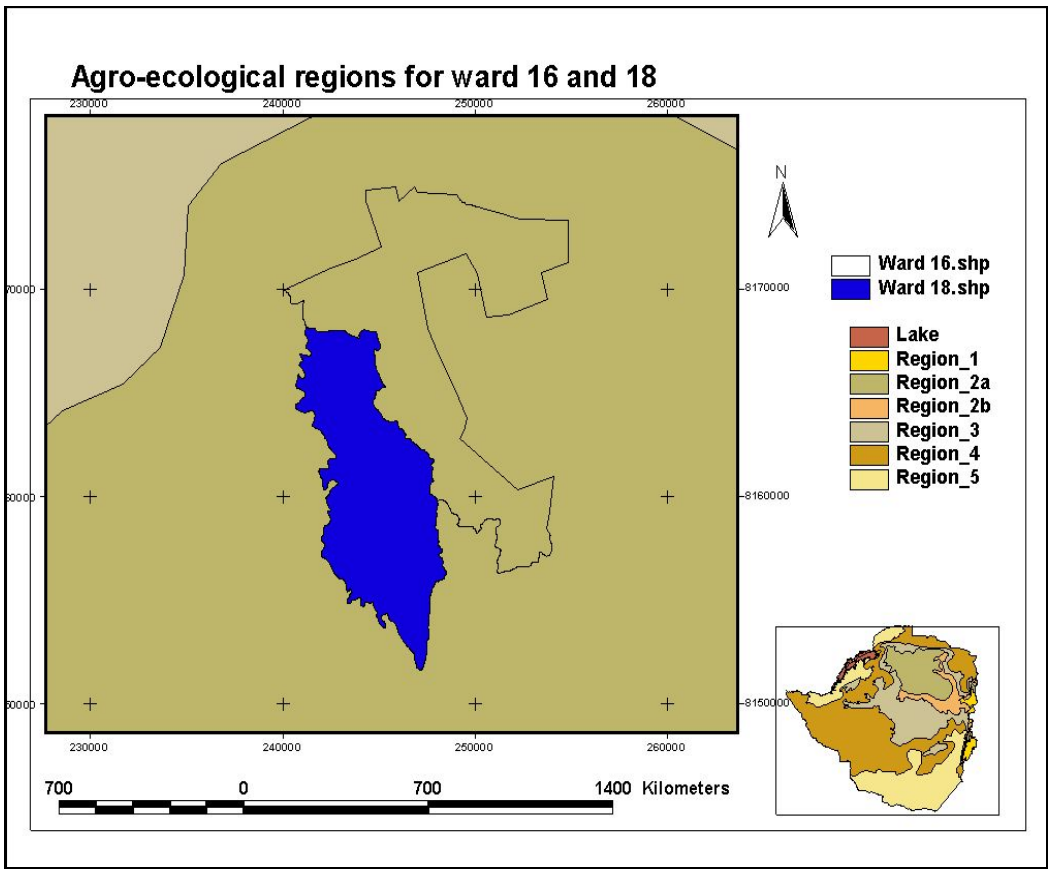


Figure 1.5: agro-ecological regions for the wards (source: extracted from the Zimbabwe Agro-ecological Region Map obtained from the Department of Surveyor General, 1985)

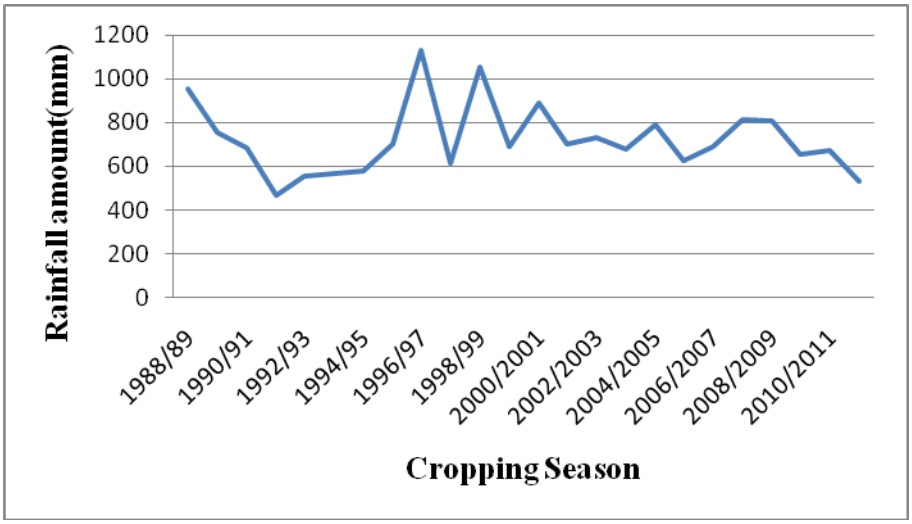


Figure 1.6: Guruve rainfall amount (source: Department of Meteorological Office (Guruve), July 2012)

The ward experiences an average temperature of 26 degrees Celsius with a maximum temperature of 32.5 degrees Celsius in October and a minimum temperature of 20 degrees Celsius in July.

Ward 18 is made up of mainly Eutric Leptosols, Mollic Leptosols and Rhodic Ferralsols. Leptosols are soils with a very shallow profile (indicating little influence of soil-forming processes). These soils often contain large amounts of gravel making them poor in fertility. The soils are also very vulnerable to soil erosion. Ferralsols on the other hand, have a high water holding capacity because they have a heavy texture. These soils also have a high content of phosphorus and calcium which allow the maintenance of high organic matter levels in the topsoil, at least in the absence of erosion.

The soils in Ward 18 are inherently of low fertility and are subject to rapid depletion in fertility. Regular applications of organic and inorganic fertilizers are necessary in order to obtain reasonable and sustainable yields. The soil map is shown in Figure 1.7. The Soil Map for the wards was extracted from the Digital Soil Map of the world using GIS. The Digital Soil Map of the world was downloaded on 27 January 2012 from www.fao.org/nr/land/soils/digital-soil-map-of-the-world/en/.

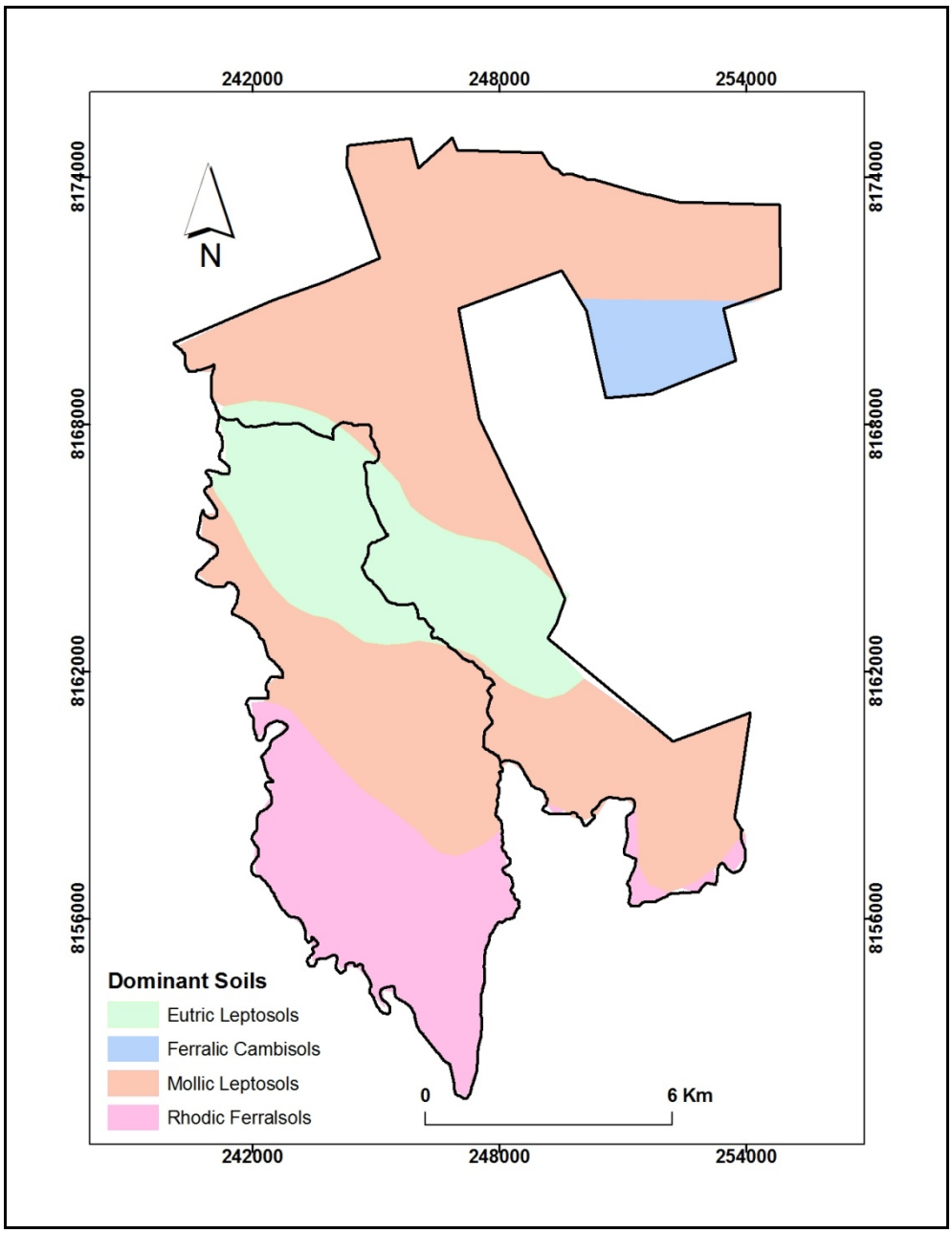


Figure 1.7: soil map for Wards 16 and 18 (source: extracted from the Digital Soil Map of the world, 1994)

1.14.2.3 Socio-economic base

Crop production and animal husbandry are the main economic activities in the ward. Crops grown are cotton, maize, groundnuts and sweet potatoes, while livestock includes goats, cattle and poultry. The majority of the households in this ward depend on subsistence farming (growing of crops and rearing of animals for consumption).

1.14.2.4 Population dynamics

In 2002 there were 889 households with a total of 7763 people. The average household size was approximately 9 (Central Statistics Office [CSO], 2002, Guruve Council). The ward sustained a population density of 118.75 people per square kilometre. Between 1989 and 2008 the population increased from 7585 to 7846, indicating a 3.44% increase.

1.14.2.5 Deforestation in Ward 18

The ward was chosen for study based on the fact that it is in a communal area. In this sub-sector households are wholly dependent on fuel wood for both cooking and heating. Agriculture is their main source of food and income. Based on these scenarios a comparison can be made between this ward and Ward 16 which is located in a large-scale commercial farming area.

1.14.3 Ward 16

1.14.3.1 Physical location

Ward 16 lies between latitudes 240444.96 and 255652.92 and longitudes 8156716.17 and 8174255.75, UTM Zone 36K. The ward is bounded to the west by the Dande River (Figure 1.8).

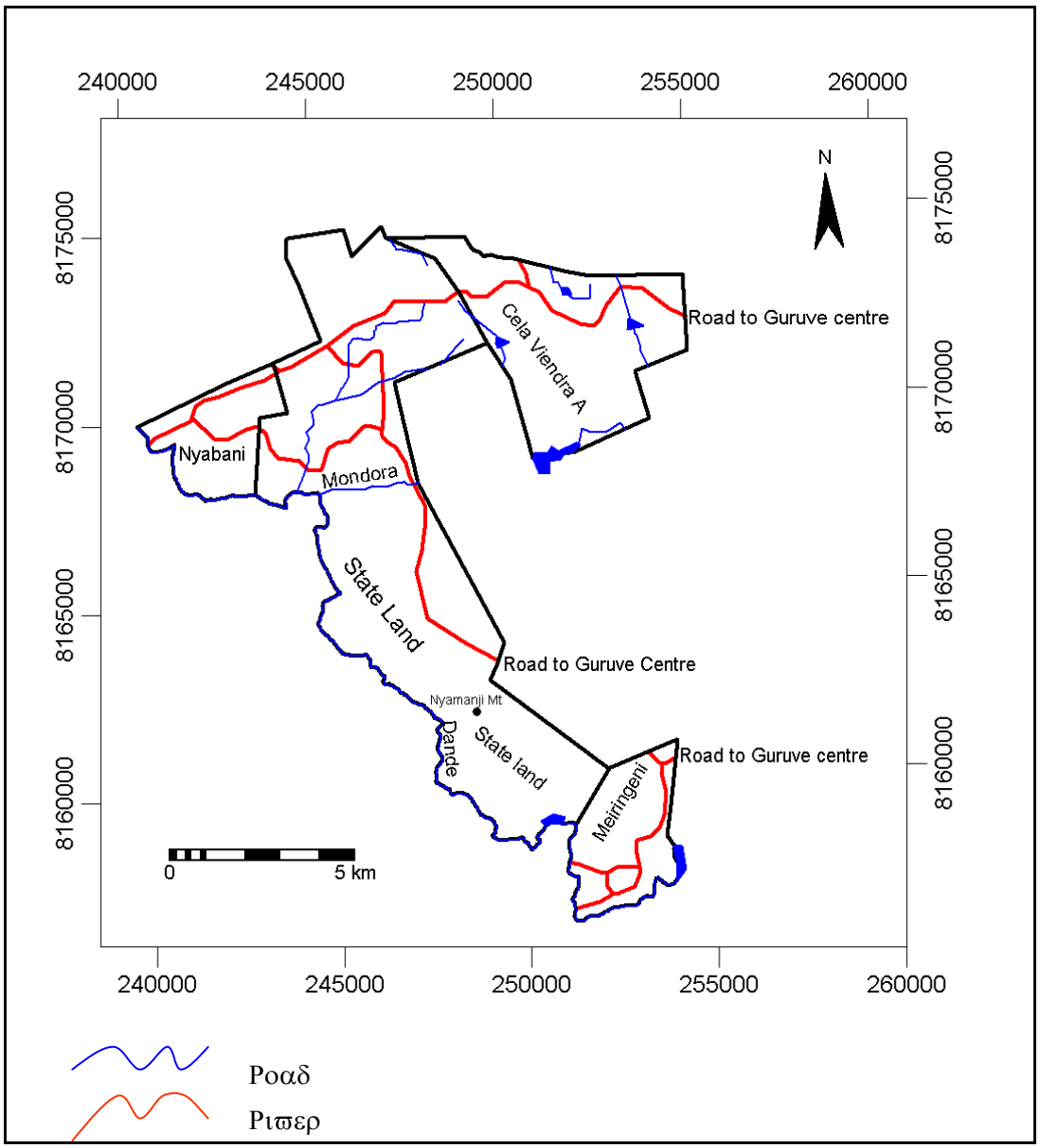


Figure 1.8: Ward 16 boundary map (source: the ward map was digitized from the Guruve Topographic Map obtained from the Department of the Surveyor General, 1979)

1.14.3.2 Climate and soils

Ward 16 lies in the same agro-ecological region as Ward 18, and therefore the ward has the same temperature and rainfall amounts as those of Ward 18. The ward is made up of mainly Eutric Leptosols, Mollic Leptosols and Ferralic Cambisols soils (Figure 1.7). The Leptosols, like in Ward 18, are soils of poor fertility hence the need to add either inorganic or organic fertilizers to improve their fertility levels. The Ferralic Cambisols are made up of very fine sandy or loamy fine sandy soils. Moisture retention in such soils is relatively good and support vertical plant root development.

1.14.3.3 Socio-economic base

Ward 16 is the country's best 'bread basket' agricultural region. Being the country's best agricultural region, its main economic activity is agriculture. The crops grown include maize, paprika, cotton and tobacco. Livestock includes cattle, goats and poultry.

1.14.3.4 Population dynamics

In Ward 16 there are three LSCFs. The three large scale farmers residing within the Ward have an average household size of three persons (CSO, 2002; Guruve Council).

1.14.3.5 Deforestation in Ward 16

Ward 16 was purposively chosen because the ward is in a large-scale commercial farm area where the farm sizes are far greater compared to those in Ward 18. Moreover, the ward sustains a low population density compared to Ward 18, offering a basis for comparison to be made between Ward 16 and Ward 18.

1.14.3.6 Choice of the wards

Wards 18 and 16 were chosen because of the following factors: these wards lie at contiguous boundaries making transport costs less expensive (Figure 1.4); the wards receive the same amount of rainfall; these wards are located within different farming systems (communal farming for Ward 18 and large-scale commercial farming for Ward 16). Ward 16 was selected because the Ward was not invaded during the fast tracked land reform programme.

1.15 Organisation of the study

Figure 1.9 shows the research flow diagram that was used for the research.

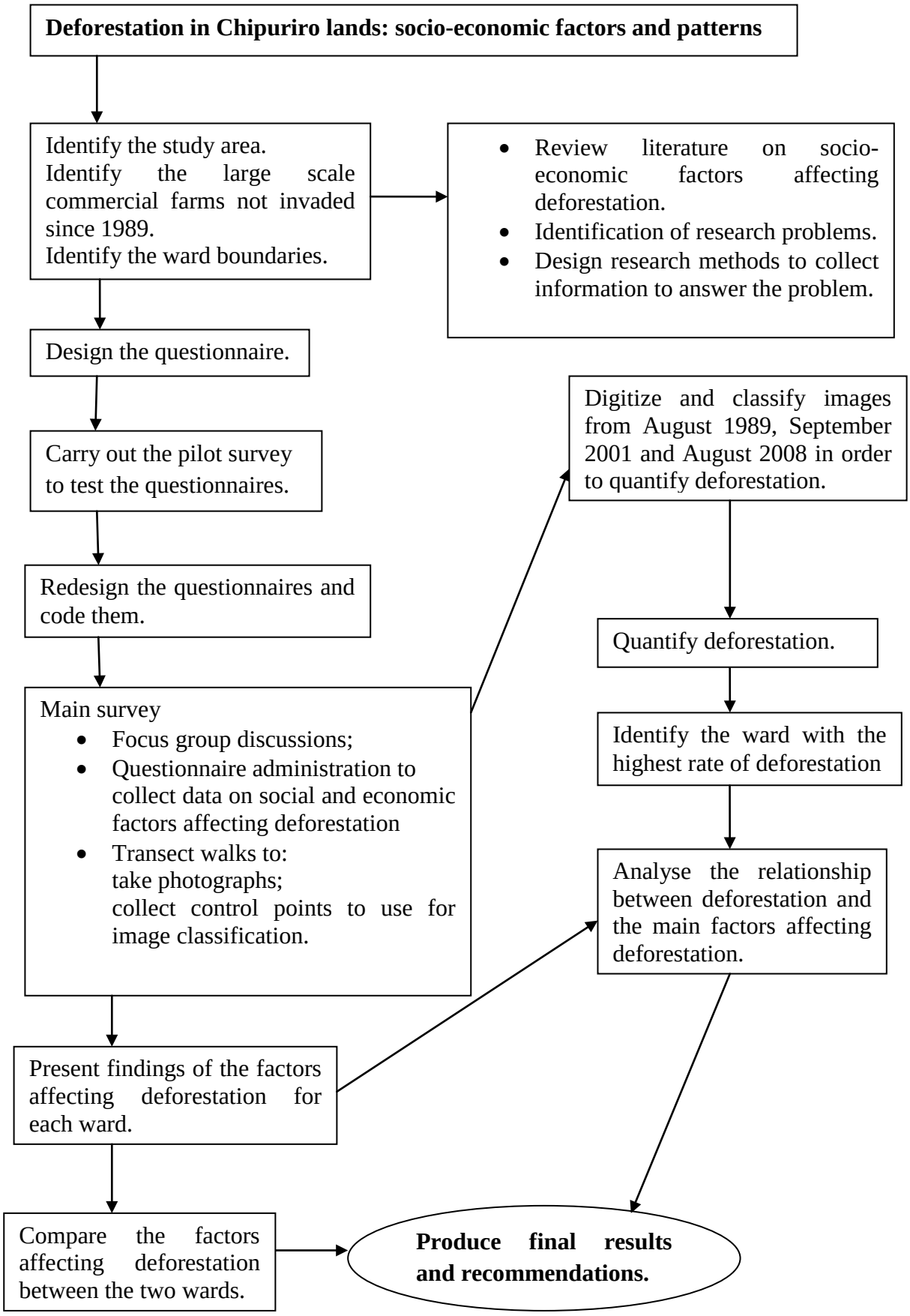


Figure 1.9: research flow diagram showing research procedures to be used for the research

The study is organised into seven chapters. The first chapter is the introductory chapter containing the statement of the problem, justification for the research, conceptual framework, hypothesis, demarcation of the study area, motivation, benefit of the research, research approach, and aims and objectives.

The second chapter reviews both the local and global literature on the socio-economic factors affecting deforestation as well as patterns of deforestation. Chapter three focuses on the research methodology where the sampling methods used in this research are outlined. The data collection and analytical procedures are also presented. The chapter concludes with notes on the limits of the research.

Chapter four analyses the data obtained from the questionnaires and focus group discussions concerning the socio-economic factors affecting deforestation. Chapter five presents information obtained from the Landsat Thematic Mapper images. Chapter six focuses on the analysis of the relationship between variables while chapter seven forms the summary, conclusion, notes on the negative effects of removing trees, and recommendations.

1.16 Conclusion

Chapter one has showed that the main concern for this research is the study of the social and economic factors affecting deforestation as well as deduction of the patterns of deforestation in Wards 16 and 18. The chapter has explored the general social and economic factors affecting deforestation and the extent of deforestation. The chapter also shows the area where the research will be conducted. A literature review on factors affecting deforestation and patterns of deforestation will be discussed in chapter two.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will start by providing different definitions of deforestation. The chapter will also describe the form or pattern of forest clearance for non-forest dwellers and for forest dwellers. A global and local review of the extent of deforestation and the factors affecting deforestation shall be presented. The chapter will end with a review of the methods employed to manage deforestation.

2.2 Definition of deforestation

Deforestation is defined in various ways. This variety of definitions for the term means that deforestation means different things to different people. This effect has been reported as making comparisons of estimates of deforestation patterns, or the extent of deforestation between countries, difficult (FAO, 1980; Myers, 1980; FAO/UNEP, 1982; WRI & IIED, 1986).

FAO (2001) defines deforestation as 'the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum ten percent threshold' while Timberlake (1991) defines it as 'any activity which disrupts the natural ecology of the virgin forest'. The 'disturbance' meant by Timberlake can range between a small area cleared of its forest cover where the trees are given room to recover, and complete removal of forest cover over a very big area. The FAO definition (2001) includes a variety of forest types from closed forest to open-wooded and some degraded forest types. Allen and Barnes (1985) define deforestation as 'clearance of forests and their replacement by other forms of land use such as shifting cultivation'. In this definition the authors do not consider the collection of fuel wood as deforestation. Fearnside (1993) only considers the removal of original forest as deforestation. This definition sidelines the re-clearing of secondary forest. Grainger (1993) defines the term as 'temporary or permanent clearance of forest for agriculture or other purposes'. The authors' definitions do not view selective logging as a factor affecting deforestation. Selective logging is the targeting of certain tree species, which will reduce tree density or diversity. The removal of certain tree species can either be permanent or temporary depending on whether those trees will regenerate or not. The decrease in tree density has been termed 'degradation' by Grainger (1993, 1996).

The degradation of forests is of major concern, especially in the tropics where the soils are shallow and are more vulnerable to erosion. Once tree cover is removed or reduced, soil erosion will accelerate and further degrade the soil of its nutrients. Given the diversity of definitions, this research will use the more comprehensive FAO (2001) definition of the term. FAO (2001) defines the term as 'the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum ten percent threshold'.

2.3 Patterns of forest clearance

A pattern is a special way of doing something. The researcher is of the opinion that there is a pattern in which the process of forest removal takes place. This pattern, however, varies between forest dwellers and non-forest dwellers. In areas where people settle in forests, they first clear the areas surrounding them. The reasons include cultivation, fuel wood collection and to create more space for settlement. As the trees near their place of residence dwindle they start to cut trees further away from their place of residence.

However, irrespective of where a person resides, there are situations where people do not follow that pattern. Some forest dwellers might search for certain tree species in areas further from where they stay; such practise is called selective logging. Selective logging has the effect of reducing tree density or structure, the phenomena described by Grainger (1993) as 'forest degradation'.

Non-forest dwellers, on the other hand, usually follow a different pattern from that of forest dwellers. They mostly practise selective logging or clear cutting of the whole area. The latter practise can lead to a variety of environmental problems such as global warming and, most of all, soil degradation through soil erosion.

This research will focus on the socio-economic drivers of deforestation in the Chipuriro lands as the depletion of forests has profound adverse effects for the peasant farmers residing there. Before examining the factors affecting deforestation, the researcher shall first address the importance of trees to the physical and social environment. The chapter will conclude with discussion of the methods currently employed to manage deforestation, which can be employed in the areas that are studied in this research.

2.4 Importance of forests

Forests are one of the most important ecosystems in the world. Forests provide a habitat for a variety of plant and animal species (Kahn & MacDonald, 1994). Forests also provide economic functions such food provision (for example fruits), medicinal (herbs to cure a variety of diseases), employment, and above all the environmental function of soil protection. The food collected from forests has been found to be important to the human diet (retrieved March 29, 2012, from http://www.fao.org/docrep/006/u5620E/u5620E03.html), despite being taken in small amounts compared with a staple diet. The food is believed to add variety to our staple food; and it tastes good and provides vitamins, proteins and energy (retrieved March, 29, 2012 from http://www.fao.org/docrep/006/u5620E/u5620E03.html). Forest food has been reported as being collected either from a piece of land left uncultivated for some time or from forested land (Dao, Tran & Le, 2001; Tran, Pham & Rasmussen, 2001; Leisz et al., unpublished report).

Apart from food provision, forests control erosion by binding the soil together, hence forests help in maintaining soil fertility (Kwaramba, 2011). Forests also help in reducing global warming through carbon sequestration (Skole & Tucker, 1993; Foody, Palubinskas, Lucas, Curran & Honzak, 1996). In 2010, the Global Forest Resource Assessment (2010) reported that the world's forests stored 289 gigatonnes of carbon in trees and vegetation (retrieved November 23, 2011, from http://www.fao.org/news/story/en/item/40893/icode/). Both big and small animals, from elephants to rats, use forests as their habitat.

Forests help in providing employment in some forest-related projects. According to Buys, Moshi and Mariki, (1996), the forestry sector in Tanzania had 1 500 professionals and technical staff working under the Forest Board Organisation, regional administration, local governments, the private sector, parastatals and non-governmental organisations. In 2005, 3000 people in Tanzania were employed in forest-related industries (retrieved January 27, 2012, from http://rainforests.mongabay.com/deforestation/2010/Tanzania.htm). Within the same country in the 90s, the forest sector has also been noted to contribute ten percent of foreign exchange earnings (Ministry of Tourism, Natural Resource and Environment [MTNRE], 1994; Ngaga, 1998). Monela, Kajembe, Kaoneka and Kowero (2000) stated that honey, charcoal, fuel wood and wild fruits were contributing 58 percent of the cash incomes for the six villages that he studied in Tanzania.

The destruction of forests or their degradation reduces the potentially unlimited provision that forests afford. Some researchers projected that by 2100 only 18-45% of the world's humid tropical forest fauna and flora will remain extant (Carnegie Institution, 2010, retrieved January 23, 2012, from http://www.sciencedaily.com/releases/2010/08/100805172957.html). Considering this scenario, the study of the factors related to forest loss is of paramount importance. Apart from degradation, the main issue that triggered this study is the rate at which the world's forests are disappearing. According to the Global Forest Resources Assessment (2010), the world lost around 13 million hectares per annum of forests between 2000 and 2010 (retrieved November 23, 2011, from http://www.fao.org/news/story/en/item/40893/icode). This figure is high, as it is equivalent in area to a country the size of Greece.

2.5 Farming systems of Zimbabwe

Zimbabwe has three farming systems, namely large-scale commercial farming, small-scale commercial farming and communal or peasant farming. These farming systems vary in plot size, and quantity of inputs and outputs. For the scope of this research only large-scale commercial farming and communal farming shall be discussed.

Peasant or communal cultivators dominate most communal areas of Zimbabwe. This communal subsector has about 700 000 peasant farmers, occupying less than 50% of the agricultural land. According to Tsvaki (1997), 75% of the peasants' agricultural land lies in the low rainfall regions IV and V. A survey by Moyo (1985) revealed that about 70% of communal households had access each to 2.5 hectares of arable land while the remainder had less than 1.5 hectares. Communal farming lands are more densely populated than commercial lands. In the communal lands the population density is 32 persons per square kilometre compared to 11 persons per square kilometre in the commercial lands (World Bank, 1996).

The peasant cultivator as defined by Clarke and Haswell (1964) is a smallholder, in most cases planting an area of some 2-8 acres, frequently divided into small and sometimes scattered plots. Smallholdings were reported to be the result of a lack of fast methods of clearing woodlands as well as the inefficiency of labour-intensive tools used for tilling the land. The authors believed that if these tools were replaced with machinery, peasant farmers could open up huge tracts of land where they could increase their production of

food and earn more income. In some areas, the authors reported that peasant farmers were given draught power to help them to till the land in the hope that this would enable them to increase production and the size of their land.

Despite those initiatives, the authors realised that very few peasants like cultivating big pieces of land. The majority only cultivate land to provide for consumption and a lesser proportion for sale, exchange or giving to friends or dependents. The authors further noted, however, that peasants would stop their work when the produce from the land they cultivate becomes very small. This was statistically analysed regarding food production among Yoruba cultivators by Galletti, Baldwin & Dina (1956).

The large commercial farms on the other hand had (before 1980) about 6 000 white farmers owning more than 45% of the agricultural land. More than half of the land is in the high rainfall regions I, II and III where the potential for agricultural production is high. The large scale commercial sector holds on average close to 2 200 hectares per farmer (Chenje, Sola, & Paleczny, 1998). Production in the LSCF has been reported as high, especially before the Fast Track Land Reform Programme; for example, in 1995-1996 maize production in the sub-sector was averaged at 4.5 tonnes per hectare (Ministry of Agriculture, 1997). After the Fast Track Land Reform the number of white-owned farms reduced as the blacks took over the farms. Some farms were shared among different households while other occupants kept farms to single use after taking them from their previous owners. Current details of the large scale farms in Zimbabwe are unclear as the topic is regarded as a political issue. Details of the agro-ecological regions of Zimbabwe are explained in chapter one.

2.6 Extent of deforestation

A number of researches have shown that the rate of deforestation varies by country. The present researcher is of the opinion that the difference is as a result of the differences in the factors affecting deforestation such as land use in each country. Although deforestation is a global problem, the problem seems to hit developing countries hardest. This is because most developing countries are poor and thus unable to fund forest conservation projects. Moreover, these countries were (and some still are) reported as being heavily indebted to developed nations (Kahn & MacDonald, 1994). These authors stated that developing countries during the 1970s and early 1980s borrowed a lot of money from developed

countries. In trying to pay back debt they were reported as having used natural resources, a concept defined as 'Dept-for-Nature Swaps' (Kahn & MacDonald, 1994). The WRI, World Bank and UNDP (1985) further explained that developed regions in North America and Europe are primarily concerned about industrial issues such as pollution, rather than issues of deforestation, despite having suffered huge forest cover losses.

In 2010, the Global Forest Resources Assessment reported the world as losing 13 million hectares of forest per annum (retrieved November 23, 2011, from http://www.fao.org /news/story/en/item/40893/icode/). Most of this loss occurred in tropical countries. In both developed and developing countries, research has shown high rates of deforestation (Bajracharya, 1983; Repetto & Holmes, 1983; Repetto, 1985; Myers, 1989; WRI, 1990; Timberlake, 1991; Fearnside, 1993). Between 1960 and 1990, Latin America lost 18% of its forest cover (WRI, UNEP & World Bank, 1996). In 2005, Central America was recorded as one of the continents with the highest rate of forest loss. The continent lost about 285,000 hectares which was equivalent to 1.3% per annum (Butler, 2005). In North America, during the same period, the United States according to FAO (2005) ranked seventh position on a list of countries with the highest rates of deforestation. Between 2000 and 2005 the country lost about 215,000 hectares of its primary forest (Butler, 2005). Research has shown that most of the damage to the primary forests in the United States occurred before 1920 (retrieved May 19, 2013, from http://www.globalchange.umich.edu/ globalchange2/current/lectures/deforest/deforest.html). The studies revealed that during that period, forests were being destroyed at a rate that coordinated with the rate of population increase. One or two hectares of land were cultivated for every one person born or added to the population. Butler (2005) reported that South America had the highest rate of deforestation between 2000 and 2005. The country lost 4.3 million hectares per annum.

In the 1970s, South and South-East Asia were recording high rates of deforestation with forest losses of up to 15 million hectares (Manshard, 1974). Between 1960 and 1990, Asia was reported to have lost 1/3 (42%) of its natural forest (Livitnoff, 1990). In 2005, tropical Asia which includes Bangladesh, Bhutan, Brunei, Cambodia, East Timor, India, Indonesia, Laos, Malaysia, the Maldives, Myanmar, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka and Thailand was recorded to have lost 1% per annum of its primary forest cover (Butler , 2005). A research by FAO (2005) revealed that Cambodia lost 29% of its primary forest between 2000 and 2005. Vietnam between 1990 and 2010 gained 4,434,000 hectares

(47.4%) of forest cover (retrieved May 19, 2013, from http://rainforests.mongabay.com/deforestation/2000/Vietnam.htm). Between 2000 and 2010, Indonesia lost 20% of its forest cover amounting to an area of 94 million hectares of forest cover (Global Forest Resource, 2010). Malaysia during the same period lost 8.6% of its forest cover which is about 1,920,000 hectares (retrieved June 21, 2012, from http://rainforests.mongabay.com/deforestation/2000/Malaysia.htm). However, current reports state that Asia has gained 2.2 million hectares of forest cover because of the tree plantation programmes taking place in China, India and Vietnam (Global Forest Resource Assessment (2010), retrieved November, 23, 2011, from http://www.fao.org/news/story/en/item/40893/icode).

