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LAND USE/ LAND COVER CHANGE DETECTION OF CHILALO MOUNTAIN AND ITS SURROUNDING, ARSI ZONE, OROMIA REGION

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A THESIS SUBMITTED TO THE COLLEGE OF DEVELOPMENT STUDIES OF ADDIS ABABA UNIVERSITY, PRESENTED PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER (MA DEGREE) IN ENVIRONMENT AND DEVELOPMENT;

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This is to certify that the thesis prepared by Yenenesh Hailu, entitled: **Land use/ land cover change detection of Chilalo Mountain and its surrounding Arsi Zone, Oromia region** submitted in partial fulfillment of the requirements for the Degree of Master of Arts (Environment and Development) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Dedication

This piece of work is dedicated to the memory of my father ***Hailu Weldeyohanis****. Dear my beloved father, the almighty God rest your soul in heaven. Amen!*

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Acronyms

C^0	degree centigrade
%	Percent
&	and
CADU	Chilalo Agricultural Development Unit
CSA	Central Statistical Authority.
EFAP	Ethiopian Forestry Action Program
ERDAS	Earth Resources Data Analysis System
FAO	Food and Agriculture Organization
FGDs	focus group discussion
GPS	Global Positioning System
GIS	Geographic information system
i.e.	That is
ha	Hectare
KARC	Kulumsa agricultural research center
Km	Kilometer
ETM	Enhanced Thematic Mapper
LULC	Land Use and Land Cover
LULCC	use land cover change
M^3	Meter cube
m.a.s.l	meter above sea level.
MSS	Multi Spectral Sensor
MOA	Minister of agriculture
NBSAP	National biodiversity strategy and action plan
Rs	Remote sensing
SIDA	Swedish International Development Agency
SPSS	Statistic Package Software System
Sq.km	square kilo meter.
TM	Thematic Mapper
WHO	world health organization

Abstract

Land Use/ Land Cover Change Detection of Chilalo Mountain and Its Surrounding; Arsi Zone, Oromia Region

Yenenesh Hailu

Addis Ababa University, 2014

LULCC is the quantitative changes in the area extent that is increase or decrease of a given type of LU and LC. In Ethiopia LULCC has been recognized as an important driver of environmental change in the country. Therefore a systematic analysis of LULCC is so crucial in order to understand the extent of the change and take necessary measures. The main objective of this study was to understand the LULC dynamics of Chilalo Mountain and its environs. More specifically, the study analyzed the LULCC over the past 38 years, assess the impact of LULCC on biophysical and socioeconomic factors and identify drivers of LULCC in the study areas. The study has made use of sequential satellite images (1973, 1986, 2000 and 2011) and the analysis carried out using RS and (GIS) in conjunction with field verifications. Moreover socio-economic surveys were also used to interpret the drivers of LULCC and associated negative impact occurring on both biophysical and local community. Accordingly the LULCC analysis showed forest land is continuously decrease during the three comparison period i.e. (1973-1986), (1986-2000) and (2000-2011) with (20.54 %), (19.61%), and (28.24%) respectively. On the other hand crop land showed continuous increment by (9.87 %), (5.92 %), and (59.86%) during the three period. The remaining LU/LC class showed fluctuation, thus increased one period and decreased on other period. The major causes of LULCC in the study area are; deforestation, agricultural expansion, scarcity of farm land, demand for wood, population growth, and fire hazard. These leads to distraction of natural resources such as reduce the availability flora and fauna, soil degradation, climate change and decline of water resources. It also negatively affects the local community through decline livestock number; increase reliance on chemical fertilizer, shortage of water, wood and medicinal plants. Thus in order to alleviate the problem possible measure must be taken such as control rate of population growth, agro-forestry, aforestation & reforestation, creating off farm job opportunity etc must be undertake.

Key words; *land use/land cover, Land use/ land cover change, satellite image, RS, GIS.*

CHAPTER ONE

INTRODUCTION

1.1 Background

Humans have been and are still using lands and its resources to satisfy their material, social, cultural and spiritual need. Land is a fundamental factor of production, and throughout the course of human history, it has been strongly tied with economic growth (Briassoulis,2000).Because of various human activities like agriculture, industry, forestry, energy production, settlement, recreation, and water diversion, land and its resources have been under continuous change.

On the other hand every parcel of land on the earth's surface is unique in its cover it possesses. Land use and land cover are distinct but they are closely linked characteristics of the earth's surface; the land use is land which being used for forestry, grazing, agriculture, urban development are among many others. While land cover categories could be cropland, forest, wetland, pasture, roads, urban areas among others (Briassoulis, 2000).

Several regions around the world have undergoing rapid and wide-ranging changes in land cover. Today close to a third of the earth's land surface is devoted to pastures or croplands, which amounts to approximately one-half of all lands suitable for agriculture. Since the dawn of plant domestication the progression of cropland was relatively slow. The past century observed over half of the worldwide increase in agricultural lands, and in the developing countries, half the land cover conversion occurred in the past 50 years (Houghton, 1994)

.

Globally the earth surface is being significantly altered due to anthropogenic activities despite the slow natural processes. Man's presence on the earth his use of land has had a profound effect upon the natural environment (Opeyemi, 2006). This is because the growing population and increasing socio-economic necessities creates a pressure on land use/land cover. This pressure results in unplanned and uncontrolled changes in LU/LC

(Seto, 2002). Different human driving forces intervened by the socio-economic situation, lead to an intended land use change of an existing land cover through the manipulation of the biophysical conditions of the land (Hussien, 2009).

The fact that human beings are the major contributors to land cover changes and are the ones experiencing the consequences of these changes. This is because land use and land cover change which is resulted due to human action in turn, produce changes that impact humans and alter the availability of different biophysical resources like water, soil, vegetation and animal feed. And these are the basic natural resource for human existence on the earth, therefore, LULCC could lead to loss or a decreased different products and services for human, livestock, agricultural production and can undermine environmental health as well (Hussien, 2009).

Ethiopia is a mountainous country, with a topographic features dominated by ragged mountains that are cut by river valleys and deep gorges, flat topped plateau, undulating hills and lowlands. The country has area of around 1.12 million km2. The major land-use types of the country are crop land (19.62%) grass land (12.44%), bare land (13.78%), woodland (26.93%), shrub land (21.31%) forest (4.3%), wetland (0.67%) water body 0.73% and urban 0.02% (MOA raw data cited in Messay, 2011).

LU/LC has been rapidly changing in the country, owing to the population pressure, resettlement programs, climate change, and other human- and nature-induced factors. Particularly, anthropogenic activities are the single most significant factors adversely altering the natural status of the Ethiopian landscape. This resulted in impressive changes in the land-use/land-cover patterns of the country over time. Specifically, the highland part of the country is the center change as it is the major area of human inhabitant. Most highlands are being used by smallholder farmers for subsistence agriculture. Apparently the size of arable and grazing land holding per household has severely reduced along with the population growth that led to land fragmentation. Thus, there is continued trend toward the conversion of forested and marginal lands to agricultural lands (Behailu, 2010).

Chilalo Mountain located in Arsi zone in the south eastern part of the country is the focus of this study. The study aimed at to analysis the past and the present land use / land cover dynamics, to identify the causes behind the change and the major impact resulted due to the change. Land use/land cover analysis provides the baseline data to understanding of how land was used in the past and what types of changes are to be expected in the future. Thus in order to improve the economic condition of the area without further deteriorating the biophysical environment, it is very important to understand the interaction between humans and terrestrial environment. This need becomes more imperative as changes in land use/land cover become more rapid and has become very frequent and often affecting the livelihoods of societies (Alex, 2002).

1.2 Statement of the Problem

Land use in East Africa has changed rapidly over the last half-century: thus land use changes have transformed land cover to farmlands, grazing lands, human settlements and urban centers at the expense of natural vegetation. These changes are associated with deforestation, biodiversity loss and land degradation (Maitima, et al, 2009).

Ethiopia is a country characterized by rapid environmental conversions and modifications attributed to various adverse human actions, like expansion of farm lands to vegetated areas, massive fuelwood and charcoal production, overgrazing and encroachment of farmsteads into vegetated lands (Messay, 2011). Historical documents show that forest and woodlands once covered over 40 percent of the total area of the country. Presently this figure is estimated at less than 3 percent. This has resulted in severe soil degradation, alteration of hydrologic regimes, disturbance of local and/or regional climates, loss of biodiversity, and expansion of desert ecological conditions (EFAP, 1994 cited in Kidane, 2002).

Land use and land cover change has been recognized as an important driver of environmental change in the country (Masterarbeit, 2012). Although changes in land cover do not necessarily imply degradation, many change of land use patterns, coupled with inappropriate use of natural resources resulted in fast and huge land degradation.

Land degradation in turn has become a serious problem affecting all spheres of social, economic, and political life of the population. Specifically it becomes the major challenges to agricultural development and food security of the country. The situation becomes worsen as most people in rural area are engaged in the agricultural (Masterarbeit, 2012). Moreover Land use /land cover change not only a serious threat to sustainable agriculture but also other demand like fuel wood and construction material.

The study area is characterized by high expansion of agricultural land associated with massive population increase. As the area is potentially important for agriculture, the activity is more likely to further expand in to other land use and land cover areas, specifically to forested upland regions.. Thus, the likelihood of areas along the gradient in the mountain to be used for agriculture in the future is very high. The main problem in connection from environmental perspective is the loss of original vegetation and other land degradation.

Importantly Chilalo Mountain which is the source of, many streams and rivers as well as the home of endemic animals being threaten recently due to the land use/land cover change resulted from deforestation and fire hazard. Areas of high altitude adjacent to the forest remnants are used for crop cultivation and grazing. This has lead to enormous environmental impact and ecological imbalance.

On the other hand the entire mentioned environmental and socio-economic problems call for an accurate investigation in the status, causes, and rate of LU/LC changes in the country in general as well as study area in particular. But in Ethiopia studies relating land use /cover change are rare, even the available are mostly focusing on northern highlands part of the country, and they are typically watershed based. Moreover the study didn't make out the factors contribute to LU/LCC as well as impact resulted due to the change, in addition to this it is still crucial to generate site-specific information on land use/cover dynamics, because some of the contributing factors and processes are likely to be area specific, and the outputs resulted in a given area may not be applicable in other areas.
In an effort to contribute in bridging the above stated gap, this study would focus on land use land cover change detection of Chilalo Mountain and its surrounding , which is found

in southeastern part of the country. Since the area facing land use/ land cover change problem, it is extremely important site for the study among the highlands. Furthermore, so far no study has been done on the area, related to LU/LCC detection. Moreover the study also identifies the drivers behind the change and the biophysical and socioeconomic effect of land use change, which is many study lack.

1.3 Objectives

1.3.1 General Objective

The study aimed to quantify the land use and land cover dynamics, at Chilalo Mountain and environs.

1.3.2 Specific Objectives

Specific objectives are:

- To analysis land use and land cover changes over the period 1973 to 2011 in the study area,
- To identify drivers of land use and land cover change in the study areas.
- To assess the major impact of LULCC on biophysical and socioeconomic factors in the study area.

1.4 Research Questions

To address the above objectives, the following research questions are designed.

- Has a land use/land cover of Chilalo mountain and its surrounding is changing?
- How is the trend of land use and land cover changes in the study area?
- Which land cover is decreasing in the study area?
- Which land cover is increasing in the study area?
- What driving forces are contributing to the land cover changes?
- What are the biophysical effects of land use/ land cover change?
- What are the major socio-economic effects of land use land cover change?

1.5 Significance of the Study

Land-use and land-cover change (LUCC) is a key driver of global environmental change and has important implications for many national and international policy issues. The impacts of land use and land cover change are critical to many government programs.

It is hoped that this study provide insights and knowledge about the magnitude and dimension of land use/cover change, their drivers, impact on both socioeconomic and biophysical resource and community mitigation strategies in the study areas. Apparently, local governments and policy makers will enable to formulate and implement effective and appropriate response strategies to minimize the undesirable effects of future land use/cover change or modifications.

Furthermore, documentation of the land use/cover change provides information for the better understanding of historical land use practices, current land use patterns and future land use trajectory. Therefore, identifying, of the types of land use/cover are important activities in support of sustainable natural resource management, consequently this study is expect to help concerned sectors in planning, developing and managing natural resource projects in the study area..

In addition it also be an input and gives bases for other researchers who want to make further investigation in the area and may be used as stepping stone,

1.5 Scope of the Study

The study is conceived to cover the issue related to land use/ land cover change detection of Chilalo Mountain and its surrounding in Arsi Zone Oromia region, Even though it is difficult to examine all areas due to different constraints, studying some specific area have of a great importance. Thus in order to investigate the problem attempt were made to look into land use/land cover change, drivers and impact resulted due to the change that restricted to Chilalo Mountain and environs. In this study the LULCC detection was carryout for three consecutive comparison period i.e. (1973-1986), (1986-2000), and (2000-2011 whereas the socio-economic survey conducted in three selected kebeles those found around Chilalo Mountain i.e. oda dawota, Dekaka koncha and Burka Chilalo.

1.6 Limitation of the Study

This study is conducted in Chilalo mountain and its surrounding which is small portion of Arsi zone but the land use/ land cover change problem is not only limited to Chilalo mountain rather the whole the zone and other part of country also facing the same problem, on the other hand it was difficult to examine all areas due to time and financial constraint. Moreover the land use/land cover change detection was done using different data source such as 1973MSS, 1986TM, 2000 ETM and 2011TM, this difference in spatial data type used might causes a trivial inaccuracy in area computation, particularly the 1973 MSS was the oldest and imaginary were used due to limitation of aerial photograph which might have better resolution.

1.5 Organization of the Thesis

This research paper is organized into five main chapters:, the first chapter deals with background, statement of the problem, objectives, and significance of the study, delimitations and limitation and organization of the study. Chapter two highlight literature review as well as empirical literatures pertinent to objectives of the study and conceptual framework. The third chapter describes materials and methods. Chapter four highlights the major finding of the study from both of the socio-economic and remotely sensed data. Finally, the conclusion and recommendations are presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definitions of Term and Concepts

Land use/Land covers change: refers to the (quantitative) changes in the area extent that is increase or decrease of a given type of land use and land cover respectively, land cover changes may result either from land conversion or modification, likewise land use change may involve either conversion from one type of land use to another or modification of a certain type of land use (Alex, 2002). Moreover (Lemlem, 2007) defined land use/ land cove change as an alteration in the surface component of the landscape and is only considered to occur if the surface has a different appearance when viewed on at least two successive occasions.

Changes in land cover driven by land use can be categorized into two types: modification and conversion. Modification is a change of condition within a cover type; for example, unmanaged forest modified to a forest managed by selective cutting. Significant modifications of land cover can occur within these patterns of land cover change. Conversion is a change from one cover type to another, such as deforestation to create cropland or pasture (Riebsame, Meyer and Turner, 1994), likewise (Lambin et al; 2003) stated that land-cover conversions are the complete replacement of one cover type by another and measured by a shift from one land-cover category to another, as is the case in agricultural expansion, deforestation, or change in urban extent. On the other hand Land cover modifications are more slight change that affects the character of the land cover without changing its overall classification.

2.2 Land use/Land covers Change Detection

The need for optimal use of the land resources and balance land-Cover capability with anthropogenic stress is one of the mega-scale issues of mankind (Milanova et al; 2007 cited in Behailu, 2010). Planners and resource managers need a reliable mechanism to assess the consequence of the changes resulted by the stress imposed on natural resource

by detecting, monitoring and analyzing land use changes quickly and efficiently. Thus accurate information on land-cover changes and the forces and process behind the change is crucial for designing a sound environmental planning and management. Land-cover analysis provides the baseline data required for proper understanding of how land was used in the past and what types of changes are to be expected in the future. Moreover studies of land-cover changes also yield valuable information for analysis of the environmental impacts of human activities, climate change, and other forces (Belay, 2002).

Land cover change detection involves the application of multi temporal datasets to quantitatively analyze the temporal effect of the phenomena. Remote sensing becomes useful source of data because it provides synoptic view and multi temporal Land uses / Land cover data that are often required (Bhagawat, 2011).

Multi temporal data of Land sat, TM could be more suitable for identifying and tracing major changes in land cover. Accordingly, satellite imagery provides an excellent source of data for performing structural studies of a landscape and has the capability of providing information about the conditions of an area by identifying differences between two or more points in time via the techniques of change detection (Gessesse, 2007).

Generally remote sensing and GIS are being increasingly used in combination spatial analysis. GIS databases are used to improve the extraction of relevant information from remote sensing imagery thus both remote sensing (RS) and geographic information systems (GIS) have been widely applied and recognized as powerful and effective tools in detecting the spatiotemporal dynamics of land use and land cover (Lambin et al;2001).

2.3 Causes of land use/land Cover Changes

Land use and land cover changes are the results of the interplay of many factors. The simple assumption that land use and land cover changes have been caused by few factors do not hold true. Rather, many interrelated complex factors best explain the processes of land use and land cover changes. Identifying the causes of land-use change requires an

understanding of how people make land-use decisions and how various factors interact in specific contexts to influence decision making on land use (Geist & Lambin, 2002).

Even though, natural processes may also contribute to changes in land cover, the major driving force is human induced land uses These human induced causes of land cover change, which are critical and currently increasing in alarming rate; Different researchers have put the reasons for land use and land cover changes in two broad categories as proximate direct and underlying indirect or root causes.

2.3.1 Proximate causes of land use/ land cover change

The proximate causes of land-use change explain how and why local land cover and ecosystem processes are modified directly by humans. These factors operate at local level (individual farms, households, or communities). As a consequence; proximate variables are context and region specific. These are causes which results immediate land cover change; while driving causes are causes which drives behind the immediate causes (Geist and Lambin, 2002).

The major historical proximate cause of change in land cover has been the expansion of agricultural lands coupled with wood extraction and infrastructure expansion. In the past two centuries, the impact of human activities on land has grown enormously because of population increase, technological development and the requirements thereafter, altering entire landscapes, and ultimately affecting the biodiversity, nutrient and hydrological cycles as well as climate because of this today close to a third of the earth's land surface is devoted to pastures or cropland (Houghton, 1994).

In Ethiopia, the proximate causes of land cover change particularly natural vegetation are agricultural expansion, both through shifting cultivation and the spread of sedentary agriculture. The demand for increasing amounts of construction material, fuel wood and charcoal are also other reason. Charcoal is common in the arid, semi-arid and dry sub humid parts of the country. Using fire to fumigate bees and to facilitate hunting is also very common, which results forest fire and destructs natural forests (Kahsay, 2004).

2.3.2 Driving force of land use change

Underlying (indirect or root) causes explain the broader context and fundamental forces underpinning these local actions. This can be originating from regional (districts, provinces, or country) or even global levels, though complex interplays between these levels of organization are common. As a result, underlying causes also tend to be complex, formed by interactions of social, political, economic, demographic, technological, cultural, and biophysical variables.

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Some local-scale factors are **endogenous** to decision makers and are therefore under local control. However, underlying causes are usually **exogenous** (originate externally) to the local communities managing land and are thus uncontrollable by these communities. In general, underlying causes tend to operate more diffusely (i.e., from a distance), often by altering one or more proximate causes (Geist, & Lambin 2002).

The five major factors for driving causes are economics, institutions, technology, culture, and demographic change.

Institutional factors: formal and informal institution influences directly or indirectly land use decision making. Policies on land use and economic development, transportation, or subsidies for land-based activities, lack of adequate governance structures, land tenure and property rights issues, issues of open-access resources and squatting by landless farmers are the major driving causes of cover change (Lambin et al; 2003).

Ethiopia's extensive natural resources have been both degraded and underutilized. The underlying causes for this state affairs lie, by and large, in policy and institutional issues, which include poor governance, inappropriate policies, frequently changing and ineffective legal and institutional framework, poor implementation of policies, misuse of human resources and ineffective bureaucracy resulting in low implementation and management capacity over the past several decades (SIDA, 2003).

The three most notable land tenure systems in Ethiopia are that of the *Imperial* Government (1930-1975), the *Derg* regime (1975-1993), and the Federal Democratic Republic of Ethiopia (FDRE) (1993-recent).

The land policy of the *Imperial* government, though varied spatially, was favoring individual landlords to amass and possess the land indefinitely. This might have encouraged the landowners to take care their land and the resources on it which, in turn, might have resulted in relatively stable LU/LC changes for over a long period of time. Contrarily, the Military Government nationalized the land and the natural resources on it under the umbrella of the renowned motto, "*Land to the Tiller*". Consequently, land and the resources were divided into pieces among peasants or smallholding farmers, which resulted in massive deforestation of vegetated lands meant for various purposes. This, in turn, might have resulted in dramatic LU/LC changes throughout the country (Messay, 2011).

Furthermore tenure security determines the extent to which farmers may benefit from investments made to improve the land. In the extreme case in which farmers expect to hold land for only the current season, they will have no incentive to invest; rather, their incentive is to get the maximum that they can from the land, even if that means undermining its future productive capacity. More generally, farmers may expect to use land for an undetermined period of time, but consider that there is some risk that they will lose this right in the future. The greater the risk of losing the right, the lesser likely they are to invest, or to conserve the productive capacity of the land (Feder et al; 1988 cited in Mesfin, 2010).

Technological factors in the wood and agriculture sectors, like technological changes in the forestry sector in the form of chain saws and heavy equipment, and in wood processing, agro-technological factors, modification of farming systems through intensification and extensification are playing significant role in cover change (Alex, 2002).

Cultural factors; - Numerous cultural factors also influence decision making on land use. Their attitudes, values, beliefs, and individual perceptions influence land-use decisions—for instance through their perception of and attitude toward risk. Land-use decisions have intended and unintended consequences on ecosystems; these depend on the knowledge, information, and management skills available to land managers (Lambin et al; 2003).

Demographic factors; - At longer timescales both increases and decreases of a given population due to natural increase or immigration is another driving factor and exert a greater impact on land use/land cover. Most of its explanatory power tends to be derived from inter linkages with other underlying forces, especially in the full interplay of all five major drivers ((Lambin et al; 2003).
In most developing countries population growth has been a dominant cause of land use and land cover change than other forces.

Though people are without doubt the most valuable resource in Ethiopia, uncontrolled population growth puts undue pressures on all other natural resources like land resource. The population of the country was estimated to be 11.8 million at the beginning of the 20th century and its growth rate was then only 0.2 percent per year. In 1950, the population size had increased to more than 19 million and its growth rate had reached 2.1 percent per year. The growth of the population followed a slow rate of increase until 1970 and accelerated thereafter In 1984, the total population of Ethiopia was 42.6 million (CSA, 1985 cited in Carla et al, 2001), The 1994 Population and Housing Census showed that population had reached 53.5 million, and by 2003 it is over 67 million (NBSAP, 2005). Moreover the population projection figures made based on the results of the 2007 Housing Census of Ethiopia for the year 2012 become 84, 32 million.

Moreover as population grows, arable land per capita declines and the fragmentation and degradation of land through overuse increases. According to the 1999/2000 agricultural sample survey conducted by the (CSA), the average farm size for the total country is 0.97 hectare whereas 29 percent of the farming households have half or less hectare of land. Thus the increase both in the rural and urban population means that there will be more

pressure both on forest and agricultural lands and resulted undesirable land use/ land cover change.

2.4 Biophysical Effects of Land Use/Land cover change

According to Riebsame, *et al*; (1994), land use affects land cover and changes in land cover affect land use. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects forest resource, biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere.

2.4.1 Forest Resource Degradation

Throughout history, the fate of the world's forests has strongly reflected the pattern and intensity of land use by societies. Demand for agricultural land, timber, and other forest products, as well as technological change in agriculture, significantly impacts the mode and rate of transformation of forested areas. Biophysical triggers may also play a role (Alex, 2002). There is roughly 39 million square kilometers (29 percent) of the world's land surface is under forest cover. the World Resources Institute (1997) estimates that only one-fifth of the world's original forest cover remains, largely in blocks of undisturbed frontier forests in the Brazilian Amazon and boreal areas of Canada and Russia.

Forests especially natural forests are used for various ecological and economic purposes. They could maintain local climate, regulates hydraulic cycle, used as wild life habitats and reduce runoff and soil erosion. The economic importance of forests includes supply of raw material for pulp and paper, provision of timber for construction and other activities and used as fuel wood for energy source. Therefore, depletion of this important natural resource will affect other valuable and life supporting resources like water and soil. In addition to these, the climate change and biodiversity will also be greatly affected by deforestation. It is very strategic and wise approach to avoid other problems by solving this key problem (Alex, 2002).

Even though forest and the benefit they provide play a critical role in enabling people to secure a stable and adequate supply raw material and environmental protection. Deforestation and land degradation in Ethiopians are impairing the capacity of forests and the land to contribute to food security and to provide other benefits such as fuel wood and fodder. Ethiopia is facing rapid deforestation and degradation of land resources. Population increases have resulted in extensive forest clearing for agricultural use, overgrazing, and exploitation of existing forests for fuel wood, fodder, and construction materials (Hurni, 1990).

According to Kahsay, (2004) deforestation is a major issue in Ethiopia, since it is one of the main causes of the prevailing land degradation and loss of biodiversity. Tree cutting is a common occurrence which has been taking place for centuries. Historical sources indicate that about 40 per cent of Ethiopia's land area was originally covered with high forest, at the beginning of the 1950s; high forests were reduced to 16 per cent of the country's total land area (EFAP, 1994 cited in Kidane, 2012). In the 1980s the estimate for land areas covered by forests was 3.65 per cent. In present day, this resource has dwindled and is being destroyed at an alarming rate and the area covered by forests at present is 2.6 percent or less compared to the estimated 40 percent before one hundred years initial coverage.

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2.4.2 Soil degradation

Soil degradation is the temporary or permanent lowering of the productive capacity of land, it could be manifested in several forms including water erosion, wind erosion, biological degradation (decrease humus), physical degradation (increase bulk density, decrease permeability, chemical degradation (acidification, toxicity) and excess of salt (Salinization, alkanization) (Tizale, 2007).

The soils of Ethiopia are inherently fertile, but have been continuously degrading and exacerbated by soil nutrient depletion due to different factors (Tizale, 2007). Among the causes and driving factors, unwise land use change is one of the major causes of land degradation in the country. The most productive forest lands have already been brought into agricultural production. Further expansion of agriculture and grazing that takes place

on marginal lands, moreover cultivation of the rugged topography and steep slopes especially in Ethiopian highlands is became a common practice, thus it increase surface runoff and soil erosion, these in turn accelerate land degradation.

Moreover, population growth in the country leads to deforestation and the conversion of pastureland to crops leading to overstocking and further degradation. Crop residues are increasingly used for fuel rather than mulch. Dung is also used as fuel rather than manure. All these factors lead to nutrient loss and increased erosion (Worku, 2012).

Soil erosion is one of the most important threats to the sustainability of agricultural systems in the country. Consequently Ethiopia could be a good example where depletion of the soil resources is enormous and one of the most severely eroded countries in the world. (EHRS) study recognized that water erosion was the most important process of soil degradation. thus the removal of soil particles by the action of water usually seen as sheet erosion (a more or less uniform removal of a thin layer of topsoil), rill erosion (small channels in the field) or gully erosion (large channels, similar to incised rivers (Hawand , 1995). Among these soil erosion process in the country, gullies play a very important role, and the amount of soil loss due to gulling has become a very serious problem in recent decade as it was associated to remarkable depletion of cultivated land.

2.4.3 Hydrological Cycle

Land use and land cover characteristics have many connections with hydrological cycle (Hougton, 1995). With the wide spread of land use/ land cover change occurring throughout the world, rivers and streams are decreasing in flow. Surface runoff and ground water flow are the two components of the stream flow. Surface runoff is mostly contributed directly from rainfall, whereas ground water flow is contributed from infiltrated water. However, the source of stream flow is mostly from surface runoff during the wet months, whereas during the dry months the stream flows from the ground water, The land use and land cover type can affect both the infiltration and runoff amount by following the falling of precipitation and this in turn significantly affect surface runoff and ground water flow (Hougton, 1995).

Different land cover has unlike response to the hydrological cycle This is due to different reason, first of all natural land cover has various properties that help to regulate water flows both above and below ground. For example forest canopy and leaf litter help to decrease the impact of raindrops on the earth's surface, in so doing reducing soil erosion. In addition roots hold the soil in place especially on steeper slopes, and absorb water. Openings in leaf litter and soil pores increase the infiltration capacity of the soil, thus the water through the soil into the ground water, this helps to have stream flow throughout the year in wet and dry season (Alex, 2002).

On the other hand increase of crop lands and decrease of forest, results increase of stream flow during wet season, this is because the crop soil moisture demand is lower than that of forest, therefore, the rainfall satisfies the shortage of soil moisture in agricultural lands more quickly thereby generating more runoff. Consequently, this leads to an increases stream flow during rainy season (Legesse *et al*; 2003).

Generally Conversion of forest to other land use specifically crops land are expected to result in increase surface runoff and reduce the amount of rainfall infiltrating the soil and eventually percolating into ground water aquifers, thus lower levels of infiltration and water shortage in the soil affect the availability of water for human use.

2.4.4 Destruction of Natural Habitats and Reduction in Biodiversity

Ethiopia is renowned for its richness in its biodiversity. The country biological diversity is made up of an estimated total of 6500–7000 plant species of which 12 are endemic. There are also 277 terrestrial mammals some 861 bird species, 201 species of reptiles, 63 species of amphibians, 150 species of fish and 324 butterfly species of which 31 mammals, 28 birds 24 amphibian, 4 fish, 9 reptile, 7 butterfly species are endemic. There are 9 national parks of which two are gazetted, 3 sanctuaries, 11 wildlife reserves and 18 controlled hunting areas, 58 national forest priority areas (National Agenda 21 Implementation Review Report, 2001 cited in SIDA, 2003),

Nevertheless, the degradation of these resources is wide spread and severs. In the country land use /land cover changes have been reported to cause loss of biodiversity, specifically

conversion of natural forests, woodlands and savannah ecosystems to agriculture is the greatest single threat to ecosystem biodiversity. Conversion results in the loss of nearly all species of fauna and flora on the site and leads to increasing fragmentation of the remaining ecosystems (NBSAP, 2005).

The Chilalo Galma Forest Priority supports many numbers of Ethiopia' unique highland fauna and flora. The area originally contained three major vegetation zones. Mixed mountains forest (3,300 m) is dominated by *Juniperus procera, Podocarpus graciler* and *Hagenia abyssinica.* The ericaceous zones (3,300-3,900 m) are characterized by *Erica arborea* and *Erica. Trimera.* The Afroalpine ecosystem (3,900- 4,300 m) consists largely of *Alchemilla, Helichrysum* and the endemic *Lobelia rhynchopetalum (*Malcolm and Sillero-Zubiri, 1997 cited in Alemayehu, 2010).

Fauna of the area includes the Ethiopian wolf, mountain nyala, Menelik's bushbuck, reedbuck, warthog, leopard, hyena and grey duicker. It also includes Starck's hare, grass rat, swamp rats and common mole rat. However, unsustainable use of natural resources and land use land cover change such as deforestation caused by man tends to disturb or eliminate completely the habitats of species thus the degradation increasingly threatens these unique highland fauna and flora *(*Malcolm and Sillero-Zubiri, 1997 cited in Alemayehu, 2010).

2.4.5 Climate change

Climate is often described by the statistical interpretation of precipitation and temperature data recorded over a long period of time for a given region or location. But currently Human activity is vastly altering the Earth's vegetative cover. Such changes have considerable consequences and. contribute to anthropogenic climate change through a variety of processes. Degradation of surface vegetation or the conversion and burning of forest for farming and the harvest of forest for timber and fuel wood cause a net release of CO2 from the biota to the atmosphere, which produces changes in the global atmospheric concentration of carbon dioxide; and The rise in mean global temperature will bring about changes in regional weather and climatic patterns changes in the land surface (Gregg Marland, 2003 cited in Nestanet, 2007).

In Ethiopia mean annual rainfall distribution over the country is characterized by large spatial variation which ranges from about 2000 mm over some pocket areas in the Southwest to less than 250 mm over the Afar and Ogaden low lands.

Baseline climate was developed using historical data of temperature and precipitation from 1971- 2000 for selected stations. The country has experienced both dry and wet years over the last fifty five 55 years. Years like 1952, 1959, 1965, 1972, 1973, 1978, 1984, 1991, 1994, 1999 and 2002 were dry while 1958, 1961, 1964, 1967, 1968, 1977, 1993, 1996, 1998 and 2006 were wet year Similarly the year to year variation of annual minimum temperatures expressed in terms of temperature differences from the mean and averaged over 40 stations. The country has experienced both warm and cool years over the last 55 years. However, the recent years are the warmest compared to the early years. There has been a warming trend in the annual minimum temperature over the past 55 years. It has been increasing by about 0.37^0c every ten years (Abebe, 2007).

There is a general observation from the regional consultative meeting that temperature has increased over the country and recurrent drought and flood are the most severe problems that affected millions of the country's population almost every year. This perception of change in temperature and in the frequency of drought could be linked to a changing climate.

2.5 Socioeconomic impacts of land use land cover change

Land and its uses are essential to all human communities. Every person is shaped in a range of ways by the landscape in which they live, and the products and resources produced on the land. Land and its uses are particularly important for rural communities, where many people are directly dependent on land for their livelihood, and the way land is used has a central role in defining the identity of an area and its community, thus changes in land use can have a profound impact on the personal, family, work and social lives of people living in rural communities, as well as those living in rural and regional towns (Schirmer *et al*, 2008).