The African continent between 1960 and 1990 lost 18% of its primary cover (WRI et al., 1996). Between 1930 and 1970, Africa lost 25 to 30% of its rainforest (Manshard, 1974), while between 1981 and 1991 the continent lost 5 million hectares per annum (Burgess, 1993). Between 2000 and 2010, Africa had a net loss of 4 million hectares per annum. The Global Forest Resource Assessment (2010) reported the continent as currently losing forest cover at twice the world rate (retrieved November 23, 2011, from http://www.fao.org/news/story/en/item/40893/icode).

In North Africa, between 1990 and 2000 Algeria was reported as losing about 40,000 hectares of forest annually, while Tunisia lost 5,000 hectares. Morocco between 1990 and 2010 was reported to have lost 4,100 hectares or 0,08% of its natural forest. Due to the plantation programmes in Morocco, the same country gained 82,000 hectares which is 1.6% of its forest cover (retrieved March 25, 2011, from http://www.rainforests.mongabay.com/deforestation/2010/Morocco.htm).

In West Africa, coastweek.com reported Cote d'Ivoire as remaining with only 2 million hectares of primary forest (retrieved August 29, 2012, from www.coastweek.com). FAO (1986) reported that the same country in 1986 registered a deforestation rate of 5% and almost 90% of its original moist forest had disappeared.

Parry (2003) pointed that in Ethiopia, at the beginning of the twentieth century, the country had around 42 million hectares covered by trees. The trees were reported to have been reduced to less than 14.2% of the total forest land area, due to factors such as shifting cultivation, fuel wood collection and livestock production. Between 1990 and 2005 the

country lost 14% of its forest cover (2.1 million hectares) and this figure indicates a 10.4% increase in deforestation between 1990 and 2005. FAO (2007) reported the country as losing about 1,410 km^2 of forest per annum. The country holds the second largest population in Africa, a factor that the researcher believes could have led to this loss of forest cover. Apart from population pressure, the production of coffee was also indicated as a contributory factor to forest cover loss in Ethiopia (FAO, 2007).

Between 2000 and 2005, Nigeria lost 35.7% of its primary forest cover, an area of about 6,145,000 hectares (retrieved June 21, 2012, from http://rainforests.mongabay.com/ deforestation/2010/Nigeria.htm). Nigeria and Sudan were reported to be among the countries that suffered the highest annual deforestation between 2000 and 2005. Nigeria reported an annual deforestation rate of 11.1%, the highest in the world. At this pace the authors were of the opinion that Nigeria would rapidly lose all its primary forest cover. (Butler, 2005).

Ghana in 1990 had 7,447,854 hectares of forest cover which was reduced to 6,093,906 hectares in 2000, and in 2005 the country had 5,516,932 hectares of forest cover. From 1990 to 2010 the country lost about 125,400 hectares or 1.68% per year, amounting to 2,508,000 hectares (33.7%) of its forest cover (retrieved July 27, 2010, from http://rainforests.mongabay.com/deforestation/2000/Ghana.htm).

Shaba (1993) noted that in the Sothern African Development Community (SADC) region, about 600,000 hectares of indigenous forests were cleared annually for other land uses. Malawi, between 1990 and 2010, lost an average of 32,950 hectares (0.85% per annum), amounting to 659,000 hectares (16.9%) of its forest cover (retrieved July 26, 2012, from http://rainforests.mongabay.com/deforestation/2010/Malawi.htm). In Mozambique, forest cover loss was recorded at 217,800 or 0.5% per annum or a forest cover loss of 4,356,000 hectares between 1990 and 2010 (retrieved August 21, 2012, from http://rainforests. mongabay.com/deforestation/2010/Mozambique.htm). South Africa, between 1990 and 2005, lost 0.8% of its forest and woodland habitats (retrieved March 25, 2011, from http://rainforests.mongabay.com/def/2000/southafrica.htm). Between 1990 and 2000, Zimbabwe lost an average of 312,900 hectares of forest per year, amounting to an average annual deforestation rate of 1.41%. Between 2000 and 2005, the rates of forest cover loss increased by 16.4% to 1.64% per annum. Zimbabwe lost 21.1% of its forest cover between

1990 and 2005 which amounts to around 4,694,000 hectares. The total forest and woodland habitat lost between 1990 and 2005 by Zimbabwe was recorded at 36.8% (retrieved January 27, 2012, from http://www.rainforests.mongabay.com/deforestation/2010/ Zimbabwe.htm). The Forestry Commission of Zimbabwe (2011), cited by Kwaramba (2011), reported that Zimbabwe lost 330,000 hectares of forest per annum with fuel wood collection being the main contributing factor to deforestation in both the rural and urban areas of the country.

From the preceding discussions, deforestation has been demonstrated to be a widespread problem that endangers the future of forest resources in both developed and developing countries. Despite disagreement on the trustworthiness of the estimates, current results give us a hint of the extent of the problem and the rate at which forests are diminishing. The controversy over the rates of deforestation, originates from differences about the definition of deforestation. For this study I shall use Landsat Thematic Mapper images while adopting the FAO (2001) definition of the term, in order to measure the extent and pattern of deforestation in the Chipuriro lands.

2.7 Factors affecting deforestation

Deforestation is a result of a multiplicity of factors, grouped as either direct or underlying. Direct factors are defined as activities by individuals, corporations, government agencies or development projects in which forests are cleared. Underlying factors are defined as factors that induce the direct causes (Rowe & Sharma, 1992). Examples of direct causes are natural forest converted into agricultural land or plantations, logging and timber production, fuel wood consumption, forest fires and human settlement. The underlying causes include population growth which leads to expansion of land for food production, poverty which puts pressure on natural resources, developmental projects (for example road and dam construction), lack of information, and the exclusion of local inhabitants from the planning or undertaking of forest projects (Repetto & Holmes, 1983; Repetto, 1985; Holmberg et al., 1991). These factors can further be categorised as social or economic factors, as explained below.

2.7.1 Social factors and economic factors

Social factors are those factors that affect or govern our lifestyle. The social factors affecting deforestation are the reasons that lead us to cut trees in order to survive

(Rademaekers, Eichler, Berg, Obersteiner & Havlik, 2010). These factors are reported by those authors to vary from country to country. The economic factors behind deforestation are activities conducted to generate money at the expense of the forests. Both economic and social factors shall be discussed in this chapter.

2.7.1.1 Population pressure

Population pressure occurs when there are more people than the resources can provide for. Population pressure is a very crucial factor affecting deforestation, especially if intensified by poverty and unequal access to land (Leplay & Thoyer, 2009). In neo-Malthusian theory, 'if population grows faster than the means of subsistence people will look for new areas of expansion to meet their food and fuel wood demands' (Bhattarai & Hammig, 2001; Shandra et al., 2008; Barbier & Burgess, 1997; Combes, Motel et al., 2009; Cropper & Griffiths, 1994). This theory, however, has been noted to apply only to African countries. The overall population in Africa as reported by FAO (2009) increased from 472 million in 1980 to around one billion in 2009 and is projected to reach 1.2 billion in 2020.

The populations of many African countries have increased over the last decade. In Tanzania for example the population is reported to have increased since independence from 9 million to 24 million in 1990 (National Conservation Strategy for Sustainable Development [NCSSD] 1994, retrieved March 25, 2011, from http://www.fao.org/docrep/AB575E.html). In July 2005 the country was reported to experience population growth of 1.83% (retrieved January 27, 2012, from http://rainforest.mongabay.com/deforestation/2000/Tanzania.htm). The Zimbabwean population increased from 7,546,071 in 1982 to 11,634,663 in 2002. In 2005 the country had a population of 12,746,990 (retrieved January 27, 2012, from http://rainforests.mongabay.com/deforestation/2000/Zimbabwe.htm). According to the Economist Intelligence Unit (EIU) (1994), the majority of people in both Zimbabwe and Tanzania live in rural areas. The majority of the people in those areas depend heavily on forests for survival. Therefore, the higher number of people in the rural areas, the higher the demand for forest resources; and this puts pressure on the existing forests.

Population growth has been found to be the main factor affecting deforestation in developing countries (Ehrlich & Ehrlich, 2004). The reason is that as population continues to grow, the needs of the people also increase. This relationship was statistically analysed

in 39 developing countries by Allen and Barnes (1985). A high population was found to exponentially increase consumption of fuel wood, thereby causing severe forest degradation.

The increase in the number of people, accompanied by increasing subsistence demands, is believed to be the root cause of expansion of land under cultivation. In the Gambia, research by Sillah (1998) showed that the growing need for food and space led to the disappearance of some plant and animal species. For this present research, the population growth for Chipuriro shall be examined from 1989 to 2008.

2.7.1.2 Subsistence agriculture

Agriculture that includes the rearing of animals and the growing of crops has long been the source of both food and income for populations in developing countries. FAO (2009) reported that small-scale agriculture provides employment to 70% of rural households. With the increase in population the demand for food also increases, leading to the extension of land for cultivation. Clearing land for agriculture has been cited as the major cause of deforestation by Ahlback (1992) and Mascarehas (1991). There are two reasons why people clear land for cultivation. In some cases people clear land because their former land is no longer productive, while others clear land to extend the land for cultivation. The latter are driven by the desire to increase their income through farming. Lindsey (2007) explained that tropical forests are destroyed to create land for cultivation and for stock rearing. In rural areas farming is mostly for subsistence purposes. The shortage of resources and capital usually forces farmers to concentrate on the production of food specifically for local consumption. This lack of resources usually drives households to leave their plots after loss in fertility and to search for new parcels of land. Such practise has been defined as unsustainable agriculture. FAO (n.d.) has indicated that unsustainable agriculture is the major cause of deforestation, especially in developing countries. In Ethiopia, for example, deforestation has been found to be a consequence of the demand for land for cultivation, stock production and fuel wood collection (Sucoff, 2003).

Zimbabwean land for agriculture during the 1981-1983 period expanded by 3.4% at the expense of woodland and forest areas, which declined by 7.4% and 2.7% respectively. Chenje et al. (1998) reported that about 70,000 hectares of Zimbabwean forests were lost

annually to expand agricultural lands. This clearing of forests sometimes occurs on fragile lands, thereby exposing the soil to erosion.

2.7.1.3 Land ownership

It is of great importance for people to own their own solid portion of the surface of the globe. Knowing that something is 'yours' makes the owner feel proud and interested in the possession. Lack of ownership makes people think to the contrary. Lack of incentives, especially in developing countries, has been found to be a contributing factor to deforestation. In the communal areas of developing nations the resources are communally owned, that is, the community has the right to use arable and grazing lands (*usufruct*) but the land belongs to the state (Chenje et al., 1998). Berkes (1989) and Chenje et al. (1998) have argued that such type of land tenure agreement is the primary source of insecurity and low investment in communal areas. This is based on the fact that there is conflict between the community interest and the interests of individuals in those communities. In Cameroon there are few incentives for rural dwellers to manage forests in the areas where they live in a sustainable manner. The people have no secured rights to forest products, so they are unwilling to cooperate with government or take adequate care for those forests. Open access to forests in Cameroon has resulted in the over-exploitation of trees due to a lack of answerability.

Research has shown that conservation of a freely accessible public resource is almost impossible. Based on this, Chenje et al. (1998) concluded that conservation of biodiversity is better on large-scale commercial farms which are privately owned than on communal farms. Large-scale commercial farmers own the land they use, and hence are eager to use their land in a sustainable manner (Gradwohl & Greenberg, 1988).

In Kenya the majority of the population reside on arable land, which is 20% of the country's land area. That has put a lot of pressure on forests which are seen as free land for potential use. In the Mau forests, people from outside (forest neighbours) seek to reap maximum benefit from the forest resource. They use the land for cultivation and grazing. Some cut trees for charcoal making and sell the charcoal to get money. The Ogieks on the other hand, because they live within the forests, are eager to utilise the forests sustainably as their lives depend on these forests. As a result there is conflict between the two groups and this leads to further degradation of the forests.

2.7.1.4 Overgrazing

Cattle are viewed as symbols of status and are considered real evidence of wealth (Chuma, Chidudza, and Utete, 1997) in most communal areas of Zimbabwe. The cattle have a multiplicity of functions, chief of which include provision of draught power, manure, supply of milk and meat, sale of stock to meet urgent cash needs and other socio-cultural factors. Due to the multi-purpose role of cattle, communal people are, by and large, not guided by scientific livestock management principles or practices which take into account aspects such as the carrying capacity of the pasture lands. Scoones (1990) states that 'in the communal areas the level of stocking is determined by economic objectives rather than the ability of the land to support large herds'. In Zimbabwe, for example, from 1982 to 1991, communal cattle numbers increased from about 2.9 to 4 million, recording an annual growth rate of 3%, despite the severe effects of the 1982-1984 drought. Overstocking which stems from high cattle numbers represents a major factor contributing to the deterioration of land quality and kraal quality in the communal lands, and decline in the productivity of grazing areas. In the communal life of developing countries a big herd is maintained as a survival strategy. However, people fail to realise that an increase in the herd of cattle is not necessarily proportional to the size of available grazing land. As a result, grazing lands suffer from overstocking and this in turn leads to a decrease in both the quality and quantity of cow dung, and of meat, as well as reducing the general health of the kraal.

From 1955 to 1976 cattle numbers in developing countries increased by 34% and goats by 32% (Arnon, 1981). Overgrazing of pasture lands first results in the replacement of nutritious and palatable species by species of lower feeding value and palatability, and finally by the destruction of the vegetation. Chidumayo, Gambiza and Grundy (1996) affirmed this, stating that 'in countries with high population of grazing animals the carrying capacity of the forests is always over stretched'. They added that overgrazing of the forests affects regeneration as the hooves of cattle kill the regenerating plants while browsing gives no opportunity for new shoots to grow. Miller (2007: 209) states that, with overgrazing, plant species not palatable to animals such as sage brush, mesquite, cactus and cheat grass will also thrive.

2.7.1.5 Domestic policies

Policies set by government play a great role in deforestation. Some policies favour the clear cutting of trees with the intention of promoting government priority needs. Ireland and Scotland used to be entirely covered by forest but under British rule the forests were cleared to provide timber for shipment. In other cases, government ordered the clearance of land to create space for modern large-scale agriculture as well as cattle raising for the export market. Miller (2007) reports that the governments of Indonesia, Mexico and Brazil allowed the poor people to settle in tropical forests. These governments gave people titles to the land they cleared. This was found to decrease poverty at the expense of the forest resources which were cleared. In Central America, forests have been cleared for cattle ranching; while in Brazil they are cleared for soya bean production. This practice, according to the World Guide 1999 and 2000, led to widespread deforestation in these countries. In Sudan, Larson and Bromley (1991) attributed the destruction of the *Acacia senegal* tree species to domestic policies under both the colonial and the independent governments. In Brazil the construction of long-distance highways which encourage migration, establishment of large cattle farms, agrarian colonisation by small-scale farmers, and establishment of industrial mega-projects, all led to the destruction of the Amazon forests. This took place in the mid-1960s in the northern part of the Amazon (retrieved May 19, 2013, from http://rainforests.mongabay.com/20brazil.htm).

Southern hemisphere governments and elites are also believed to have contributed to deforestation, occurring in the countries of this hemisphere (The World Guide, 1999/2000). Government policies on indigenous peoples' rights, particularly those affecting territorial rights, are the root cause of deforestation. Policies on land tenure rights resulted in the concentration of the best agricultural lands in the hands of a small elite and the consequent, migration of poor peasants into forests has resulted in the large-scale felling of trees.

In Zimbabwe, the high concentration of people in the communal areas means that deforestation is high in those areas, as rural communities use mainly fuel wood as a source of energy. In Africa, FAO (2009) reported that only 7.5% have access to electricity. On the large-scale commercial farms the population density is low and moreover most commercial farms have electricity, hence they depend less on fuel wood. The World Guide (1999/2000) interprets the deforestation that is occurring globally to be a consequence of

interlinked national and international policies, which have created the conditions for deforestation to happen.

2.7.1.6 Fuel wood demand

Fuel wood has been regarded as a cheap source of energy since the creation of man. Although fuel wood is primarily a mainstay for human energy demands in developing countries, the demand for fuel wood has been documented as a universal contributor to deforestation (Lindsey, 2007; Ahlback, 1992). With population increase, energy needs in Sub-Saharan Africa have also increased and people gather more and more fuel wood which, in most cases, leads to forest destruction (Malaysia, 1986). In Africa south of the Sahara, Munslow, Katerere, Kerf and O'Keef (1988) discovered that almost every person depends on fuel wood. Wood accounts for 50% of national energy consumption in Zimbabwe, and 90% in Tanzania, Mali, Upper Volta and Ethiopia (Eckholm et al., 1984). The current situation in Zimbabwe is likely to make everyone rely on fuel wood for cooking as can be witnessed by numerous power cuts. In the rural flood plains of Bangladesh, Miah, Rashid and Shin (2009) discovered that about 42% of the population were using biomass fuels. In Africa, 90% of the population are reported as relying on wood for cooking and heating (Agyei, 1998). Figure 2.1 gives a summary projection of fuel wood consumption in Africa from 2000 to 2020.

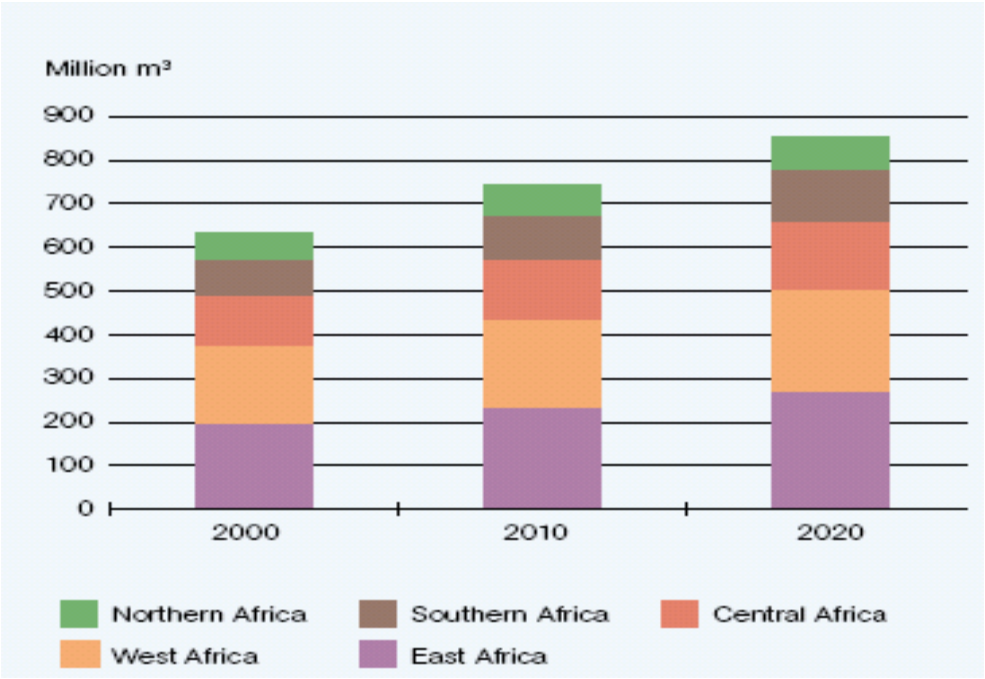


Figure 2.1: fuel wood consumption in Africa (source: adapted from FAO, 2009)

Figure 2.1 shows that fuel wood consumption continues to rise, with East Africa registering high levels of fuel wood consumption. North Africa registers the least fuel wood consumption for the period 2000 to 2020. FAO (2009) fuel wood projections for Africa indicate an increase in fuel wood consumption of 34% from 2000 to 2020.

A question to ask is whether fuel wood consumption should be stopped, as it leads to deforestation. If it is stopped, then the rural poor will have no source of energy as fuel wood is their main source of energy due to their weak financial status. In poor countries fuel wood is cheaper than imported fossil fuel. For example, in the 1980s the Sudan was using 291 petajoules (PJ) of energy of which 2.7PJ were derived from hydroelectricity, 41.5PJ from imported fossil fuels, and 246.7PJ from biomass fuels. Biomass fuel is fuel from firewood, charcoal and crop residues (Sudan National Energy Administration [SNEA], 1983). This implies that if Sudan stopped using fuel wood, the country would need to import 246.7PJ of energy to meet her demands. This situation explains the difficulty of weaning poor countries from using fuel wood as their source of energy.

2.7.1.7 Poverty

Poverty is a condition in which people are unable to access all the basic needs for life (Miller, 2007: 583). Poor people are viewed as major drivers of ecological decline. They are described as people with no land at all, or whose land is insufficient to support them. FAO (1989) explains that it is the condition of poor people that pushes them to depend almost wholly on natural resources in order to survive.

Although both agricultural expansion and increase in fuel wood demand are a result of population increase, they are also reported as a symptom of the vicious cycle of poverty, and of low land productivity (Bajracharya, 1983; WRI et al., 1985; Cline-Cole, Main & Nichol, 1990; Holmberg, Bass & Timberlake, 1991). Poverty is understood as preventing people from accessing basic needs. Sillah (1998) reinforces this by stating that ‘it is expensive to be poor’. Many people in developing countries cannot afford to use alternative fuels because of widespread poverty. Thus wood remains the main source of fuel even in areas where forests are rapidly disappearing. Adeleke (1998) reported that poverty worsens and increases pressure on natural resources. The same author believed that poverty and population pressure remove people’s choice to manage resources in a

sustainable manner. These conditions prevent people from investing in programmes to develop or improve land resources.

In developing countries, research by Sillah (1998) revealed that the poor can hardly meet their financial, material and personal requirements, let alone the requirements of sustainable forest management. Poverty and environmental degradation were viewed as linked in a self-destructive cycle in which people cannot afford to take proper care of the environment. It is also argued that, when people lack ample financial as well as other resources, they are left with nature alone as the sole source for their needs, without the possibility of consideration for the future generation (Chenje et al., 1998).

The World Guide (1999/2000) viewed small-scale poor migratory farmers as having a profound effect on deforestation. These farmers were described as settling along roads through the forest to clear a patch of land to grow crops for consumption. Once the fertility of the soil declines they will migrate to a new site where they again clear a patch of land. This practise is reported to lead to soil degradation through erosion, especially in the tropics where soils are shallow.

Chenje et al. (1998) revealed that 71% of the Zimbabwean population are poor. Most of these people reside in rural areas, eking out a living from agriculture and the related over-exploitation of natural resources. They further stated that poverty continues to be the single most important determining human pressure on the environment in Zimbabwe. Although this relationship between poverty and deforestation has been vividly demonstrated by the authors mentioned above, it must also be stated that some authors, notably Khan and Khan (2009), did not find such a close correlation (between poverty and deforestation) in the richly forested Swat district of Pakistan.

2.7.1.8 Selective logging

This involves the cutting down or removal of certain tree species. The species are usually not replaced. The practise has been reported to have caused severe damage to the worlds' forests especially in South-East Asia where commercially valuable timber was cleared (The World Guide, 1999/2000). Selective logging is done to harvest trees either for construction of houses as reported by Lindsey (2007) or for furniture or paper production.

In some cases, mile upon mile of forest has been cleared. This practise was reported in Malaysia and Canada in the early nineties by the World Guide (1999/2000). In countries like Ireland and Scotland (once entirely forested), British colonists were reported to have cleared almost all the forest to get timber for ship building. In regions such as the Guianan Shield, Central Africa, East Siberia and British Columbia, logging has been regarded as the main force behind deforestation (The World Guide, 1999/2000).

2.7.1.9 Commercial agriculture

In most cases people or companies, both big and small, clear huge tracts of forests with the purpose of generating substantial income through agriculture. Agriculture as defined earlier includes growing crops and rearing of animals. Cattle raisers usually clear forest to create grazing lands, since grass and trees exist in competition. The World Guide (1999/2000) reported the clearing of forests for modern large-scale agriculture or cattle raising aimed for the export market. In their research they noted that in Central America, forests were cleared for cattle raising, and in Brazil for soya bean production. This led to huge areas of forests being cleared and a lot of hamburgers being produced in the United States which was the market for beef. Meat production in Europe at the same time required cheap grains and this according to the World Guide (1999/2000) led to huge tracts of forests being cleared for soya bean production in Brazil. Indonesia suffered high rates of forest destruction as high income countries required cheap raw materials for paper production. The country had to clear vast areas of forest to pave way for plantation agriculture.

The same authors explained that it should be noted that it is not the production of food for the poor that leads to deforestation. They claimed that high income countries pressurise low income countries into destroying their forests. Crops such as coffee, soya bean, beef, and cocoa are usually for export as they are not consumed in large quantities in producing countries, which are usually low-income countries.

The preceding discussion clearly shows that no single factor can explain the process of deforestation. So many factors are involved and interlinked that the problem becomes complex. Dealing with deforestation therefore demands a holistic approach.

2.8 Methods of controlling deforestation

2.8.1 Introduction

Sustainable food production is dependent on a good and stable environment. Trees and forests the world over play an important role in the environment. They protect the soil from erosion, especially in fragile areas like hill slopes or coastlines. This keeps soil intact and fertile and helps in maintaining agricultural production. Forests influence local climates through evapotranspiration as well as providing shade for the soil, making it possible for infiltration to take place, all of which are fundamental to agriculture which forms the backbone of most communal households.

The advantages that trees provide can sometimes be easily identified but often go unnoticed. The removal of trees exposes the soil to erosion, and the damage caused by erosion is noticeable especially when steep slopes are cleared of their tree cover. There is therefore a need to protect forests from being degraded in order to maintain environmental integrity and this in turn helps to maintain agricultural production.

Deforestation has become a global menace and, as a result, communities must work together to fight it at both national and international levels. Bearing this in mind, the international community under the Framework of Commission for Sustainable Developments, Intergovernmental Forum on Forests has been reported to be working towards disclosing the underlying factors that cause deforestation. It is of great importance to first understand the factors that cause deforestation, as that will shape the way we solve the problem.

2.8.2 Sustainable livelihoods and development

Deforestation threatens the livelihoods of people, especially the poor whose life depends on the productivity of the soil. Sharma (1992) explained that ‘people everywhere are concerned at the rate at which forests are being depleted and the extent of destructive deforestation’. He emphasised that deforestation and degradation deepen the problem of poverty in rural areas. In addition to immediate environmental and social costs, deforestation is regarded as leading to general economic loss which includes the loss of fauna and flora (notably medicinal plants) and a decline in agricultural production. The question to ask at this point is how the problem should be addressed.

Sharma viewed the participation of each and every individual as helpful if we are to manage deforestation. He encouraged all stakeholders to find a balance between developmental goals and the conservation of trees, ensuring that when we use these resources we also consider the interests and well-being of future generations. This study will therefore examine if there are ways towards the sustainable use of tree resources in Chipuriro lands.

2.8.3 Farming

Some types of farming have been noted as reducing deforestation. New methods of farming such as the growing of more crops on less farmland (high-yield hybrid crops and greenhouse crops) have been developed (retrieved May 19, 2013, from http://www.arc.agric.za/home/asp%3Fpid%3D636). In Zimbabwe people practise the use of high-yield hybrid crops as well as greenhouse farming. High-yield farmlands will, however, depend on massive chemical inputs to maintain yields. Cyclic agriculture, which involves grazing cattle on farmland that is resting and recovering, is known to increase the fertility of the soil. Selective over-farming has also been considered as helping in the release of nutrients from the subsoil. Research has shown that most plants use nutrients from the topsoil as most plant roots do not go deep down into the soil profile.

2.8.4 Forest management

Efforts to stop deforestation have been attempted for many centuries because it has long been known that deforestation can cause great environmental damage, sometimes big enough to destroy entire societal cultures (Clarke & Haswell, 1964). In Tonga, the powerful rulers designed policies to prevent the destruction of forests to meet immediate demands, as they realised that the destruction of forests will cause lasting problems (Diamond, 2004). The rulers also set taboos in some communal areas that forbade the use of certain tree species. These tree species were designated as sacred trees. Breaking the rule by abuse of these sacred trees would, it was stated, invite disasters such as famine and hunger (Clarke & Haswell, 1964).

2.8.5 Reafforestation

One of the key ways of controlling deforestation is to plant trees in already cleared areas. In the Republic of China, for example, where large-scale deforestation has occurred, the government asked every citizen between the age of 11 and 60 to plant three to five trees

per annum or do work in other forest services. According to the Chinese government at least 1 billion trees have been planted in China every year since 1982 in an effect to arrest and combat deforestation. This practise, however, is no longer being carried out and it has been substituted by making 12 March a 'Planting Holiday' in China. In the same country, the government introduced a 'Green Revolution' which is aimed at stopping the extension of the Gobi Desert by planting trees which act as a shield (Owen, 2006). In Zimbabwe one December is a national tree planting day. However this has been received with reluctance in most rural areas, and little has been documented about the success of it. In the United States, a special day called the "Arbour Day" was introduced. On this day, people take part in tree planting events and other celebrations which raise awareness of trees and the important role the trees play in the environment. Arbour day in United States is celebrated on the last Friday of April (retrieved May 19, 2013 from www.dnr.state.oh.us/tabid/5103/default.aspx).

2.8.6 Agro-forestry

Agro-forestry is the mixture or retention of trees or woody perennials and crops within the same piece of land. Sometimes people inter-mix a row of trees and a row of crops in the same piece of land. The method has been found to improve the use of the land as well as increasing agricultural production. Agro-forestry have been deduced to be well-fitting, especially to those farmers that lack adequate resources, for example farmers who cannot afford the increasing cost of fertilizers, pesticides, improved seeds, and other modern farming resources. As population pressures rise and tree cover disappears, it will be an advantage to plant agro-forestry systems on farms to meet the requirements for wood products, firewood, poles and posts, tree fruits, and animal fodder. Other viable agricultural techniques for marginal and hillside lands include minimum tillage, contour planting, composting, ground covers, fodder trees, and deferred grazing.

2.8.7 Involvement of the locals

There is a need to involve indigenous people and local communities in the planning and implementation of programmes to manage forests. There must be agreements between government and local communities to create combined ventures for the management and benefit-sharing of forest resources.

2.8.8 Sustainable forest management

Forest management technologies are required to move from unsustainable logging to sustainable forest management. Although further research is needed about truly sustainable silvicultural systems for forests, there are many well-known practices which can be employed more extensively that will reduce the degradation of forests by logging. People must be taught the best way of cutting trees without destroying underground seeds as well as young trees nearby.

2.8.9 Timber certification

Timber certification means that people or companies who are skilled in cutting trees are issued certificates for that purpose. These people or companies are issued certificates after they have proved that they are able to carry out their task without damaging the environment. Certification has been reported to assist in reducing deforestation by preventing illegal wood cutting, while the people who cut the trees have the knowledge to minimise damage to the environment. This practise will also help in safeguarding the habitat of local fauna (retrieved March 25, 2011, from http://www.wrm.org.uy/deforestation/UNreport.html).

2.8.10 Plantation of fast-growing trees

Plantations of fast-growing trees have the potential to satisfy much of the demand for forest products while reducing pressure on natural forests. However, these plantations must not involve the clearing of natural forests. In the town of Chimanimani in Zimbabwe, there are huge plantations. However, these are at the expense of the natural forests. Despite that, these plantations go a long way to serve the nation's timber demands.

2.8.11 Participation of all stakeholders

To arrest deforestation all the stakeholders must be involved in planning and carrying out the varied tasks required to manage forest resources. These include communities, companies, local government and other land users. Controlling deforestation must take into account the special interest groups from within and outside the forest sector that share, and at times compete for, the same land – such as the conservation, energy, and water sectors. A positive step to enhance participation would be support for the formation and functioning of natural resource user groups. Natural resources must be managed more holistically, with all sectors alert to their interdependence. Of particular importance is the

question of how a formula can be developed for sharing in the benefits and responsibilities that are derived from sustainable use of forest resources, as an alternative to deforestation. Failure to involve all the parties that use these resources will lead to the Mau situation, where there is conflict between the Ogieks and the non-forest-dwellers. When there is conflict no programme will succeed, and most likely this will result in more and more forest loss.

2.8.12 Re-structuring of natural resource policies

Local governments must remodel their natural resource policies and other policies affecting forest lands, and these should be given the highest priority at national level. Incentives that encourage deforestation and other destructive land use practices should be changed, and replaced by policies that encourage the sustainable use of natural resources.

2.8.13 Public awareness

There is a need for public education and awareness of the values and importance of forests for our social, economic and physical environment. This awareness must be carried out at international, national and local levels, and should target the public at large to teach audiences in both cities and rural areas, adults, children, rich and poor. In some cases deforestation in the communal areas is caused by lack of knowledge; therefore it is of paramount importance to advise the public on ways to limit deforestation.

2.9 Conclusion

This chapter has reviewed the importance of forests to the social, economic and physical environment, the extent and rate of deforestation, and the factors that affect deforestation globally, within developed countries, within developing countries, and in Zimbabwe. The chapter has observed that the rate and extent of deforestation vary between countries, and that it is difficult to compare rates for different countries because of different definitions given to the concept. For the purpose of this research, the FAO (2001) definition was used. The chapter has noted that various factors affect deforestation and that these factors are interlinked, hence the need for a holistic approach. The chapter also observes that while a few studies have been conducted on the subject in Zimbabwe, there are no studies on the extent and pattern of deforestation in Wards 16 and 18 of the Chipuriro lands. This lack of information thus creates a strong case for academic enquiry into the subject.

CHAPTER 3: RESEARCH METHODS

3.1 Introduction

This chapter elaborates on the sources of data for the research, the sampling procedures employed to collect primary data and the analysis methods. This research being exploratory, a survey as well as field observations were used to collect both qualitative data and quantitative data. Maree (2007:155) defines a survey as the face-to-face administration of questionnaires that help to get a deeper understanding of the research subject. Field observations help in taking note of the interviewee's feelings and also help the researcher to observe some features in their natural setting. In this research the researcher was able to observe the state of woodlands and cultivated lands during the field observations.

3.2 Research methods

This research used Landsat Thematic Mapper images, surveys, observations, and focus group discussions. Remote sensing and digital image processing were used as they are the best tools to map land cover change for natural resource planning support (Leisz et al., unpublished article).