One of the immediate impacts of the thinning and destruction of the forest land is shortage of fuelwood and construction materials for the farming community. This condition forces farmers not only to travel very long distances to collect wood, but also to increasingly burn crop residues and organic manure for cooking and heating. The latter has grave consequences for the fertility and productivity of the cropland as the action leads to depletion of the organic matter in the cultivated soils (Belay, 2004). In addition the removal and destruction of forest are followed by land degradation through soil erosion and loss of soil fertility. These, in turn, affect agricultural production that results in the reduction of yield (Yonas, 2004). The loss of soil fertility requires the use of chemical fertilizers to compensate the loss of organic matter to maximize crop yield (Kassu, 2011).

Furthermore the scarcity of fuel wood resulted due to distraction of the forest usually leads to increase in price of this commodity both in distance urban and rural areas. As forests disappear from village centers, there is an increase in to the fuel wood gathering areas. The increase in distance means that women and children have to carry on heavy loads on long distances. Also women have to wake up early in the morning for firewood and thus, cannot take care of other houschold duties. Furthermore, they cannot do other income generating activities and in the long run their health will be affected especially the children (Kiunsi, 1994).

Moreover land use /land cover change also reducing the availability of medicinal plants. According to WHO et al; 1993 report as many as 80% of the world population depends on herbal medicine for primary health care needs which are mainly derived from forests. The consequences of deforestation will therefore be felt by the many poor because of lack of cash to buy modern medicine. In Ethiopia plants have been used as source of medicine for centuries. About 80% of the people of depend on traditional medicine for their health care practices; and more than 95% of traditional medical preparations are of plant origin.but the availability of medicinal plant reduced, threatened species include *Hagenia abyssinica*, *Securidaca longepedunculata* and *Warburgia* (NBSAP, 2005).

2.6 Land use/Land cover Studies in Ethiopia

Land is the major natural resource that economic, social, infrastructure and other human activities are undertaken on. In Ethiopia most of the land is being used by smallholders who farm for subsistence. despite the fact with rapid population growth and in the absence of agricultural intensification, smallholders require more land to grow crops and earn a living; it results in deforestation and land use conversions from other types of land cover to cropland. As a consequence, considerable land use/cover changes have occurred in Ethiopia during the second half of the 20th century.

Since documentation of the land use and land cover change provides information for the better understanding of historical land use practices, current land use patterns and future land use trajectory, it has become one of the major issues for environmental change monitoring and natural resource management. Thus Identifying, delineating and mapping of the types of land use and land cover are important activities in support of sustainable natural resource management.

Actually some study have been conducted in different part of country,(Belay,2002; Messay,2011;Mesterarbeit,2012;Husen,2009;woldemedhin,2011;Binyam,2012; Netsanet,2007; Behailu,2010; Kahsay,2004; Merkebu,2010; Muleta,2009; Lemlem,2007; Wallelign,2007). The result of these studies indicated the existence of considerable change in land use/cover over the past 30 to 50 years.

Belay (2002) reported the shrub land,, disappeared at the rate of 1.6 and 0.31 per cent per year from 1957 to 1986, and from 1986 to 2000, respectively. This change involved a gradual thinning of the shrub and its modification to shrub grassland, and then grassland, due to the selective cutting of the woody biomass for fuel wood and charcoal production in Derekolli catchment of the south Wllo zone of Amhara region. Simillrly Messay (2011) reported that shrub land shrunk in *Nonno* district, central Ethiopia at the rate of 3.5 and 8.8 percent per year from 1984 to 2002 and from 2002 to 2007, respectively, A significant conversion from natural vegetation cover to cropland was observed between

2002 and 2007, where the cultivated land expanded by 26.5 percent but resettlement site, appeared only in the satellite image of 2007.

On the other hand study conducted by Mesterarbeit (2012) at Ketar catchments, Zeway watershed revealed that the out spread of small holder agriculture and rural settlement but the out spread of agricultural land and the depletion of natural vegetation increase the danger land degradation in the study area. Lemlem (2007) report that vegetation cover has been changing negatively from 1973-1986 by 168.7 km^2area and from 1986-2000 by 108.1 km^2 area, and agricultural area has been changed positively from 1973-1986 by 143 km^2 and from 1986-2000 by 100 km^2. Similarly 6 km^2 built up area of 1973 has grown to 8 km^2 and 13 km^2 in 1986 and 2000 respectively in Awassa catchment, southern Ethiopia

Likewise Binyam (2012) conducted on carbon stock potentials of woodlands and land use and land cover changes in north western lowlands of Ethiopia, specifically in Kafta Humera District, Metema District and Sherkole District, the results of LULCC analysis showed that in all study sites the classes of agricultural and bare land have been increased at an average rate of 2,322.94 and 726.58 ha/year, respectively; while the woodland coverage in the three district was decreasing at an average rate of 2,833.77 ha/year during the last 25 years (1985-2010).

The role of community conservation on quality of habitat and watershed health in Guassa community conservation area, Menz central Ethiopia done by Woldemedhin (2011) revealed that farming has been expanding on the unprotected area since 1986 (13.1%) to 2009 (15.6%). Furthermore, forest cover has decreased from 12.2% in 1986 to 3.3% in 2009 in the unprotected area. On the other hand, farming on the protected area has decreased from 9.8% to 6.0% in 1986 and 2009 respectively. But, forest cover shows a slight increase (1.1% in 1986 to 1.2% in 2009) as a result of plantation in GCCA Guassa community conservation area

Generally different studies have been conducted on land use/land cover changes, in different part of the country but it is still very essential to generate site-specific

information on land use/cover dynamics to ensure planning of sustainable and integrated management of the land resources.

2.7 Conceptual Frame Work

Land use and land cover changes are the results of many interrelated complex factors. Ever though natural process may also contribute to changes in land use land cover, the major force is human induced. These human induced causes of land cover change can be grouped in to proximate and driving causes. Proximate causes are human activities or immediate action, results immediate land cover change such as agricultural expansion, wood extraction, over grazing, infrastructure expansion, these originate from intended land use and directly impact a given land cover. While underlying causes are the indirect or root causes of land use/ land cover change, these are economical, demographic, technological, institutional, Scio-cultural and biophysical factors. For example, a proximate cause might be a farmer's decision to clear a plot of land for agriculture. That decision, in turn, is embedded within a context of different factors, such as economic, government policy and institutions, technology, demographic factor and, socio-cultural environment in which the farmer lives. These constitute the driving forces – that is, the fundamental social processes that underpin the proximate causes.

Thus shifting land use patterns that derived by variety of social causes, result in land cover change that negatively affect forest resource, biodiversity, water availability, soil etc but changes in land use/ land cover do not necessarily imply degradation, if there is a natural resource management or rehabilitation on degraded land the shift will have positive impact on forest resource, biodiversity, water and radiation budget.

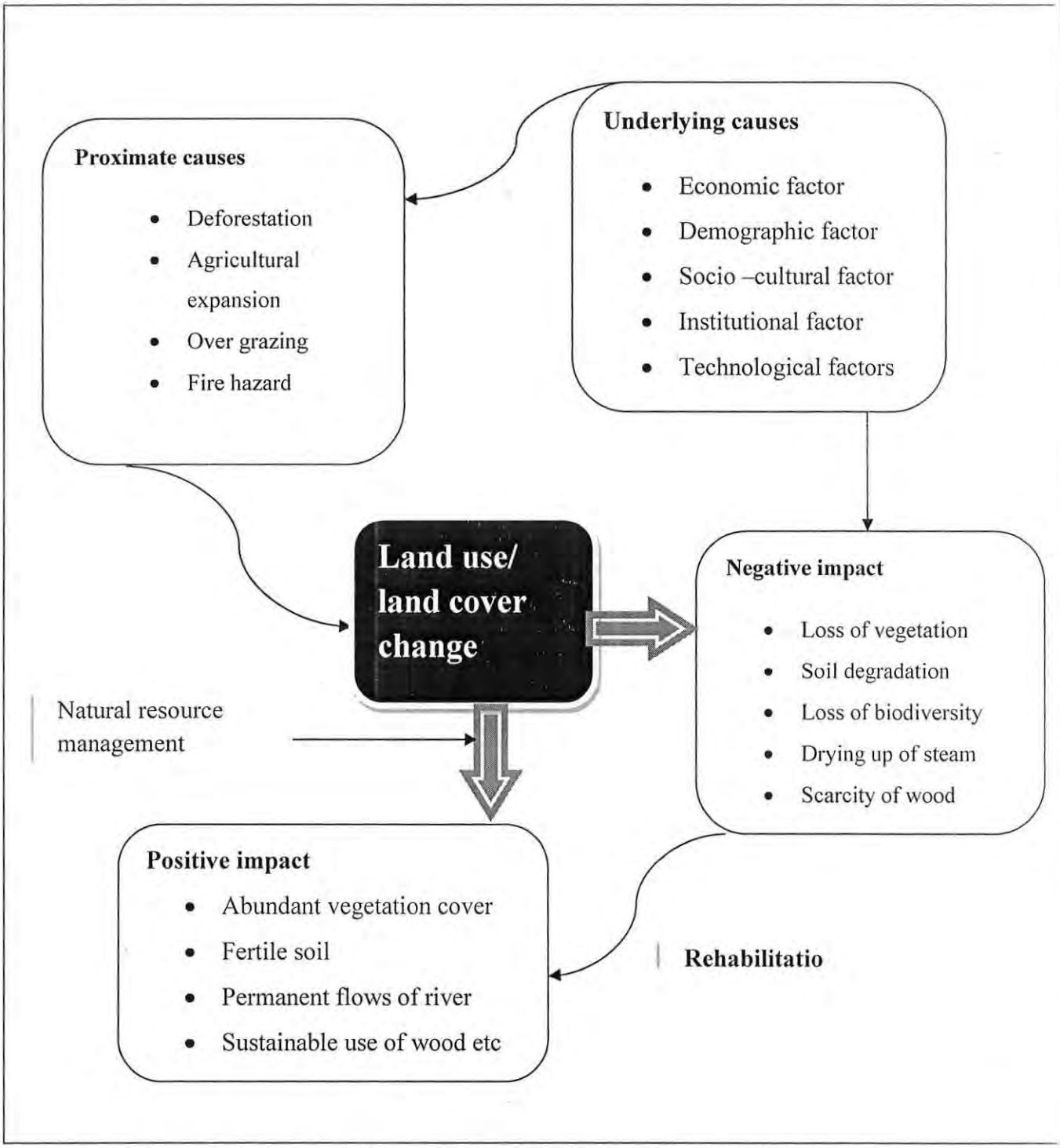

Fig 1 conceptual framework; (Source developed by the researcher).

CHAPTER THREE

MATERIA AND METHOD

3.1 General Description of the study area

3.1.1 Location

Chilalo Mountain and its surrounding is found in Arsi Zone of Oromia region which located 175 km Southeast to Addis Ababa at 7° 55' 00" N and 39° 16' 00" E and it share different Weredas boundary, distinctively Tiyo *Wereda* take the largest portion and it is one of the Twenty *Weredas* found in Arsi Zone of Oromia Regional State situated in the North Western part of the Zone. (Getachew et al, 2008).

3.1.2. Relief

The study area consists of a great diversity of landscape. These are high and rocky mountainous ridges, flat topped highland, a wide caldera and slightly raised slopes. It also comprises gently rising and falling steep hills and frequently intersected gorges along streams and rivers. It rises from the flat land surrounding from about 1500 m to 4,036 m elevation. It forms triangular shaped highland massifs with (4,036 m) elevation at Chilalo Mountain peak.

3.1.3 Drainage

The perennial rivers and springs of the district are Ketar, Kulumsa, Gonde, Dosha and Walkesa. All the rivers originated from Chilalo Mountain and drained to the lake Ziway. The major uses of these rivers are for drinking water, both modern and traditional irrigation activities on Kater River and Dosha Spring. (http://en.wikipedia.org/wiki/Tiyo woreda)

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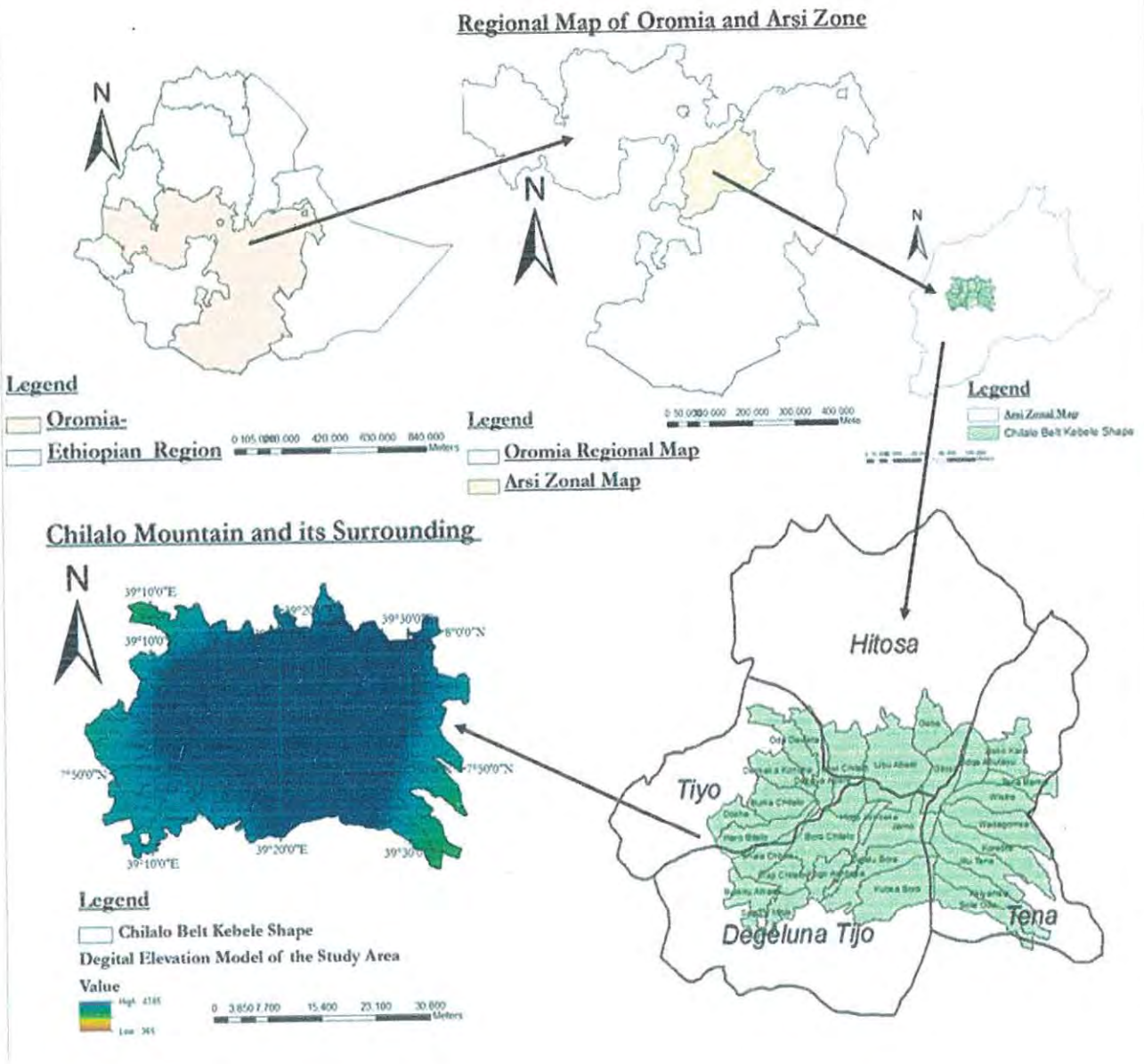

Fig 2 map of the study area

3.1.4 Climate

The study area has a tropical heavy and erosive rainfall as well as cool to moderate climate. The mean annual temperature and rainfall is vary depending on the altitude of the area. Areas above 3,300 m a,s.l have annual mean temperature less than 10^0C and areas below 3,300 m asl have annual mean temperature of 17-21.6 C. The high altitudes especially around Chilalo Mountain get moderate rainfall. The annual rainfall ranges

between 878-2,231 mm. The rainfall pattern is bimodal which are short rainy season and long rainy season (Alemayehu, 2010).

3.1.5 Soil

Concerning the soil types of the study area is characterized by two predominant soils types, namely Chromic and Pellic vertisols with texture ranging from black clay to loamy clay. The black clay soil constitutes 80%, red clay soil 15% and loamy clay 5% of the total area of the district. The fertility status of the soil ranges from fairly good to good, but has a limitation due to water lodging susceptibility to water erosion (http://www.oromiyaa.com).