Both qualitative and quantitative data were collected from the field. The two data collection methods were used, as a quantitative method alone would have been inadequate on a subject as sensitive as deforestation, particularly in the rural areas where households depend almost wholly on forest resources. As has been argued by Campbell and Fiske (1959: 268):

> More than one method of data collection should be used as a measure of validation to ensure that any variance reflected is that of the trait and not of the method and that the results obtained are valid and not merely a methodological artefact.

Methodological triangulation yielded a number of advantages for this study. First the quantitative data enabled the researcher to identify changes in population size, and changes in land cover or land use, between 1989 and 2008. Second, the quantitative method also

indicated which crops were being most widely grown in Wards 16 and 18. The method also allowed the study of households' average income, related to their sources of income. The qualitative method on the other hand assisted in explaining information and aspects that were not quantifiable, but nonetheless noted as significant for the research, such as the social and economic drivers of deforestation.

Additionally, participants in the focus group discussions within the study areas were eager and willing to discuss the factors affecting deforestation. This is because questions during the focus group discussions focused on the study areas in general rather than on specific households. The fact that households were more eager to talk during these focus group discussions resulted in a lot of useful information being gathered during the sessions. The focus group discussions also served as a platform to verify the authenticity of trends that emerged in the data collected through household questionnaires. The use of both quantitative and qualitative data collection methods in this study thus enhanced the validity and the quality of the results. To show how data was collected and analysed, a research matrix was used (Table 3.1).

3.3 Research matrix

The research matrix (Table 3.1) shows the four objectives used for the research, sources of data, and the analysis procedures employed. Primary data for the research was collected through surveys, interpretation of the 1989, 2001 and 2008 Landsat Thematic Mapper images, interviews and observations, to meet objectives one to three. Secondary data was collected through the review of literature to achieve objective ones and four.

Table 3.1: research matrix

Objective	Data Sources	Analysis
1. To examine the socio-economic drivers of deforestation in the Chipuriro lands.	Primary data and secondary data: questionnaires, interview guides and literature review.	Qualitative
2) To analyse which sub-sector suffered the highest rate of deforestation.	Primary data: questionnaires, Landsat Thematic Mapper images.	Quantitative contingency tables
3) To deduce methods of controlling deforestation in the Chipuriro lands.	Secondary data: literature review	Qualitative
4) To determine the percentage of woodland, wooded-grassland and cultivation cover change for the period 1989 to 2008.	Primary data: August 1989, September 2001 and August 2008 Landsat Thematic Mapper images.	Quantitative

(Source: researcher's own construction)

3.4 Research design

A multi-method approach was used to achieve the four objectives. To acquire both the qualitative and quantitative data a variety of sources were used as shown in Table 3.1. Semi-structured questions, semi-structured interview guides, observations, image interpretation and secondary data collection are among the techniques used to acquire data.

3.5 Primary data sources

The primary data sources were questionnaires, interview guides and Landsat images.

3.5.1 Primary data collection and analysis

Data collection from the household survey:

A pilot survey was conducted in April 2011 and the main surveys were conducted in October and December 2011. The choice of two time periods was to check the condition of

the environment at two different periods. Information gathered from these surveys covered objectives one to three.

3.5.1.1 The pilot survey

This survey was carried out in April 2011. During the survey, Chief Chipuriro provided the researcher with a map showing the boundaries of the study area. The District Administrator also showed the researcher the large-scale commercial farms not invaded during the Fast Track Land Reform Programme. The main aim of carrying out the pilot survey was to allow major research methods to be tested in the field as well as establishing contacts within the study area. Ten households were interviewed: five in Ward 16 and five in Ward 18 of the Chipuriro lands. The five questionnaires for each ward were administered to the first five households since the only requirement to be fulfilled was that the pilot survey be held in the study area. One of the five questionnaires administered in Ward 16 was directed to the owner of the farm and the other four were administered to farm workers. The farm workers were interviewed so that the researcher could access information that the owner of the farm may not have wanted to disclose. Chief Chipuriro and Headman Padzinoenda were interviewed as the senior traditional leaders in Ward 18. The choice of Wards 16 and 18 was convenient as the two wards lie at contiguous boundaries with Ward 16 in the large-scale area while Ward 18 is in the communal area.

Questionnaires were administered to the respondents in order to elicit both qualitative and quantitative data. The questions covered issues that deal with the factors affecting deforestation. Shona, one of the major local (Zimbabwean) languages, was used during the administration of the questionnaires and the data was recorded in English by the researchers. Besides testing for the major research methods the pilot survey also gave an opportunity to expose the research assistant to conditions similar to those that would be encountered in the actual survey.

3.5.2 The main survey

Data Collection procedures:

Data collection was done through household surveys, field observations, and interviews with key informants, focus group discussions and the analysis of images of the research area.

3.5.3 The household survey

A standard questionnaire was administered to selected households in the Chipuriro communal area as well as in the large-scale commercial area. The questionnaires ensured that respondents were asked exactly the same questions in the same sequence so that data could easily be compared. Questions were written in English and interpreted using both the vernacular language and English during the administration of the questionnaire in the field. Choice of the language used was based on the subjective measure of the language proficiency of the interviewee. Both open and close-ended questions were included so as to capture both quantitative and qualitative information. The questions were designed to extract information on the size of fields or farms, period of stay in the ward, sources of income, food security, land use practice on farms, sources of fuel and where they obtain it, number of livestock they possess, use of biomass, and what the interviewees perceive as the factors affecting deforestation. These questions were meant to achieve objectives one to three. The responses were recorded and entered into a digital database for computer-aided statistical analysis.

3.5.4 Interviews with the key informants

In order to achieve objectives one to three, data was collected by interviewing some key informants. The key informants are the Agricultural Research and Extension (AREX) officers and the village headmen. These were selected using both convenience and purposive sampling to be explained in this chapter. The number of key informants and their percentage representation for the ward is shown in Table 3.3. Village kraal heads were asked questions on the average size of their fields, the factors affecting deforestation in their wards and how they conserve trees. The interviews were meant to partly validate the information obtained from the household survey. The questions allowed the researcher to probe for more data and there was room for clarification.

3.5.5 Focus group discussions

The focus group discussions were carried out in the Chipuriro communal area. This was essentially a qualitative data gathering session where the interviewer directed the interaction and inquiry into the factors affecting deforestation, using a structured discussion guide (Appendix L). A tape recorder was used to record the proceedings of the focus group discussions and the information on the tape was later transcribed for inclusion in data capturing and analysis. Three focus group discussions were conducted, one at Chief

Chipuriro residential area, one at Headman Padzinoenda residential area, and the third at the Zimbabwe Assemblies of God Africa (ZAOGA) Church at Guruve Centre. Each focus group discussion lasted between two to three hours. At most twenty-five people participated in each session of the focus group discussion, bringing the total number of people to participate in all the three sessions in the Chipuriro area to 75. The twenty-five people per session were regarded as a manageable size for the researcher and the research assistant.

3.6 Sampling procedures

It was not possible to interview all households in the study area because of limited time and manpower and the high cost of data collection. A sample survey was carried out in Chipuriro.

3.6.1 The sampling frame

Wards 16 and 18 of Chipuriro were chosen for the research. The reason for choosing these wards has been stated above. Table 3.2 shows the sampling frame used and the sample size for each ward.

Table 3.2: the sampling frame

Area	**Size of sampling frame (number of households)**	**Sample size**
Ward 18	889	90
Ward 16	3	3

3.6.2 Sample size

There is no fixed or rigid sample size in research. However, Cohen and Manion (1994) argued that the researcher should ensure that the sample size should contain representative sub-groups with enough numbers to provide a basis for comparison. To reinforce that, Taylor (1977) pointed out that larger samples produce more precision in research. However, because of time and cost implications it was discovered that large sample sizes are impractical. As a result a statistical formula was developed to aid researchers to produce necessary and statistically acceptable sample sizes that deliver valid results. For

this research where the sampling frame consisted of less than 10 000 sampling units, the following formula was used:

$$n^* = \frac{(n)}{[1+(\frac{n}{N})]}$$

Where:

*n** = necessary sample size

n = desired sample size when population is greater than 10000 (see appendix G)

N = estimated population size

n/N = the sampling fraction.

Using these statistical procedures, 268 households were selected in Ward 18. In Ward 16 there are only three large-scale commercial farmers who remain farming on their land subsequent to 1989, and these were selected for inclusion in the sampling frame for Ward 16. The limited financial constraints forced the researcher to administer only 90 questionnaires instead of 268. The 90 households selected for Ward 18 were considered adequate for the research because as Payne (1983) points out, a survey involving 5-10% of the target population is fairly representative of the whole especially where the total units from which the sample is selected are less than 10 000. Another factor is that the population of Chipuriro is uniform as it is composed of only one cultural group, '*Makorekore'*. The uniformity of the ethnic group limits the diversity of characteristics. Table 3.3 shows the percentage of the targeted population.

3.7 The sampling design

The sampling designs used for the study are random area sampling, purposive and convenience sampling methods as shown in Table 3.3.

Table 3.3: the sampling design used for the research

Target group	Sampling methods	N	N as % of the target population
Ward 18	Random area sampling	90	10
Household heads	Purposive	90	10
Headsmen	Convenience	1	20
AREX	Purposive	1	100
Ward 16	Purposive	3	100
Focus group discussion	Random stratified	75	8

NB: the population for Ward 18 was worked out using the 1992 and 2002 population census records (interpolation**)**

3.7.1 Household selection

3.7.1.1 Random area sampling

Random area sampling was considered the most appropriate sampling method because settlements in Ward 18 are scattered and there are no comprehensive household registers. The Northings and Eastings on the 1:250 000 topographical maps of the Ward were used to demarcate the area into sampling grids of 10,000m by 10,000m. Within each grid square all households were listed alphabetically and assigned numbers. By using the random number table, at least 50% of the households in each sampling grid were selected for inclusion in the overall sample. The sampled households were identified on the ground using a Global Positioning System receiver (GPS). The locations of some of the selected households were plotted on the ward map using ILWIS under the GIS environment (Figure 3.1). For Ward 16, there are only three large-scale commercial farms and these were included in the sampled households for Ward 16. The names of the farms are Meiringeni, Nyabani and Cela Viendra (Figure 1.8).

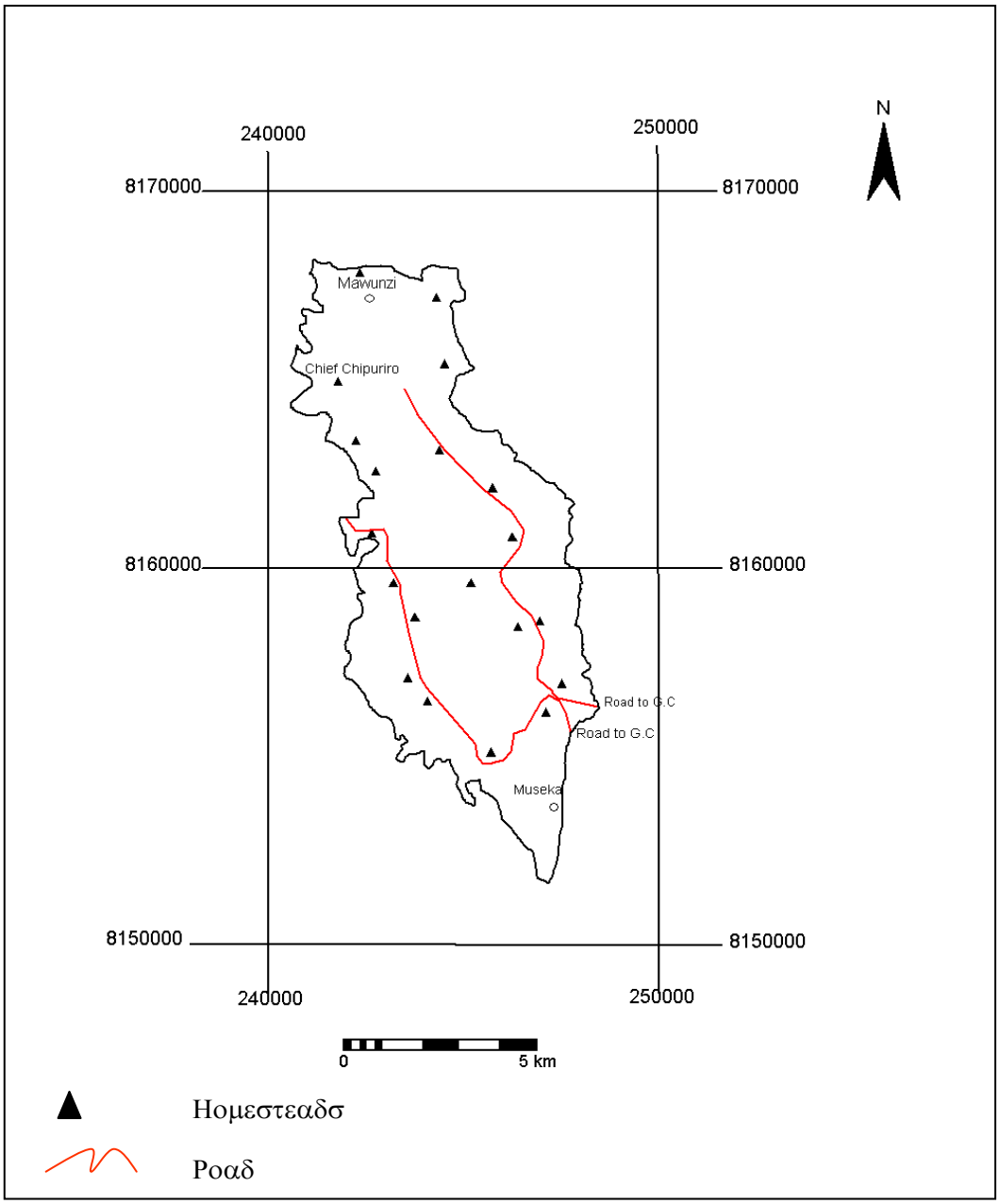


Figure 3.1: some of the selected households in Ward 18 (source: the 2002 Zimbabwean Ward map was crossed with the households' (coordinates) points of location using GIS)

3.7.1.2 Purposive sampling

Purposive sampling was used to select households' heads with whom questionnaires were administered. From each sampled household, the household head was targeted for an interview because the head was best placed to provide sufficient data on the factors affecting deforestation in Chipuriro. In the absence of the household head, the questionnaires were administered to the most senior member of the household present. AREX officials were also purposively sampled and interviewed because these are the only experts within the study area able to provide deforestation data. Thus all the key

informants were deliberately and purposively chosen on the basis of their being able to provide useful data in the research.

3.7.1.3 Convenience sampling

Convenience sampling was used to select the headmen for interview. Only those headmen present in their homesteads during the survey period were interviewed. The headmen were interviewed because, as community leaders, they usually were in regular contact with the households in the villages. They were therefore in a position to provide valuable information on the extent of deforestation and factors affecting this in their respective villages.

3.7.2 Analyzing questionnaires and interview-generated data

Data from household surveys were coded and organised for computer-aided analysis. Data from the key informants was classified according to the order of the questions on the interview schedule and important quotes from the interviewees were noted for citations. Field observations were recorded separately and were used where deemed appropriate.

3.7.3 Assessing the factors affecting deforestation

A questionnaire was designed to solicit information on the socio-economic factors affecting deforestation. These factors include demand for fuel wood, agricultural land, settlement, population growth, overgrazing and poverty. It was necessary to ascertain these factors as they are believed to affect deforestation.

3.7.3.1 Population data collection

The populations of the respective wards were obtained from the District Administrator (DA) as well as using the 1992 and 2002 Census records from the Central Statistics Office.

3.7.3.2 Fuel wood use

Information on the number of fuel logs households use per day was captured through the use of a questionnaire. The researcher is of the opinion that a log is a piece of wood of a metre in length. This is based on the fact that most huts used as kitchens are mostly six meters in diameter. The logs are usually cut in such a way that they will not interfere with peoples' movement in the hut if they are too long; and they are also designed in a manner that leaves space for people to sit around the fire as they warm their bodies.

3.7.3.3 Overgrazing

Information on the number of cattle each family possesses was obtained through the administration of questionnaires. Households were questioned on how many cattle they possess and the size, quality and type of grazing land they feed on.

3.7.3.4 Poverty status

The Poverty Datum Line (PDL) of Zimbabwe was used to measure the food security status of the households. The PDL figure in Zimbabwe is uniform irrespective of whether one lives on a commercial farm or in a rural area. The figure was US$500(retrieved December 13, 2011, from http://allafrica.com/stories/201201110137.html). Households were asked how much they earn either from formal employment or from any other income-generating activity.

3.7.4 Analysis of the factors affecting deforestation

To deduce the relationship between deforestation and the factors affecting deforestation, null hypotheses of no significant relationship were set. To test the relationships, Product Moment Correlation coefficient (PMC) was used. The data was first tested for normality before use. A probability value (p-value) of 0.05 for 95% confidence interval was used. If $p>0.05$ or equal to 0.05 the null hypothesis was accepted. However for $p<0.05$ the null hypothesis was rejected.

3.8 Determining vegetation cover and cultivation cover changes

To determine vegetation cover changes in the two wards, Landsat Thematic Mapper images were used. The images were readily available from the Department of Geography and Environmental Science at the University of Zimbabwe but could be downloaded from the website: www.glovis.usgs.gov. The landsat Thematic Mapper images were acquired in August 1989, September 2001 and August 2008. Apart from the images being readily available, a 19-year period was deemed appropriate for the detection of deforestation.

3.8.1 Landsat Image processing and classification

Before the images were classified, they were georeferenced using ground control points from the scanned topographic map, to an accuracy of not more than 0.500 pixels (7.5m). These ground control points included places such as road junctions and river intersections.

The study area lies on 170/71 and 170/72 path/row. The different path/row for a single year was glued to form one image from the georeferenced image. The 5, 4 and 3 band combinations were used. These bands were chosen based on the following factors:

Band 3

Band 3 provides better discrimination among vegetation types and between non-vegetated areas.

Band 4

For emphasis of soil-crop and land-water differences.

Band 5

For better identification of vegetation type and soil moisture.

In the context of image classification, the images were classified into different land cover/use using maximum likelihood supervised classification arigorithm. The training sites were obtained from the field using the hand-held Global Positioning System (GPS). Ground truth data or training data is necessary as it provides training samples for the computer-assisted land cover classification system. Furthermore, ground data also enabled assessment of the accuracy and reliability of the classifications.

The training sites were from the six-land cover/use types, which are woodlands, wooded grasslands, grasslands, cultivated lands, water and bare surfaces. The land cover categories were represented by more than one site in order to cover for the full range of reflectance characteristics. During the data collection period the general description of the surface (land cover type) was formally associated with the relevant coordinates.

After classification, the ward maps were used to subset the images in order to create the land cover/use for each ward. The area under each land cover/use was then calculated using the histogram function in ILWIS (GIS). The resulting areas were then plotted onto a histogram (Figure 5.1 and 5.2), bar graphs (Figure 5.3a; 5.3b; 5.3c; 5.5; 5.6a; 5.6b; 5.6c and 5.8) and line graphs (Figure 5.4 and 5.7) to show the proportion under each land cover/use as well as the changes over time in land cover/use.

3.8.2 Accuracy assessment

To validate the classified results, Kappa statistics were used.

3.8.3 Analysis of the extent of deforestation and cultivation cover changes

Integrated land and water information software (ILWIS) under the GIS was used to calculate the area under woodland, wooded-grassland, grassland and cultivated land for the three selected study periods. A Digital Elevation Model (DEM) was used to create the slope map for the study area. Statistical analyses were carried out to deduce the relationship between deforestation and the factors affecting deforestation. Cross tabulations, graphs and contingency tables were used to present the data.

3.9 Field observations

The survey was carried out during the growing season to enable the researcher to observe agricultural activities and deforestation activities taking place. Field observations were carried out in order to compensate for the uncertainty that might arise from satellite data, as well as to corroborate data received from the household survey. Taking photographs was another reason for conducting the transect walks. The quality of the grazing lands was also observed.

3.10 Secondary data sources

Secondary data sources that were used in the research include books, journals, pamphlets and online sources. These were accessed from the library of the University of South Africa, the Institute of Development Studies (IDS) at the University of Zimbabwe, the meteorological office and online sources. The meteorological station provided rainfall data from the period 1988/89 to 2010/11. Thematic Mapper images (topography and land use) for 1989, 2001 and 2008 were obtained from the Department of Geography, University of Zimbabwe. All images were cloud free. From the Central Statistics Office, population data for the years 1982, 1992 and 2002 was collected. The Meterological office of Guruve provided rainfall data from the 1988/9 cropping season to the 2010/2011 cropping season. These sources provided the basis for the literature review relating to the patterns of deforestation and the factors affecting deforestation. A review of secondary data helped in the development of the framework for field data collection and analysis as it is an ongoing process that started with the conceptualisation of the study and will end with data analysis**.**

3.11 Limitations of the study

In carrying out this research, the researcher was faced with a number of constraints that include suspicion by villagers regarding the intention of the research, the sensitivity of the topic, accuracy of crop records, and lack of adequate Landsat Thematic Mapper images.

3.11.1 Suspicion about research intentions

In Zimbabwe, the political situation of the country has actually made people become uneasy with answering questions to do with land, especially from a stranger. In the communal areas, when you ask people anything to do with land they think you are from the opposition party (Movement for Democratic Change [MDC] - Morgan Tsvangirai's political party). They will think that you perhaps seek information to use against them. On the commercial farms, they will think you are from the ruling party and are maybe targeting their farm for invasion. This issue was settled after the researcher produced letters from the research institution and the District Administrator, indicating that the research was for academic purposes. The District Administrator also asked the researcher to produce a letter from the institution before he drafted the letter of consent that the researcher was to use during the administration of questionnaires in the DA's district.

3.11.2 Accuracy of crop records

The researcher discovered that households in the rural areas do not keep records of crops or the income they receive from the sale of crop yields. This was evidenced by the fact that none could remember all the types of crops they were growing in the early nineties. As a result the researcher was forced to start recording the crops the households were growing as from 2006, since their memories could not take them back to the nineties. Despite these limitations, the findings of this study are generally reflective of the crops grown as the amount of rainfall an area receives is the ultimate determining factor on what crop is to be grown in a particular area.

3.11.3 Lack of adequate Landsat Thematic Mapper images

The researcher wanted images from the 1970s and from 2011 but could not get them. As a result she had to use images from August 1989, September 2001 and August 2008 which she obtained free of charge. Despite that, a 19-year period is adequate enough to deduce whether deforestation occurs in the Chipuriro lands.

3.12 Conclusion

Chapter three has explained the methods employed to collect data for the research. These methods are surveys (Landsat image use, questionnaires, and interview guides) and field observations. The chapter also explained the methods used to analyse the data. Chapter four will present the data collected from the household surveys.

CHAPTER 4: A DESCRIPTION OF THE HOUSEHOLD SURVEY

4.1 Introduction

This chapter provides a description of the demographic structure, land use, area under cultivation, resource use, and management in Ward 16 and 18 of the Chipuriro lands. The main aim is to explore the factors affecting deforestation within the two wards. Furthermore, a comparison of the factors affecting deforestation between the two wards shall be carried out.

4.2 Ward 18: Communal Area

4.2.1 Life history of the farmers

A total of 90 households were interviewed in which 814 people lived with an average of nine people per household. The proportions of the age groups are shown in Figure 4.1.

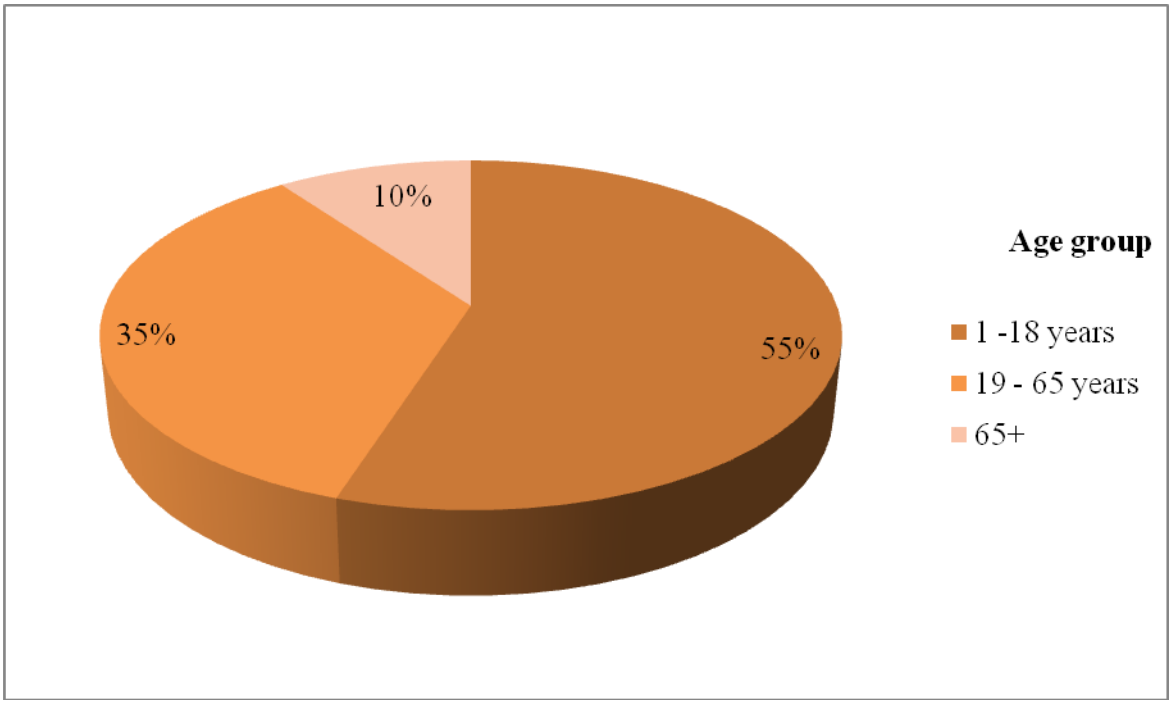


Figure 4.1: age-group proportions (source: Research Survey, 2011)

Figure 4.1 shows that the 1-18 years age group was dominant, constituting 55% of the population. This group from the research was mostly composed of school-going children. The working group (19-65 years) registered as 35% while the retirement age group formed only 10% of the population.

Research revealed that females constituted the highest proportion of the population (68%). The research further revealed various levels of education achieved by households within the ward (Figure 4.2).

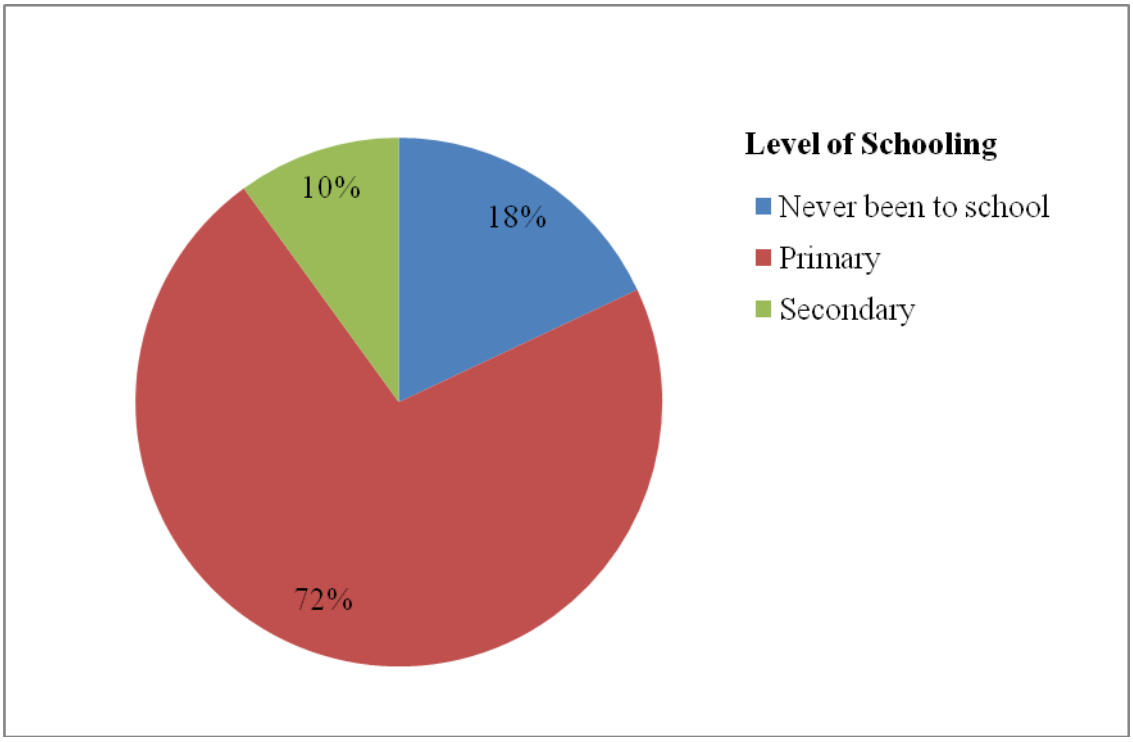


Figure 4.2: levels of education (source: Research Survey, 2011)

Figure 4.2 shows that the majority of the population had primary level as their highest level of education. This was followed by some households who had never been to school (18%). Only a few had gone to secondary school (10%) and none had attained college or university level. Households in this ward also indicated various periods of stay within the ward (Figure 4.3).

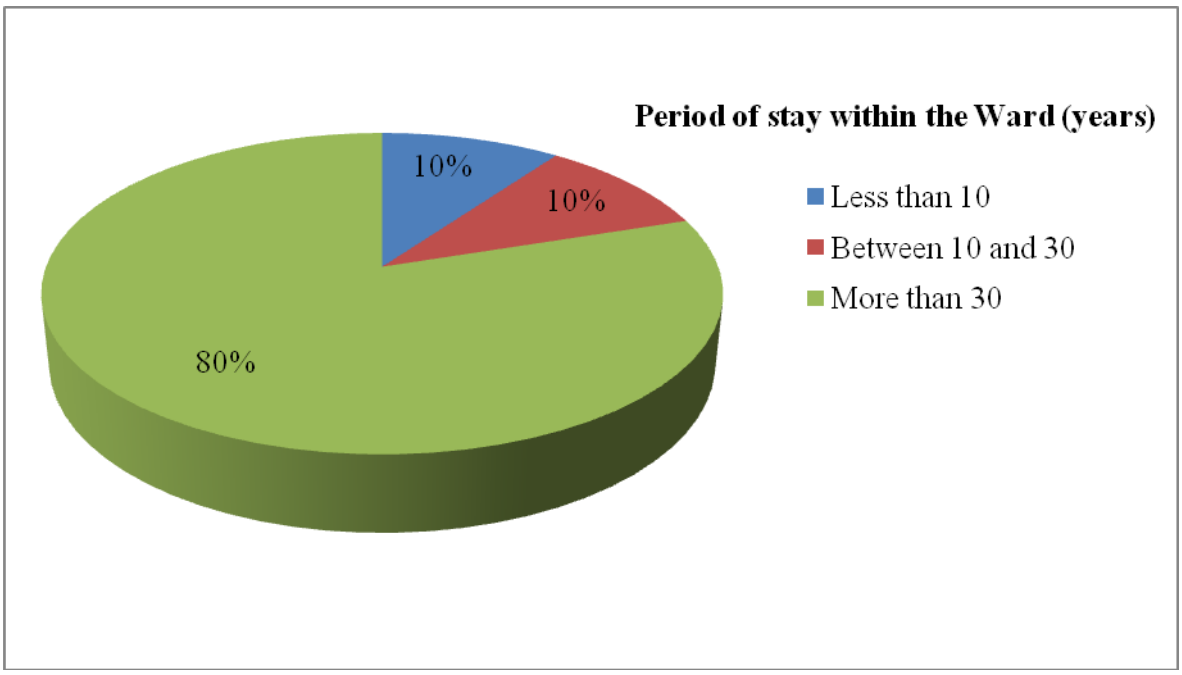


Figure 4.3: period of stay within the Ward (source: Research Survey, 2011)

Figure 4.3 shows that 80% of the households had stayed for over 30 years while only about 10% had stayed for less than 10 years. The remaining 10% had stayed for between 10 years and 30 years. From the research it was discovered that none of the interviewed households was formally employed.

4.2.2 Land uses

This section presents findings on the land use, crops grown, livestock reared and the state of pasture lands in Ward 18.