3.1.6 Vegetation

The study area is characterized by three natural vegetation zone, these are mixed mountains forest (3,300 m) is dominated by *Juniperus procera, Podocarpus graciler* and *Hagenia abyssinica.* The ericaceous zones (3,300-3,900 m) are characterized by *Erica arborea* and *Erica trimera.* The Afro-alpine zone, or high wurch, encompasses the highest elevations (>3,700 m). This habitat type is characterized by steep, rocky outcrops and sparse vegetation dominated by *Alchemilla* spp., *Helichrysum* spp (Malcolm and Sillero-Zubiri, 1997 cited in Alemayehu, 2010). While eucalyptuses tree is the most common type of manmade vegetation.

3.1.7 Wildlife

Fauna of the area includes the Ethiopian wolf, mountain nyala, bushbuck, warthog, leopard, Zebra, Colobus Monkey, hyena and grey duicker. It also includes Starck's hare, grass rat, swamp rats and common mole rat (Malcolm and Sillero-Zubiri, 1997 cited in Alemayehu, 2010).

3.2. Socio-economic condition

3.2.1 Population

According to the population projection figures made based on the results of the May 2007 National population and Housing Census of Ethiopia, the total population of the *wereda*

is 100,237 of which 50,199 were male and 50,038 were women. The total population is distributed over an area of 605.38 km^2. This gives an average density of 165.6 person per /km^2 (CSA, 2012).

3.2.2 Occupation

Mixed farming, both crop production and livestock (cattle and sheep) raring are practiced in the district Agriculture is the main source of livelihood for population. It is the major source of cash income for rural population and the dominant sector to generate employment opportunity in the district.

There is one agricultural research institution at Kulumsa town, which was previously established by CADU (Chilalo Agricultural Development Unit). The main objective of this research center during its establishment was limited to cereal crop research and demonstration. Presently the institution is under administration of national institute for agricultural research and is focused on to extend the breeding of wheat and barley as well as short cultural crops to the peasants. It has also the research units on soil and forage production held at different areas (KARC, 2011).

3.2.3 Crop Production

The study area has very diverse climatic conditions, such diverse climatic conditions and habitats contributed to the presence of high plant species diversity. Thus, cool temperature crops like barley, teff and wheat from cereals and field peas, horse beans from pulses and flax from oil seeds) are the major annual crops grown in the district during the long rainy seasons. On the other hand, hot land crops like maize and sorghum are supplementary crops. Vegetables are also widely grown (Berhanu, 2010).

3.3 Research Methodology

The nature of research problems often dictates the methodology of the study. This study aims at assessing the trend of land use land cover change over the past 38 years; possible drivers and the major impact of land use/ land cover change. Thus, both qualitative and

quantitative information can help to better understand, explain, and interpret the land use and land cover change.

Therefore the methodology part of this research is grouped into parts.ie Socio-economic, Land Use/ Land Cover study.

Accordingly in order to analyze the land use/ land cover change of the study site, satellite image interpretation with appropriate software were employed. Moreover in order to identify the causes and effect of LU/LCC of the study site socio-economic survey were conducted, which could helped to gain qualitative and quantitative data, collected through sampled household questionnaire, focus group discussion, key informant interview and direct observation. In addition secondary data were also used. Generally in order to address the stated objectives the following research instruments, sampling techniques, and analysis methods were employed in the research process.

3.3.1 Socio-economic Study

3.3.1.1 Sample size and sampling procedure

In order to select sample house hold multi stage sampling technique were used. In the first stage Tiyo wereda was selected purposively, this is because among other wereda those found around Chilalo Mountain, Tiyo take the largest portion. Since Tiyo woreda has 21 administrative units, of which 18 are rural kebeles and 3 urban administrative units. Therefore In the second stage three kebeles' such as Oda Dhawate, Burka chilalo and Dekaka Konich were selected purposively. The researcher decided to select these kebeles, due to their location around the Chilalo Mountain. Finally, the sample households were selected from the three selected kebeles' using simple random sampling methods. Since there are a total of 138 sample household that, 55, 47, and 36 housed will be interviewed from Dekaka konicha, Oda Dhawote and Burka chilalo respectively based on their population proportion.

To determine the sample size of the study will apply the formula provided by Cochran's (1977)

$$n_0 = \frac{Z^2 pq}{e^2}$$

no= is the sample size,

Z2=the desired confidence level, 95%

e = the desired level of precision

p =the estimated proportion =90%

q =1-p.

So, that the total sample size was 138.

3.3.1.2 Data Sources and Data collection Instruments

3.3.1.2.1 Data source

Data were collected from primary and secondary sources.

3.3.1.2.2 Data collection instrument

Primary data

The following techniques were employed to generate the primary data.

I Household survey: A structured questionnaires were used to collect data from selected samples of 138 households from three *kebeles.* The major issues addressed in the questionnaires were household demographic characteristics, major economic activity, trend of land size and livestock number, LULC type in the study area, major shift in the land use occurred, the cause of LULCC and biophysical & socioeconomic impact observed in the study area due to the change. Three enumerators were trained for one day on contents of questionnaires and method of data collection. The researcher conducts the training and supervised the enumerators during data collection. The survey was conducted from February 7/2014 to February 19 /2014. Affaan Oromo and Amharic languages were used to conduct interviews and the responses were recorded in English.

II Focused Group discussion: This method of data collection was design to supplement and cross check the data obtained from household survey. Three FGDs were conducted in the three sampled *kebeles.* In all the three kebeles discussions were made with a group of farmers composed of different social groups. The elders were important source of information through sharing their observations and experiences on the change in the land use land cover, the major derivers behind the change and associated impact observed on both biophysical and community found in and around the area. A total of 6-8 people were participated in the group discussions, the members were the local farmers living in the *kebeles,* who are volunteers to take part in the discussion. Checklists were prepared to lead the discussions.

III Key informant interview

The discussion was also held with different people selected based on their responsibilities linked to Chilalo Mountain and the elders those have historical information about the study area.

III Observation: personal observation of the facts on the ground is very important in order to gain relevant data that supplement the information gathered through the above instrument. Observation was done through transect walks across the selected *kebeles*. It was a useful technique to characterize and understand biophysical nature of the study area such as topography, land use/land cover type, land degradation and general socioeconomic condition of the community.

Secondary Data

Data about population, age structure, land use pattern, farming systems, infrastructure situation, crop production trend, meteorological data (rainfall and temperature), etc. were collected, through review of relevant documents from published and unpublished materials; books, journals, reports, maps and photographic.

3.3.1.3 Social survey analysis

Statistical Package for Social Scientists (SPSS) software version 20 was employed to analyze data drawn from household survey. Descriptive statistics like mean, percentage and frequency distribution were used to analyze quantitative data. Qualitative data generated from key informant interview, focus group discussion and secondary sources was analyzed by narrative description.

3.3.2 Land Use and Land Cover study

3.3.2.1 Remote Sensing Data Acquisition and material used.

Multi-temporal Land sat image of four periods (1973 MSS, 1986TM, 2000ETM and 2011TM) remote sensing data of the area was used, These images were procured and processed with help of the image processer tools like EARDS IMAGINE 9.2 and Arc GIS 9.3 to generate land use/land cover dynamics of the study area, moreover Georefernced topographic map was also used for georeferecing satellite imageries. Land sat images were acquired from Ethiopian Mapping Agency.

Table 1 Land sat Data Used in Land Use and Land Cover Classification

Satellite image	Path and Row	Pixel Size/Ground Resolution (m)	Acquisition Date
Landsat MSS	P178r55	57*57	01/28/1973
Landsat TM 1986	P168r54	28.5* 28.5	01/21/1986
Landsat 2000 ETM+	P168r55	28.5*28.5	05/13/2000
Landsat 2011 TM	P168r55	28.5*28.5	02/17/2011

3.3.2.2 Image Analysis

3.3.2.2.1 Image Pre-processing

Image preprocessing are those operations that are normally required prior to the main data analysis and extraction of information. Selecting appropriate satellite imagery is the first task in image data processing. Then raw digital images cannot be used as map without correcting geometrically thus in order to be able to work in a GIS environment the images must be linked to a co-ordinate system and a projection of the earth's globe (Universal transverse Mercator (UTM), Zone 37 North, Datum Adindan). In this study the topographic map of the study area with scale of 1:50,000 were important in order to correct the image geometrically with road and river intersection on the images themselves. After the raw data are georeferenced, they have been clipped with the boundary of the study area for further processing. Moreover Visual interpretation of satellite images was enhanced through the use of contrast stretching in ERDAS IMAGINE software.

3.3.2.2.2 Image Classification Analysis

Classification of a satellite image can be achieved by supervised or unsupervised procedures. In this study supervised classifications was carried out to identify the overall land use and land cover type based on training area. In order to determine the patterns and processes of landscape change over time of the study area fieldwork was carried out in February 2014. Structured interviews were conducted with elder persons who have been familiar with land-use and land cover histories in the study area over longer period of time. The information obtained from the interviews and documents allowed us to describe the land use/ land cover type of the study area, moreover GPS has been used in the collection of ground control points for training samples used for image classification.

Supervised image classification was a method in which the analyst defines small training sites, in which major land cover types are delimited manually as a key for electronically classifying the image which were representative of each desired land cover category. The delineation of training areas representative of a cover type was most effective when an

image analyst has knowledge of the geography of a region and experience with the spectral properties of the cover classes.

In contrast, the unsupervised classification technique is performed when there was little or no knowledge to the geography of the region where classification is under taken. Therefore, in this study the satellite image was classified in the supervised classification.

3.3.2.2.3 Change Detection

Change detection is the process of identifying differences in the state of an area by observing it at different times. Principally, it involves the ability to quantify temporal effects using multi temporal data sets (Singh, 1989; Lu *et al.*, 2004). In this research post classification comparison change detection technique was used, thus LULC maps of the year 1973, 1986, 2000 and 2011 have been generated independently. The classified land use/land cover data were used for change detection analysis. The comparison of the land use/land cover statistics assists in identifying the percentage change between t1 and t2. So that, three comparisons based on four satellite images, 1973, 1986, 2000 and 2011 were made. In achieving this, the first task was developing a table showing the area in hectares and percentage and changes between the periods (1973 – 1986), (1986-2000) and (2000-2011) measured for each land use land cover type.

3.3.2.2.4 Accuracy Assessment

Land use /land cover classification results have been evaluated in order to investigate how the result reflects the reality on the ground. This is important because land use and land cover maps derived from remote sensing may contain some sort of errors, due to several factors, which range from classification technique to method of satellite data capture. In order to wisely use the maps the errors must be quantitatively evaluated in terms of classification accuracy and intended to produce information that describes reality. Therefore, an accuracy classification assessment was carried out to verify to what extent the produced classification is compatible with what actually exists on the ground. It involves the production of references (samples) that evaluate the produced classification. These references were produced from Google Earth and GPS points during

field work, which were independent of the ground truths used in the classification. Using this process error matrix was produced for each image.

3.4.1.1 Rate of Land Use/Cover Change Detection

The statistics of LULC were computed to detect the land use land/cover change between different comparison periods i.e. (1973 and 1986), (1986 and2000) and (2000 and 2011).

Change in (ha) between Ua and Ub = **Ub-Ua**.....,. (Equation 1)

Change in (%) between Ua and Ub = $\frac{(Ub-Ua)}{Ua} * 100$ ..... (Equation 2)

Moreover Land-use and land-cover change patterns and processes were described by the land-use change rate (ha year-1 and % year-1), thus rate of change was calculated for each land use and land cover type using the following formula (Derege, 2013).

K (ha year^{-1}) = $\frac{(Ub-Ua)}{1} * \frac{1}{T}$ ..... (Equation)

K (% year^{-1}) = $\frac{(Ub-Ua)}{Ua} * \frac{1}{T} * 100$..... (Equation)

Where, **K**= Land-use /land cover change rate

Ua = Previous area of land use/ cover in ha

Ub = Recent area of land use/ cover in ha

T = Time interval between Ua and Ub in year.

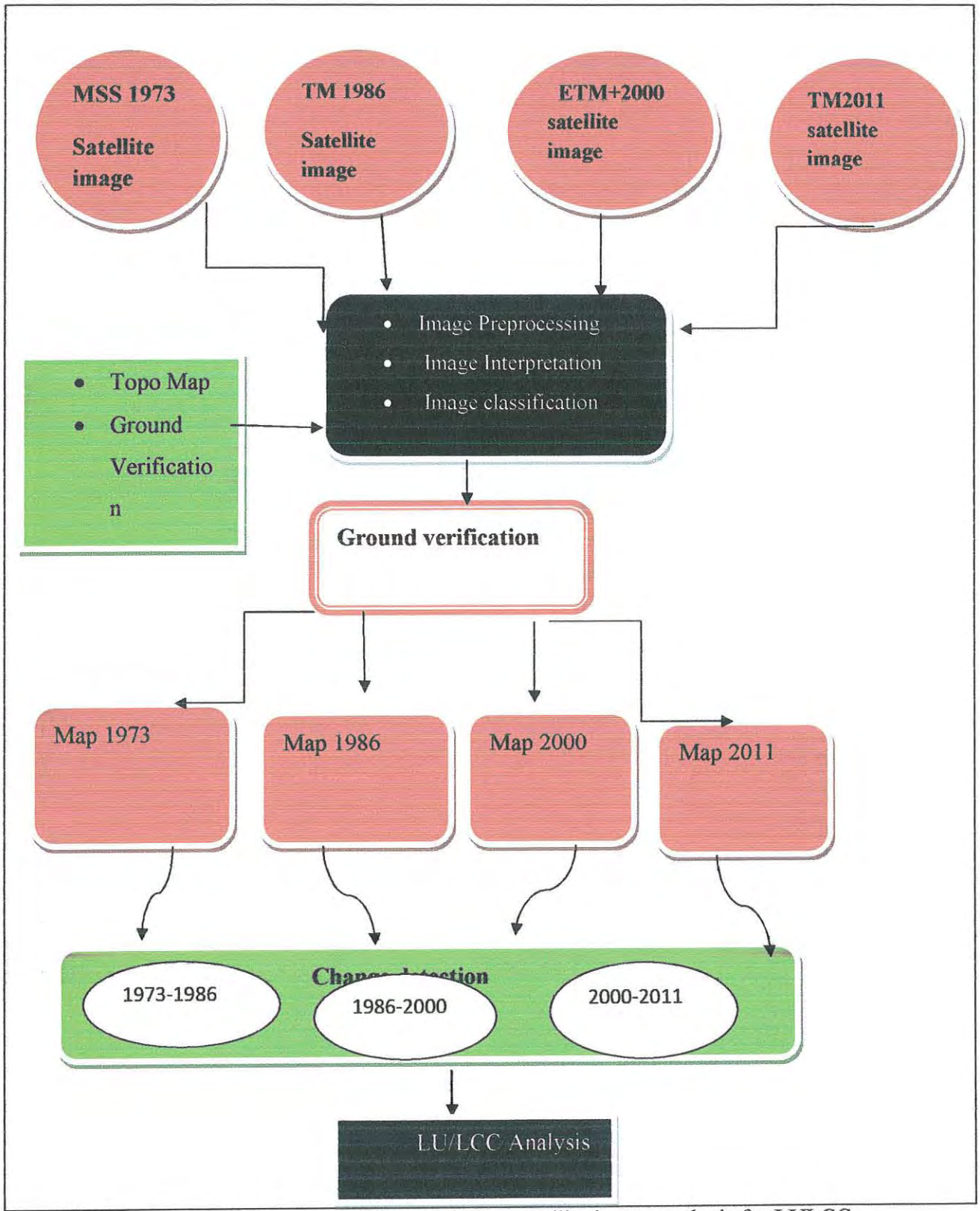

Fig 3 Summary of major steps followed during satellite image analysis for LULCC detection

CHAPTER FOUR

RESULTS AND DISCUSSION

4. 1 Demographic characteristic of the Sample Households

Sex-: the total households participated in the study were 138, of which 76.85% were male headed household and 23.2 % female headed household.

Table 2 ***Gender of sample household head***

Sex	Frequency	Percent
Male	106	76.8
female	32	23.2
Total	138	100.0

Source: Field survey, (February 2014)

Age: Age is an important variable/ factor which may indicate the experience of the respondent. The result of the field survey show that 71 percent of the household's respondents are within the age group of 36-65 year. About 22.5% of the respondents are between 18-35 years while 6.5% are above 65 years old.

Table ***3 Respondents' age distribution***

Age group	Frequency	Percent
18-35	31	22.5
36-50	58	42.0
51-65	40	29.0
above 65	9	6.5
Total	138	100.0

Source: Field survey, (February 2014)

Marital status-: the majority of the respondents 80.4% were married. The rest of the respondents, i.e. 14.5%, 2.9% and 2.2% are single/unmarried, divorced and widowed respectively.