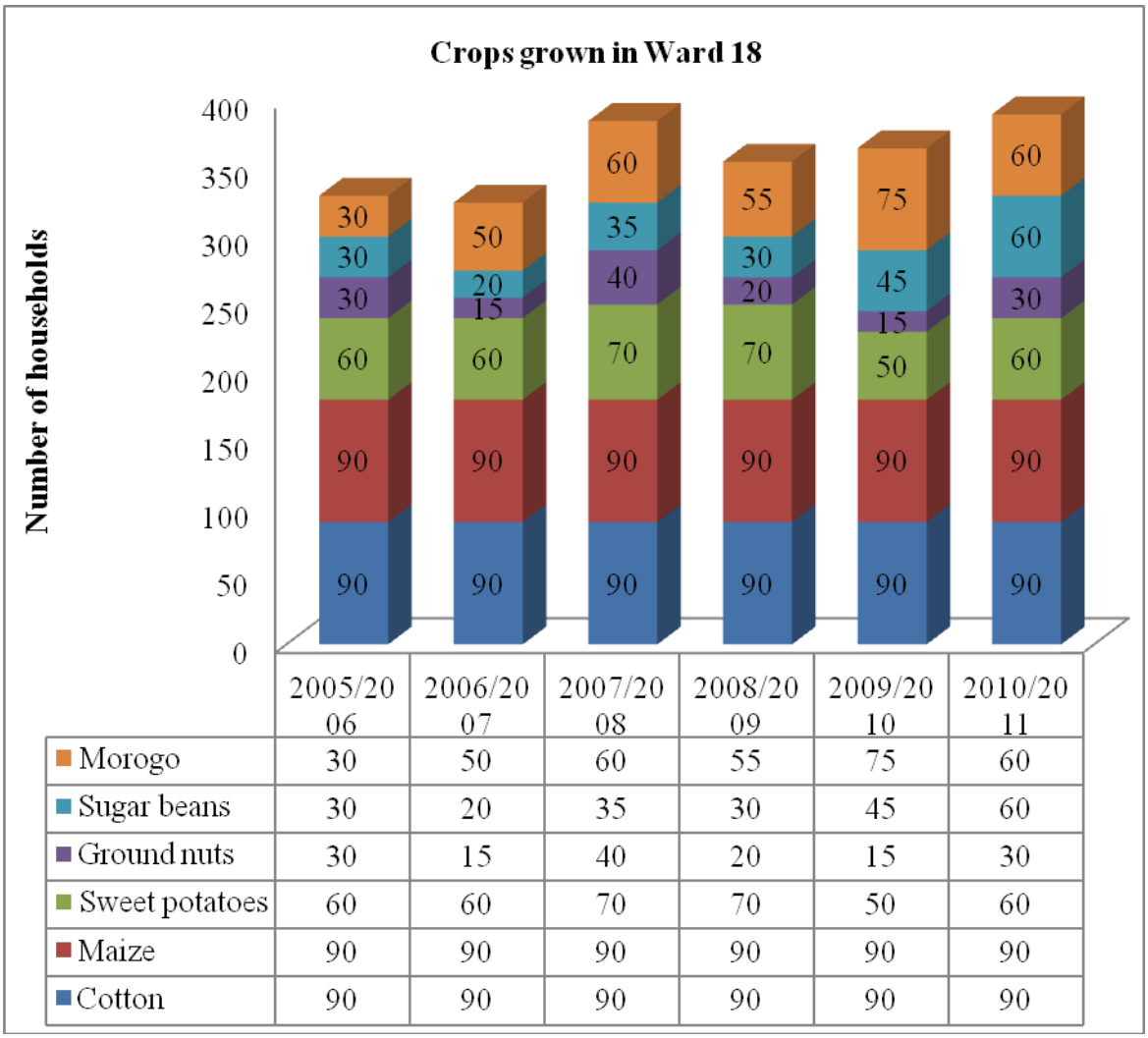
4.2.2.1 Land use practices

As discussed in chapter one, the environmental conditions in Chipuriro are favourable for agriculture. To support this, all the interviewed households indicated that they used their plots for farming. Although farming is the main land use, it is ironic that none indicated having gone through an agricultural college to gain farming knowledge. The research also showed that 80% of the interviewees had been cultivating their plots for more than 30 years. On average, households possessed five fields of a mean size of four acres. Although the size might look too small compared to the large-scale plots, households in this ward explained that they were unable to cultivate all the fields they possessed. The reasons were that some had abandoned their fields due to lack of resources such as fertilizer to enrich the

soil. On average, households were using four fields of mean size three acres for the 2010/11 cropping season. Research showed that these fields were not compact, but rather fragmented into smaller fields separated from each other by distances of approximately two km. Households pointed out that a lot of energy and time was spent as they moved from one field to the other.

4.2.2.2 Cultivation

Households indicated the cultivation of a wide variety of crops. These crops include maize, cotton, *morogo*, groundnuts, sugar beans and sweet potatoes. Figure 4.4 gives a summary of the crops grown from the 2006/7 to 2010/11 cropping seasons as well as the number of households growing them.



	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Morogo	30	50	60	55	75	60
Sugar beans	30	20	35	30	45	60
Ground nuts	30	15	40	20	15	30
Sweet potatoes	60	60	70	70	50	60
Maize	90	90	90	90	90	90
Cotton	90	90	90	90	90	90

Figure 4.4: crops grown and the number of households growing the crops

(source: Research Survey, 2011)

Figure 4.4 shows that cotton and maize are the most widely grown crops. Households explained that these two crops are their major income earners. The income was used for the purchase of fertilizer, paying fees, and buying other household basics. Additionally, maize as the staple crop provided the bulk of the food for the households. Thus all households endeavoured to grow these two crops so as to ensure household security in terms of food and cash income. Besides these two key crops, households in Ward 18 also grow crops such as sugar beans, ground nuts, *morogo* and sweet potatoes. Sugar beans, ground nuts and sweet potatoes were mainly for consumption but could be sold where excess was produced. Excess ground nuts were sold as either raw nuts or peanut butter, which fetched more money on the market. Beans and ground nuts were quoted as important as they provided proteins, while sweet potatoes provided the carbohydrates required for a nutritional balanced diet for the farmers. *Morogo* grown in Ward 18 was mainly pumpkin leaves which were used as a relish. This was grown solely for consumption. Other types of vegetables like cabbage and many more were grown for sale.

4.2.2.3 Animal Husbandry

Chickens, goats and cattle were among the most commonly reared stock. Figure 4.5 gives a summary of the total number of livestock possessed by households in Ward 18.

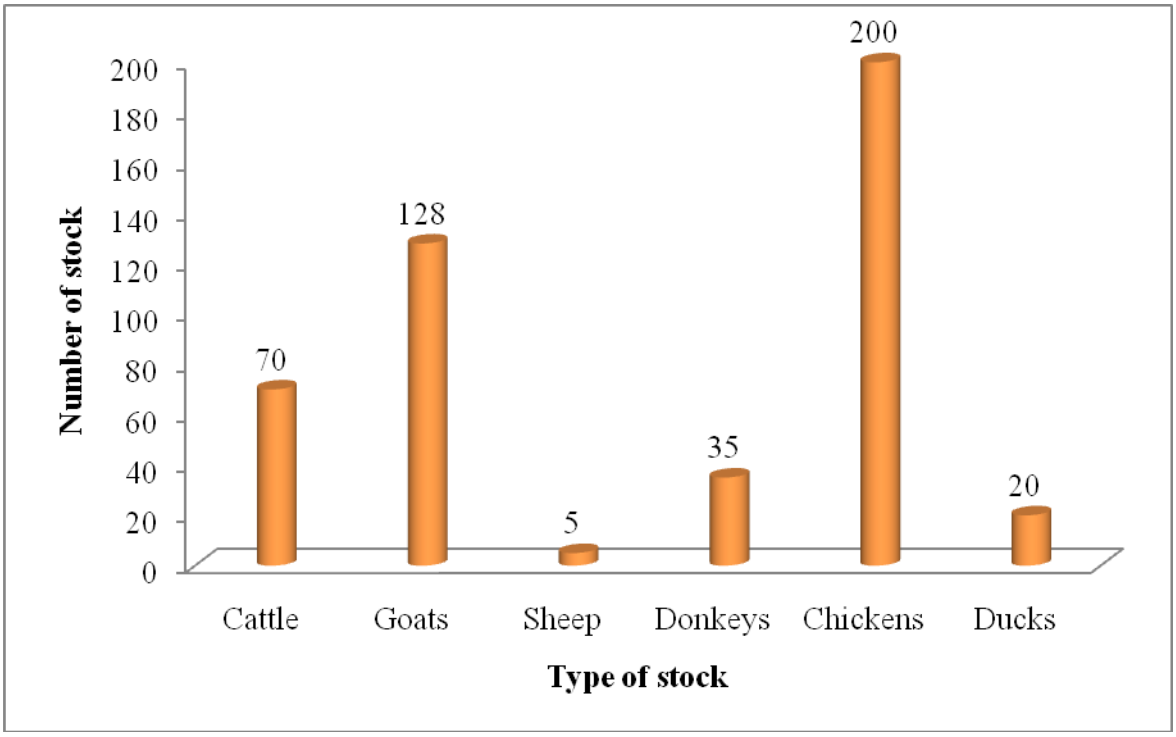


Figure 4.5: total stock reared in Ward 18 (source: Research Survey, 2011)

Figure 4.5 shows that chickens and goats were among the most reared stock by households. The research showed that only one family kept sheep. Cattle, donkeys and ducks were among the livestock reared by households in Ward 18. The livestock was reported as being kept for a variety of reasons. In this survey, multiple responses were allowed. Some households explained that they used cattle for draught power (36%), consumption (100%), traditional rituals (14%) and the payment of bride payments (*lobola),* (36%). Chickens were reared for consumption (100%) and for the payment of seasonal labour (40%). All the households who reared donkeys used them as a source of draught power. Other livestock reared was for both consumption and sale.

Results of the research revealed that the cattle grazed on the communal grazing lands. The grazing lands were reported as being poor by 23% of the respondents while 77% reported them as very poor. The deterioration of the grazing lands was reported to be the result of lack of restriction as to the number of cattle allowed to graze on a piece of land. Moreover, there were limited pasture lands in Ward 18.

4.3 Description of the area under cultivation

Households explained that their fields were on varying slope angles. Some of the fields were on gentle slopes while others were on steep or very steep slopes (Figure 4.6 and Figure 7.1).

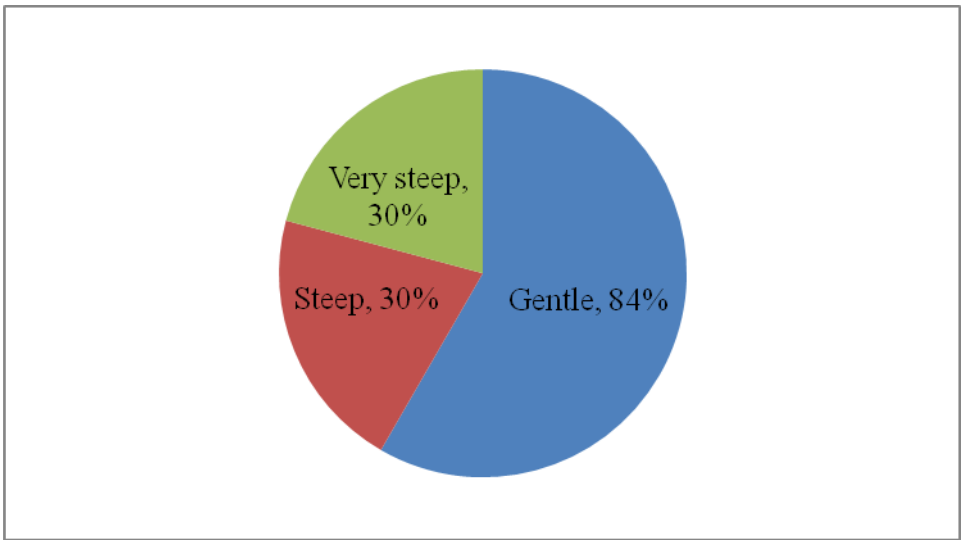


Figure 4.6: nature of slope angle under cultivation (source: Research Survey, 2011)

In this research, multiple responses were allowed. Figure 4.6 shows that 84% of the households had some of their fields on gentle slopes while 30% had their fields on steep

slopes and another 30% on very steep slopes. Figure 7.1 shows the slope map for the study area. The cultivation of steep slopes was reported as a way of creating land for cultivation for the increasing population. However, on steep slopes, households explained that soil erosion was rife and the soils were thin, hence crop yields were not as much as anticipated. Households also explained that their soil was very poor. When asked how households improve their soil, a variety of responses were given (Figure 4.7). Multiple responses were allowed.

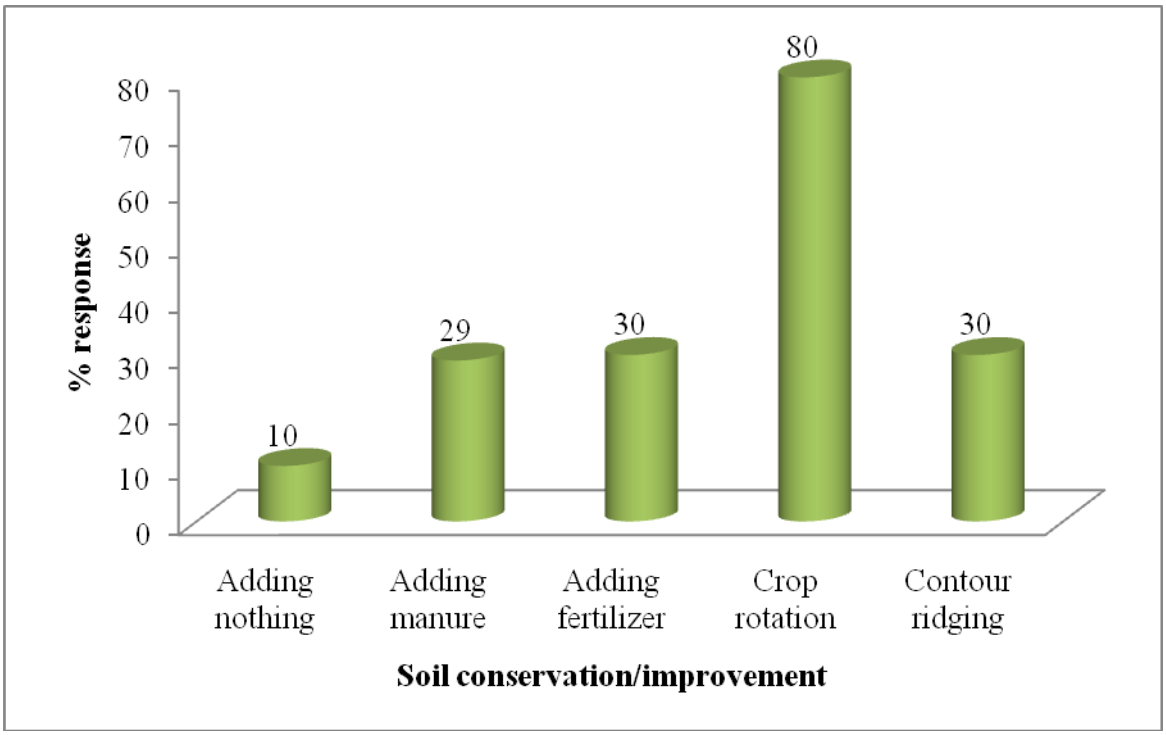


Figure 4.7: soil improvement/conservation methods (source: Research Survey, 2011)

Figure 4.7 shows that 30% of the households were applying fertilizer to the soil while about 29% applied manure, 80% practised crop rotation, 30% practised contour ridging and 10% added nothing to the soil. Of the 30% who applied fertilizer, the results showed that they were not applying the entire recommended amount. Most of the households explained that they were applying top dressing, which they believed to be the most important fertilizer for crop production. However, further questioning revealed that lack of finance to purchase all the required fertilizers forced households to rely solely on top dressing. Households that practised contour ridging were mainly those who had their fields on steep and very steep soils. They complained that every year during the rain season a lot of soil was washed away by rain water, and therefore by constructing contours they were

trying to stop soil erosion. As regards crop rotation, some farmers stated that they usually rotate the crops they grow and include ground nuts as they were taught by the AREX officer that ground nuts add nitrogen into the soil. They reported that nitrogen was an important nutrient for the growth of plants.

4.4 Resource Use and Management

All the households reported using wood as their source of energy. They obtained the wood from both within and outside the ward. Half of the households stole the wood from the A1 and A2 farms while about 45% obtained the wood from Mawunzi Mountain. Due to its high demand and dwindling supply some households had to rely on purchasing wood from the youth, who would have stolen the wood from the nearby farms. The youth would collect the wood during the evening when very few people roam the fields. They charged US$40 for each scotch cart load, as at December 2011. The A1 and A2 farms were located between five and twenty km from the Chipuriro communal area. For the legal collection of wood both women and men were involved. Men indicated the use of scotch carts while women carried the load on their heads. Immediately after harvesting, households used de-husked maize cobs, as there would be limited time to collect the wood. Neighbouring house members would gather at one house and de-husk the cobs with their labour paid in de-husked cobs. Households also pointed out the use of wet-pruned fruit tree branches from their orchards during the growing season, as in that season they had limited time to collect wood. At gatherings, when fuel wood demand is high, households indicated that they supplemented wood with cow dung collected from the communal grazing lands. The daughters-in-law were reported as being responsible for the collection of cow dung from pasture lands. All households, when asked the source of energy they would prefer if resources were available, indicated electricity. They reported that it is clean as compared with the smoke produced by fuel wood. Households also indicated that electric stoves do not soot the pot while cooking, and cook faster. They also reported that they were unable to hear current news from television sets and radios as fuel wood cannot be used to power electrical gadgets.

The households explained that in the case of fuel wood, they were using an average of ten logs per day, which they considered as inadequate. They explained that during the harvesting period they will have a lot of food to cook so the wood will be inadequate. These results coincide with Miah et al. (2009), who state that the amount of fuel wood to

be used depends on the amount of food to be cooked, burning hours, and the family size to be fed. Households in this ward indicated the collection of wood at different intervals. 50% collected the wood monthly and stockpiled it, while 30% collected once a week and stockpiled it. The other 20% reported to observe no particular order as to when they collect and stockpile wood. They reported collecting wood at any time the pile is finished. The research revealed that some species, such as *Brachystegia spiciformis* and *Julbernadia globiflora,* were favoured for fuel wood because they are flammable. Selection of the specie for fuel wood was pointed out by about 76% of the households while 24% were non-selective.

Households explained that in Msokeri village, the former vegetation used to comprise of a diversified array of tree species such as *Brachystegia spiciformis* (Msasa), *Julbernadia globiflora* (*Mnondo*) and *Syzigium* spp (*Mukute*), but now only a narrow tree species base made up of *Acacia spp* (*Munzwa*), *Azanza garckeana* (*Mutohwe*) and citrus fruits remains. Other tree species remaining include the *Pseudolachnostylis maprouneifolia* (*Mutsonzowa*), *Ochna schweinfurthiana* (*Muminu*) *and Afzelia quanzensi* (*Mugogoma*), as these tree species are regarded as sacred trees in the Chipuriro communal lands. Households explained that the use of these tree species would invite disaster such as drought or death.

The narrowing of the range of tree species experienced in the communal area was considered to be a product of the selective tree felling that targeted *Julbernadia globiflora* and *Brachystegia spiciformis,* after which non-food trees were also cleared. The second process involved the revisiting and complete removal and destruction of tree stumps as soon as current household stockpiles were exhausted. Households were also asked their opinion on wood collection and deforestation. All the interviewees stated that the collection of wood played a significant role in deforestation and the presence of bare surfaces near homesteads bears witness to their testimony (Photograph 4.1).

Photograph 4.1: bare surface (taken October 2011)

Photograph 4.1 shows a bare surface near one of the Ward 18 homesteads. The trees have been cleared to create space for settlement as well as for cultivation. In other areas, the fields close to homesteads were no longer cultivated due to fertility loss and lack of soil enrichment. The research further revealed that the nature of the stoves (traditional stoves) most households were using wasted energy. Households in this ward were using the traditional stoves shown in Photograph 4.2 instead of modern stoves which consume less fuel wood.

Photograph 4.2: a four-legged traditional stove (taken December, 2011)

Photograph 4.2 shows the four-legged stove used by one of the households in Ward 18. The household explained that the stove lost one of its legs some three years ago but that they were able to use it even with three legs. The interviewee explained that she bought the stove in 1990 and has been using the stove until today. She was not even thinking of replacing it as she did not have the money to buy a new one. The four-legged stoves were the common stoves used by most households in this ward.

Apart from fuel wood collection, households indicated population pressure, fire, brick manufacturing and the construction of stock pens (Photograph 4.3), fencing and settlement as other factors responsible for deforestation within the ward. In the case of brick manufacturing, none of the interviewed households indicated the current manufacturing of bricks. They explained that in the past (five to ten years ago) they used to make bricks for sale but could not make them now because of the dwindling supply of fuel wood, as the firing of clay bricks requires huge supplies of wood.

In the Chipuriro communal area, some households built their houses using *dagga*, wooden poles and grass. They use grass to thatch the roofs of their huts (Photograph 4.4). Chicken and goat pens were also made out of wood, grass, wire and sometimes asbestos sheets. The asbestos sheets were bought at Guruve Centre. The chicken pens were constructed using wood, nails and wire mesh. The wire mesh was built around the pen and was used to protect the chickens from predators such as snakes which were reported as killing the chickens during the night. The snakes were unable to pass through the wire mesh. Photograph 4.4 shows a goat pen constructed at one of the households in the Chipuriro communal area.

Photograph 4.3: a goat pen in the Chipuriro lands (taken December 2011)

In Chipuriro, goat pens were built close to the main house. The reason why they built the pens close to the main house was to protect the goats from thieves. Some of the pens were roofed with grass while others were roofed with asbestos sheets. Photograph 4.3 shows a

pen roofed with asbestos. The pen was a house to only three goats since the household had only that number of goats. To enter the pen the goats used the ladder at the front of the pen.

Photograph 4.4: one of the huts built in the Chipuriro communal area (taken December, 2011)

Photograph 4.4 shows a hut built at one of the Chipuriro communal area households. The household reported that they were using the hut as a kitchen. As can be seen from the photograph the hut is made up of grass, wooden poles and *dagga*. Inside the hut there are shelves built on the walls where plates are displayed. The shelves are made up of clay and wood (Photograph 4.5).

Photograph 4.5: the shelves used to place dishes and other cooking utensils (taken December 2011)

Photograph 4.5 shows the *dagga* shelves constructed in the kitchen walls in the Chipuriro communal area. The shelves are used for placing plates, cups and other things needed to prepare a meal such as a 750 millilitre bottle of cooking oil. On interviewing, households explained that when constructing the house men do not design the shelves. They reported that it's a woman's job to design the shelves using wet clay. The process of making the shelves was reported to take only a day but the drying of clay was reported to take several days.

Photograph 4.6: a bathing room used by one of the households (taken December 2011)

Bathing in the Chipuriro communal area is carried out in bathing rooms which are usually constructed outside the main house. The walls of the bathrooms are made up of grass and wooden poles. Photograph 4.7 shows one of the bathing rooms in the Chipuriro communal area. The bathing room's door is a sheet of black plastic. Some households had their bathing rooms with no doors and they explained that they would bath during the night.

Results showed that the population of Ward 18 has not been stagnant over the period under review; rather it has been increasing at differing rates over a number of years. The population increased from 7 626 people in 1992 to 7 762 in 2002 (CSO, 1992; CSO, 2002). Within the ten year period, the population increased by 1.8%. Households explained that in the 1970s, rich and woody natural woodlands dominated the Chipuriro landscape and that bare patches of land were a rarity outside cultivated lands. They said that the population in the area was then very low and single families owned relatively large pieces of land that were adequate for their timber, firewood and agricultural land requirements. However by the beginning of the early 1990s a rapidly increasing population began to put pressure on these forests and threatened the existence of woodlands within the ward. Extensive areas of

woodlands began to be indiscriminately cleared for reasons ranging from firewood collection and settlement, to increasing demand for land for cultivation, thereby reducing some of the area from naturally productive landscapes into bare land. The high incidence of fires which were used to clear fields in the wards in preparation for cultivation as well as re-growth of new pasture was said to leave no room for the trees to regenerate. As a result, more areas in the ward were reported to eventually become bare. Transect walks within the ward revealed the existence of extensive former woodland areas that were converted into cultivated land. In some places in Ward 18, extensive grasslands are sparsely populated with nothing more than shrubs (Photograph 4.8) and remnants of woodlands are found only on field boundaries where they act as fences against stray animals, or on areas of higher elevation such as the Mawunzi Mountain.

Photograph 4.7: shrubs and grass covering most of the landscape (taken October 2011)

Lack of any conservation method is considered a factor affecting deforestation in the Chipuriro communal area. In this ward no single household showed the practise of afforestation or reafforestation, meaning to say that they were not replacing the trees they

cut. During interviews, households admitted that they knew the trees were disappearing but expressed reluctance to replace them.

4.5 Source of income and food security

As explained earlier on, farming is the main source of income in this ward. Apart from farming, households indicated various other sources of income (Figure 4.8).

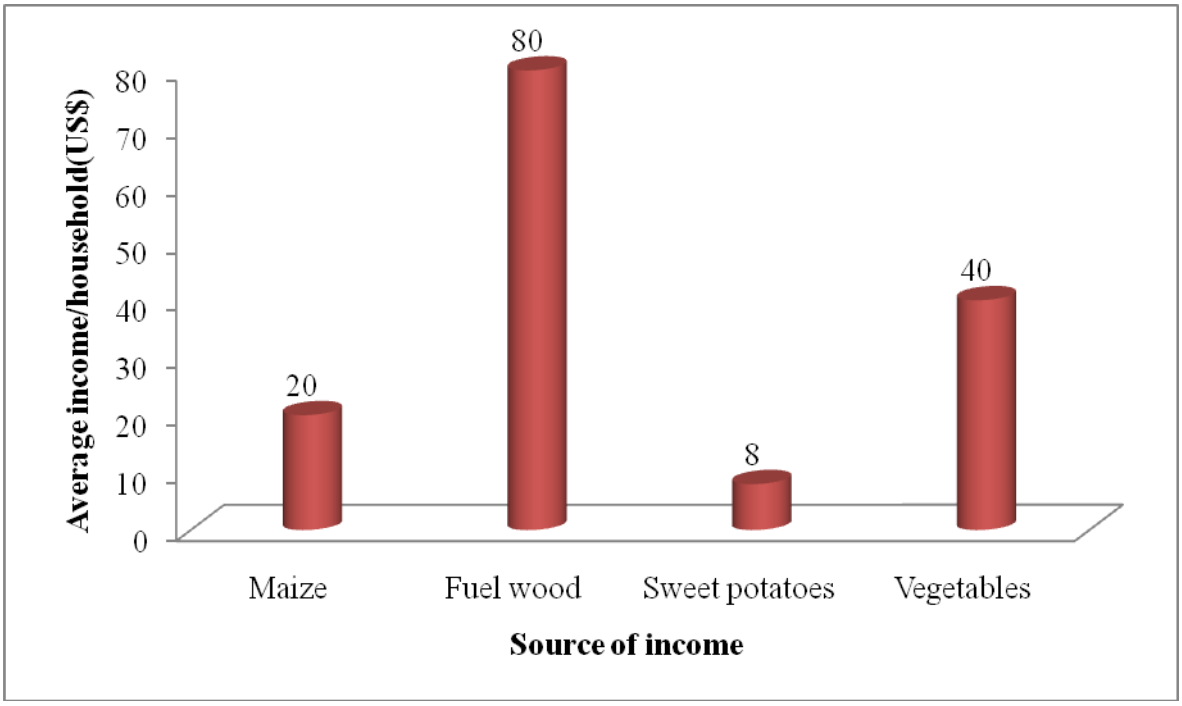


Figure 4.8: monthly average income per household (source: Research survey, 2011)

Figure 4.8 shows that in the Chipuriro communal area households rely on a variety of sources of income. The sources include the sale of maize, fuel wood, sweet potatoes and vegetables. Only one household indicated receiving money from her son working in Mozambique but during the period of interviewing she reported having last received money some three years earlier. Households explained that fuel wood collection was carried out on illegal grounds by some youth who would steal the wood from the A1 and A2 farms during the night. They carried the wood using a scotch cart. Each scotch cart load was sold at US$40 and per month they could generate an average of US$80. The youth limited their collection of wood to about twice or thrice per month for fear of being caught. The harvested crops (maize and cotton especially) were sold during the harvesting period, so households couldn't give a price for the produce. However, some households stated that they were selling a 20 litre bucket of maize at US$5. Households reported that they could

sell four buckets per month, giving rise to US$20 per month. The money collected from the sale of maize was used to buy household basics such as sugar. A bucket of sweet potatoes was sold at US$2 and depending on the market the households could sell an average of four buckets per month. Vegetables were sold at US$1 for two bundles. Per month the vegetable sellers could get an average of US$40 dollars though they reported that they couldn't sell every month as they needed to give the vegetables time to recover. The vegetable gardens were located along the river bank as there are no strict conditions regarding stream bank cultivation.

The sale of livestock was carried out by only 3% of the interviewed households. These households reported that they had only sold stock up to five years past. The rest reported that they were not in a position to sell their stock as they hoped to have more stock for investment. The households who were not willing to sell their stock reported that their cattle could have increased in number if it wasn't for the 2002 drought as well as other diseases that were killing the cattle. They reported that the cattle were no longer going to the dip tank at the time they were suppose to be treated because of lack of chemicals to kill the ticks. This was reported to cause a lot of cattle death due to diseases and, to make matters worse, no-one wanted to eat sick cattle, so the meat was reported to be buried in the soil.

From the sale of crop harvests and other items, none came close to the Poverty Datum Line (US$500), meaning that the households were living below the PDL. About 80% of the households reported two meals per day: *sadza* in the morning and evening and nothing in-between except during the harvesting period. The rest reported a single meal per day which they could afford after selling wood. In December 2011 there were no donors in Guruve, hence households were not receiving supplemental food. Only one family reported that they were receiving help from fellow Church members. The old woman reported as follows:

> *'Dai vasiri vanhu vamwari handizivi kuti ndairarama sei. Vana vangu vaviri vane mhuri dzavo uye havasevenzi. Kuti ndirime musana unorwadza uye handina mbeu nefetiraiza.'*

Translated, this means, ‘if it wasn’t for these people of God I don’t know how I was going to survive. My two sons are married so have their own family to feed and to make matters worse they are not working. Even if I want to cultivate I don’t have the seeds and fertilizer and moreover I have a back ache.’

4.6 Ward 16

4.6.1 Life history of the farmer

This section provides a discussion of the number of households interviewed, household size and source of income for the households within the ward.

In Ward 16, a total of three farm owners were interviewed. The average number of persons on these farms was three. This average was lower than that of Ward 18 (CA). In this ward the 19-65 age group was dominant as opposed to the 1-18 age group which was dominant in Ward 18. The farmers indicated different periods of residence. One of the farmers indicated that he had been staying within the ward for 40 years, while the others had stayed for 36 and 27 years. All the households in this ward indicated that farming was their source of income. However, one farmer indicated that apart from farming he was formerly employed. Contrary to the farmers in Ward 18, all the farmers in this ward had gone through an agricultural college to gain farming knowledge.

4.6.2 Land use and production

4.6.2.1 Introduction

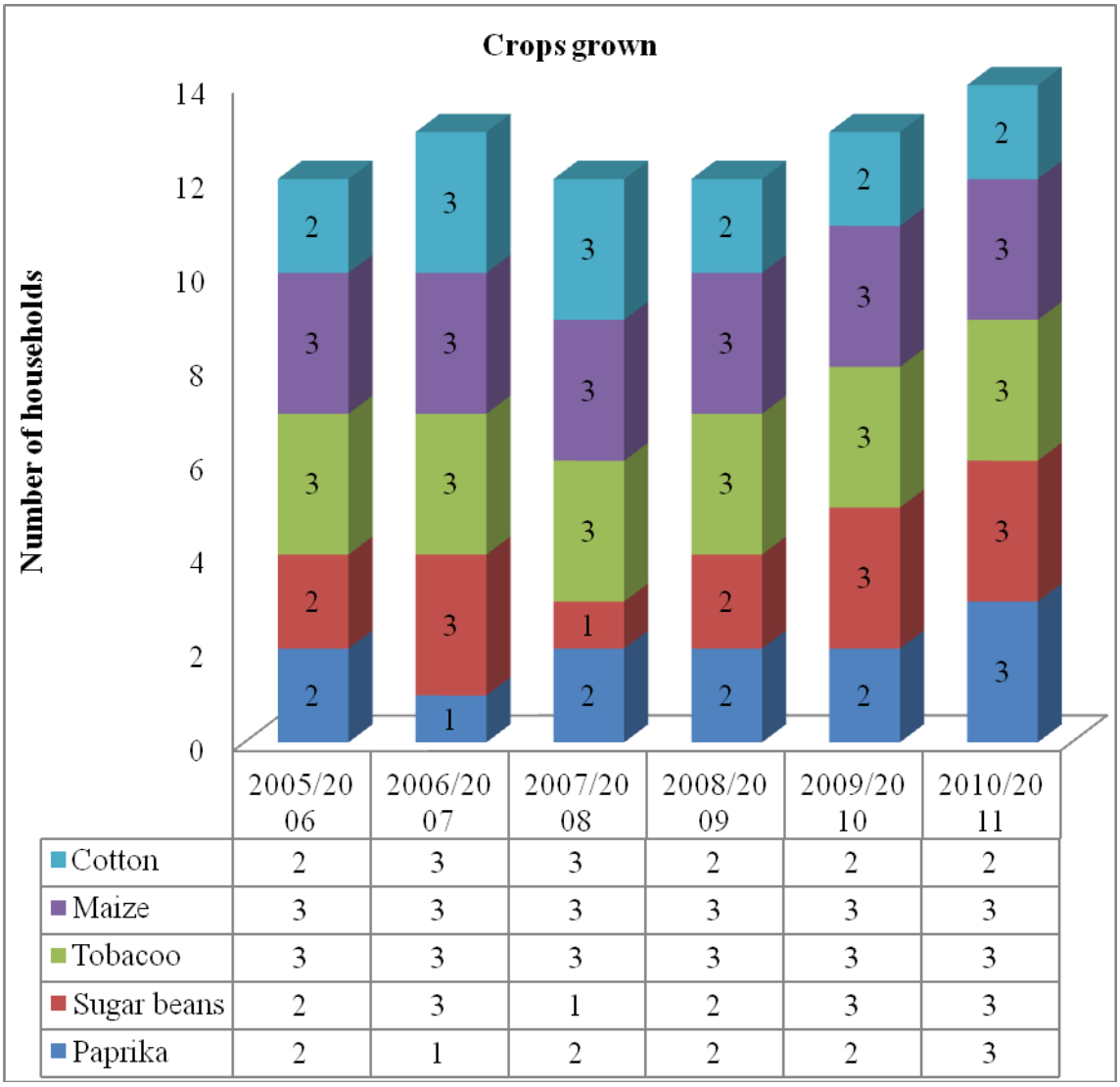
This section focuses on land use, livestock reared, and the state of pasture lands.

4.6.2.2 Land use practise

Farming is the main land use practice within the ward as evidenced by the fact that all farmers indicated that they obtained their income through farming. Each household possessed an average of three plots averaging some 283 hectares. This size is considered far bigger than the Ward 18 plots. Like households in Ward 18, households in this ward also indicated that they were not cultivating all the plots that they possessed as they left some fallow or for the cattle to graze. On average, the households were cultivating some 192 hectares.

4.6.2.3 Cultivation

Maize, cotton and tobacco were the key crops grown by households in this ward. Other crops grown include paprika and sugar beans. Figure 4.9 shows the crops grown by households in Ward 16 from the 2006/7 to 2010/11 cropping season.



	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Cotton	2	3	3	2	2	2
Maize	3	3	3	3	3	3
Tobacoo	3	3	3	3	3	3
Sugar beans	2	3	1	2	3	3
Paprika	2	1	2	2	2	3

Figure 4.9: Crops grown and the number of households growing those crops
(source: Research Survey, 2011)

Figure 4.9 shows that maize and tobacco are the key crops grown by households in this ward. On questioning, households explained that they favour tobacco as the crop is regarded as 'the country's green gold'. The farmers explained that it fetched a very good income at the Harare auction floors. Maize was reported being favoured as well since it's the country's staple crop and, moreover, at the Grain Marketing Board the farmers were

able to get input loans in the form of fertilizers after they proved that they were capable of growing the crop. The households in this ward supplemented the natural rainfall with the water from irrigation dams constructed on their farms.

4.6.3 Animal husbandry

Unlike households in Ward 18 households in this ward indicated the rearing of a narrow stock base. They explained that they prioritised the rearing of cattle and chickens. Research showed that the number of cattle the farmers possessed was higher than in Ward 18. Other stock kept included goats. Households explained that they kept the cattle and goats mainly for sale and for consumption, while the chickens were strictly for consumption. Figure 4.10 gives a summary of the average stock reared in December 2011.

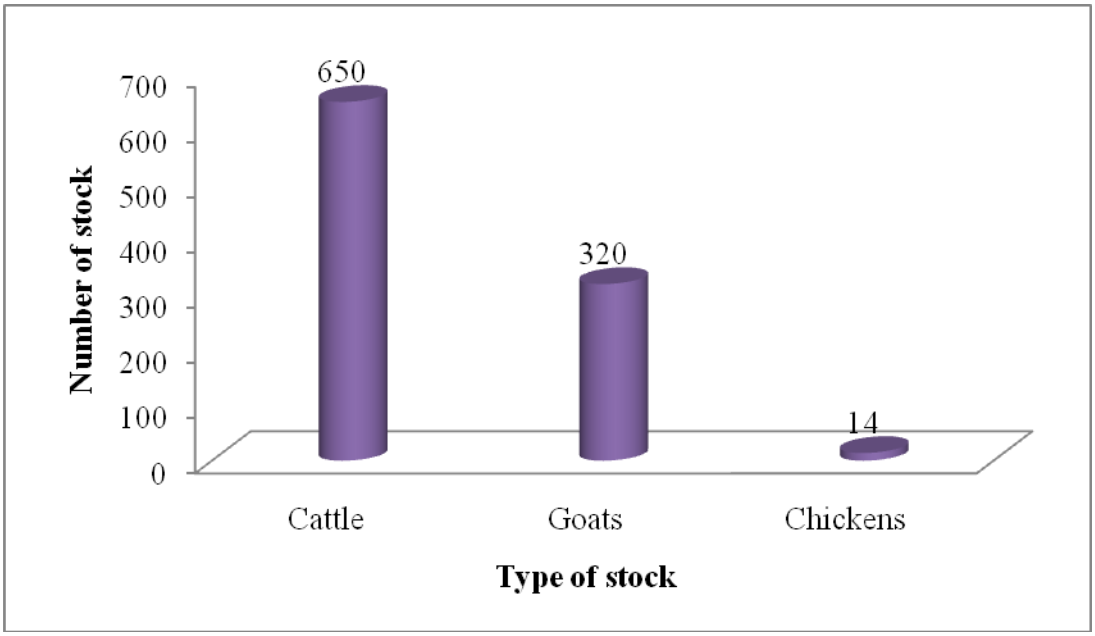


Figure 4.10: average stock/ household (source: Research Survey, 2011)

Figure 4.10 shows that cattle and goats constituted the highest proportion of the livestock reared by households in Ward 16. All households in this ward indicated that they had paddocks where their cattle would graze and this contrasts with households in ward 18 where communal grazing lands were used. To feed the stock, the farmers used maize stover and cut hay. Despite the rotation of paddocks to reduce the deterioration of pasturelands, households in this ward were displeased with the state of their pasturelands. Two of the households pointed out that their pasturelands were poor as a result of the overgrazing from the neighbouring straying livestock (stock from the communal areas).

4.6.4 Description of the area under cultivation

All households explained that their fields were on medium or gentle slopes. None had fields on steep slopes (Figure 7.1).

4.6.5 Resource use and management

In this ward, households cited electricity as their main source of energy for lighting and cooking. They only used fuel wood during periods of power cuts. They obtained the wood from the farm plantation where the bluegums (preferred species) were grown. On average, households indicated using an average of 10-15 logs per day, which they cited as being adequate. One of the farmers had a gas stove which he would use during power cuts. The farmers who used fuel wood during power cuts reported stockpiling the wood for future use.

To construct buildings and stock pens, households used wood and wire, which they obtained from the farm plantation as well as from the shops. When asked if deforestation was present in their farms, all households explained that it existed. They cited overgrazing from the neighbouring stock as well as fuel wood poaching by the rural households as the main causes of deforestation. To conserve the wood households indicated that they grew plantations.

None of the households indicated that their soils were poor. They explained that they add fertilizer and manure into the soil to enrich it. They also explained that they practised crop rotation involving some crops which add nitrogen into the soil such as sugar beans. The farmers explained that they gained farming knowledge from friends, AREX officials, farmers' field workshops and from farming booklets issued at the workshops. This is unlike Ward 18, as respondents in this ward show that they had a diverse source of information on farming.

4.6.6 Sources of income

Households in this ward explained that farming was their main source of income. Apart from farming, one of the farmers was formerly employed. The farmers sold the maize to the local GMB and the tobacco to the Harare Tobacco Auction Floor. To cure the tobacco they used coal which they bought from Hwange National Coal Company and to supplement that, they used wood from their own plantations.

4.7 Conclusion

This chapter presented the findings of the survey conducted in Wards 16 and 18 of the Chipuriro lands in the Guruve district of Zimbabwe. 90 households were interviewed in Ward 18 and three focus group discussions were also held in the same ward. In Ward 16, three households were interviewed. In Ward 18, the information from the interviewees showed that the social factors which drive people to clear forests or tree stands were the needs to extend land for cultivation and obtain fuel wood for cooking, the demand for land for house construction, and demand for building materials. The majority of the households within the ward had houses made of *dagga* and wood, and thatched with grass. Population growth (from 7 585 people in 1989 to 7 846 people in 2008) also increased the demand for forest resources. Overgrazing further caused the deterioration of pasturelands as there were limited pasturelands and no strict conditions to the number of cattle to graze on an area. Economic factors were mainly brick manufacturing which was no longer practiced due to the absence of adequate fuel wood to burn the bricks and agriculture, which was mainly the growing of crops and also led to forest clearance. Cotton was grown mainly for sale while maize was sold if there was excess. Vegetable crops like *morogo* were grown along river banks for sale. Although agriculture played an economic and social factor, it was mainly the need to feed the population that caused major forest clearance. Results also showed that most households were living below the poverty datum line (US$500), and had inadequate food to eat since they only had two meals a day, with some having only one meal per day.

In Ward 16, deforestation was caused mainly by wood poachers and overgrazing by stray animals from the communal areas. Households had plantations to provide for their wood requirements. Households had adequate meals and had access to loans, households were schooled and could sell their produce to the market and earn income.

Chapter five will discuss the results of the Landsat images. It will show the rates of deforestation and extent of deforestation for both wards.

CHAPTER 5: LAND COVER CHANGES IN THE CHIPURIRO LANDS

5.1: Introduction

This chapter presents findings on the land cover changes that took place between 1989 and 2008 in Wards 16 and 18 of the Chipuriro lands. Landsat Thematic Mapper images from August 1989, September 2001 and August 2008 were classified and the area under each land cover/ use type was calculated using Integrated Land and Water Information Software (ILWIS), under the Geographical Information System (GIS) environment.

5.2: Land cover/use changes

Woodland cover loss has been found to be a serious problem in the Chipuriro lands. The factors related to woodland cover loss are explained in the previous chapter. This chapter therefore focuses only on describing the land cover changes that took place during the study period.

Using unsupervised classification under the maximum likelihood classification method, the August 1989, September 2001 and August 2008 images were classified. Figures 5.1 and 5.2 give a summary of the total area for each land cover type, mainly woodlands, wooded-grasslands, cultivated lands, bare surfaces, water and grasslands for Wards 16 and 18 respectively.

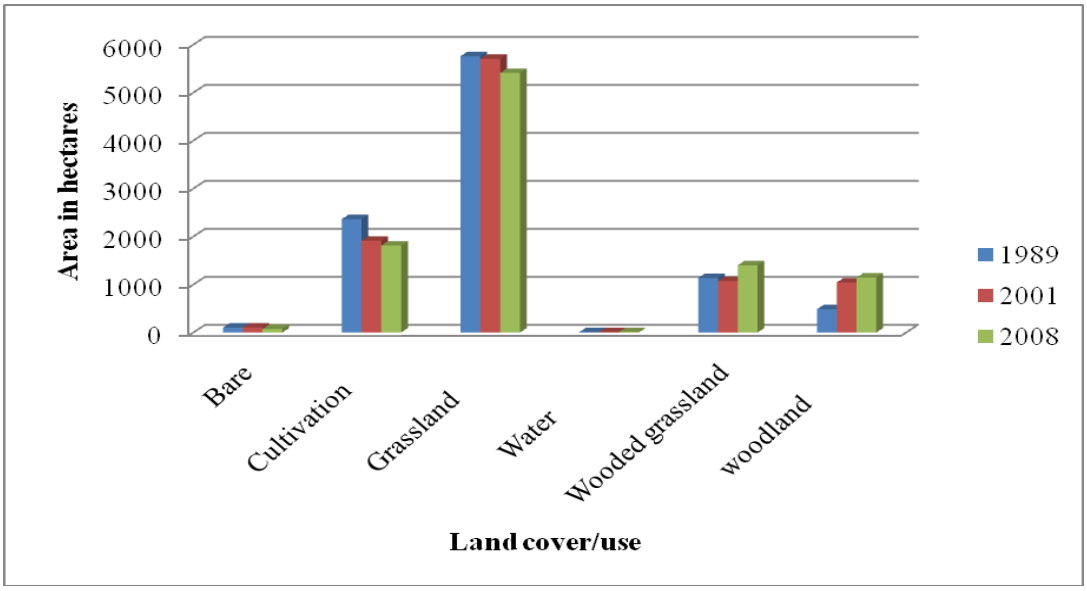


Figure 5.1: Ward 16 landcover/use map from 1989 to 2008 (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

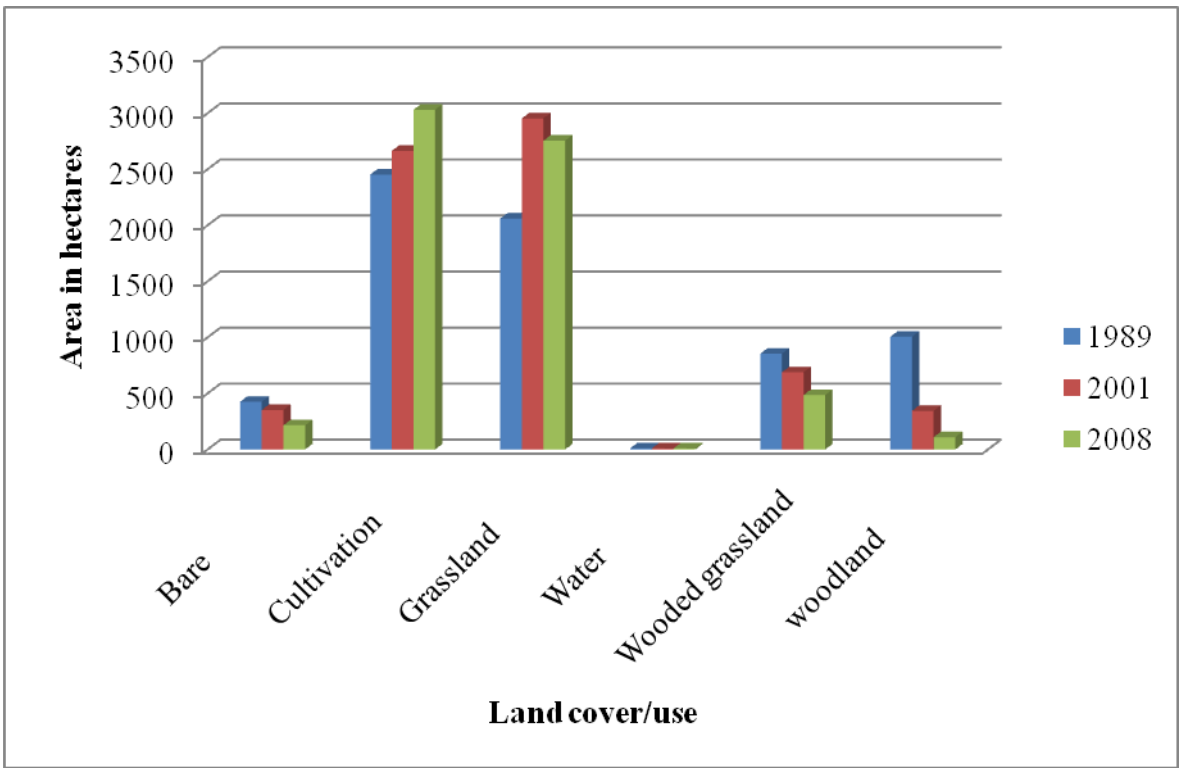


Figure 5.2: Ward 18 land cover/use map from 1989 to 2008 (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

5.3: Accuracy assessment

For accuracy assessment, Kappa statistics were used. The overall accuracy was as follows: 87% (1989); 82% (2001) and 93% (2008). Appendix E gives a summary of how the Kappa statistics were calculated. To get the Kappa statistics values, the following formula was used: Kappa = (Observed –Expected)/ (1-Expected).

5.4: Classified images

The classified images for both wards are shown in Figure 5.3 for Ward 16 and Figure 5.6 for Ward 18.

5.5: Ward 16

Classified images as well as bar graphs showing land cover and land use types for Ward 16 are shown in Figure 5.3.

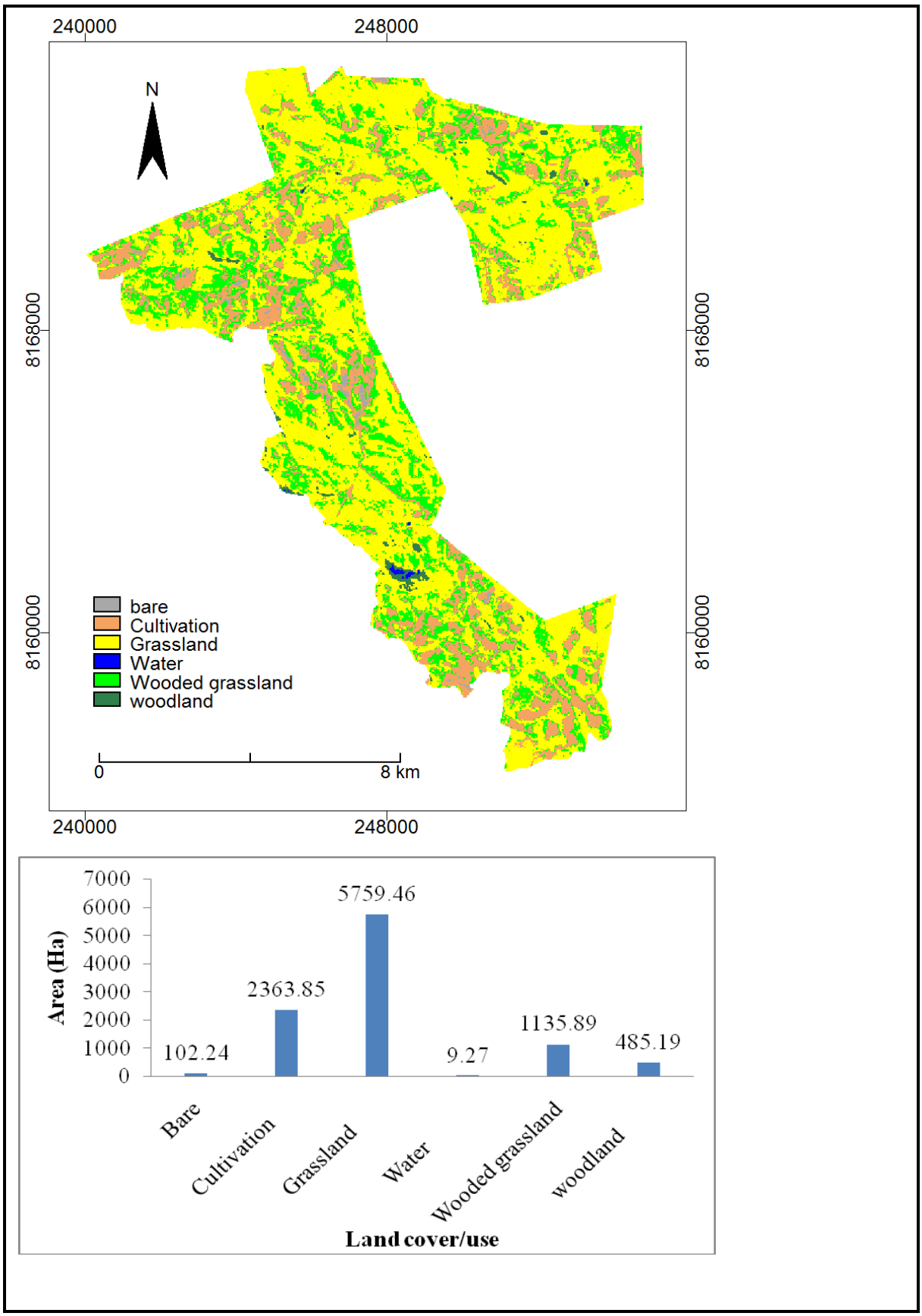


Figure 5.3 (a): Ward 16, 1989 land cover/use map and bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

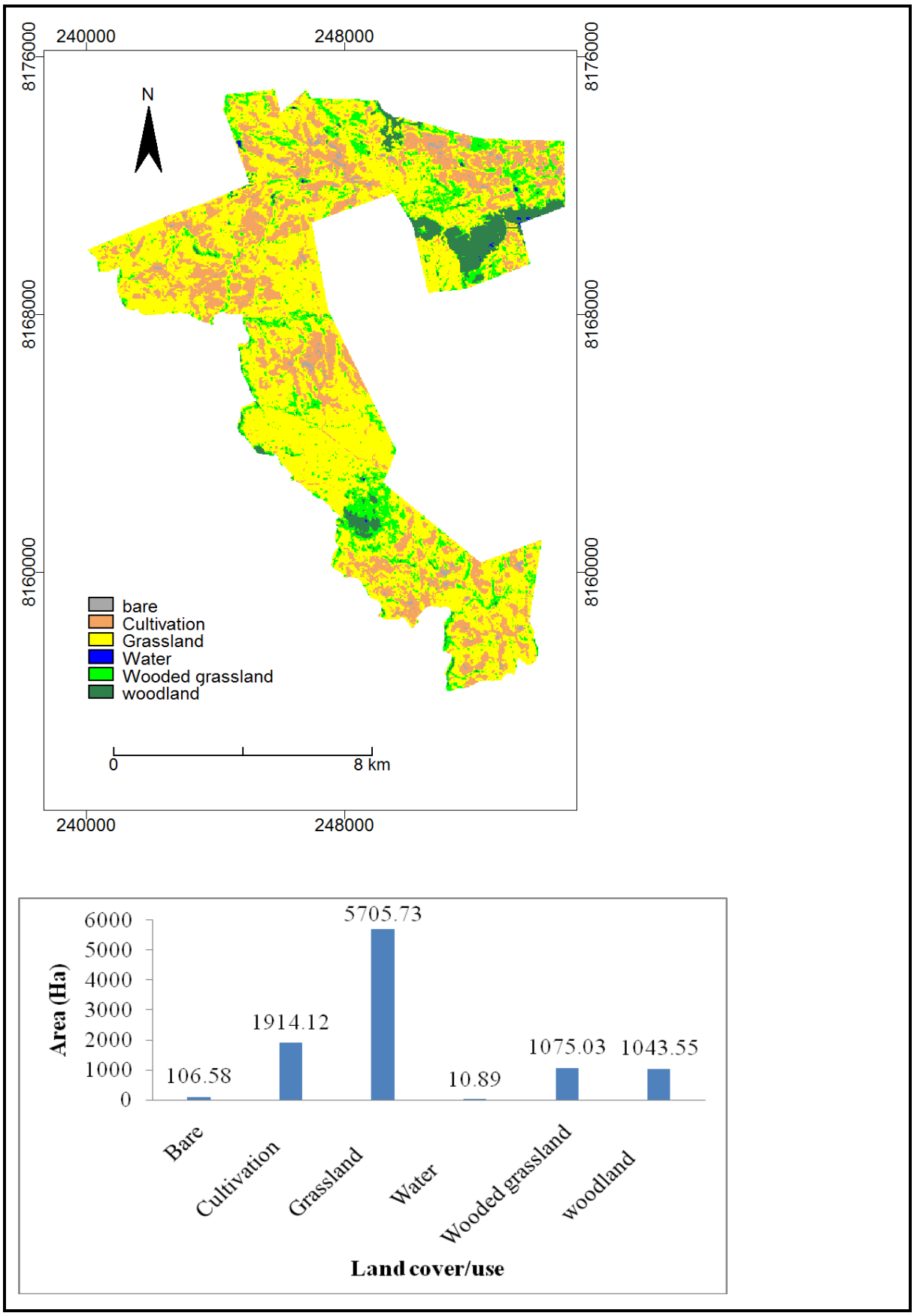


Figure 5.3 (b): Ward 16, 2001 land cover/use map and the bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

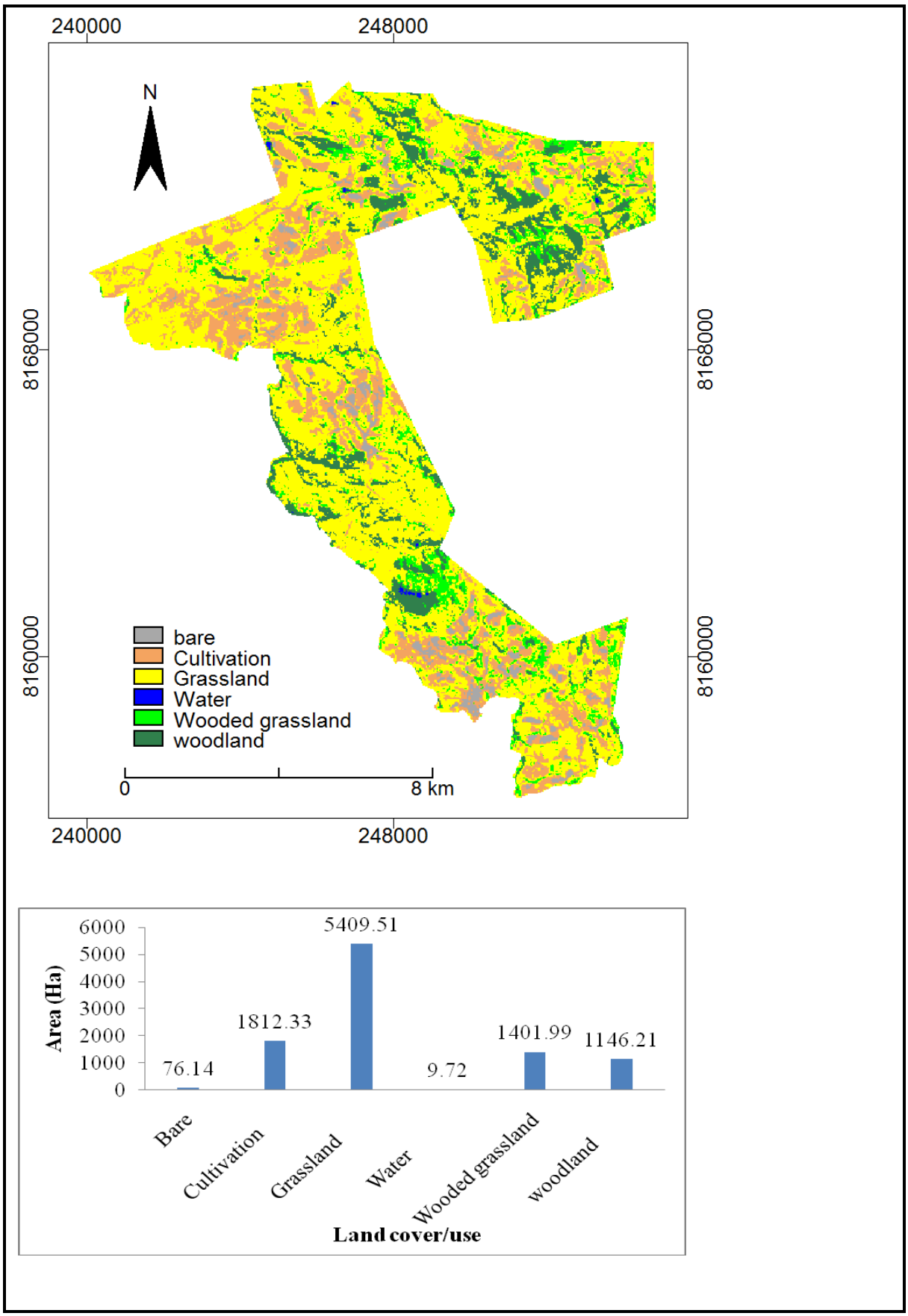


Figure 5.3 (c): Ward 16, 2008 land cover/use map and the bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

For the purpose of this study focus was placed on the changes in cultivated lands, grasslands, wooded grasslands and woodlands. Figure 5.4 shows the land cover/use changes that took place during the study period.

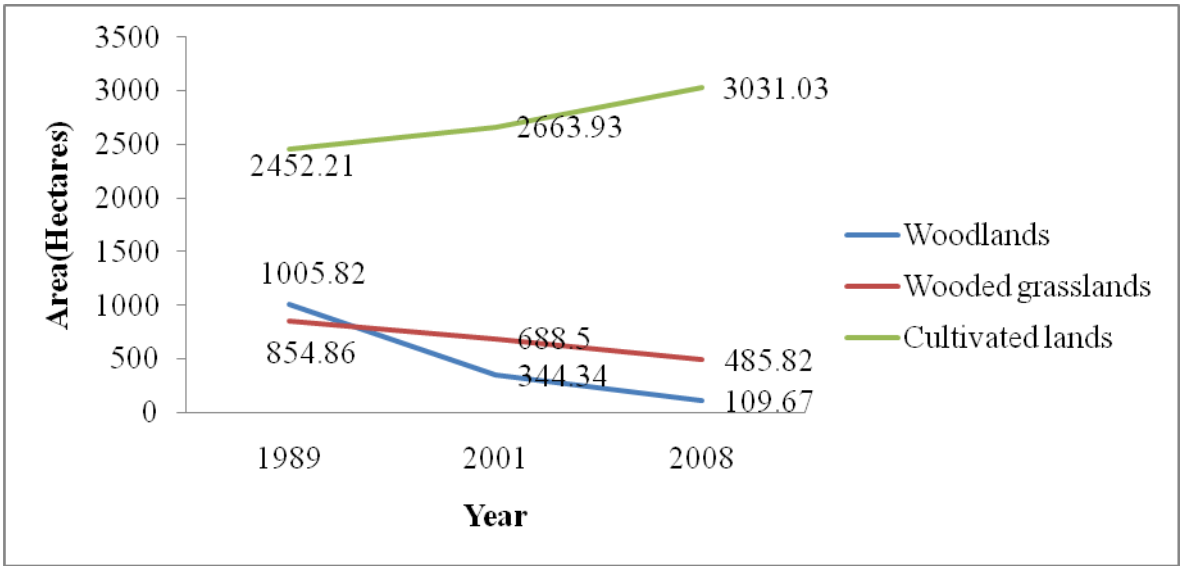


Figure 5.4: Changes in land cover/use from 1989 to 2008 (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

5.5.1: Woodland cover changes

Figure 5.4 shows that between 1989 and 2001 woodlands increased from 485.19 hectares (ha) to 1 043.55ha. This represents a 115% increase in woodlands. This percentage is equivalent to 558.36ha of woodland cover. A further increase of 9.8% (102.7ha) was recorded between 2001 and 2008. The research deduces that the period between 1989 and 2001 had the highest increase in woodland cover. Overall results showed an increase in woodland cover throughout the study period of 7.2% per annum.

5.5.2: Changes in cultivated lands

Figure 5.4 shows that in 1989, cultivated lands covered some 2,363.85ha while in 2001 the area decreased to 1,914.12ha. This indicates a decrease of 449.73ha (19%). For the 2001 and 2008 period, cultivated lands continue to decrease from 1,914.12ha to 1,812.33ha, representing a decrease of 101.79ha (5.3%). Overall results showed a decrease in area under cultivation during the study period of 1.2% per annum.

5.5.3: Changes in wooded grasslands

Figure 5.4 shows that between 1989 and 2001, wooded grasslands decreased from 1,135.89ha to 1,075.03ha. This represents a decrease of 60.86ha (5.4%). During the 2001 and 2008 period wooded grasslands recorded an increase of 326.96ha (30.4%). Overall results showed an increase in wooded grasslands during the study period of 266.1ha which is an increase of 1.23%/annum. The percentage changes in woodlands, wooded grasslands and cultivated lands within the ward are shown in Figure 5.5.

Figure 5.5: Percentage changes per annum in woodlands, cultivated lands and wooded grasslands (source: the figures were calculated from the land cover/use figures obtained using the histogram function in ILWIS [GIS])

Figure 5.5 shows that only cultivated lands recorded a decrease throughout the study period within the ward while woodlands and wooded grasslands were increasing during the same period. Ward 18 results are represented next.