Table 4 Marital status of sample household

Marital status	Frequency	Percent
married	111	80.4
single	20	14.5
divorce	4	2.9
widowed	3	2.2
Total	138	100.0

Source: Field survey, (February 2014)

Religion-: the information generated from the field survey depicts that, from the total sample household, 59.4%% of respondents are Muslims, 39.9% Christian and one person (0.7%) belongs to traditional religious believers.

Table 5 Religion of sample household

Religion	Frequency	Percent
Christian	55	39.9
Muslim	82	59.4
Traditional belief	1	0.7
Total	138	100.0

Source: Field survey, (February 2014)

Family size: It is the number of family members regardless of the age groups, and sex. In the study area the majority of the sample households have large family size. Of the total, 73.2% of, the respondents have a family size of five and more. The maximum family size is 17 and the minimum one is 1.

Table 6 Family size of sample household

Family size	Frequency	Percent
1-4	37	26.8
5-8	52	37.7
9-12	42	30.4
13-17	7	5.1
Total	138	100.0

Source: Field survey, (February 2014)

Education: Educational backgrounds of the sampled households of the study area, show that the majority of the respondent are illiterate and only read and write. This account about 53.7% of the total sample household, while 17.4%, 19.6% and 5.8% were attended their primary, secondary and preparatory school.

Table 7 Educational status of sampled households

Education status	Frequency	Percent
Unable to read and write	35	25.4
read and write (non primary)	39	28.3
Primary	24	17.4
secondary	27	19.6
preparatory	8	5.8
diploma	5	3.6
Total	138	100.0

Source: Field survey, (February 2014).

4.2 Households Economy

Land holding: most of the respondents (96.4%) replied that they have their own farm land while remaining respondent are landless. However, there is a significant variation in the size of holding among the land holders of the sampled households, the majority (76.7%) hold land that is between one and two ha, whereas 20.3% of households hold have land between three and four hectare, the other 3% have farm size above four ha.

Table 8 Land holding of the sample household

Farm size	Frequency	Percent
Less than 1 ha	38	28.6
1-2 ha	64	48.1
3-4 ha	27	20.3
Above 4 ha	4	3.0
Total	133	100.0

Source: Field survey, (February 2014)

Occupation: the main source of livelihood of the local community in the study area is mixed farming (crop farming and livestock keeping) which accounts 94.6%. Crop production such as wheat, barley, teff, pea and bean are the major annual crop grown in the study area, whereas maize and sorghum are supplementary crop accounts 1.4%. In addition domestic animal, such as cattle, goat, sheep, donkey, horse and chicken, are kept on a traditional basis, accounts 1.4%.The remaining of the respondents (2.2%) participated in processing and selling locally produced alcoholic drink such as "Tela□and , Arekie□

Table 9 Occupation of sample households

Major economic activity	Frequency	Percent
crop production	2	1.4
animal rearing	2	1.4
mixed farming	131	94.9
selling alcohol drink	3	2.2
Total	138	100.0

Source: Field survey, (February 2014)

4.2 Land Use and Land Cover

4.2.1 Land use/land covers classification Accuracy

Land use /land cover classification results have been evaluated in order to investigate how the result reflects the reality on the ground. This is important because land use and land cover maps derived from remote sensing may contain some sort of errors. Therefore, an accuracy classification assessment was carried out to verify to what extent the produced classification is compatible with what actually exists on the ground,

According to Lilesand and Kiefer, 2000 the minimum level of accuracy in the identification of land cover categories from remote sensor data should be at least 80 %, the accuracy assessment result of this study showed that the minimum overall classification accuracy was 85%% with a Kappa coefficient of 0.8125, while maximum overall classification was 90% with a kappa coefficient 0.877 . Thus the classification accuracy of the study meets standard requirement. The data used to assess the accuracy of classification are presented in (Appendix I).

4.2.2 Description of the main LU/LC class in the study areas

Six major land use/cover types were identified on the 1973, 1986, 2000 and 2011 satellite images of the Chilalo Mountain and its surrounding areas .These are forest, wood land, shrub land, pasture, crop land and bare land/ degraded

Forest: it includes both natural and plantation forest. Natural forest is. a multi-strata community, with interlocking canopies, composed of canopy, sub canopy, shrub and herb layers whereas plantation forest is land covered with human-made forests of eucalypt and conifer species. This land use/land cover class in the study area served as a source of wood and other products used for house construction, fuel wood, farm equipment and fencing.

Wood land:

.Areas covered with sparse woody plants mixed with shrubs, bushes, and grasses. It also includes areas with immature trees that may be in transition to forest or a low-density forest forming vegetation. In the study area woodland is the most important source of firewood, and woods for construction.

Shrub land: Areas covered with mainly shrubs and other small sized plant species those have several stem, but none dominant. In some cases mixed with grasses. It is less dense and smaller than woodland. In the study area this land cover class used as grazing during winter and the woody part is use for fuel wood.

Bare land: the category of bare land denotes areas that are without any vegetation cover at the time of satellite image acquisition. They are not covered by any type of crops, grass or any other shrub or tree species. It represent surface of the land which is mainly covered by bare soil, degraded land and rural villages.

Grass land: grasslands are non-woody areas where the vegetation is dominated by grasses and herbs. It is land units allocated as a source of animal feed. In the study area this land cover class is used for grazing and browsing. It includes privately and communally owned grazing areas.

Crop land: area of land that includes, areas currently under crop, fallow land, and land prepared for planting. In the study area this category encompasses areas allotted for seasonal crops production, most cultivated lands are meant for seasonal subsistence rain-fed crops. Crop cultivation is carried out on land ranging from gentle to very steep slopes. And various food crops are grown; the most predominant are barley, wheat, and teff from cereals and peas, beans from pulses.

4.2.3 Land Use/ Land Cover class and area coverage

Table 10 LU/LC classes, their corresponding areas (hectares) at different periods.

LU/LC type	Area in hectare			
	1973	1986	2000	2011
Forest	32,472.78	25,802.58	20,742.30	14,883.84
Woodland	22,719.93	21,117.53	28,117.91	17,345.52
Bare land	17,788.92	19,655.72	18,790.54	25,108.83
Shrub land	18,394.21	19,074.31	17,107.72	17,376.48
Grass land	18,343.20	22,632.78	22,578.15	22,484.25
Crop land	14,551.94	15,988.09	16,934.40	27,072.09
Total	124,271	124,271	124,271	124,271

4.2.3.1 Land Use/ Land Cover for 1973

Land use /land cover categories, identified in the study area are forest, wood land, bare land, shrub land, grass land and crop land. These land use/cover category have a total of 124,271 ha. The land use/ land cover classification for 1973 generated from satellite image showed that the majority of the study area was under forest accounting for 32,472.7803 ha (26.13%), beside forest, wood land have a significant portion, that is 22,719.9321 ha (18.28%) in the study area. bare land is also one of the land cover that identified from the satellite image with the area coverage of 17,788.9248 (14.32%), while shrub land, grass land and crop land accounted18, 394.2135ha (14.81), 18,343.2042(14.76) and 14,551.9461ha (11.70%) respectively.

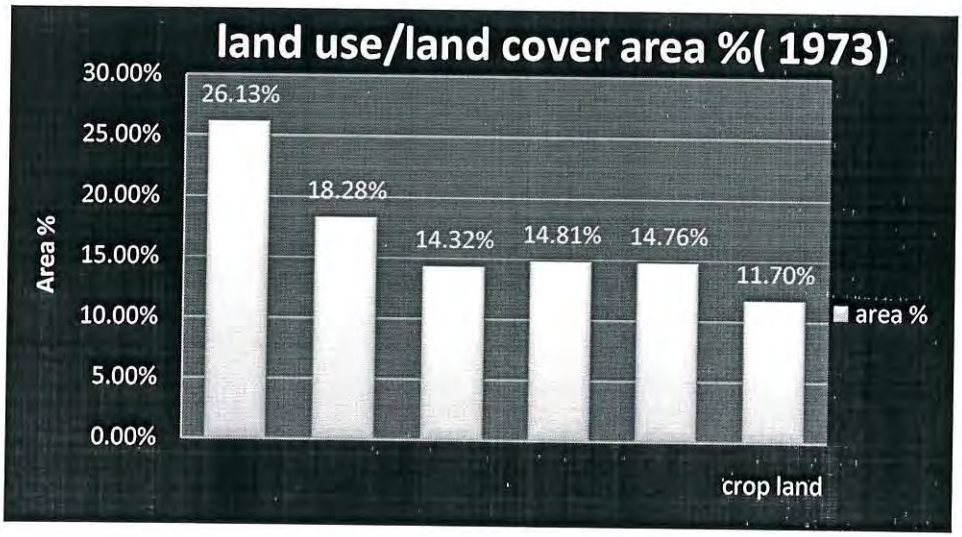

Fig 4 land use land cover class and their corresponding area (%) in 1973

Land use/ land cover map of Chilalo Mountain and its surrounding areas in 1973.

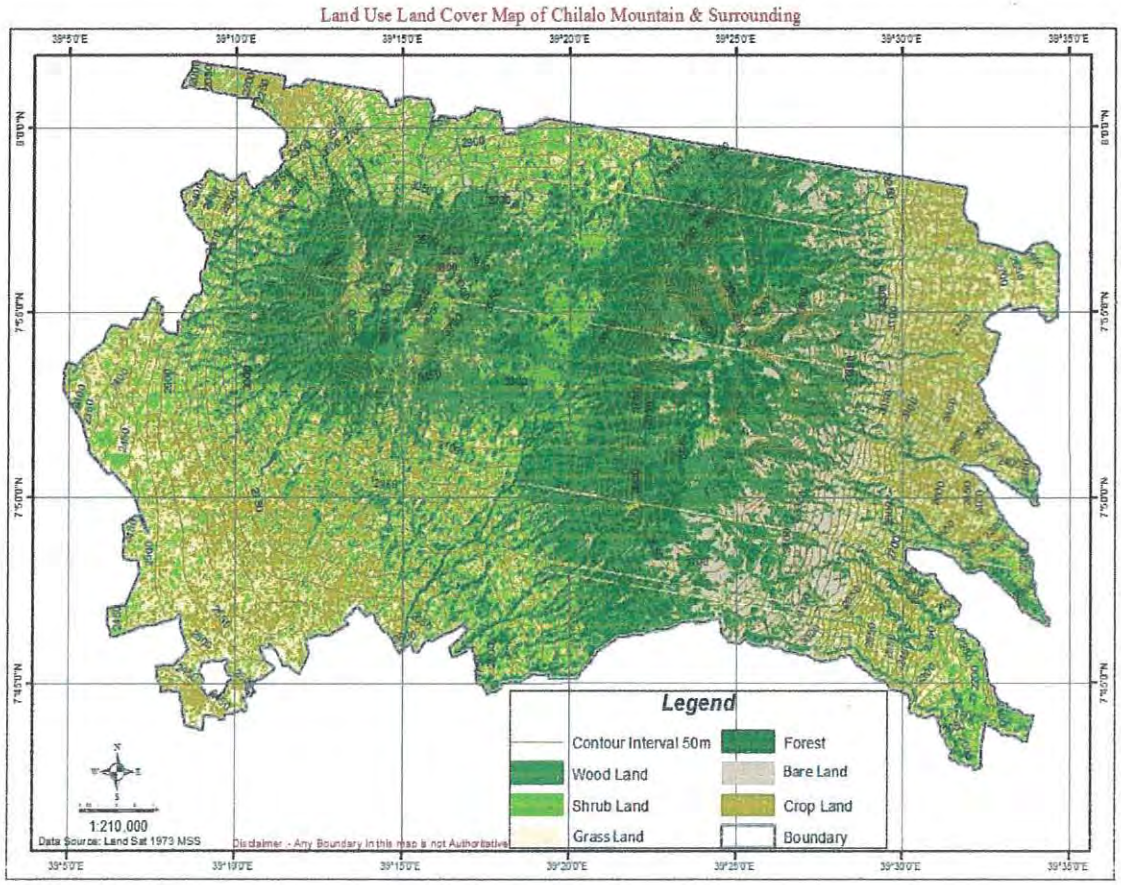

Fig 5 Land use land cover classification map of 1973

4.2.3.2 Land Use/ Land Cover for 1986.

The land use/ land cover analysis for 1986 from satellite image also showed that the majority of the study area was under forest and grasslands land accounting for 25,802.58 ha (20.76%), 22,632.78 ha (18.21%) respectively. while wood land, bare land ,shrub land and crop land amounted to about 21117.53ha (16.99%),19655.72 ha (15.82%),19074.33ha (15.35%), 15988.09 ha (12.87%) respectively.

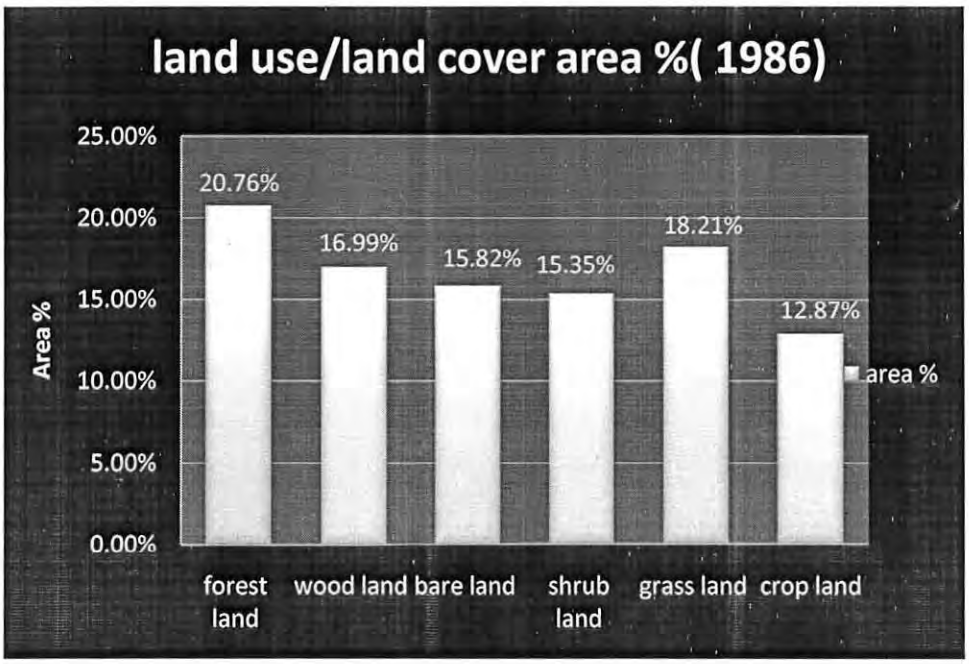

Fig 6 land use land cover class and their corresponding area (%) in 1986

Land use/ land cover map of Chilalo Mountain and its surrounding areas in 1986.