5.6: Ward 18

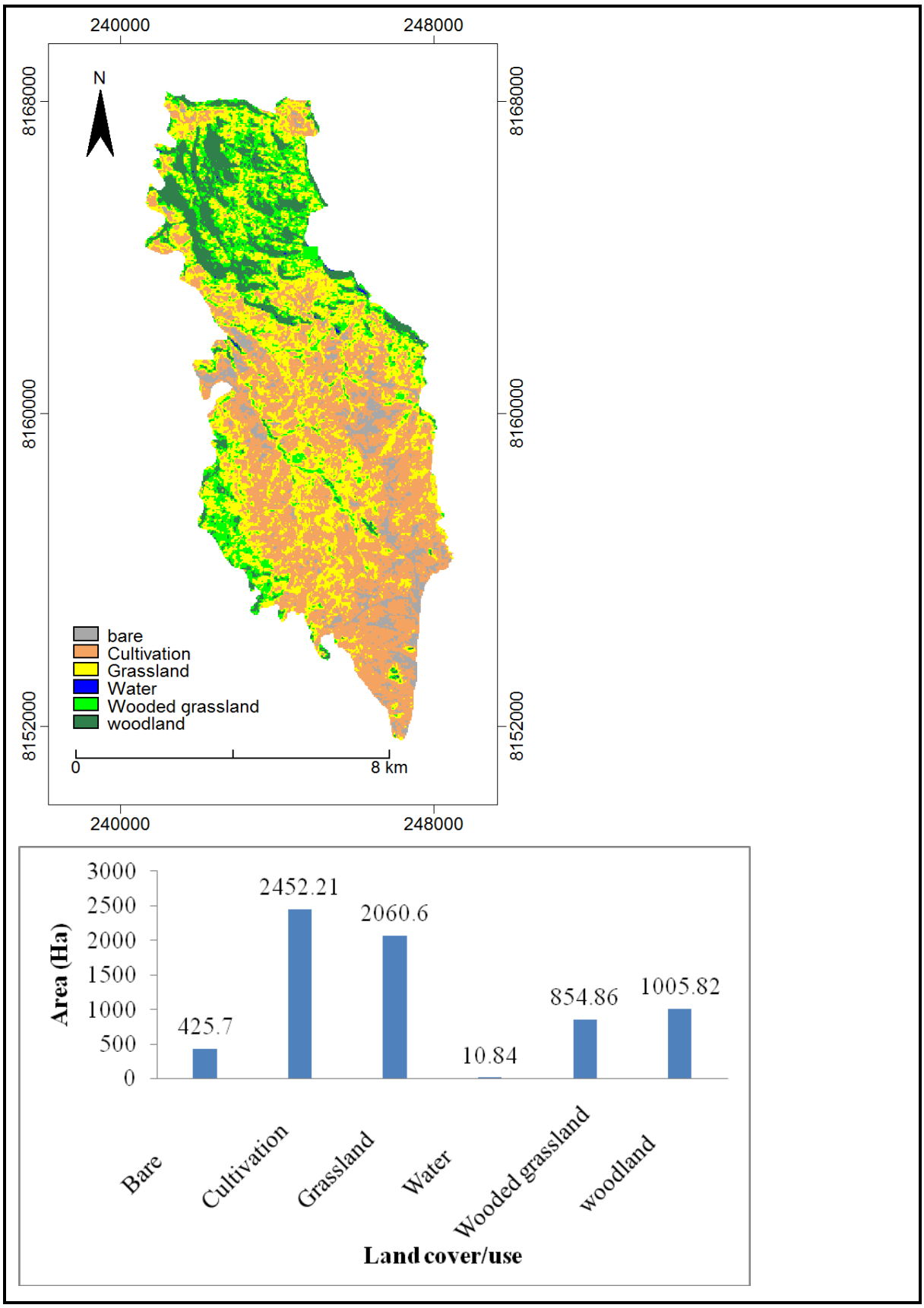


Figure 5.6 (a): Ward 18, 1989 land cover/use map and the bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

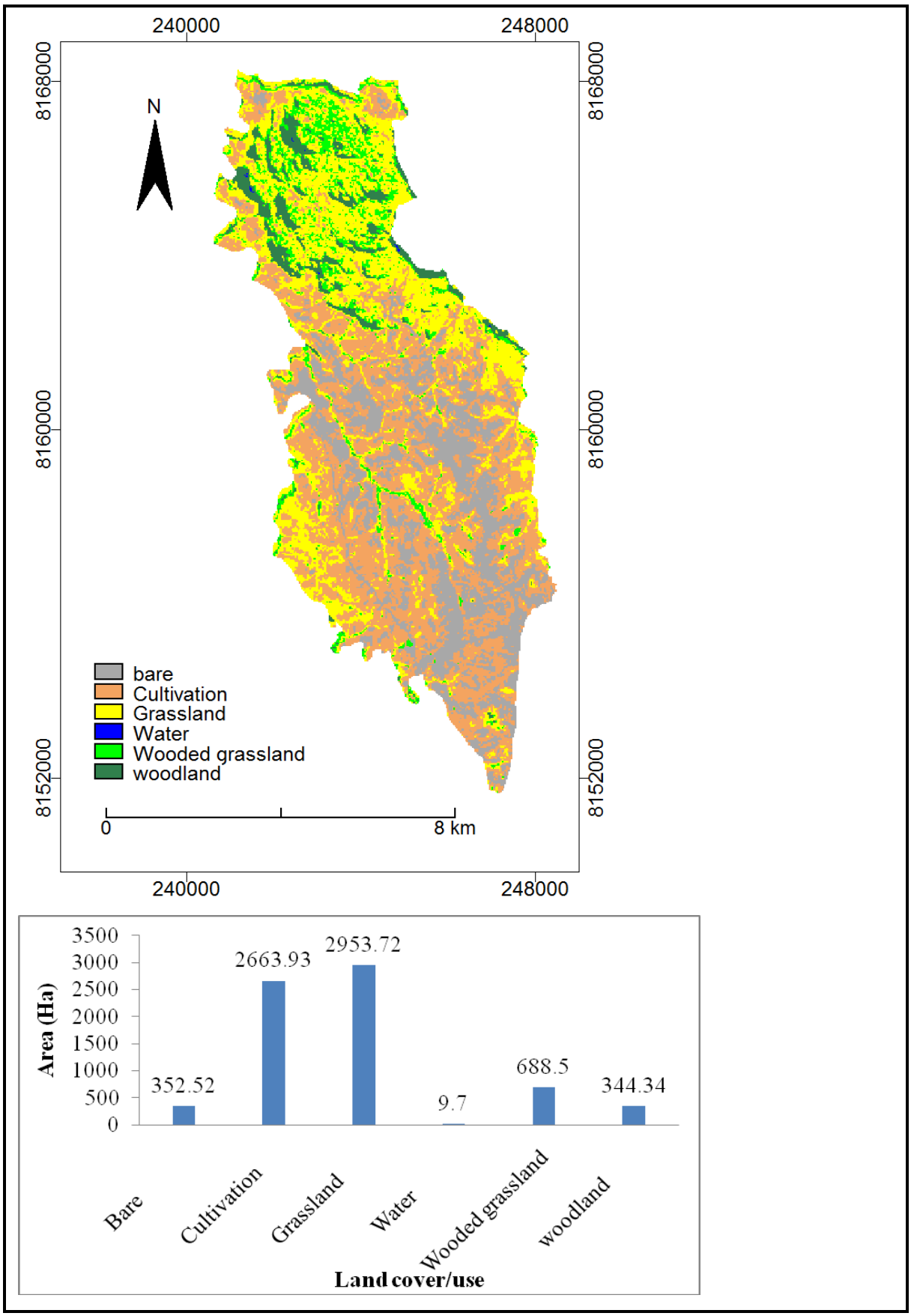


Figure 5.6 (b): Ward 18, 2001 land cover/use map and the bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

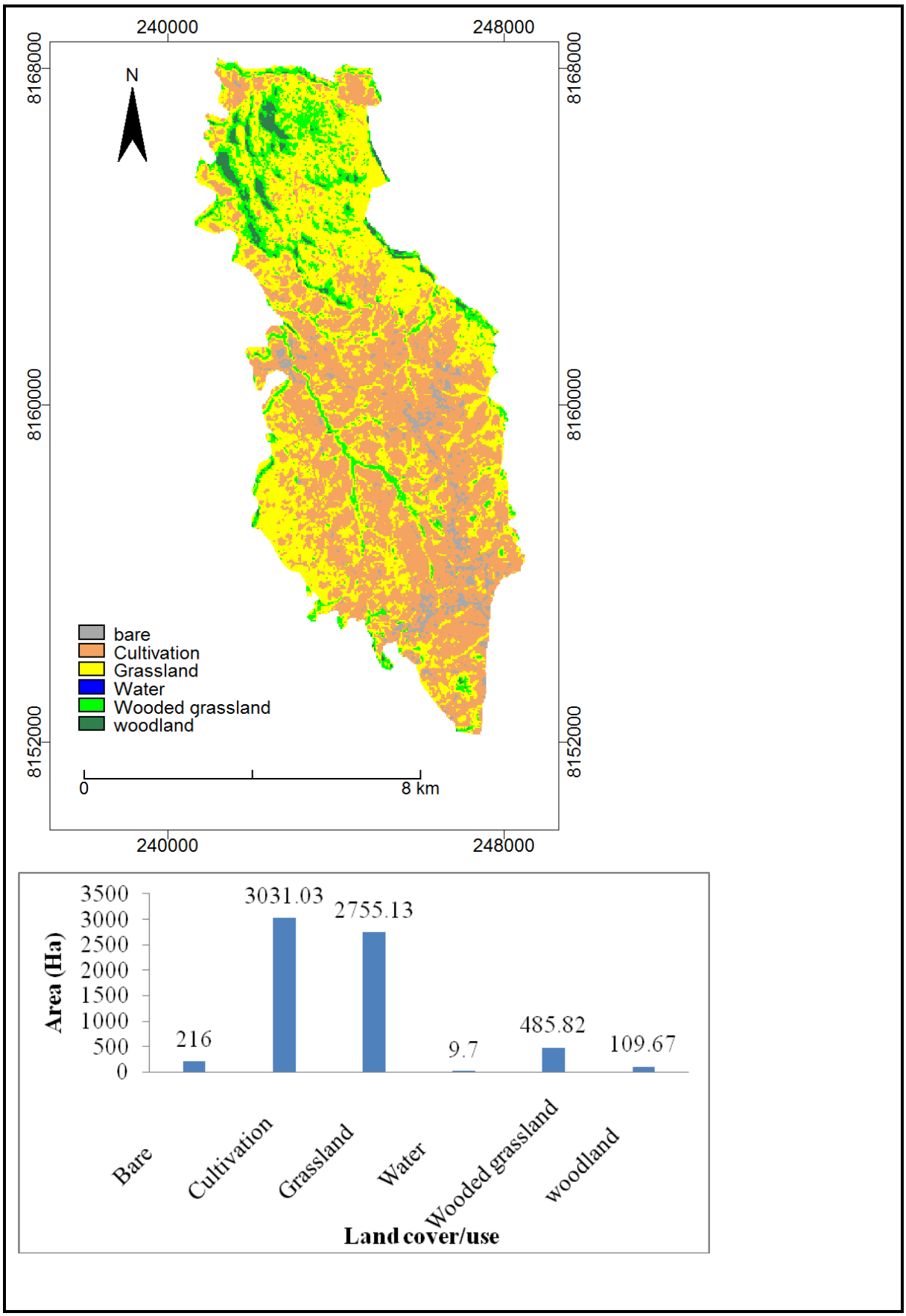


Figure 5.6 (c): Ward 18, 2008 land cover/use map and bar graph (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

The changes in woodlands, wooded grasslands and cultivated lands in Ward 18 are shown in Figure 5.7.

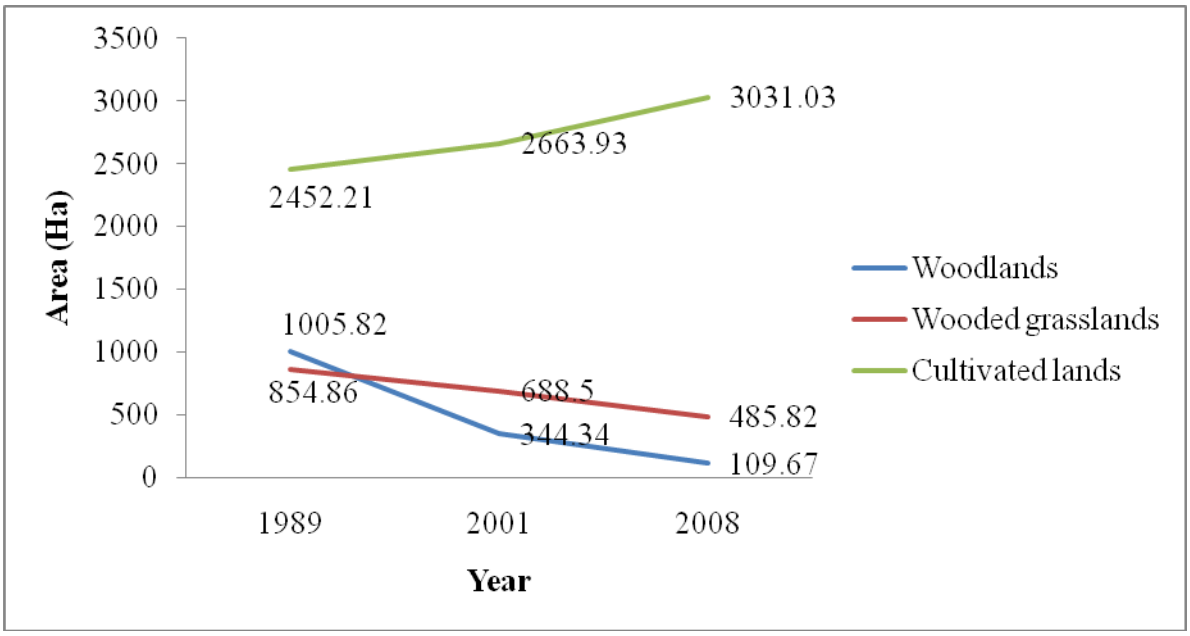


Figure 5.7: land cover/use changes from 1989 to 2008 (source: the area under each land cover/use was calculated using the histogram function in ILWIS [GIS])

5.6.1: Changes in woodlands

Figure 5.7 shows that woodlands, which covered 1,005.8 hectares in 1989, decreased to 344.34 ha in 2001, indicating a 65.8% (661.48ha) decrease in total area. Between 2001 and 2008 woodlands experienced a further decrease of 68.2% (234.67 ha). Unlike in Ward 16, woodlands in Ward 18 experienced a decrease throughout the study period. The research also shows that the area cleared of woodland cover as a percentage of the whole area is about 13.2% between 1989 and 2008. Overall woodlands decreased by 4.7%/annum.

5.6.2: Changes in cultivated lands

Figure 5.7 shows that between 1989 and 2001, cultivated lands increased by 211.72ha (8.6%). During the 2001 and 2008 period the area increased by 367.1ha (13.8%). Unlike in Ward 16, Ward 18 registered an increase in the area under cultivation through the study period. Overall increase was 1.2%/annum.

5.6.3: Changes in wooded grasslands

Figure 5.7 shows that during the 1989 and 2001 period, the ward experienced a decrease in wooded grasslands of 166.36ha (19.5%). Between 2001 and 2008, a further decrease of 202.68ha (29.4%) was registered within the ward. This ward unlike Ward 16 experienced a decrease in wooded grasslands throughout the study period of 1.6% per annum. The percentage changes in cultivated lands, wood lands and wooded grasslands are shown in Figure 5.8.

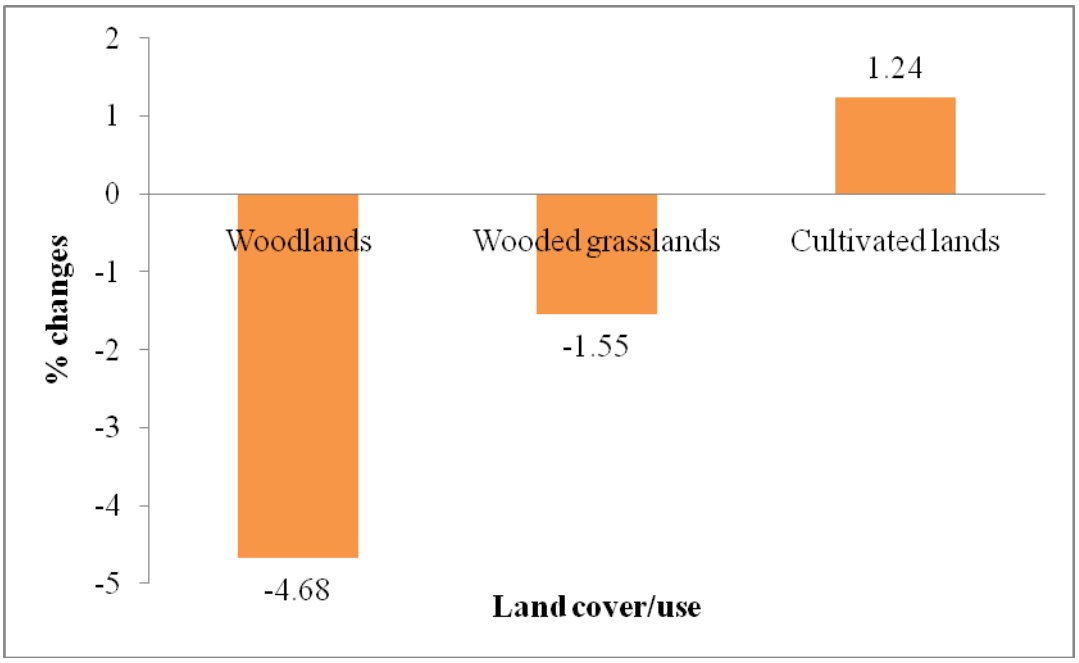


Figure 5.8: percentage changes per annum in woodlands, wooded grasslands and cultivated land (source: the figures were calculated from the land cover/use figures obtained using the histogram function in ILWIS [GIS])

Figure 5.8 shows that in Ward 18 only cultivated lands show an increase during the study period. Woodlands and wooded grasslands recorded some decreases of 4.68% and 1.55% per annum respectively.

5.7: Conclusion

Results showed that Ward 18 suffered both woodland and wooded grassland cover loss throughout the study period. These results contradict the Ward 16 results which showed an increase in woodland cover throughout the study period though wooded grasslands had a

decrease for the period 1989 to 2001.Cultivated lands on the other hand registered a decrease in Ward 16 while in Ward 18 the area increased throughout the study period.

Chapter six will analyse the relationship between deforestation and the factors affecting deforestation.

CHAPTER 6: FACTORS AFFECTING DEFORESTATION AND HOUSEHOLD COPING STRATEGIES

6.1 Introduction

This chapter analyses the research findings concerning the factors that affect deforestation, and the changes in woodland, wooded grassland cover and cultivated lands in Wards 16 and 18 of the Chipuriro lands. The aim is to deduce the factors associated with woodland cover loss in each ward. The chapter also examines whether there is a significant difference in woodland cover, wooded grasslands, and the area under cultivation between the two wards. To test for the difference, Welch's t-test set at 0.05 for 95% level of confidence was used. Welch's t-test formula is in Appendix F. The degrees of freedom were calculated using the Welch-Satterthwaite equation, also in Appendix E. The relationship between variables was also examined. To establish the relationship between variables, null hypotheses were set and tested using the Pearson's Product Moment Correlation Coefficient (PPMCC). A discussion of households' copying strategies to deal with the negative effects of deforestation concludes the chapter.

6.2 Analysis of the difference between woodlands and wooded grasslands

Table 6.1 shows the changes in woodland and wooded grassland cover that took place between 1989 and 2008.

Table 6.1: changes in woodland and wooded grassland cover (ha) from 1989 to 2008.

Ward Number	Land cover type	1989	2001	2008
Ward 16	Woodlands	485.19	1043.55	1146.21
	Wooded grasslands	1135.89	1075.03	1401.99
Ward 18	Woodlands	1 005.82	344.34	109.67
	Wooded grasslands	854.86	688.5	485.82

(Source: the area under each land cover was calculated using the histogram function in ILWIS [GIS])

6.2.1 Woodland cover

Table 6.1 shows that both wards were in one way or another affected by deforestation during the study period. This is evidenced by the fact that Ward 18 recorded an 89%

decrease in woodland cover between 1989 and 2008. Wooded grasslands also recorded a decrease of 43% within the same ward. In Ward 16, a decrease of 5.5% was registered in wooded grasslands between 1989 and 2001. Woodlands within the ward registered an increase throughout the study period (136%). The higher percentage decrease in woodland cover recorded in Ward 18 could be an indication of the higher dependence on woodlands by households within the ward. Woodland cover loss is therefore predicted to be more prevalent in Ward 18 than in Ward 16. To find out whether there is a significant difference in mean woodland cover between the wards, the following null-hypothesis was set and tested:

H_0 *: There is no significant difference in mean woodland cover between Ward 16 and 18.*

Welch's T-test found a significant difference ($p<0.05$) in mean woodland cover between Wards 16 and 18 ($t = 3.572$, $p = 0.02294$, $d.f \approx 3.745$). The differences in mean woodland cover could be explained by the following factors:

a) Households in Ward 16 practised afforestation and reforestation while in Ward 18 none practised either irrespective of their sole dependence on wood for cooking and construction. Afforestation has been defined by FAO (2001b) as 'establishment of forest plantations on land that, until then, was not classified as forest'. Reforestation by the same author has been defined as 'establishment of forest plantations on temporarily unstocked lands that are considered as forest'.

b) On interviewing, households in Ward 18 explained that they were solely dependent on fuel wood for cooking and heating.

c) In Ward 18 forest resources are communally owned while in the large-scale commercial farms the resources are privately owned. If resources are communally owned it means that no-one is responsible for such resources, and as a result each and every individual seeks to use the resources to his or her maximum benefit without considering the common interest or future generations. In the large-scale commercial farms, the farmers own the land they cultivate and have security rights to the land. This scenario puts them in a better position to be able to conserve the resources, as they know that they own the land as well as the forest resources.

6.2.2 Wooded grasslands

As explained above, wooded grasslands in Ward 16 only experienced a decrease between 1989 and 2001 (5.5%). In Ward 18, wooded grasslands decreased throughout the study period. A decrease of 43% was registered within the ward. To deduce whether there is a significant difference in mean wooded grassland cover between Wards 16 and 18 the following hypothesis was set and tested:

H_0 : There is no significant difference in mean wooded grassland cover between Wards 16 and 18.

Welch's T-test established a significant difference ($P<0.05$) in mean wooded grassland cover between Wards 16 and 18 ($t = 3.60$, $p = 0.0227$, $d.f \approx 3.985$). The difference in wooded grassland cover between the two wards is explained by the same set of reasons as for differences in woodland cover.

6.3 Factors affecting woodland cover loss.

The factors affecting woodland cover loss have been explained in chapter four. From the research it was deduced that the major factors affecting deforestation in Ward 18 were population pressure with its demand on land for cultivation, settlement and fuel wood demand. Overgrazing was also pointed out as negatively affecting woodland cover within the ward. The reason why overgrazing is thought to affect deforestation shall be explained first, while the other major factors shall be explained later when the relationship between various factors will be analysed.

6.3.1 Overgrazing

The grazing lands in Ward 18 are communally-owned, hence there are no restrictions as to the number of cattle that graze on a piece of land. The grazing lands therefore suffer from the tragedy of the commons. In Ward 16, the land is privately owned and the owners have paddocks where they can practise rotational grazing, thus managing pasture land in a sustainable manner. The fact that grazing lands were well managed in Ward 16 compared with Ward 18 supports Sullivan, Smallidge, Finley & Jacobson (2006) who state that land under private ownership is well managed compared with land under communal ownership where no-one is responsible for the land.

6.4 Relationship between variables

Chapter four revealed that woodland cover loss is the result of a multiplicity of factors. For the purpose of this chapter only population growth and demand for land for cultivation shall be considered, as these two factors were noted to be the major factors affecting woodland cover loss in the Chipuriro lands. The relationships between these variables are stated below.

6.4.1 Relationship between population growth and woodland cover change

The results of the research showed that the population of Ward 16 did not change during the period of 1989 to 2008. The three large-scale commercial farms have been occupied continuously since 1989. In contrast, the population of Ward 18 has not been stagnant over the period under review. Between 1989 and 2008 the population of Ward 18 increased by an average of 3.44%. In 1989 there were 7,585 people and the number increased to 7,846 in 2008. This increase in population size leads to the assumption that woodlands suffered huge losses during the same period as households in this ward reported their sole dependence on wood for fuel. To deduce the relationship between population growth and woodland cover for Ward 18, the following hypothesis was formulated and tested:

H_0 *: There is no relationship between population growth and woodland cover.*

The results indicate that there is a significant ($p = 0.000013$) and a very strong negative ($r = -0.9926$) relationship between population growth and woodland cover. The relationship is strong ($r^2 = 0.9852$). These findings imply that as the population increases, woodlands decrease. These findings comply with the findings by Allen and Barnes (1985) and Ehrlich and Ehrlich (2004), who state that an increase in population is the root cause of the outright clearance of forests. Neo-Malthusian theory further states that an increase in population has the effect of raising the demand on forest resources. However, this theory has been proved to apply only to developing nations where the majority of the people depend on natural resources, especially crop cultivation, for their livelihoods.

The average household size in Ward 18 was nine, which was three times that of Ward 16. With such a big family size, there will be more mouths to feed. Considering that these households are not formally employed, free resources were used to support the family and these were obtained from the forest. Since most of these households were poor the big

family size also worsens forest destruction. This effect of family status and size on deforestation is supported by Miah et al., (2009). These authors state that the size of the family, the number of hours taken in preparing food, the amount of food to be cooked and the income of the family all affect the amount of fuel wood to be consumed by a family. From their perspective the above factors increase the demand for fuel wood leading to an increase in the loss of woodland cover.

Research has shown that a person's desire for a big family is driven by a variety of reasons. Miller (2007: 18) points out that poor people have big families for security reasons. He argues that children help with gathering wood and animal dung, begging in the streets, fetching water, cultivating fields and tending livestock. Little seems to be realised by these people that the more children they have, the more the mouths to feed. As a result poor people with big family sizes will be forced to rely mostly on forest resources for their survival. Having a big family, from Miller's point of view, will result in more and more forest destruction as these children will chop trees for fuel wood and – being a big family – will also use more fuel wood to prepare meals. Having a big family, in the researcher's opinion, means absence of contraceptive use. To reduce the high birth rates in the Chipuriro communal area, stakeholders must discuss issues such as child spacing, preventing pregnancy through using condoms, and other means of birth control. Willing households can be issued condoms, contraceptive pills or injections to prevent pregnancy. This idea emerges from the point that population growth has been deduced to be the major factor contributing to natural resource depletion (Ehrlich and Ehrlich [2004]) mainly in developing countries, and in particular for this project in Ward 18.

As regards the large-scale commercial farms where the average household size was three persons, all the three farmers reported selling their produce to the Grain Marketing Board (GMB), the Cotton Marketing Board and the Tobacco Auction floors in Harare. They had adequate meals and adequate fuel wood.

Settlement is a factor that contributes to deforestation. People, irrespective of their number, always need a shelter as shelter is a human basic need. With an increase in population from 7,585 people in 1989 to 7,846 people in 2008 there was an increase in demand for shelter, leading to further clearance of forests either to get materials for building or to create space to build the houses. The type of shelter to be built depends on the economic status of the

individuals. If as in Ward 18 the households are not formally employed and lack finance, they will use natural resources to build their homes. In the Chipuriro communal area, most households earn below the PDL, hence they rely heavily on wood and grass to build their homes as these natural resources are free. In Ethiopia Haileselassie (2004) discovered that deforestation in the country was mainly caused by house construction and other factors. In Ward 18, the researcher discovered that people were clearing forests to construct their houses and the amount of woodlands cleared was found to increase with the increasing population. The cleared woodlands provided space for settlement construction and materials for building such as poles.

The bark of some tree species was removed and used for tying poles together. The bark of *Brachystegia spiciformis* was one of those most widely used for house construction in Ward 18. When tree bark is removed the tree will take time to recover and, if there are no adequate rains, the tree may eventually die. The research has also revealed that some households were using wooden plates because they were reluctant to buy plastic or metal plates. The households who were using wooden plates explained that wooden plates were stronger than plastic plates and they were able to get them without paying money.

6.4.2 Relationship between population growth and area under cultivation

The area under cultivation in Ward 16 decreased throughout the study period while in Ward 18 the reverse occurred. Between 1989 and 2008 cultivated lands increased by 23.6% in Ward 18. The increases in area under cultivation could be attributed to the increase in population size. To establish the relationship between population growth and area under cultivation the following null hypothesis was formulated and tested:

H_0 : There is no relationship between population growth and area under cultivation for Ward 18 from 1989 to 2008.

PPMCC indicated a significant ($p = 0.000011$) and a very strong positive relationship ($r = 0.955$) between population growth and the area under cultivation. The relationship is also strong ($r^2 = 0.912$). These findings correspond with the findings of Allen and Barnes (1985) who state that an increase in population growth could lead to an increase in area under cultivation. Ward 18 being an agrarian economy coupled with unemployment and population increase meant that forests were being cleared to increase agricultural

production in order to feed the increasing population. Research has shown that even marginal lands in Ward 18 were being cultivated to try and eke out a living (Figure 7.1). This also led to land degradation. Results from the research showed that on these slopes soil erosion was rife and crop harvests were not as anticipated, but were very low due to fertility loss.

Agriculture in Ward 18 was mainly crop production which demands large pieces of land as they practised extensive farming. None of the households practised other activities that demand less space such as bee keeping or poultry. Bee keeping has the advantage that it generates income as well as providing honey which serves as a substitute for sugar. Moreover, the presence of bees also helps pollination to take place, especially if these households have fruit plantations within the same yard. Irrespective of family size, if bee keeping and poultry projects are managed properly they can generate enough income for households to feed their families properly and fight food insecurity within their ward.

6.4.3 Relationship between woodland cover and area under cultivation

The research showed that cultivated lands increased throughout the study period in Ward 18. The area increased by 23.6% while in Ward 16 the area decreased throughout the study period by 23.3%. The reason for the decrease in cultivated lands in Ward 16 is because the farmers were afraid that War Veterans might take over their farms, as this period also marks the period of the Fast Track Land Reform Programme. During this period some people who were not War Veterans were also taking advantage of the programme and were taking over some of the white-owned farms. To determine the relationship between woodland cover and area under cultivation, PPMCC was used. The following null hypothesis was set and tested:

H_0 : *There is no correlation between woodland cover and the area under cultivation.*

6.4.3.1 Ward 16

PPMC produced a significant ($p = 0.013$) and a very strong negative relationship ($r = -0.999$) between woodland cover and the area under cultivation. This relationship is strong ($r^2 = 0.999$). These results imply that as the area under cultivation decreases, woodland cover increases. The reason why woodlands were increasing is because some of the households in this ward had stopped cultivating some of their plots and their focus was on

gum plantation which provided them with fuel wood for cooking and heating as well as supplementing coal for tobacco curing.

6.4.3.2 Ward 18

As in Ward 16, this ward also registered a significant ($p = 0.002158$) and a very strong negative relationship ($r = -0.9122$) between woodland cover and the area under cultivation. This relationship is strong ($r^2 = 0.83$). Unlike in Ward 16 the cultivated lands were increasing at the expense of woodlands. These results comply with Ahlback (1992) who views agriculture as the major cause of forest loss in the tropics. The author views the need for agricultural land as exerting pressure on existing woodlands. People in Ward 18 were clearing forests to pave way for agriculture. The desperate need to feed an increasing population left households with no option but to rely on what nature could provide for them.

6.5 Area under cultivation

As explained earlier, there has been significant expansion in area under cultivation over the period under review in Ward 18. Ward 16 recorded a decrease throughout the study period. Table 6.2 gives a summary of the area cultivated by households in 1989, 2001 and 2008 for both wards.

Table 6.2: Area under cultivation for Wards 16 and 18 from 1989 to 2008 in hectares

Cropping season	Ward 16	Ward 18
1989	2 363.85	2 452.21
2001	1 914.12	2 663.93
2008	1 812.33	3 031.03

(Source: the area under cultivation was calculated using the histogram function in ILWIS [GIS]).

To determine whether the mean area under cultivation differs significantly between wards, Welch's T-test was used. The following null hypothesis was set and tested:

H_0 : *There is no significant difference in the mean area cultivated by households in Wards 16 and 18.*

The research showed that in Ward 16 the area under cultivation between 1989 and 2001 decreased by 19% while in Ward 18 the area increased by 8.6%. Between 2001 and 2008 Ward 16 recorded another decrease of 5.3% contrary to Ward 18 which recorded an increase of 13.8%. Applying Welch's T-test established the following with regard to the size of cultivated lands:

Welch's T-test established a significant difference in the mean area cultivated by households in Ward 18 and Ward 16 of the Chipuriro lands ($p = 0.0475$, $t = 2.864$, $d.f \approx 4$). The discrepancy in area cultivated between wards could be attributed to the following factors:

a) During the Fast Track Land Reform Programme some of the households in Ward 16 were afraid of increasing the land under cultivation for fear of losing their farms to the War Veterans. Most of the War Veterans and non-War Veterans were targeting already planted fields. If a farmer was to increase the land for cultivation and it so happens that the farm was taken over, it would mean a loss to the farmer as there was no compensation. The new farm owner would benefit as they would simply harvest what they did not even cultivate nor carry expenses for.

b) The population for Ward 18 has not been stagnant during the period under review but rather has been increasing throughout the study period. The increase in population also means more mouths to feed. For agrarian economies, research shows that these people rely heavily on extensive farming or agriculture with maize and cotton cultivation as the key crops. From the sale of these products households are able to get the income to use for their household basic needs.

c) In Ward 18, research showed that most of the households lacked new technologies for farming as they relied on information from friends and parents. To increase production the farmers therefore believed in having a bigger piece of land (extensive farming) rather than intensive farming. Within the same ward, research has shown that there were some government officials, Agricultural Research and Extension (AREX) officials, who were helping farmers with farming advice. Although these officers were reported to have meetings with households, results show that the meetings were done infrequently, once in four months. On

interviewing, some households reported not have attended any of the meetings as they were not aware when the meetings occurred and where they took place. Moreover, the number of these officials needs to be improved as only one official for four wards which are very far apart is inadequate considering the fact that most AREX officials in Zimbabwe do not have their own vehicles to use for transport. In Ward 16, households had access to farming workshops which equipped them with new farming technologies, hence the use of intensive farming. Moreover lack of access to resources like fertilizer and chemicals forced households in Ward 18 to rely on extensive farming.

To cope with the negative social and economic effects of deforestation, households in Ward 18 practised various strategies, which the researcher regards as household copying strategies.

6.6: Household copying strategies

The household copying strategies practised by households in Ward 18 can be grouped as: strategies for raising household income; strategies for household food security; and strategies for improving energy resources for cooking.

6.6.1 Strategies for raising household income

Selling fuel wood was one of the strategies used by some of the households in Ward 18. The households obtained the wood by stealing it from the nearby farms. The youth would collect the wood during the night when the guards were focused on guarding the main house. Most of the households whose family collected wood also indicated a lack of resources such as fertilizer to enrich the soil and lack of access to loans from the bank as they did not have collateral security.

Some of these households also reported manufacturing bricks some five to ten years ago but could no longer carry out this task due to a limited supply of fuel wood. In Ward 16, the farmers employed guards to protect the woodlands from wood poachers.

6.6.2 Strategies to maintain household food security

6.6.2.1 Reducing the number of meals

The majority of households indicated reducing the number of meals they eat per day. Most households had two meals a day which were basically carbohydrate-rich. Although by using this strategy, the meagre household food resources would stretch for a longer period of time, this strategy might make sick people become worse as they would lack adequate nutrition.

6.6.2.2 Switching to cheaper food alternatives

Most households reported having *sadza* (a form of thick porridge made from a mixture of maize meal and water) in the morning and evening. They explained that *sadza* was cheap as they grew the maize crop which is subsequently processed to make mealie meal. The disadvantage of this strategy is that households were eating only carbohydrates, to the detriment of the growth nutritional needs of young children. Some of the households explained that at times they cook the relish without cooking oil. They would just add water and salt since they could not afford buying cooking oil.

6.6.2.3 Cultivation of marginal lands

To increase the land under cultivation some households in Ward 18 had some of their pieces of land on slopes of between 16.131 and 20.145 degrees (Figure 7.1). Cultivation of steep slopes was driven by lack of access to gently sloping arable land. This strategy however was reported to be the cause of much soil erosion and the yields on such slopes were reported as low as compared to gentle slope sites.

6.6.3 Strategies to cope with fuel wood shortage

Households in Ward 16 had plantations to provide them with fuel wood. In Ward 18, households had to rely on stealing fuel wood from the farms as well as substituting wood with cow dung, de-husked maize cobs and wet or freshly pruned fruit tree branches. The households reported pruning the tree branches and using these for cooking, especially during the growing season. They explained that the branches at first produce a lot of smoke but will later burn. This strategy, though it makes them achieve their goal, has the effect of causing air pollution. During fuel gathering, households supplemented fuel wood with cow dung collected from the grazing lands. Although cow dung will cook the food, during the process of burning it releases carbon dioxide into the atmosphere and this contributes to pollution and global warming. Moreover, the researcher is of the opinion that using cow

dung for cooking is a waste of resources as the dung can be better used to enrich the soil and boost crop harvests.

6.7 Conclusion

Statistical results show high rates of woodland cover loss in Ward 18, attributed to population growth with its demand on forests products and resources. The increase in population significantly caused a decrease in area under woodland cover because as the population continued to grow more woodlands were cleared to create land for settlement (social factor), cultivation (social and economic factor) and to provide fuel wood (social and economic factor). In Ward 16, woodlands increased throughout the study period. In Ward 16 research showed a significant negative relationship between woodland cover and the area under cultivation. Woodlands were increasing at the expense of cultivated lands as farmers had stopped cultivating some of their plots and start to concentrate on planting trees. Results also showed that the area under cultivation was significantly different between Ward 16 and 18. This is because in Ward 18 there were more mouths to feed and moreover agriculture was the main source of both food and income generation.