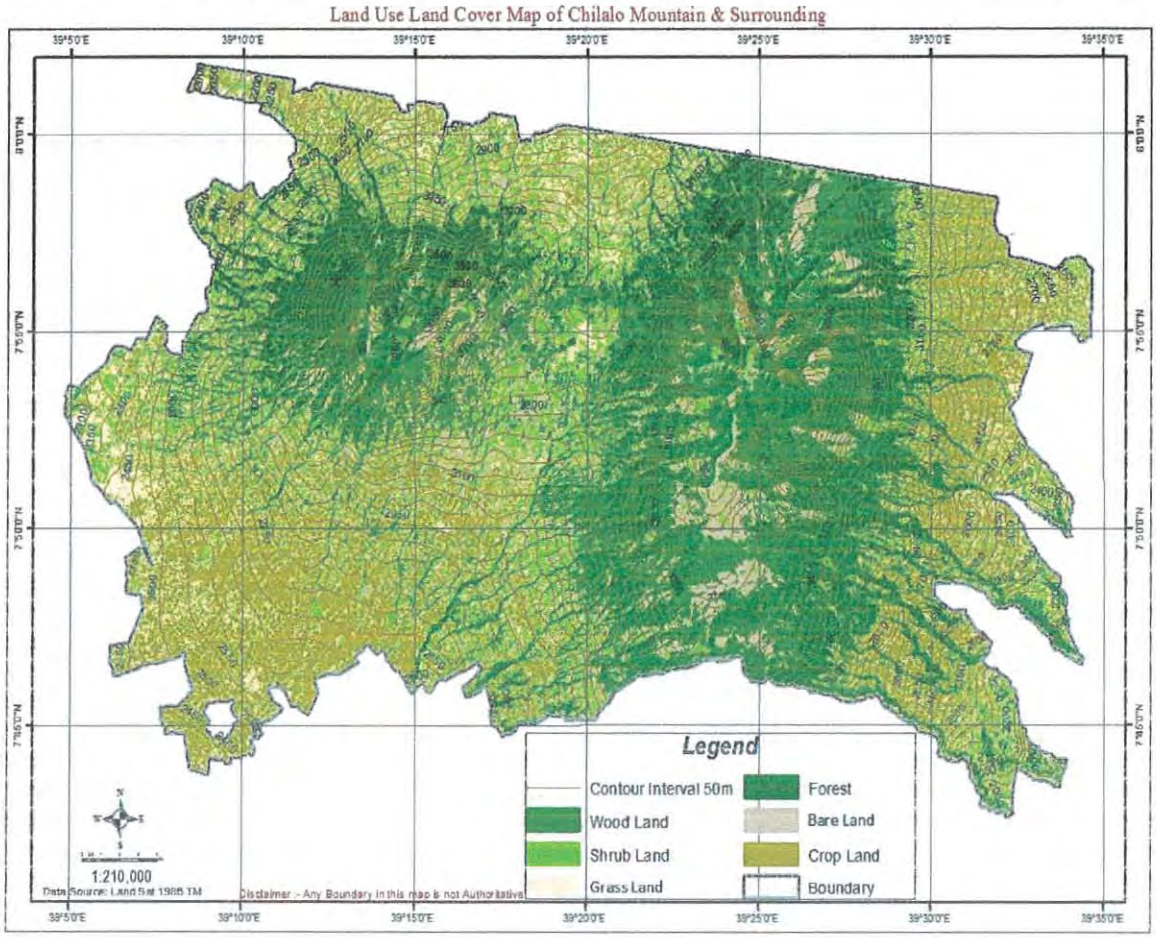

Fig 7 Land use land cover classification map of 1986

4.2.3.3 Land Use Land Cover for 2000.

The land cover analysis conducted for 2000 from satellite image reveal that wood land was one of the most massive land cover among other land cover, followed by grassland. While forest land, shrub land, bare land and crop were estimated 20,742,29,657 ha (16.69 %),17,107.72ha(13.77%),18,790.54ha(15.12%)and16,934.39827ha(13.63%).respectively..

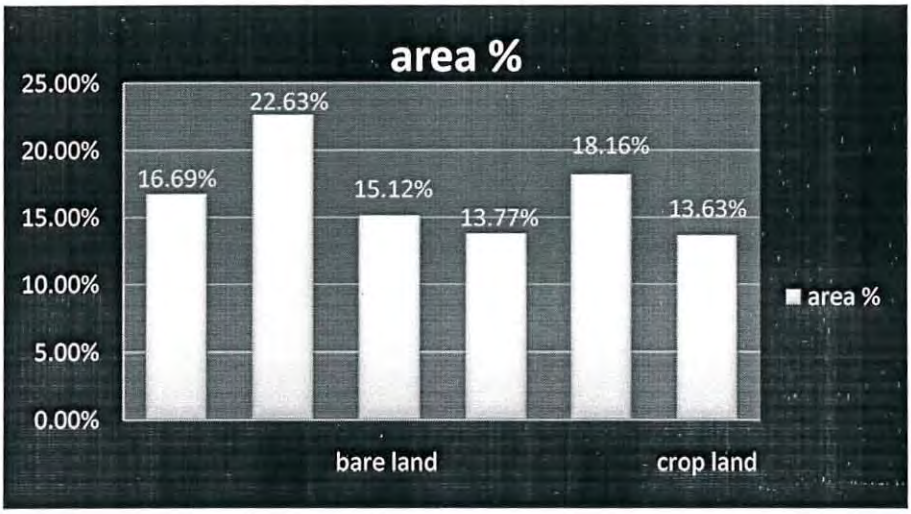

Fig 8 land use land cover class and their corresponding area (%) in 2000

Land use/ land cover map of Chilalo Mountain and its surrounding areas in 2000

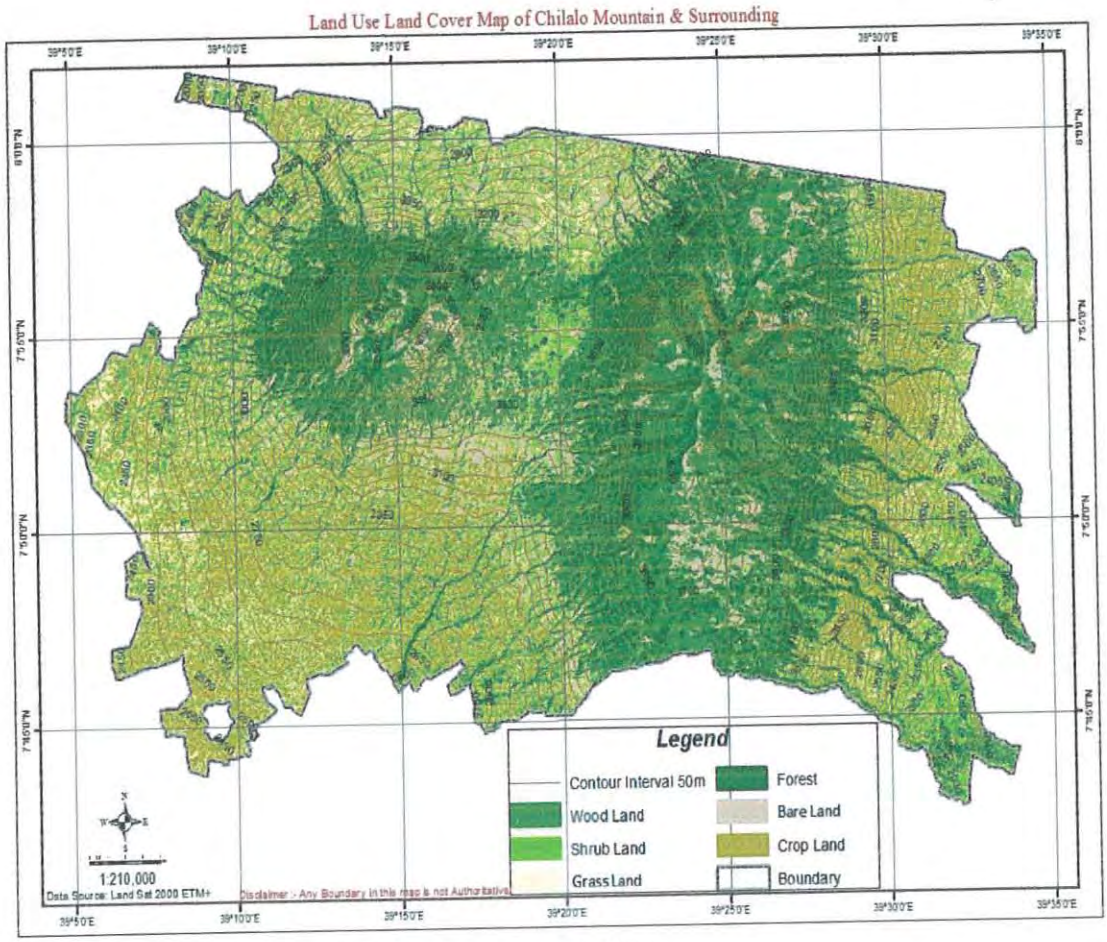

Fig 9 Land use land cover classification map of 2000

4.2.3.4 Land Use Land Cover for 2011.

In the study area, in 2011, agriculture was the biggest share of the land use and land cover classes, which occupied an area of 27072.09 ha (21.78 %) followed by bare land 25108.83 ha (20.21 %) and grass land 22484.25 ha (18.09 %).The least area coverage are shrub land, Wood land, and forest with an area coverage of 17376.48 ha (13.98 %), 17345.52 ha (13.96 %) and 14883.84 ha (11.98 %), from the total extent of the study area. respectively.

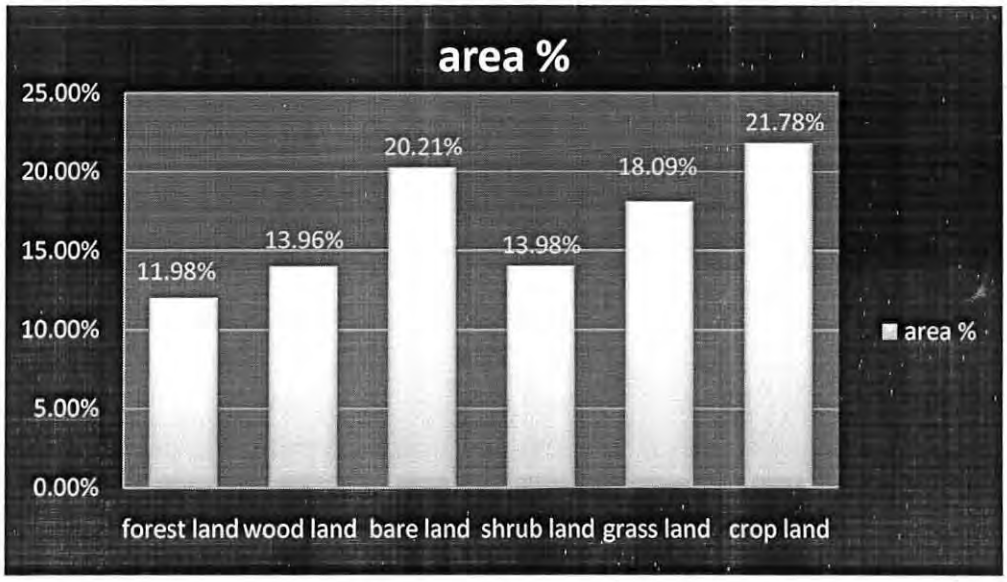

Fig10 land use /land cover class and their corresponding area (%) in 2011

Land use/ land Cover map of Chilalo Mountain and its surrounding areas in 2011

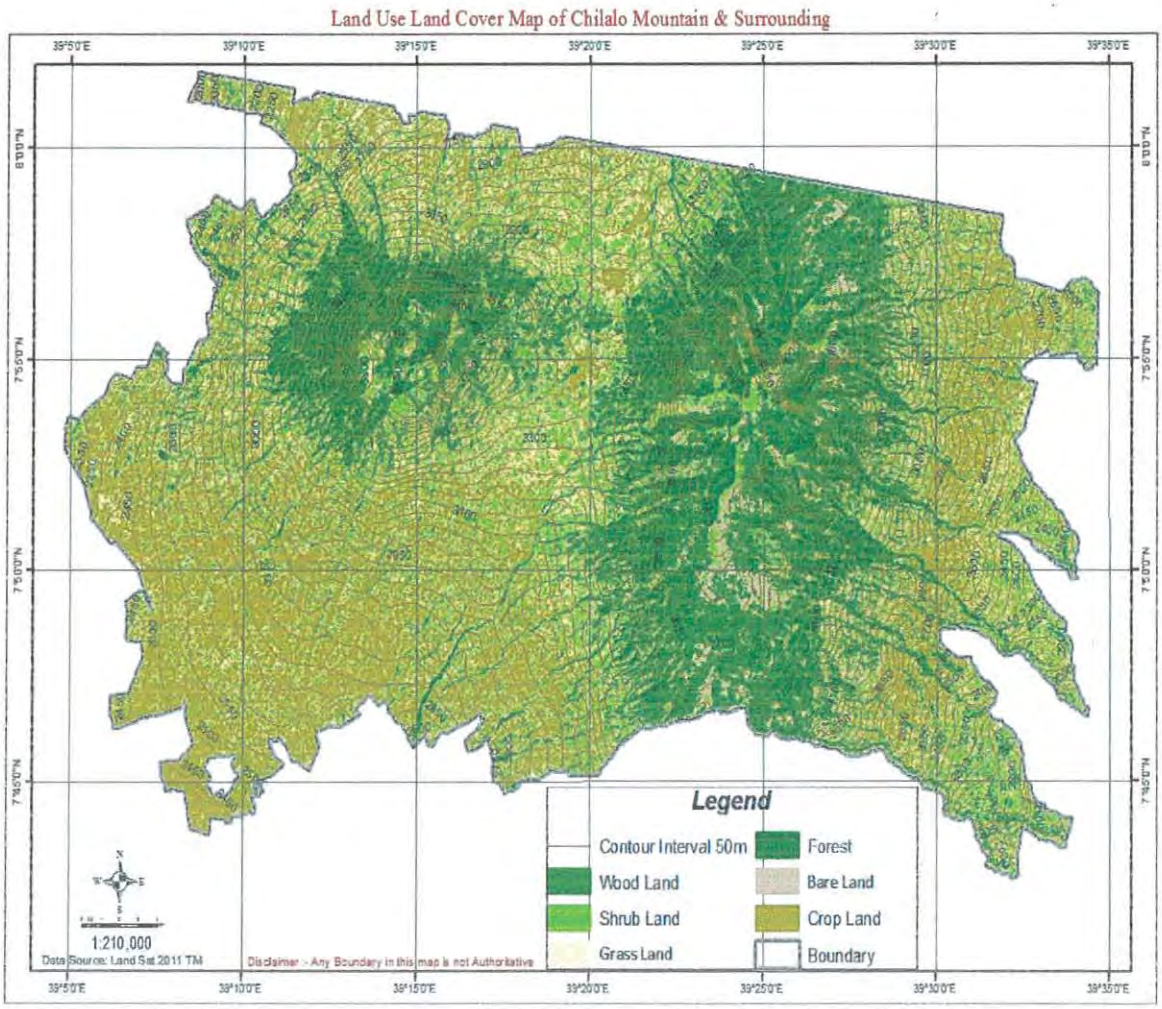

Fig11 Land use land cover classification map of 2011

4.2.4 Land use and land cover change detection

4.2.4.1 LU/LC Change Detection between 1973 and 1986

Between 1973 and 1986, the area under forest land and wood land showed decrease amounted to 6670.20 ha (20.54%) and 1602.40ha (7.05%), this reveal that forest and wood were declined at an average rate of 513.09ha (1.58%) and 123.26ha(0.54%) per year, while those under shrub land, grass land, crop land and bare land registered a remarkable increase of 680.10 ha (3.70%), 4289.57ha (23.39%), 1436.14ha (9.87%) and 1866.79 ha (10.49%) respectively. This show that shrub land was increased at an average rate of 52.32ha (0.28%) per year. whereas grass land, crop land and Bare land were

respectively expanding at rate of 329.97ha (1.80%), 110.47ha (0.76%) and 143.60ha (0.81) per year within the 13 years time interval.

Table 11 Extent and trends of LU/LC changes between 1973 and 1986

LU/LC Type	1973-1986			
	Change/ ha.	change /%	Change/ ha/year.	change /%/year
Forest land	-6670.20	-20.54	-513.09	-1.58
Wood Land	-1602.40	-7.05	-123.26	-0.54
Bare Land	+1866.79	+10.49	+143.60	+0.81
Shrub Land	+680.10	+3.70	+52.32	+0.28
Grass Land	+4289.57	+23.39	+329.97	+1.80
Crop Land	+1436.14	+9.87	+110.47	+0.76

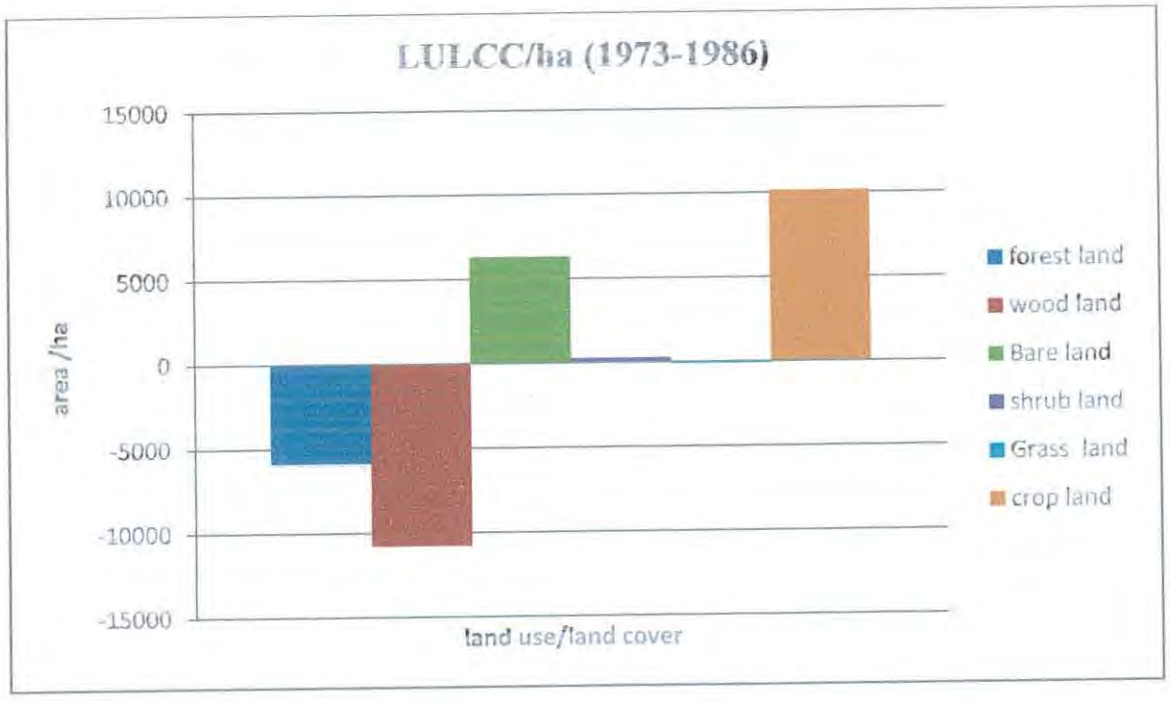

Fig 12 land use/ land cover change/ha between 1973&1986

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4.2.4.2 LU/LC Change Detection between 1986 and 2000

The result obtained from LU/LC changes detection between 1986 and 2000, be evidence that forest land and shrub land, diminished by 5060.29 ha (19.61percent), and 1966.59 ha (10.31 per cent). The annual average diminishing rate of forest land and shrub land were, 361.45 ha (1.40 percent) and 140.47 ha (0.74 percent/year within 14 years), Moreover bare land and grass land have decreased by 865.18ha (4.40 percent) and 54.63 ha (0.24 percent).at an average annual rate of change 61.80 ha/year (0.31 percent/year) and 3.90 ha/year (0.02 percent/year).

Contrarily wood Land and crop land expanded by 7000.38 ha (33.15 per cent) and 946.31 ha (5.92 percent). It should be noted that within 14 years both wood land and crop land increased at an average annual rate of change 500.03 ha/ year (2.37 percent/year) and 67.59 ha/year (0.42 percent/year) respectively.

Table12 Extent and trends of land-cover and land-use changes between 1986 and 2000

LU/LC Type	1986-2000			
	Change/ ha.	change /%	Change/ ha/year.	change /%/year
Forest	-5060.29	-19.61	-361.45	-1.40
Wood Land	+7000.38	+33.15	+500.03	+2.37
Bare Land	-865.18	-4.40	-61.80	-0.31
Shrub Land	-1966.59	-10.31	-140.47	-0.74
Grass Land	-54.63	-0.24	-3.90	-0.02
Crop Land	+946.31	+5.92	+67.59	+0.42

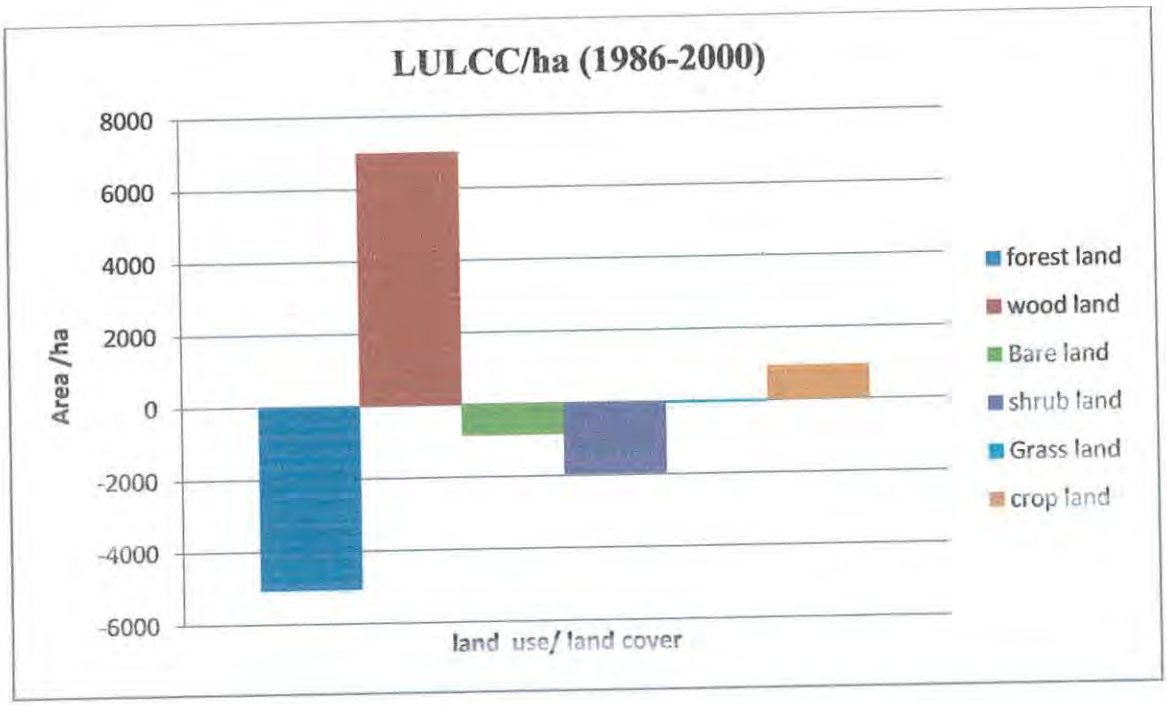

Fig 13 land use/ land cover change/ha between 1986 &2000

4.2.4.3 LU/LC Change Detection between 2000 and 2011

Table 13 show that between 2000 and 2011, enormously, agricultural and barc land has expanded 10137.69 ha (59.86 percent) and 6318.29 ha (33.62 percent) respectively, this implies that the agricultural land expanded at an average rate of 921.61 ha/year (5.44 percent/ year). While bare land expanded at an average rate of 574.39 ha/year (3.06 percent/year) over the 11 years period. Likewise shrub land also increased 268.76 ha (1.57 percent) with an average rate of 24.43 ha/year (0.14 percent/yeas).

On the contrary the area under forest land and wood land declined rapidly by 5858.46 ha (28.24 per cent), and 10772.39 ha (38.31 percent), furthermore the average rate of change for these land use/ land cover classes was 532.59 ha/year (2.57percent/year) and 979.31 ha/ year (3.48 percent/year) respectively over 11years period. Grass land also reduced by 93.90ha (0.42 percent) at an average rate of 8.54 ha/year (0.04 percent/year).

Table 13 Extent and trends of LULCC between 2000 and 2011

LU/LC Type	2000-2011			
	Change/ ha.	change /%	Change/ ha/year.	change /%/year
Forest	-5858.46	-28.24	-532.59	-2.57
Wood Land	-10772.39	-38.31	-979.31	-3.48
bare Land	+6318.29	+33.62	+574.39	+3.06
Shrub Land	+268.76	1.57	24.43	0.14
grass Land	-93.90	-0.42	-8.54	-0.04
Crop Land	+10137.69	+59.86	+921.61	+5.44

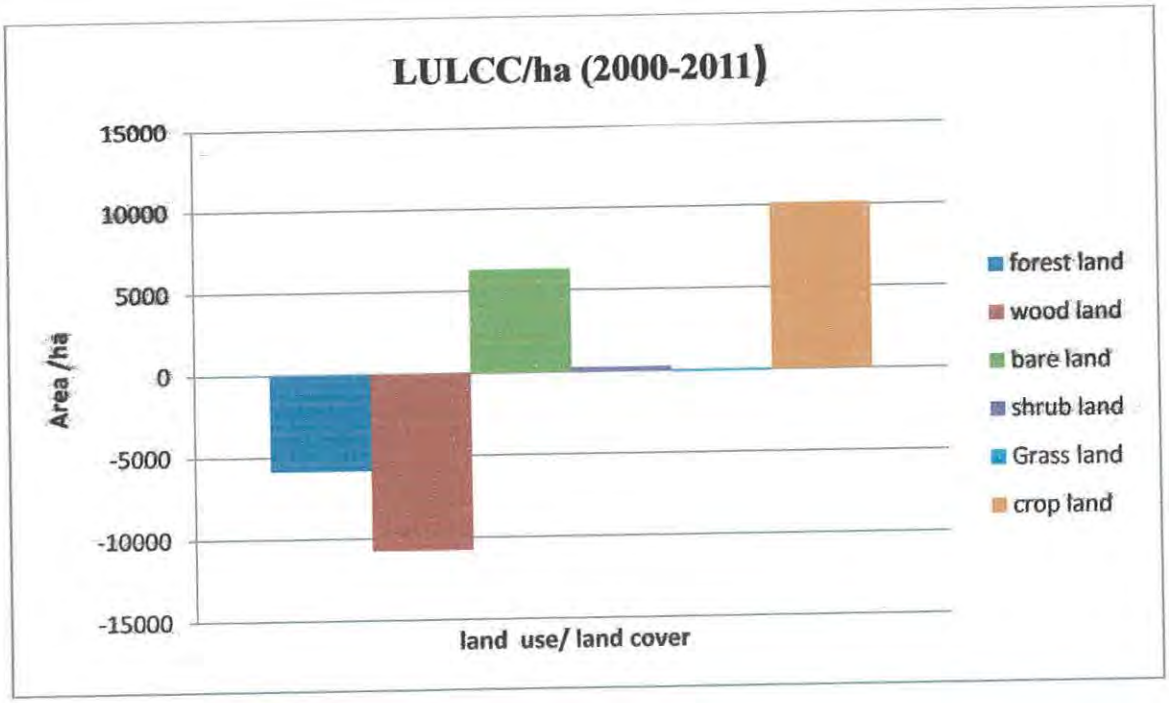

Fig 14 land use/ land cover change/ha between 2000 &2011

In general when early period land use/ land cover classes of the study area compared with subsequent period land use/ land cover classification there is change that shows decrease or increase in particular land use/ land cover.

As it was observed from the result of land use land/ cover change detection, forest land showed a continuous decrease during the three comparison period i.e. 1973-1986,1986-2000 and 2000-2011 with 6670.20 ha (20.54 percent), 5060.29 ha (19.61percent), and 5858.46 ha (28.24 percent) respectively. On the other hand crop land showed continuous increment by 1436.14 ha (9.87 percent), 946.31 ha (5.92 percent), and 10137.69 ha (59.86pecent) during the three period.

On the other hand wood land, shrub land, bare land and grass land showed fluctuation in different period, this mean that it may increase one period and may decrease on other period.

4.5 The Causes of Land Use/ Cover Change in the study area

Land use and land cover changes are the results of the interplay of many factors. The simple assumption that land use and land cover changes have been caused by few factors do not hold true. Rather, many interrelated complex factors best explain the processes of land use and land cover changes (Lambin & Geist, 2007). In the study area land use /land cover change specifically forest cover change is activated by various factors,

Even though, natural processes may also contribute to changes in land cover, globally the major driving force is human induced land uses, these human induced causes of land cover change, which are critical and currently increasing in alarming rate. Likewise among the factors those affected the land use/ land cover change of Chilalo Mountain and surrounding area, most of them are stimulated by the activity of man and it's responsible for massive conversion of forest land into other land forms and land use units in the Chilalo Mountain and surrounding area, Different researchers have put the reasons for land use and land cover changes in two broad categories as proximate (direct) and underlying (indirect or root causes) (Habtamu, 2011).

4.5.1 Proximate cause of LULCC in the study area

4.5.1.1 Agricultural land expansion

In Ethiopia, one of the proximate causes of land cover change, particularly natural forest destruction is agricultural expansion (Kahsay, 2004). The land use and land cover change detection results of the study areas indicated that there is an increasing trend of agricultural land from 1973 to 2011. The implication of increased agricultural land in terms of area coverage means other land use and land cover classes have been converted into agricultural lands.

Moreover data generated from the field survey and information obtained from the sample respondents showed that one of the major factors land use/ land cover change is agricultural land expansion in expense of other LU/LC types, to satisfy food demand for the ever increasing human population and house construction for newly married.

The respondents also point out that, as the area is potentially important for agriculture, the activity is more likely to further expand in to other land use and land cover areas such as grazing land and forest land, therefore most of private grazing land are changed into agriculture. In addition this activity also expanded to forested upland regions. Thus increasing conversion of forest land for cultivation and further encroachment of farmland on mountain forest edges is leading to continuous reduction of forest in the area As a result even an altitude more 3000 m a.l small-holder agriculture is practiced.

Fig 15 cultivation of crop on steep slope Photo: Author field survey, February, 2014

4.5.1.2 Deforestation

Reports on the forest resources of Ethiopia are dominated by the alarming deforestation that goes on unabated and at an accelerating rate. Deforestation for agricultural use is the main factor for the loss in forest cover. Extensive agricultural activities plus demand for firewood due to population increase are the major causes for deforestation (Carla et al, 2001). It is one of the main causes of land use/ land cover change. In the study area it is evidence that forest resource decrease from time to time. The result that obtained from land use land/ cover change detection showed, forest land is in a continuous decreasing

process during the three comparison period, between 1973 and 1986 the forest land decreased by 6670.20 ha (20.54%) from the original forest, from 1986 to 2000 it reduced by 5060.29 ha (19.61percent), likewise between 2000 and 2011 5858.46 ha (28.24 percent) of forest of land decrease and change to other land use.

Moreover the information generated from focus group discussion held with elders have evidenced that the whole study area was covered by dense forest and they are a living witness for the fact that the forest coverage have been diminishing,. Forest is severely deforested and converted into cultivations and grazing land.

Fig 16 forest degradation on Chilalo Mountain once under vegetation photo: Author field survey, February, 2014

4.5.1.3 Fire Hazard

Based on the field survey and information obtained from the sample respondents fire hazards were one of the key factor that contributed for destruction of forest in the study area, In addition Participants in focus group discussion and key informant interview explained that the fire hazard was occurred due to both human activities and natural hazard. The most significant threat to the Chilalo Mountain ecosystems is intense, uncontrolled burning of *Erica* to promote the growth of grasses and forbs utilized by livestock. This is because mature Erica stands tends to have closed canopies that hold back the growth of grasses and forbs, so that in order to increase forage, and to open the landscape for livestock grazing, the respondents also explained that, local people set fire to vanish the wild life. Therefore local people repeatedly set fire. The key informant also pointed out that in addition to human activity natural events also contributed for fire hazard.

Fig 17 Fire hazard on Chilalo Mountain photo (Genene, 2013).

4.5.2 Underlying cause of LULCC in the study area

4.5.2.1 Demographic Pressure

Population growth causes degradation of resources that rely on the available land and the interaction between them is very complex. Interactions can contribute positive or negative effects on the resources. People demand land for food production as well as for housing, and it is common practice to clear the forest to make areas for farming and housing. The result is that land cover and land use are changed due to daily human intervention (Daniel, 2010).

In Ethiopia rural and urban population increase from time to time The growth of the population followed a slow rate of increase until 1970 and accelerated thereafter In 1984, the total population of Ethiopia was 42.6 million (CSA, 1985 cited in Carla et al, 2001), The 1994 Population and Housing Census showed that population had reached 53.5 million, and by 2003 it is over 67 million (NBSAP, 2005). Moreover the population projection figures made based on the results of the 2007 Housing Census of Ethiopia for the year 2012 become 84, 32 million.

The sample households in the study area were asked whether there was increase in population growth or not. All of the respondent agree that the current number of population is very large as compare to the population number living in the area before 30 years ago. They also described that the population number is enhanced due to natural increase of the local people rather than immigration. Moreover participants in focus group discussion stated that majority of the household in the study area have large number of family size, therefore, the farmers are forced to find an extra farming land to feed their family. Likewise National Population and Housing Census result shows that population number of the study site is growing, i.e. in 1994 Arsi zone had a total population of 2,217,245 with an estimated population density of 93.5 people per km^2, while in 2007 the total population of the zone was 2,635,515 and the estimated population density were 132.17 people per km^2. Moreover according to the projection

made using the population data of 2007, the zone populations were expected to reach 3,056,372 by 2012 with population density 154.2 people per km^2.

4.5.2.2 Economic factor

The information generated from focus group discussion is showed that there is scarcity of farm and grazing land, this is because as the stated before most of people have large number of family size, besides this newly married family member shares his family land to maintain his livelihood. This idea also supported by sample respondent, indicated that the trend of their farm land size deceased from time to time. This is because their children share their farm land, and the current land hold size is very small as compare to the previous one The key informant also point out that the maximum land holding in the study area is five hectare and the minimum is zero (there are farmer who have no land) but majority of the people in the study have average land holding size of one & half hectare.

Furthermore majority of the respondent in the study area depict that current land holding size is not sufficient to support their household. Therefore farmers are forced to exert pressure on the nearby forest and grazing land, to get additional land in order to expand their farm land.

Table 14 current land holding of the respondent to support the household

Current land holding	Frequency	Percent
Excess	6	4.5
Sufficient	49	36.8
Insufficient	78	58.6
Total	133	100.0

Source field survey February 2014

On the other hand the demand of forest products for the construction of house and fence also enhanced, as result, the destruction of forest has been aggravated in the study areas.