Research showed that households in Ward 18 had strategies to deal with the negative effects of deforestation. In the case of fuel wood shortage, households had to use cow dung, wet or freshly pruned fruit tree branches for fuel wood, and de-husked maize cobs. For income generation the youth were stealing fuel wood from the neighbouring farms. As a result of lack of food, they had to reduce the number of meals per day and rely on cheap and affordable food (*sadza*). Households also extended their cultivation into marginal lands. See Figure 7.1 for a slope map. Some of the strategies used caused further damage to the environment although they were providing households with solutions to their problems. Take for example a household cultivating on steep slopes. When the rain comes the soil will be washed away causing land degradation. On the other hand the burning of cow dung releases carbon dioxide into the atmosphere and this damages the ozone layer.

CHAPTER 7: SUMMARY, CONCLUSIONS, NEGATIVE EFFECTS OF CLEARING FORESTS, AND RECOMMENDATIONS

7.1 Introduction

The aim of the research was to establish the socio-economic factors affecting deforestation and the patterns of deforestation in Ward 16 and 18 of the Chipuriro lands. This chapter presents the major findings of the study and draws conclusions upon which key recommendations for managing deforestation are suggested. Before recommendations are made, the researcher first examines the role of forests as well as the negative effects of deforestation.

7.2 Summary of major findings

7.2.1 Changes in woodland cover and wooded grasslands

The study established that Ward 18 suffered the highest rate of woodland cover loss during the period from 1989 to 2008. The ward lost 4.7% per annum while Ward 16 experienced an increase of 7.2% per annum. The study also revealed that wooded grasslands decreased by 0.45% per annum in Ward 16 for the period 1989 to 2001, while in Ward 18 a decrease of 2.3% per annum was recorded for the period of 1989 to 2008. Between 2001 and 2008, Ward 16 recorded an increase of 0.45% per annum. The research further revealed a significant difference in mean woodland cover and wooded grasslands between the two wards. The higher decrease in woodland cover and wooded grasslands recorded in Ward 18 was attributed to the fact that households within the ward were solely dependent on woodlands for settlement, land for cultivation, poles for construction, and fuel wood for cooking and heating. In Ward 16 households had electricity and coal and would resort to fuel wood during power cuts. All the houses in Ward 16 were built with bricks unlike in Ward 18 where most houses were built from poles, *dagga* and grass. In Ward 16 there were plantations which provided households with wood for cooking as well as poles for construction unlike in Ward 18, where no household planted trees. Households in Ward 18 also reported the use of tree stumps which barely reach knee height as well as freshly pruned fruit tree branches to supplement their limited fuel wood supplies. Cow dung was used at gatherings to supplement the limited fuel wood supplies as the demand for fuel wood was high at these events.

7.3 Factors affecting deforestation

7.3.1 Population growth

The population of Ward 18 had not been stagnant over the period under review but rather was increasing throughout the study period. The population of the ward in 1989 was 7,585 and it increased to 7,846 in 2008. This increase in population was found to significantly increase the demand for fuel wood, settlement, land for cultivation and other things. Settlement contributed to deforestation because most houses within the ward were built using poles and *dagga* and were thatched with grass. In Ward 16, the number of farm owners did not change since 1989 so there was no need to establish the relationship between population and wood land cover. The names of the large-scale commercial farms which did not change since 1989 were obtained from the District Administrator. The researcher searched for that information so that she could determine the 'control', which in this case was the example of the large-scale commercial farms. These farms were not invaded during the Fast Track Land Reform Programme. Results showed a significant negative relationship between population growth and woodland cover in Ward 18. The increase in population caused a significant decrease in woodland cover.

7.3.2 History of the research site

From the research, the researcher was informed that the people of the Chipuriro communal area (Ward 18), especially in areas like Gota, were at one time circa 1950 forced to leave their places of residence. This was because the whites wanted to mark the boundaries for the large-scale commercial farms. The family of one of the interviewees during that time moved to Hurungwe, while other households moved to settle on the neighbouring reserves. The interviewees stated that around 1950 there was a lot of vegetation cover around their homesteads.

The interviewees reported that it was around 1965 that people were allowed to come back to the Chipuriro communal area and resettle in areas not intended for the whites. During that period the interviewees reported that there were still huge tracts of forested lands. Forests were reported as being indiscriminately cut in the 1990s as there was no control over the influx of people from neighbouring wards and districts, and this resulted in huge tracts of forests being cleared to create land for cultivation and settlement. Even now trees are still being indiscriminately removed as the area is communally owned, and hence no-

one cares about the depletion of tree resources. Each individual is concerned only for their own immediate needs and wants. In the large-scale commercial farms, the farmers own the land and jealously guard the forests, protecting them from being over-exploited.

7.3.3 Fuel wood demand

Households in Ward 18 used fuel wood for energy and heating. They regarded fuel wood as a cheaper source of energy than paraffin which was their alternative source of energy. The households explained that they could not afford electricity as the construction of supply lines was considered expensive for low income households. The Mawunzi Mountain (Figure 3.1) and the A1 and A2 farms were reported to be their source of fuel wood. The youth were reported as stealing wood from the farms by night. In Ward 16, the households were using electricity and would resort to fuel wood during power cuts. One farmer in Ward 16 had a gas stove to use for cooking during power cuts. To cure tobacco, households in Ward 16 used coal from the Hwange National Coal Company and fuel wood from their plantations.

7.3.4 Demand for agricultural land

The area under cultivation in Ward 16 decreased throughout the study period. The farmers reported that they were afraid that their farms, after working on them, could be taken by the War Veterans as this period also marks the period of the Fast Track Land Reform programme. In contrast, in Ward 18 the area under cultivation increased throughout the study period by 23.6%. The increase in population was found to significantly increase the demand for agricultural land in Ward 18. The reason for the increase in demand for agricultural land is because the number of mouths to be fed also increased during the same period. To cater for the increasing population, households in Ward 18 reported the cultivation of various slope angles. Figure 7.1 shows the slope map for Wards 16 and 18. Figure 7.2 shows areas under cultivation in 2008 as well as the slope map for both wards.

7.3.4.1 Slope maps

The slope maps for the wards were constructed using the Digital Elevation Model (DEM) and ArcView software under the geographical information system environment. The National Aeronautics and Space Administration's (NASA's), Shuttle Radar Topography Mission (SRTM) elevation data was downloaded on 27 January 2012 from ftp://e0srp01u.

ecs.nasa.gov/srtm/version2/SRTM3. To create the slope map for the two wards, the ward maps were used to subset the DEM using ArcView software in the GIS environment.

The Ministry of Natural Resources, Environment and Meteorology (2005) defined a DEM as a ‘raster or grid-based terrain model with each cell in the DEM having a value to represent the elevation of the area’. The slope map for the study area is shown in Figure 7.1. The slope map is in degrees. The figures around the inside border line represent coordinates. The coordinates were inserted to show the location of the study area.

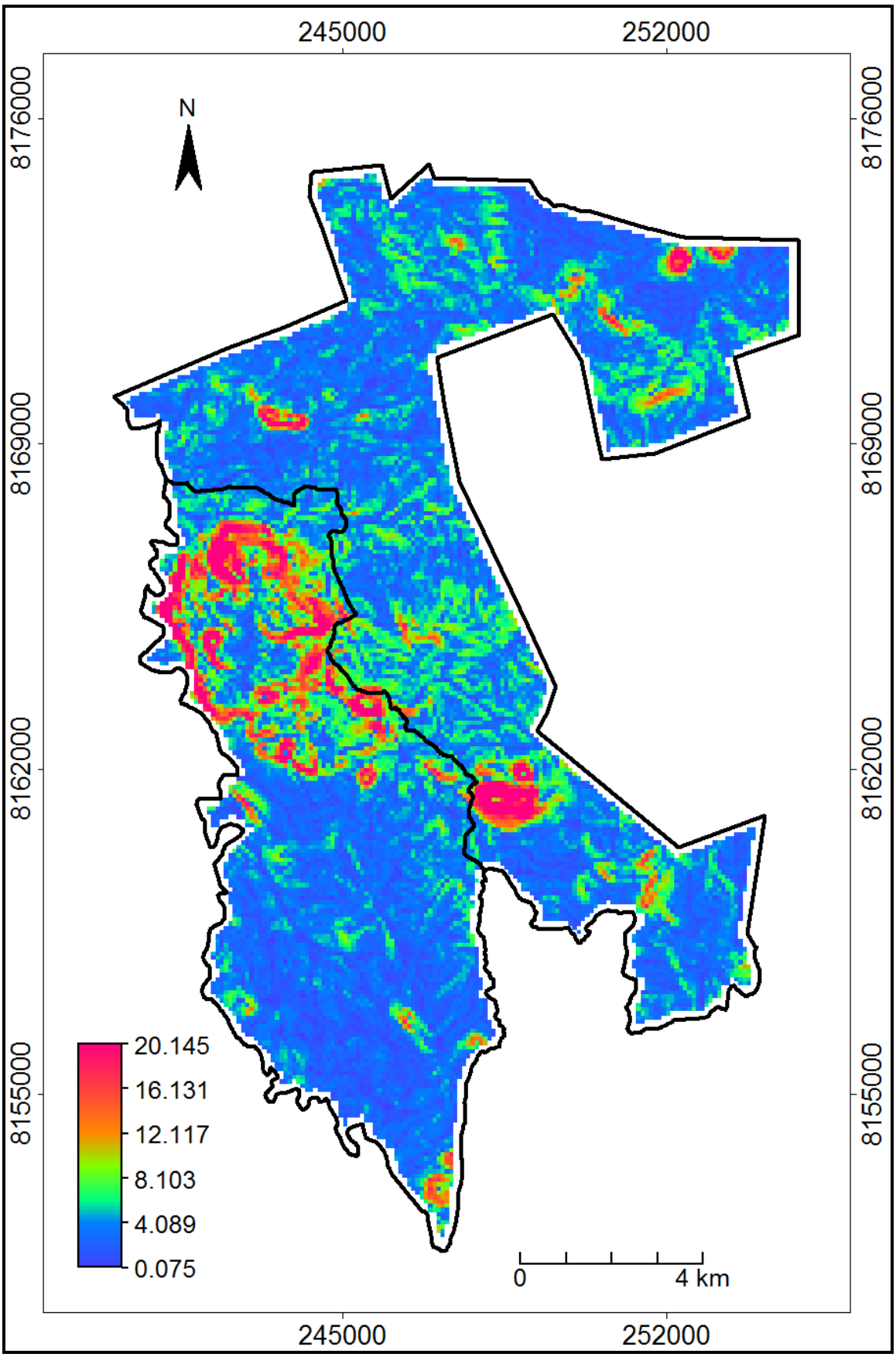


Figure 7.1: slope map in degrees for Wards 16 and 18 (source: extracted from the NASA's SRTM elevation data)

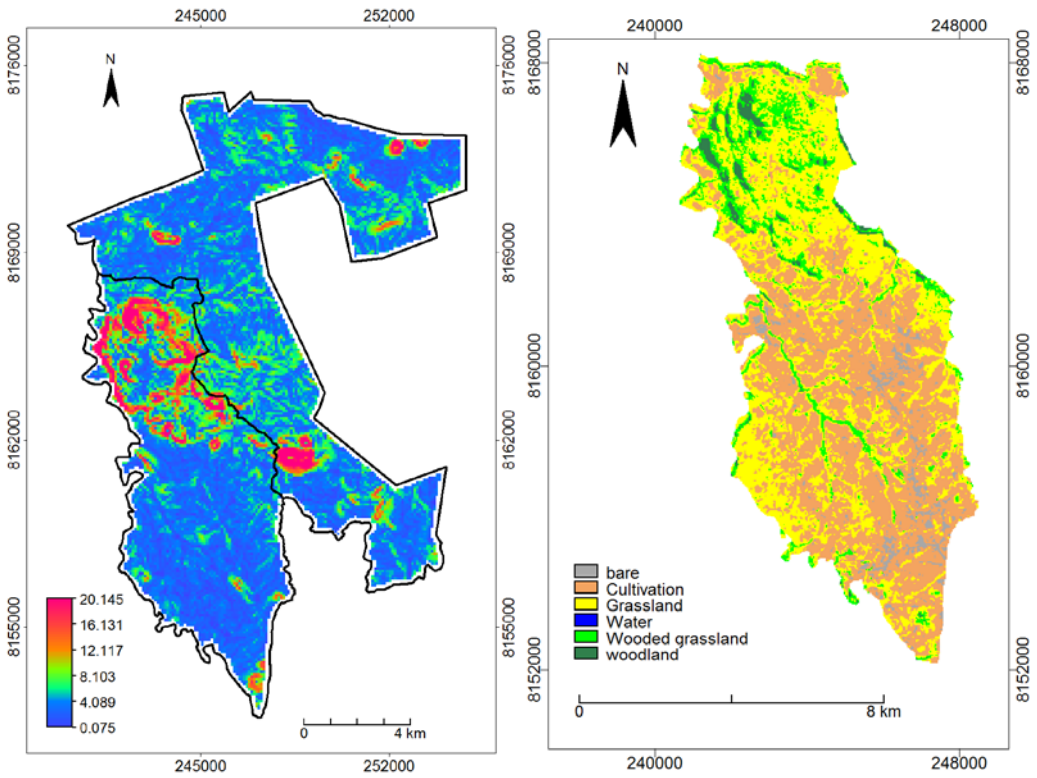


Figure 7.2 (a): slope map Figure 7.2 (b): Ward 18, 2008 land cover/use map

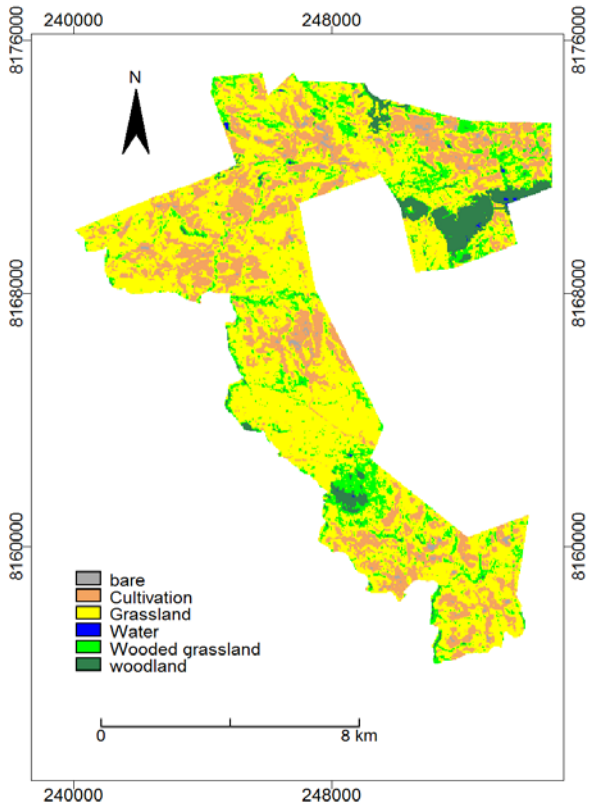


Figure 7.2 (c): Ward 16, 2008 land cover/use map

Figure 7.2 shows that most of the cultivated lands in Ward 18 were on slopes of between 0 and 8.103 degrees. The figure also shows that some fields were on slopes of between 16.131 and 20.145 degrees. In Ward 16, all the plots were on slopes of between 0 and 8.103 degrees. Not a single farmer in Ward 16 cultivated on fields of above 8.2 degrees.

From the interviews carried out, households explained that most of their fields (84%) were found on gentle slopes, while 30% were on steep slopes and 30% on very steep slopes. In Ward 16, no cultivation was done on steep or very steep slopes. Households in Ward 18 reported relying on crop production for both food and income generation. The major crops grown include maize which forms their staple diet and cotton which was one of their major cash income earners. The households in Ward 16 grew tobacco and maize as their major crops, with tobacco grown solely for sale.

7.3.5. Brick manufacturing

Households in Ward 18 used to use fuel wood to manufacture bricks for sale. In Ward 16 the farmers bought bricks from Harare, the capital city of Zimbabwe, to construct houses. The manufacturing of bricks in Ward 18 was reported as not being currently practiced because bricks required huge amounts of fuel wood which was now scarce.

7.3.6 Settlements

The majority of the houses in Ward 18 were built with poles, grass and *dagga*. The *Brachystegia spiciformis* (*Msasa)* tree bark was used to tie poles and grass while the nails were used to join the poles together so that a rondavel house could be constructed. (See photograph 4.5). The grass was cut along the edges of roads and from the A1 and A2 farms. Fencing around the yards was of poles and barbed wire. Stock pens were also made of poles and wire and some of them were thatched with asbestos sheets. The asbestos sheets were bought at the hardware shop at the Guruve Centre. In Ward 16, all households used bricks and asbestos sheets to build their houses.

7.3.7 Overgrazing

The numbers of cattle in Ward 18 were not as many as those in Ward 16 where a single farmer had an average of 650 cattle. Some households in Ward 18 had at most twenty while others had none at all. The cattle in Ward 18 were grazing on the communal grazing lands which households reported as being poor. Lack of land ownership in Ward 18 was

reported as contributing to the deterioration of the pasture lands as no household took good care of the pasture lands. None in this ward owns the pasture so each household was using the pasture lands for their own maximum benefit. This practise however, was to the detriment of the pasture lands.

The cattle in Ward 18 were reported as grazing on the same grazing lands throughout the year. Soon after harvesting, households reported that they would feed their cattle with maize stalks from their fields. In the grazing lands, households reported that the number of cattle on this portion was not limited as there were no strict conditions as to the number of cattle allowed to graze on a piece of pasture. In Ward 16, the cattle were grazing in paddocks and the farmers practised the rotation of paddocks to prevent the deterioration of pasture lands.

7.4 Results of research

The rate of woodland cover loss is high in Ward 18. A number of factors were discovered as contributing to deforestation within the ward. For the purpose of this research, only social and economic factors were recorded. The social factors contributing to woodland cover loss within the ward are settlement construction, clearing land for agriculture, overgrazing and cutting wood to provide energy for cooking. The economic factors were the clearing of woodlands to create land to grow crops for sale, especially cotton and maize, manufacturing of bricks, and cutting wood for sale. The population of the ward increased from 7,585 in 1989 to 7,846 in 2008. This increase put pressure on the existing forest as no person reported the planting of trees or replacement of trees that they had already destroyed. The increase in population also led to the increase in area under cultivation (23.6%). Households also reported using fuel wood for cooking and heating and, on average, households were using ten logs which are equivalent to a quarter of a tree, amounting to an average of seven trees per month. None of the households indicated the planting of trees, even on the National Tree Planting Day which is 1st of December. In Ward 16 households used electricity and had plantations which provided them with wood to use, especially during power cuts. On average households used an average of ten to fifteen logs, which they reported as being adequate. To cure tobacco they used coal which they bought from Hwange National Coal Company and fuel wood from their plantations. One of the farmers indicated the use of a gas stove during power cuts to prepare food. Ward 16 registered an increase in woodland cover throughout the study period because the

households had plantations. However a decrease in wooded grasslands was recorded for the 1989 to 2001 period. Cultivated lands also registered a decrease within the ward throughout the period. In Ward 18, cultivated lands recorded an increase throughout the study period because households needed to feed an increasing population.

The degradation or complete removal of forests which is occurring in Ward 18 has some negative effects on the social, economic and physical environment. The effects will not only be felt at a local scale but can also affect other neighbouring countries as pollution knows no boundaries. Some of the negative effects are shown in Figure 7.3.

7.4.1 Negative effects of removing forests

Before making recommendations, it is necessary first to discuss the negative effects of removing trees. The indiscriminate cutting down of trees without replacing them can result in various factors. Some of the effects are shown in Figure 7.3.

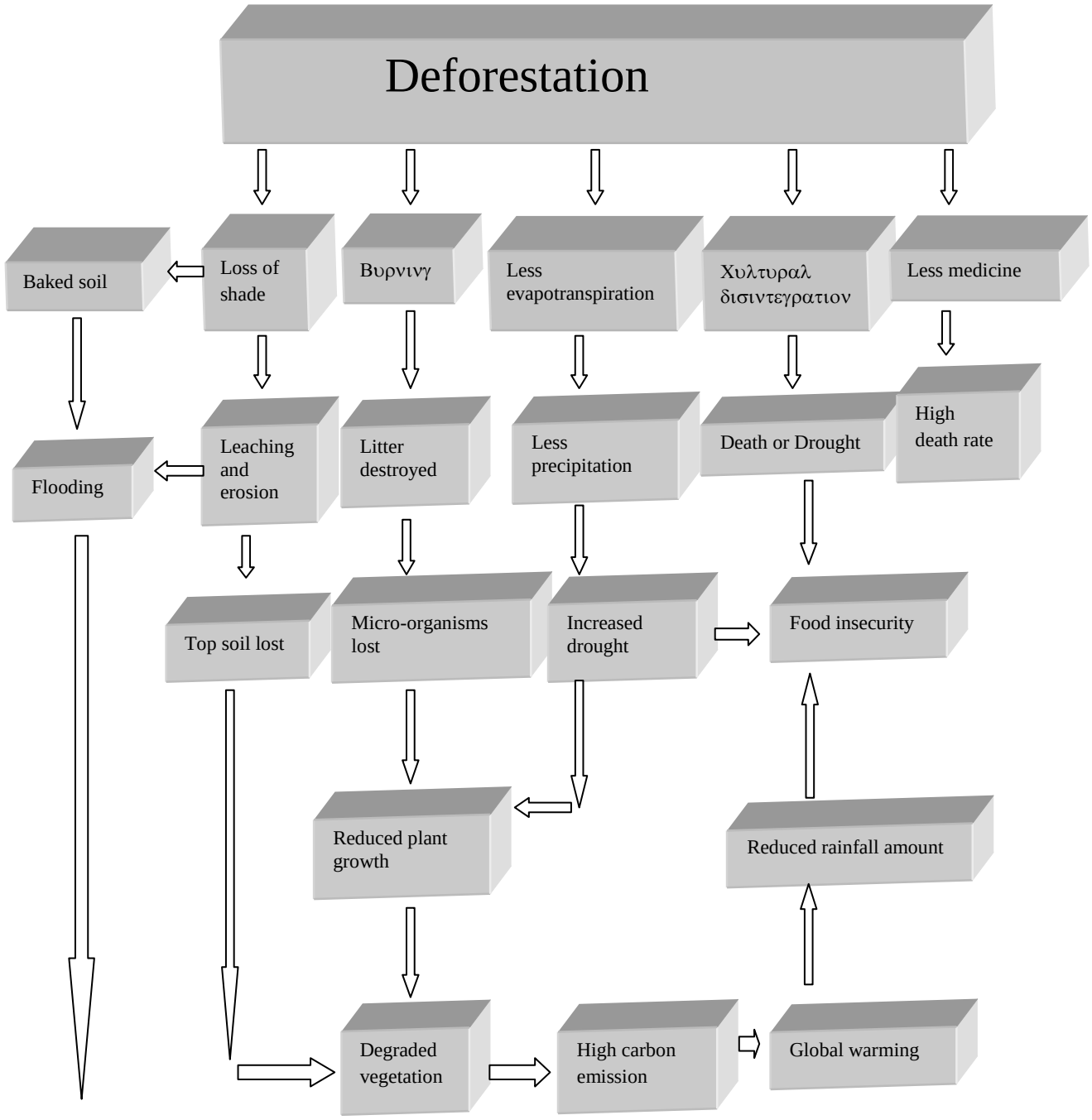


Figure 7.3: negative effects of removing forests (source: adapted from Drew, 1983)

Figure 7.3 shows that heat from the sun has the effect of burning litter and hence destroying it. When litter is destroyed, some of the organisms living within it will die and this will reduce plant growth. If the growth of plants is reduced, degraded vegetation will result. Since vegetation acts as a carbon sink, the degradation of vegetation implies that more carbon dioxide will be released into the atmosphere. The high concentration of carbon dioxide into the atmosphere will lead to the destruction of the ozone layer leading to global warming. Global warming has the effect of reducing rainfall amounts or making

rainfall more uncertain, and this will affect the food security status of poor households in developing countries, as in the communal areas of Zimbabwe such as Chipuriro. With high temperatures resulting from global warming, and ultraviolet radiation from the sun, people can suffer a number of diseases which include skin diseases, skin cancer and eye problems.

The change of climate in Southern Africa has been deduced to cause an increase in temperature of above 0.5^0 Celsius over the past century (Intergovernmental Panel on Climate Change [IPCC], 2001). This increase in temperature was found to cause a decrease in the amount of rainfall received (National Centre for Atmospheric Research [NCAR], 2005). Poor rainfall especially in rural areas where households depend solely on natural irrigation will negatively affect the food security status of those households. In countries such as Malawi, Zambia, Zimbabwe, Swaziland, Mozambique and Lesotho, the 2001 and 2002 drought was reported to have caused a food shortage of 1.2 million tonnes of cereals and other food requirements. These shortages were estimated at US$611 million (SADC, 2002).

The 1992 drought in South Africa was reported to have reduced the Gross Domestic Product by ZAR 1.2 billion and the country was reported to have faced an economic drop of 0.4 to 1.0% (Glantz, Betsill & Grandall, 1997).

Figure 7.3 shows that the cutting down of trees leads to loss of shade, thus exposing the soil to the sun's heat. Uncovered soil is exposed to the sun's heat and is highly vulnerable to leaching and erosion. With soil erosion, topsoil is lost and this leads to the degradation of the vegetation as humus or the top layer of soil is washed away by rainfall.

The amount of water collecting in the atmosphere through evapotranspiration is reduced with deforestation. This scenario has the effect of reducing the amount of precipitation received. With less precipitation there is less crop production and this also affects the food security status of poor households.

Trees provide medicines, either known or as yet unknown by researchers. The destruction of trees will thus lead to a reduction in supply of natural medicines and this will lead to more and more diseases with less or no medicines to fight them. Eventually people will die

if they continue to be short of medicines. Moreover, even if the medicines will be available they will be in short supply making them expensive to buy at pharmaceutical shops.

Trees play a crucial role in people's religious and traditional customs. Traditionally there are certain tree species which are designated as sacred. Agbo and Sokpon (1997) defined a sacred tree as 'a tree worshiped and/or feared and is devoted to the cultural expression of a fixed community'. Soury (2007) further reported that a sacred tree is accessed and managed by the traditional powers and is believed to be inhabited by spirits. The destruction of such tree species according to Diamond (2004) may lead to the collapse of certain societies. There are indigenous people whose life depends on the forests. These people depend on forests for their food and shelter. Once the forests are destroyed the lives of these people are also threatened.

In Zimbabwe, the Tonga people in Binga live in forests. Their children do not go to school. The elderly men teach the young boys how to hunt and the girls are taught by the elderly women how to cook. When a child is born, they cut the three middle toes and leave the big toe and the small toe. They believe the other toes will impede them when they want to climb trees quickly like monkeys. Dudley, Jeanrenaud and Sullivan (1995) also pointed to other groups of people like the Waorani of the Amazon's tropical rainforest, the Sami of Lapland's Taiga and the Kyuquot of Vancouver Island's temperate rainforest as being wholly dependent on forests for their livelihood. The destruction of forests, to these groups of people, would mean a destruction of their traditional culture and they would be forced to adapt to a new environment.

In the Chipuriro communal lands, there are certain tree species which once removed may lead to drought or death and are hence not to be removed. These trees are regarded as sacred. The *Afzelia quanzensis* (*Mugogoma*) tree is a sacred tree and is not to be removed as its removal will lead to drought. Before the rainy season, the traditional healers of the community gather under the tree and perform their traditional rituals. During that period, the traditional healers will consult the ancestors concerning the rain. They sing traditional songs and dances and drink traditional beer. After performing this activity, as reported by one of the local elders, hardly a week will pass before the area receives some rainfall.

The *Pseudolachnostylis maprouneifolia* (*Mutsonzowa*) tree is also a sacred tree within the same communal area. The tree is used to cover the top of the grave, hence no-one is

allowed to use it as it is associated with death. The *Ochna schweinfurthiana* (*Muminu*) tree is also not used either for building or firewood as it is believed that once used, the tree will cause the family to separate (divorce) or cause one of the household members to become sick or die. The *Parinari curatelifolia* (*Muhacha*) tree leaves are used by the Johannes Masowe Christian Church to chase away bad spirits. The leaves are dipped in water and the afflicted person is asked either to bathe in the water with the leaves or to drink it, for a number of stated days, so that the bad spirits will leave the person.

From the preceding discussions it is clear that trees play a major role in our life. It is therefore very important to use them in a sustainable manner. After considering the factors affecting deforestation in the Chipuriro lands and the negative effects of removing trees on both the local and global scale, the following recommendations are made.

7.5 Recommendations

7.5.1 Controlling and managing deforestation

The government should recognise that trees which are actually the source of life are under threat from the increasing population in most communal areas of Zimbabwe. There is therefore a need to protect the existing forest in order to prevent further damage or complete destruction and, last but not least, to avoid the consequences explained in Figure 7.3. The best way is to ensure that everyone (especially the people who do not reside in forests) are made aware of the importance of trees and how to protect them. The government must incorporate forest protection and management awareness programmes into school curricula and into the Agricultural and Research Extension (AREX) officials' messages.

The government must reinforce orders or charges on those who are found cutting down trees. The government must also encourage every household to plant at least one tree every month so that they can replace the trees that they have already destroyed. People must establish nurseries where they will obtain the seeds for the trees they want to grow. They must grow fast-growing trees to provide for their immediate demands.

7.5.2 Introduction of farming lessons

Farmers' schools should be introduced with affordable fees so that the people can learn methods of conserving the soil and trees at low cost. The schools must teach households, especially in the communal areas, the skills of proper timing of the onset of the farming season and how to grow varied crops that also give them higher income such as tobacco and paprika. If households have adequate money they will be able to fight poverty in their locality and find a remedy against food insecurity.

7.5.3 Diversifying income-generating activities

One of the best ways the people in Chipuriro can diversify their income-generating projects is to include economic activities other than crop production. They must practise poultry, bee farming and pig rearing.

7.5.4 Storing adequate food

Households in Ward 18 must keep adequate food for the whole year. This conclusion comes from the realisation that some households, who reported food insecurity within the ward, were selling their produce before meeting their own food requirements. Households are therefore supposed to be informed, especially by the AREX officials, that they must keep enough food until the next harvesting period.

7.5.5 Afforestation

Households in Ward 18 must grow trees on all the bare surfaces. The headmen and the AREX officials must help the households with supervision of these tasks.

7.5.6 Climate change mitigation

To reduce climate change, people all over the world are supposed to put into practice very stringent programmes for the conservation of trees. They must reduce the emission of greenhouse gases that destroy the ozone layer. This practice must be carried out at an international level as pollution knows no boundaries. Internationally, governments can also implement Dept-for-Nature-Swaps. In this case Western governments can encourage the governments of developing countries to conserve trees based on an agreement that the developed governments will cancel the debts owed to them by developing countries. This agreement will be grounded in the fact that it is in the developed countries that most greenhouse gases are emitted.

7.5.7 Local involvement in nature conservation programmes

Governments in their plans to conserve trees must involve locals. Communities must be encouraged to form groups to supervise nature conservation. There must be a group of people who will manage the various activities required for the protection of natural resources, for example sourcing of funding for reforestation, organizing of awareness campaigns, developing the use of improved fireplaces to reduce fuel wood wastage as the four-legged traditional stoves waste wood, and putting into practice the planting of trees. The group must also encourage people to practise family planning and hence control population growth. Locals must be involved as they will not only protect their sacred tree species but will also protect other endangered species. These people know their area more than any other person outside their community. Local governments must use a bottom-up approach.

7.5.8 Reforestation

People must grow fast-growing fuel wood trees in degraded forest areas. The trees will quickly supply them with much-needed fuel wood. They must also grow trees that will provide them with nuts. The nuts will provide proteins and help to reduce malnutrition and with the nuts people can fight against food insecurity in their communities. Apart from gaining protein, households can sell surplus nuts and earn income. The income can be used to buy other basic household needs.

7.5.9 Controlling grazing lands

People must work as a community and control the number of cattle grazing on their grazing lands, and the duration of the grazing. This should be done to avoid exceeding the carrying capacity. The community have to replant barren areas with grass seeds and apply fertilizer. The grass they plant must be fast growing and must be palatable to animals.

7.5.10 Poverty reduction

Poverty and dependence on natural resources are two things that work hand in hand. If people are poor it is very hard to conserve nature as poor people are highly dependent on the resources freely provided by nature. Therefore if we plan to sustainably conserve woodlands in the Chipuriro communal lands we should also work on lessening poverty and find other ways for people to survive without abusing natural resources. Poverty alleviation

programmes must be put into practise so that the natural resources that are over-exploited can be spared, as people will have other survival strategies.

7.5.11 Farming on already degraded land

People must concentrate their farming on already degraded land. This practise has the advantage that people will not clear more land for cultivation. They must add manure and fertilizer if they are to increase production on such pieces of land. They must practise new farming technologies, such as 'Farming in Gods' Way' which causes fewer disturbances to the soil and requires very minimum tillage. Farming in God's Way is a farming technique which involves digging small holes in an uncultivated land during the dry season and packs the holes with fertilizer. With the onset of rains seeds are dropped inside the holes and covered with soil (retrieved March 20, 2012, from www.farming God's way in Zimbabwe-IPS-Terraviva_Africa.html).

7.6 Possible future research

Deforestation is occurring at a rapid rate, especially in the communal areas of Zimbabwe. Poverty, unemployment, lack of money to buy bricks for house construction, lack of capital to buy farm necessities such as fertilizer to improve the soil, and the absence of other alternative sources of energy for cooking, means that households will have to rely on clearing woodlands for a long time to come. Research is thus essential, especially regarding sources of energy, to help in identifying sources that households can use apart from fuel wood. The findings of this research have shown that all households in the Chipuriro communal area rely on fuel wood for cooking, most houses are built with wood, and all households rely on agriculture for income and food generation, and yet none seems to replace the trees they have already destroyed. This fact leads to an important need for research on how the community can use the natural resources (trees) in a sustainable manner. There is also need for research on other activities in which households can engage themselves so that they can stop being reliant on crop cultivation for income generation. There is a need for research on activities households can be involved in that would help them to become employed, which in turn will reduce poverty and help to reduce the use of trees for house construction, as their standard of living would have improved.

The other area relates to overgrazing, which is partly responsible for deforestation. There is a need to research how households can feed their cattle without exceeding the carrying capacity of grazing land, as this has been known to kill plants and is still killing plants in the Chipuriro lands.

7.7 Conclusion

This chapter presented the summary, conclusion, and negative consequences of removing forests in the world. The chapter further expanded on recommendations that will help households in managing deforestation and improving their food security in the communal areas. Topics for further research were also suggested. This research has revealed that in the communal areas poverty coupled with population growth with its demand on forest resources is the root cause of forest destruction. It has also shown that deforestation is high in communal areas where no single household plants trees and where resources are communally owned.

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APPENDIX A

LETTER OF PERMISSION BY THE COMMUNITY FOR THE PARTICIPATION IN THE RESEARCH

TO WHOM IT MAY CONCERN

This questionnaire is part of the research done by Agreement Hlanganayi, student number 4616546-0, for the degree of Masters of Science in Environmental Management at the College of Agriculture and Environmental Science, UNISA.

The aim of the research is to examine the socio-economic factors affecting deforestation and the patterns of deforestation in Chipuriro lands. It is therefore of great importance that people complete this questionnaires in order to come to conclusions regarding deforestation and make suggestions to manage it. If you need feedback you are free to contact the researcher. The researcher chooses Ward 16 and 18 to make room for comparisons.

Names of respondents will not be recorded throughout the study. The information gathered will be treated as confidential and is for academic study.

For any information contact the researcher on the following:
93 Ecaleni Section
Tembisa
1632
Johannesburg

Contact cell: 074 708 1425
E-mail address: agreement5h@yahoo.com
Your participation in this research is greatly appreciated.

Yours faithfully
Agreement Hlanganayi (Researcher)

APPENDIX B

LETTER OF CONCERT FROM UNISA

UNISA university of south africa

Stud nr/no: 4616 5460
Navrae/Enq: Mrs P N Ngcobo
Tel: (011)471-3296
Faks/Fax: (012)429-4150

2011-12-12

TO WHOM IT MAY CONCERN

This letter serves to inform you that Ms Agreement Hlanganayi , student number 4616 5460 is a registered student at the University of South Africa (UNISA). Proof of registration is attached to this letter.

She is carrying out a research project on : Deforestation in Chipuriro Lands (Guruve) Socio-Economic factors and patterns.

We would hereby like to request that you permit her to conduct her research in your district.

Your favourable response will be highly appreciated.

Yours sincerely

Prof. W A J Nel

Supervisor and Chair of Department: Environmental Sciences
nelwaj@unisa.ac.za
Tel. 011-471 2324
Cell. 082 836 0372

UNIVERSITEIT VAN SUID-AFRIKA
PRETORIA
UNIVERSITY OF SOUTH AFRICA

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX C

LETTER OF CONSENT FROM THE DISTRICT ADMINISTRATOR OF GURUVE.

Ministry of Local Government, Rural and Urban Development

Correspondence should not be addressed to individuals

ZIMBABWE

Office of the District Administrator
P.O Box 10
Guruve

Telephone: 058-2217
Telefax: 058-2262

Reference: MIN/1

Wednesday, December 21, 2011

TO WHOM IT MAY CONCERN

RE:HLANGANAYI AGREEMENT UNISA STUDENT(46165460)-MSC ENVIRONMENT MANAGEMENT

The above mentioned student can carry out her research in Guruve District.

N GATSI
DISTRICT ADMINISTRATOR - GURUVE

DISTRICT ADMINISTRATOR
MIN. OF LOCAL GOVERNMENT
AND NATIONAL HOUSING
21 DEC 2011
P.O. BOX 10 GURUVE
ZIMBABWE. Tel: 2217

APPENDIX D

LETTER OF CONSENT FROM THE HOUSEHOLDS

TO WHOM IT MAY CONCERN

I, (full name and surname) hereby give permission to participate in the research process by completing a questionnaire.

I have taken into consideration the following:

a) No names will be recorded throughout the study.
b) Data collected will be treated as strongly confidential.
c) The data collected is mainly for academic purposes.
d) The data collected will be stored at a safe place for a period of four years.

_____ _____

Signature Date

_____

Witness

Thank you for your time, have a good day.

APPENDIX E

How to calculate Kappa Statistics

Kappa statistics for August 1989, September 2001 and August 2008 were calculated using the following formula. Kappa = (Observed –Expected)/ (1-Expected). Table 1a, b and c show the kappa for 1989, 2001 and 2008.

Table 1(a): 1989 Kappa Statistics

	B	CL	GL	W	WG	WL	ACCURACY
Bare (B)	36	0	0	0	0	1	0.97
Cultivation (CL)	3	16	0	0	1	0	0.8
Grassland (GL)	0	1	28	0	2	1	0.88
Water (W)	0	0	0	20	0	0	1
Wooded grassland (WG)	4	1	4	0	28	0	0.76
Woodland (WL)	0	0	0	0	1	28	0.96
RELIABILITY	0.83	0.88	0.88	1	0.88	0.93	
Observed Accuracy	0.89	89%					
Expected	0.1772						
Kappa	0.86585						

Table 1(b): 2001 Kappa statistics

	B	**CL**	**GL**	**W**	**WG**	**WL**	**ACCURACY**
Bare (B)	29	3	0	0	0	0	0.91
Cultivation (CL)	0	20	4	0	0	0	0.83
Grassland (GL)	1	0	36	0	2	2	0.88
Water (W)	0	0	0	40	0	0	1
Wooded grassland (WG)	1	0	0	0	20	1	0.91
Woodland (WL)	0	0	1	0	2	28	0.9
RELIABILITY	0.93	0.87	0.88	1	0.83	0.9	
Observed Accuracy	**0.85**	**85%**					
Expected	**0.1749**						
Kappa	**0.81928**						

Table 1(c): 2008 Kappa Statistics

	B	CL	GL	W	WG	WL	ACCURACY
Bare (B)	29	3	0	0	0	0	0.91
Cultivation (C)	0	20	4	0	0	0	0.83
Grassland (GL)	0	0	36	0	0	0	1
Water (W)	0	0	0	40	0	0	1
Wooded grassland (WG)	0	0	0	0	16	4	0.8
Woodland (WL)	0	0	0	0	0	36	1
RELIABILITY	1	0.87	0.9	1	1	0.9	

Observed Accuracy	**0.94**	**94%**
Expected	**0.17768**	
Kappa	**0.92683**	

APPENDIX F

Welch's t-test Formula

$$t = \frac{\overline{X}_1 - \overline{X}_2}{s_{\overline{X}_1 - \overline{X}_2}}$$

$$s_{\overline{X}_1 - \overline{X}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}.$$

n = number of participants, 1 = group one, 2 = group two and S^2 stands for variance.

Welch-Satterthwaite equation

$$\text{d.f.} = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{(s_1^2/n_1)^2/(n_1 - 1) + (s_2^2/n_2)^2/(n_2 - 1)}.$$

Source: Retrieved March 30, 2012, from http://en.wikipedia.org/wiki/Welch%E2%80%93Satterthwaite_equation.

APPENDIX G

Calculating the sample size for a population of less than 10 000.

$$n^* = \frac{384}{\left[1+\frac{384}{889}\right]}$$

=268.

Where:

*n** = necessary sample size

n = desired sample size when population is greater than 10000 (384)

N = estimated population size (which is 889 households)

n/N = the sampling fraction.

Source: Mutambirwa (2002).

APPENDIX H

Interview Guide with the Agricultural Research and Extension Officials

My name is Agreement Hlanganayi, a Masters student in the College of Agriculture and Environmental Science at the University of South Africa. I am carrying out a research on the socio-economic factors affecting deforestation and the pattern of deforestation in the Chipuriro lands. Are you comfortable to participate? In this discussion, for privacy sake, no names shall be recorded. The information obtained will only be used for the purpose of the academic study. Your cooperation in responding to this questionnaire will be greatly appreciated. Please circle the correct code for the answer and where possible write down the answer.

Section 1: Work place Profile

1.1 What ward numbers do you cover?

1-10	1
11-20	2
21-30	3
Other specify	4

1.1 How long have you been working in those wards?

1-10	1
11-20	2
21-30	3
31-40	4
Other specify	5

1.2 How often do you have a meeting with the farmers?

Once every forty-night	1
Twice a month	2
Once a month	3
Other specify	4

Section II: Land use and Production Profile

2.1 How would you describe the slope of the land that people in your wards cultivate?

Gentle	1
Medium	2
Steep	3
Very steep	4

2.2 How would you describe the quality of the soil in each ward?

Very good	1
Good	2
Medium	3
Poor	4
Very poor	5

2.3 What soil conservation/soil improvement has you encouraged farmers to apply in your wards? Tick where appropriate.

Manure application	1
Crop rotation	2
Contour ridging	3
Fertilizer	4
Other specify	5

Section III: Resource Use and Management

3.1 What source of source of energy do most households use for domestic purposes?

Electricity	1
Paraffin	2
Fuel wood	3
De-husked maize cobs	4
Cow dung	5
Other	6

3.2 What resources do they use to construct buildings, fencing and stock pens?

Nails	1
Wooden poles	2
Steel wire	3
Steel poles	4
Asbestos tiles	5
Other specify	6

3.3 Where do they source these resources?

Shops	1
Maunzi mountain	2
A1 and A2 farms	3
From their own plantations	4
Other specify	5

3.4 What is your opinion on deforestation in your area?

It exists	1
It does not exist	2
I don’t know	3

3.5 If existing, what do you think could have caused it?

Population growth	1
Overgrazing	2
Demand for land for cultivation	3
Demand for fuel wood	4
Poverty	5
Demand for settlement	6
Other specify	7

3.6 What measures have you taken to conserve wood?

Plant trees	1
Use cow dung to reduce pressure on fuel wood	2
Limit the number of cattle grazing per unit area	3
Other specify	4

Are you happy with the discussion? Do you feel your participation was fair or unfair?

Do you have any other things to add or subtract on this issue?

APPENDIX I

Interview Guide with the headmen in Chipuriro lands

My name is Agreement Hlanganayi, a Masters student in the College of Agriculture and Environmental Science at the University of South Africa. I am carrying out a research on the socio-economic factors affecting deforestation and the pattern of deforestation in the Chipuriro lands. Are you comfortable to participate? In this discussion, for privacy sake, no names shall be recorded. The information obtained will only be used for the purpose of the academic study. Your cooperation in responding to this questionnaire will be greatly appreciated. Please circle the correct code for the answer and where possible write down the answer.

Section 1: Demographic Profile

1.1 How long have you been a headman in this ward?

1-10	1
11-20	2
21-30	3
31-40	4
Other specify	5

1.2 How many households are in your ward?

100-150	1
151-200	2
201-250	3
251-300	4
Other specify	5

1.3 How would you describe the household food security status in the ward at household level and at community level?

Household Level		Community Level	
Very Critical shortage	1	Very Critical shortage	1
Critical shortage	2	Critical shortage	2
Average	3	Average	3
Satisfactory	4	Satisfactory	4

1.4 If the food security situation is critical or very critical, what strategies are households using to cope with the food shortages?

Rely on stock sales	1
Rely on crop sales	2
Rely on brick manufacturing	3
Rely on fuel wood sale	4
Rely on donors	5
Rely on remittances	6
Other specify	7

1.5 How effective are these strategies in improving household food security?

Very effective	1
No difference	2
Not effective	3

Section II: Land use and Production Profile

2.1 What is the average number of fields per household?

1 field	1
2 fields	2
3 fields	3
4 fields	4
Other specify	5

2.2 What is the quality of the soil in your ward?

Excellent	1
Good	2
Satisfactory	3
Poor	4
Very poor	5

2.3 What is the quality of the grazing lands in your ward?

Excellent	1
Good	2
Satisfactory	3
Poor	4
Very poor	5

2.4 If poor/ very poor, can you explain why the grazing land is poor /very poor?

Too many animals per unit time and space	1
Space for feeding is too limited	2
No other feeds for the stock as the grazing lands recover	3
Other specify	4

Section III: Conservation profile

3.1 What is your opinion on deforestation in your area?

It exists	1
It does not exist	2
I don’t know	3

3.2 If existing, what do you think could have caused it?

Population growth	1
Overgrazing	2
Demand for land for cultivation	3
Demand for fuel wood	4
Poverty	5
Demand for settlement	6
Other specify	7

3.3 What measures have you taken to conserve wood?

Plant trees	1
Use cow dung to reduce pressure on fuel wood	2
Limit the number of cattle grazing per unit area	3
Other specify	4

3.4 How successful were the practices?

Not successful	1
Successful	2
Very successful	3
No change	4

3.5 What do you think should be done to control deforestation?

Plant trees	1
Use electricity	2
Use biogas	3
Use solar energy	4
Educate households on the importance of trees	5
Other specify	6

Are you happy with the discussion? Do you feel your participation was fair or unfair?

Do you have any other thing to add or subtract on this issue?

APPENDIX J

Interview Guide with the Households in Chipuriro Communal Area

My name is Agreement Hlanganayi, a Masters student in the College of Agriculture and Environmental Science at the University of South Africa. I am carrying out a research on the social and economic factors affecting deforestation and the pattern of deforestation in the Chipuriro lands. Are you comfortable to participate? In this discussion, for privacy sake, no names shall be recorded. The information obtained will only be used for the purpose of the academic study. Your cooperation in responding to this questionnaire will be greatly appreciated. Please circle the correct code for the answer and where possible write down the answer.

Section 1: Life history of the farmer

What is the number of your Ward?

Ward 16	1	Ward 18	2

1.2 How many people live in your household including yourself? State their age and gender.

a)

	Age	Number
1	1-18	
2	19-65	
3	65+	

b)

	Gender	Number
1	Female	
2	Male	

1.3 What is your highest level of schooling?

Primary	1
Secondary	2
College	3
University	4
None of the above	5

1.4 How long have you stayed in this ward?

1-10 years	1
11-20 years	2
21-30 years	3
Other specify	4

1.5 Which of these are your sources of income?

Wages from formal employment	1
Crop Sales	2
Fuel wood sales	3
Livestock sales	4
Vegetable sales	5
Remittances	6
Other specify	7

1.6 If other, please specify----------

1.7 From your source/s of income, how much do you earn per month in United States dollars?

Less than US$500	1
Above US$500	2

1.8 How would you describe the household food security status in the ward at household level and at community level?

Household Level		Community Level	
Very Critical shortage	1	Very Critical shortage	1
Critical shortage	2	Critical shortage	2
Average	3	Average	3
Satisfactory	4	Satisfactory	4

1.9 If the food security situation is critical, what strategies are households using to cope with the food shortages?

Rely on stock sales	1
Rely on crop sales	2
Rely on brick manufacturing	3
Rely on fuel wood sale	4
Rely on donors	5
Rely on remittances	6
Other specify	7

1.10 How effective are these strategies in improving household food security?

Very effective	1
No difference	2
Not effective	3

Section II: Land use and Production Profile

2.1 How many fields do you have?

1 field	1
2 fields	2
3 fields	3
4 fields	4
Other specify	5

2.2 How many acres is each field?

1 acre	1
2 acres	2
3 acres	3
Other specify	4

2.3 What crops did you cultivate in the following seasons?

Crops	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
1. Maize						
2. Cotton						
3. Sugar beans						
4. Tobacco						
5. Paprika						
6. Sweet potatoes						
5. Other						

2.4 If other, please state. ----------

2.5 Do you sell your products?

Yes	1
No	2

2.6 Where do you sell your products?

I sell to the Grain Marketing Board	1
I sell to the Cotton Marketing Board	2
I sell to the Tobacco Auction Floors in Harare	3
I sell to the local households	4

2.7 Do you rear any livestock?

Yes	1
No	2

2.8 If yes, what do you rear and how much livestock of each kind do you have?

Type of Livestock		Total number of livestock
1	Cattle	
2	Donkeys	
3	Goats	
4	Sheep	
5	Other	

2 .9 If other, please state? ----------

2.10 What do you keep your livestock for?

For meat	1
To pay farm labours	2
For prestigious purpose	3
To pay bride payments (Lobola)	4
Other specify	5

2.11 Where do you graze your livestock?

Communal grazing lands	1
Paddocks	2
Other specify	3

2.12 If paddocks, where do you get the food for the livestock?

Shops	1
Steal from the A1 and A2 farms	2
Other specify	3

2.12 How do you rate the quality of the grazing lands?

Excellent	1
Good	2
Satisfactory	3
Poor	4
Very poor	5

2.13 If poor/ very poor, why the grazing land is poor /very poor?

Too many animals grazing per unit time and space.	1
Space for feeding is too limited.	2
No other feeds for the stock as the grazing lands recover.	3
Other specify	4

`

Section III: Description of the area under cultivation

3.1 How would you describe the slope of the land that you cultivate?

Gentle	1
Medium	2
Steep	3
Very steep	4

3.2 How would you describe the quality of the soil that you cultivate?

Good	1
Medium	2
Poor	3
Very poor	4

3.3 What soil conservation/soil improvement do you apply in your farm?

Manure application	1
Crop rotation	2
Contour ridging	3
Fertilizer	4
None	5
Other specify	6

3.4 If other, please specify? ----------

Section VI: Resource Use and Management

4.1 What source of source of energy do you use for domestic purposes?

Electricity	1
Paraffin	2
Fuel wood	3
De-husked maize cobs	4
Cow dung	5
Other	6

4.2 If wood, how many logs do you use per day? A log is a wood of meters length.

1-5	1
6-10	2
11-15	3
Other specify	4

4.3 Is that sufficient?

Yes	1
No	2

4.4 If not, why?

My family is too big	1
The logs do not produce enough charcoal	2
The logs are too thin	3
Other specify	4

4.5 How often do you collect it?

Once a week	1
Once a forty-night	2
Twice a month	3
Once a month	4

4.6 Do you stockpile the wood?

Yes	1
No	2

4.7 Where do you source the wood?

Buy from the vendors	1
Steal from the A1 and A2 farms	2
Collect from Maunzi Mountain	3
Collect from the surroundings	4
Collect from my plantation	5
Other specify	6

4.8 Which tree specie do you prefer?

Brachystegia spiciformis	1
Julbernadia globiflora	2
Syzigium spp	3
Azanza garckeana	4
None selective	5
Other	6

4.9 Why do you prefer that specie?

The most common specie	1
Produces lots of charcoal	2
Easy to get	3
Is highly inflammable	4
Other specify	5

4.10 Do you have an alternative source of fuel?

Yes	1
No	2

4.11 Given the resources what alternative source of fuel would you like?

Paraffin	1
Electricity	2
Biogas	3
Solar power	4
Other Specify	5

4.12 Explain why?

Its clean	1
It's used for many things eg to power radios, and televisions	2
I won't use my energy to have it	3
It cheaper	4
Other specify	5

4.13 What resources do you use to build buildings, fencing and stock pens?

Nails	1
Wooden poles	2
Steel wire	3
Steel poles	4
Other specify	5

4.14 Where do you source these resources?

Shops	1
Maunzi mountain	2
A1 and A2 farms	3
From my plantation	4
Other specify	5

4.15 What is your opinion on deforestation in your area?

It exists	1
It does not exist	2
I don't know	3

4.16 If existing, what do you think could have caused it?

Population growth	1
Overgrazing	2
Demand for land for cultivation	3
Demand for fuel wood	4
Poverty	5
Demand for settlement	6
Other specify	7

4.17 What measures have you taken to conserve wood?

Plant trees	1
Use cow dung to reduce pressure on fuel wood	2
Limit the number of cattle grazing per unit area and time	3
Other specify	4

Are you happy with the discussion? Do you feel your participation was fair or unfair?

Do you have any other thing to add or subtract on this issue?

APPENDIX K

Interview Guide with the Large Scale Commercial farmers

My name is Agreement Hlanganayi, a Masters student in the College of Agriculture and Environmental Science at the University of South Africa. I am carrying out a research on the social and economic factors affecting deforestation and the pattern of deforestation in the Chipuriro lands. Are you comfortable to participate? In this discussion, for privacy sake, no names shall be recorded. The information obtained will only be used for the purpose of the academic study. Your cooperation in responding to this questionnaire will be greatly appreciated. Please circle the correct code for the answer and where possible write down the answer.

Section 1: Life history of the farmer

1.1 What is the number of your Ward?

Ward 16	1	Ward 18	2

1.2 How many people live in your household including yourself? State their age and gender.

a)

	Age	Number
1	1-18	
2	19-65	
3	65+	

b)

	Gender	Number
1	Female	
2	Male	

1.3 What is your highest level of schooling?

Primary	1
Secondary	2
College	3
University	4
None of the above	5

1.4 How long have you stayed in this ward?

1-10 years	1
11-20 years	2
21-30 years	3
Other specify	4

1.5 Which of these are your sources of income?

Wages from formal employment	1
Crop Sales	2
Fuel wood sales	3
Livestock sales	4
Vegetable sales	5
Remittances	6
Other specify	7

1.6 If other, please specify----------

1.7 From your source/s of income, how much do you earn per month in United States dollars?

Less than US500	1
Above US500	2

1.8 How would you describe the household food security status in the ward at household level and at community level?

Household Level		Community Level	
Very Critical shortage	1	Very Critical shortage	1
Critical shortage	2	Critical shortage	2
Average	3	Average	3
Satisfactory	4	Satisfactory	4

1.9 If the food security situation is critical, what strategies are households using to cope with the food shortages?

Rely on stock sales	1
Rely on crop sales	2
Rely on brick manufacturing	3
Rely on fuel wood sale	4
Rely on donors	5
Rely on remittances	6
Other specify	7

1.10 How effective are these strategies in improving household food security?

Very effective	1
No difference	2
Not effective	3

Section II: Land use and Production Profile

2.1 How many plots do you have?

1 plot	1
2 plots	2
3 plots	3
4 plots	4
Other specify	5

2.2 How many hectares is each field?

1 hectare	1
2 hectares	2
3 hectares	3
Other specify	4

2.3 What crops did you cultivate in the following seasons?

Crops	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
1. Maize						
2. Cotton						
3. Sugar beans						
4. Tobacco						
5. Paprika						
6. Sweet potatoes						
5. Other						

2.4 If other, please state. ---------- ----------

2.5 Do you sell your products?

Yes	1
No	2

2.6 Where do you sell your products?

I sell to the Grain Marketing Board	1
I sell to the Cotton Marketing Board	2
I sell to the Tobacco Auction Floors in Harare	3
I sell to the local households	4

2.7 Do you rear any livestock?

Yes	1
No	2

2.8 If yes, what do you rear and how much livestock of each kind do you have?

Type of Livestock		Total number of livestock
1	Cattle	
2	Donkeys	
3	Goats	
4	Sheep	
5	Other	

2 .9 If other, please state? ----------

2.9 What do you keep your livestock for?

For meat	1
To pay farm labours	2
For prestigious purpose	3
For sale	4
To pay bridewealth payments (Lobola)	5
Other specify	6

2.10 Where do you graze your livestock?

Communal grazing lands	1
Paddocks	2
Other specify	3

2.11 If paddocks, where do you get the food for the livestock?

Shops	1
Steal from the A1 and A2 farms	2
Other specify	3

2.12 How do you rate the quality of the grazing lands?.

Excellent	1
Good	2
Satisfactory	3
Poor	4
Very poor	5

2.13 If poor/ very poor, why the grazing land is poor /very poor?

Too many animals grazing per unit time and space.	1
Space for feeding is too limited.	2
No other feeds for the stock as the grazing lands recover.	3
Other specify	4

Section III: description of the area under cultivation

3.1 How would you describe the slope of the land that you cultivate?

Gentle	1
Medium	2
Steep	3
Very steep	4

3.2 How would you describe the quality of the soil that you cultivate?

Good	1
Medium	2
Poor	3
Very poor	4

3.3 What soil conservation/soil improvement do you apply in your farm?

Manure application	1
Crop rotation	2
Contour ridging	3
Fertilizer	4
None	5
Other specify	6

3.4 If other, please specify? ----------

Section VI: resource use and management

4.1 What source of source of energy do you use for domestic purposes?

Source	Very important
Electricity	1
Paraffin	2
Fuel wood	3
De-husked maize cobs	4
Cow dung	5
Other	5

4.2 If wood, how many logs do you use per day? A log is a piece of wood of about one meters in length.

1-5	1
6-10	2
11-15	3
Other specify	4

4.3 Is that sufficient?

Yes	1
No	2

4.4 If not, why?

My family is too big	1
The logs do not produce enough charcoal	2
The logs are too thin	3
Other specify	4

4.5 How often do you collect it?

Once a week	1
Once a forty-night	2
Twice a month	3
Once a month	4

4.6 Do you stockpile the wood?

Yes	1
No	2

4.7 Where do you get the wood?

Buy from the vendors	1
Steal from the A1 and A2 farms	2
Collect from Maunzi Mountain	3
Collect from the surroundings	4
Collect from my own plantations	5
Other specify	6

4.8 Which tree specie do you prefer?

Brachystegia spiciformis	1
Julbernadia globiflora	2
Syzigium spp	3
Azanza garckeana	4
None	5
Other	6

4.9 Why do you prefer that specie?

The most common specie	1
Produces lots of charcoal	2
Easy to get	3
Other specify	4

4.10 Do you have an alternative source of fuel?

Yes	1
No	2

4.11 Given the resources what alternative source of fuel would you like?

Paraffin	1
Electricity	2
Biogas	3
Solar power	4
Other Specify	5

4.12 Explain why?

Its clean	1
It's used for many things eg radios, tvs	2
I won't use my energy to have it	3
It cheaper	4
Other specify	5

4.13 What resources do you use to build buildings, fencing and stock pens?

Nails	1
Wooden poles	2
Steel wire	3
Steel poles	4
Asbestos tiles	5
Other specify	6

4.14 Where do you source these resources?

Shops	1
Maunzi mountain	2
A1 and A2 farms	3
From my own plantation	4
Other specify	5

4.15 What is your opinion on deforestation in your area?

It exists	1
It does not exist	2
I don't know	3

4.16 If existing, what do you think could have caused it?

Population growth	1
Overgrazing	2
Demand for land for cultivation	3
Demand for fuel wood	4
Poverty	5
Demand for settlement	6
Other specify	7

4.17 What measures have you taken to conserve wood?

Plant trees	1
Use cow dung to reduce pressure on fuel wood	2
Limit the number of cattle grazing per unit area	3
Other specify	4

4.18 How successful were the practices?

Not successful	1
Successful	2
Very successful	3
No change	4

4.19 What do you think should be done to control deforestation?

Plant trees	1
Use electricity	2
Use biogas	3
Use solar energy	4
Educate households on the importance of trees	5
Other specify	6

Are you happy with the discussion? Do you feel your participation was fair or unfair?

Do you have any other thing to add or subtract on this issue?

APPENDIX L

Focus group discussions

My name is Agreement Hlanganayi, a Masters student in the College of Agriculture and Environmental Science at the University of South Africa. I am carrying out an academic research in this ward on the socio-economic factors affecting deforestation and the patterns of deforestation. Please feel free to discuss openly what you know or think about the issue that we will discuss in this forum. This discussion will last for one-and-a-half to two hours. The information discussed will be treated as highly confidential and no names shall be recorded.

1(a) Is deforestation present in this Ward?

1(b) If yes, how serious is it?

2(a) What do you think are the social factors affecting deforestation?

2(b) What do you think are the economic factors affecting deforestation?

3. What are your sources of income?

4(a) What do you use for cooking and heating?

4(b) If fuel wood, where do you source it?

4(c) How far do you collect the fuel wood from your homestead?

4(d) Who does the collection?

4(e) Do you stockpile the wood?

4(f) How often do you collect it?

4(g) What tree species do you prefer for fuel wood?

4(h) Why do you prefer that specie?

4(i) Is the tree specie still abundant or it's now scarce?

4(j) If scarce, what could have caused its scarcity?

4(k) What alternative source of energy do you have?

4(l) For how long have you been using the alternative source of energy?

5(a) What do you use to build houses and stock pens?

5(b) What tree specie do you prefer for building stock pens and houses?

5(c) Why do you prefer that specie?

5(d) How abundant is the specie?

6(a) What measures have you taken to conserve wood?

6(b) Where did you get the knowledge of the conservation method?

6(c) Is the conservation method successful?

7(a) What is the quality of the grazing lands?

7(b) If poor, what do you think could have contributed to that?

8(a) On average how many fields does a household have?

8(b) How many acres is each field?

8(c) How far are the fields from your homestead?

9(a) How would you describe the household food security status in the ward at household level and at community level?

9(b) If the food security situation is critical, what strategies are households using to cope with the food shortages? How effective are these strategies in improving household food security?

9(c) Are there community level strategies that are being used to enhance the food security situation in the ward?

9(d) If yes, what are they and how effective are they, in improving food security in the ward?

9(e) If no, why is this the case?

Are you happy with the discussion? Do you feel your participation was fair or unfair? Do you have any other thing to add or subtract on this issue? Thank you for the time you spend in this discussion.

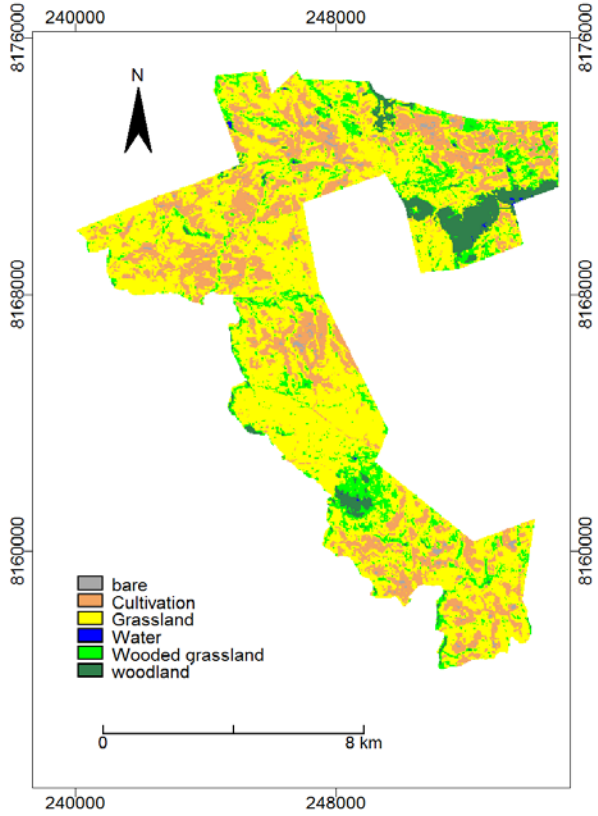

Figure 7.2(c): Ward 16, 2008 Land cover map

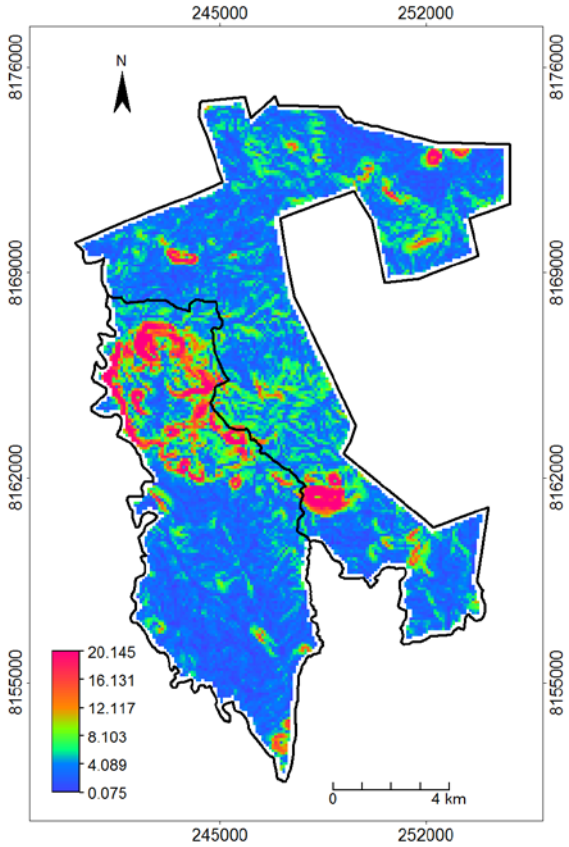

Figure 7.2(a): Slope Map

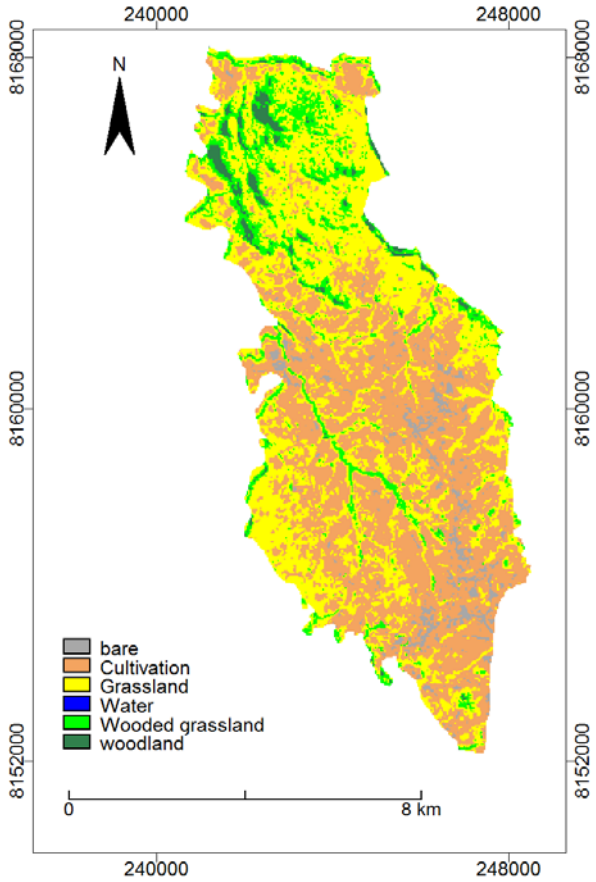

Figure 7.2(b): Ward 18, 2008 Land cover map