According to the participant point of view in the focus group discussion, it was evident that cutting trees to fulfill the demand of fuel wood and constructional material is considered to be the causes of deforestation in the study area.

According to Rural Devolvement Agent from Burka Chilalo as key informant expressed that dependency of poor people on forest as their livelihood is also one of the major problems for the land use land cover change of Chilalo Mountain and the surrounding area. This is because selling of wood and wood products are means of income generation for the resource poor people, particularly landless youths and women in the study area, trigger to forest cover change.

4.5.2.3 Institutional factor

Ethiopia's extensive natural resources such as natural forest have been degraded. The underlying causes for this state affairs lie, by and large, in policy and institutional issues, which include poor governance, inappropriate policies, frequently changing and ineffective legal and institutional framework, poor implementation of policies, misuse of human resources and ineffective bureaucracy resulting in low implementation and management capacity over the past several decades (Sida, 2003).

The three most notable land tenure systems in Ethiopia are that of the *Imperial* Government (1930-1975), the *Derg* regime (1975-1993), and the Federal Democratic Republic of Ethiopia (FDRE) (1993-recent).

Concerning the impact of the land tenure system on land use/ land cover change of the study area, questions were raised to focus group discussion participants. According to their response majority of the participants were observed the three governments, accordingly the view local people massive size of land use/land cover change on Chilalo mountain take placed during the military governance. This finding also supported by Messay (,2011) the military government nationalized "*Land to the Tiller*" accordingly, land and the resources were divided into pieces among smallholding farmers, which resulted in massive deforestation of vegetated lands intended for various purposes. This,

in turn, resulted in dramatic LU/LC changes throughout the country, in general, and the study area, in particular.

Moreover the focus group participant point out that during the *Derge* regime the peasant association set communal land and resource for the community, this lead to tragedy of the common or everyone wants to maximize the benefit earned from that land/resource, Their suggestion also supported by Shaxon (1981a) cited in Lakew et al, (2000) communal ownership is believed to lead to mismanagement, particularly, over-grazing and inefficient removal of wood for fuel.

The participant also revealed land tenure insecurity caused the land cover change as well as land degradation in the study area, particularly during the *Derge* regime there were frequent redistribution of cultivated land, thus farmer were lost their sense of ownership and lack of confidence on their farm land, this in turn lead to mismanagement and unwanted land cover modification and conversion, that only aimed to maximize the current benefit. According to Feder et al; (1988) cited in Mesfin, (2010) tenure security determines the extent to which farmers may benefit from investments made to improve the land. In the extreme case in which farmers expect to hold land for only the current season, they will have no incentive to conserve; rather, their incentive is to get the maximum benefit from the land. More generally, farmers may expect to use land for an uncertain period of time, but consider that there is some risk that they will lose this right in the future. The greater the risk of losing the right, the lesser likely they conserve the productive capacity of the land.

On the other hand concerning rule and regulation system of the Chilalo Mountain forest conservation, question was raised to sample household respondent, focus group and key informant participant. Accordingly the entire participant pointed out that even though there is rule and regulation to control unwanted change and degradation of the Mountain. But, there was no or still lacking strong rule & regulation, moreover measures taken to punish those who violate rules and regulation is not much. As a result parts of protected areas and natural forest in the study area have been converted to farming. This idea also

supported by sample household respondent, majority of them 64.5% stated that, there is no regular monitoring and regulation system of the Chilalo Mountain.

Besides, the suggestion of the local community Evangelista, et al, (2007) indicated that even though the Chilalo Mountains became one of 39 forest priority areas in Ethiopia,, that is aimed to be managed for the production, protection and conservation of its forests but cutting of the forests, uncontrolled burning and the expansion of agriculture continue to have a significant impact. Management of the Mountains forest priority area is particularly difficult because it encompasses portions of different weredas of the Arsi Zone. Additionally the boundaries of these weredas meet at the higher elevations and are not clearly defined. This loose interpretation of wereda boundaries have suppressed any effective management of the Mountains and created a situation where extensive exploitation of natural resources can be conducted without regulation.

4.5.2.4 Scio-cultural factor

regarding the perception of local community towards the management of Chilalo Mountain and the surrounding area, the respondents were asked about the importance of conserving Chilalo Mountain, all of the sample respondents (100%), has a positive attitude towards the conservation of the study area and they thought that conserving the natural resources of Chilalo Mountain is very important.

The respondents justify the important of conserving the Chilalo Mountain from consumptive uses point of view and its environmental services. Consumptive uses including grazing, source of fire wood and construction material and generation of income by selling fire wood.

All of the respondent also reason out the significance of conserving Chilalo Mountain from the environmental services perspective, they indicate that Chilalo Mountain is the source of many stream and river therefore conservation is essential in order to gain continuous flow of river and stream, In addition it is the home for varied flora & fauna, which attract tourists. Furthermore the respondent point out that conserving the upland around the mountain helps in order to safe their farm land from soil erosion. Generally

the local people have positive attitude towards conservation effort and have good awareness about the benefit they obtain from the Mountain.

4.6 Effect of Land Use /Land Cover Change

The land cover change of Chilalo Mountain produces change that affects both the biophysical resource and the livelihood of the local community. Participants of focus group discussions, key informant as well as sampled house hold identify the major impacts those observed in the study area.

4.6.1 Biophysical impacts of land use land cover change

The participant in the focus discussion were asked to identify and discusses the biophysical impact resulted due to the land use land cover change of Chilalo Mountain. According to the view of the discussion the major effects of land use/ land cover change observed in the study area include the reduction of flora and fauna, reduce soil fertility, gully formation, declining/drying up of river and stream water, reduce rainfall and increasing temperature of the area

4.6.1.1 Affected flora and fauna diversity

Ethiopia is an important regional center of bio-diversity (NBSAP, 2005). Land use/ land cover change, particularly conversion forest land into other land use/land cover leads to disappearance of both fauna and fauna as a result of the reduction in their food production that is due to loss in the green cover.

Regarding the study area, Chilalo Mountain is the home for different plant and animal species. Based on the information obtained from the participants the major types of wild animals in the study area are Hyena, Bushbuck, Zebra, Leopard and Monkey and 'Karkaro'. There are also endemic animals such as mount Nyala and Ethiopian Wolf (red fox), however the land use/ land cover change which resulted due to deforestation and fire hazard reduced wild animal number very much, as compared to the past 30 years.

Moreover the respondent identify the most important tree types found in the study area; these are *Hagenia abyssinica, Podocarpus* gracillors, *Olea Africana*, *Juniperus procera*

and *Erica* areborea. Even these all available at the present their quantity reduced severely. What is more the elder at Oda dhawata also indicate that one plant species ''shinet'' *myrica salicifolia* disappeared from the area.

4.6.1.2 Enhance land degradation

Questions were raised to sample household respondents if there is land degradation in the study area, and all respondents replied that there is a problem of land degradation in their surroundings. According to the information obtained from household survey, and focus group discussion soil erosion, deforestation, and overgrazing and gully formation are mentioned as the major type of land degradation .

According to key informants the land use/ land cover change of Chilalo Mountain is the main reason behind the occurrence of soil erosion at the lower elevation. This is because the removal of vegetation covers couple with steep slope topography accelerated soil erosion in the study area. As result majority of farmlands are affected by soil erosion, this in turn decrease soil fertility. The respondent indicated that some management effort is required in order to improve soil fertility through conserving soils on cultivated fields and protecting the farm land from further degradation.

Fig 18 soil and water conservation on cultivated land photo: Author field survey, February, 2014

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Observation during field survey showed that the problem of land degradation in the study area is visible; it includes widening and deepening gully, sheet erosion, and deforested slope and over grazed range land has been detected

Fig 19 Gully formation in the study area photo: Author field survey, February, 2014

4.6.1.3 Enhanced drying up of stream and river

The findings from focus group discussion indicated that Chilalo Mountain is the source of many stream and rivers. The major perennial river that originated from the Chilalo Mountain are Ketar, Kulumsa, Gonde, Dosha and Walkesa and all of them are flows to Lake Ziway. According to the participant of focus group discussion, the quantity of these river flows reduced very much and become seasonal. Especially the elder explained that the flows from the rivers were in large quantity and flow without intermittent throughout the years, but currently the flows of the rivers rely on seasonal rain fall. That means during summer the flow of the rivers to some extent it is better; however during winter flow of the rivers reduced severely or totally dry,

The information obtained from the focus group discussion also supported by Hougton, (1995) Surface runoff and Ground water flow are the two components of the stream flow. Surface runoff is mostly contributed directly from rainfall, whereas ground water flow is

contributed from infiltrated water. However, the source of stream flow is mostly from surface runoff during the wet months, whereas during the dry months the stream flows from the ground water, the land use and land cover type can affect both the infiltration and runoff amount by following the falling of precipitation.

In the view of focus group discussion and key informant, the land use /land cover change of Chilalo Mountain, specifically the conversion of forest to agricultural and other land use, is the main contributing factor for the reduction/drying of rivers and streams flow in the study area.

4.6.1.4 Change of local climate

Land use/land cover change particularly conversion and burning of forest for farming and the harvest of forest for timber and fuel wood cause a net release of CO2 from the biota to the atmosphere, which produces changes in the global atmospheric concentration of carbon dioxide; this in turn bring changes in regional weather and climatic patterns (Gregg Marland, 2003 cited in Nestanet, 2007).

In the study area participants on focus group discussion pointed out that, local climate change is observed. even though the global climate change have an impact on regional and local climate change, but it also clear that change in land cover of a given area at local level have its own contribution to local, regional even global climate change..

The participant of focus group discussion particularly the elders were the living evidence those indicated the climate change by comparing the current with the past. Accordingly they described that the agro-climatic zone which is observed in recent past was mostly cold climate (Worch) and temperate (Dega), But now these shifting to warm (Woina Dega) and hot & arid type (Kola) agro-climatic zone. the justification behind their response is that before thirty years ago in the study area farmer mostly sow, cool temperature cereal crops such as barely, teff, wheat, this is due to the area is more favorable for the stated cool temperature crops.

Whereas, hot temperature crops were plant grown rarely, But now in the study are hot land crop such maize become widely growing. This showed that the temperature is

increased. Moreover the majority of sample household participant (89.9%) depicted that the local temperature of the study area is raised moderately, while the other (10.1%) confirmed that, it is raised severely.

Table 15 trend of temperature in the study area

Increasing temperature	Frequency	Percent
Severely	14	10.1
Moderately	124	89.9
Total	138	100

Source: Field survey, (February 2014)

Additionally the analysis of climate data of Kulumsa weather station, which is the nearest metrological station of the study area, showed that the maximum average annual temperature of the study area is increased.

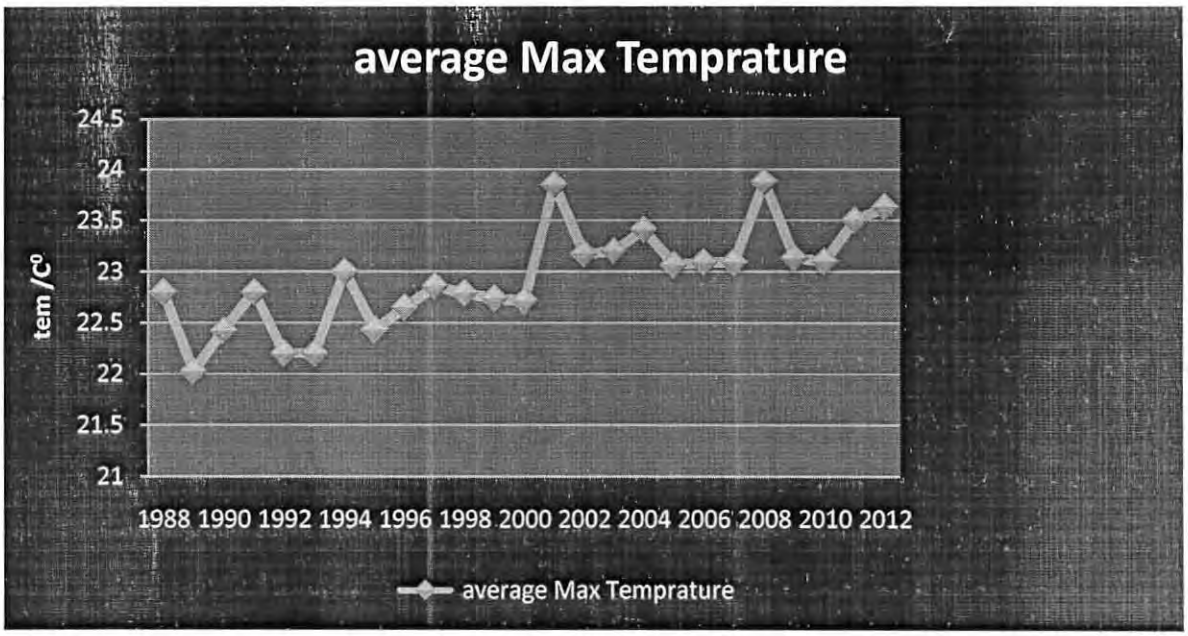

Fig 20 average maximum Temperature

Likewise annual average minimum temperature is increasing in the from 1988 to 2000 but it in turn decreased for the period 2001 to 2010.and it increased in 2011, even though the change is not significant in number, but it is possible to say the annual average

temperature is increasing very much, since data interpretation is made based on local climate, the change not expected to be very much.

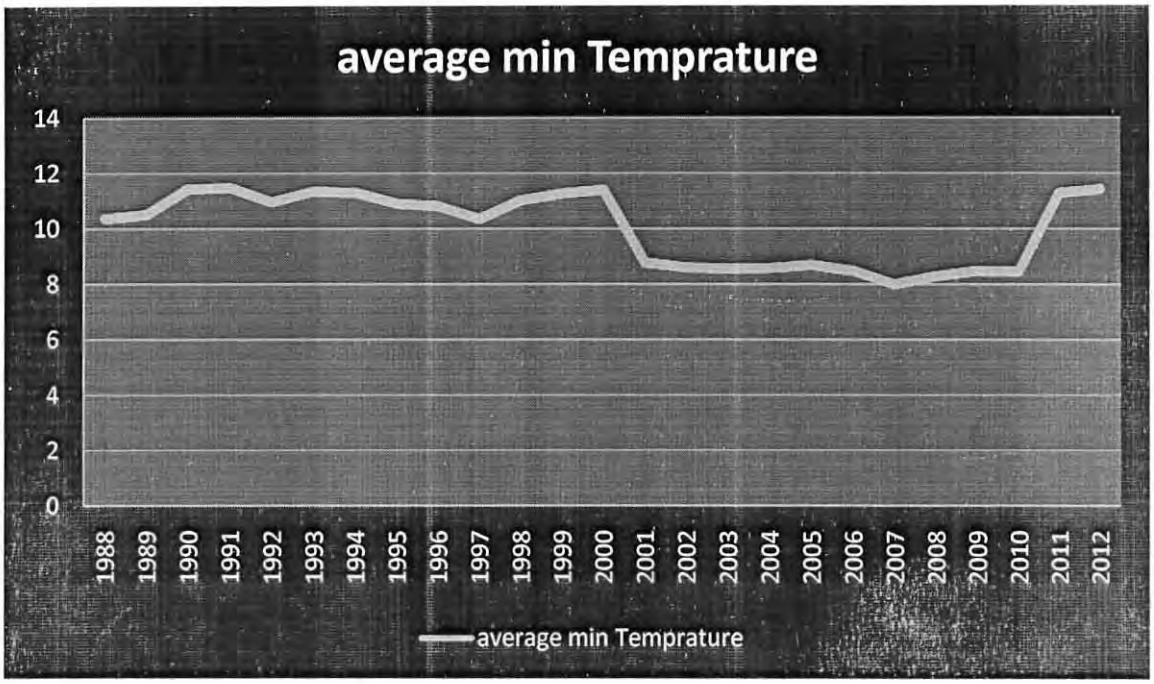

Fig 21 average minimum Temperature

Furthermore the participants also described that the pattern of rainfall is changing over time. In the past the amount of rain fall received in the area were good both in quantity and intensity but recently the pattern of the rainfall is becoming unusual i.e. it may dropped or it may excess and resulted flood. According to their view these change is resulted due to the land use/ land cover change of the study area, specifically conversion of forest land to other land use. Likewise the sample household respondent confirmed that local climate is changing over time, they further note that the climate change is resulted due to the previous land cover change, accordingly majority of the respondent (79.7%) perceived that the rainfall amount is reduced moderately and the remaining (20.3%) believed that it reduced severely.

Table 16 Trend of rainfall in the study area

Decrease rain fall	Frequency	Percent
Severely	28	20.3
Moderately	110	79.7
Total	138	100

Source field survey February 2014

Moreover the demonstration made based on climate data from record of Kulumsa meteorological station for the period 1973 to 2013 showed that there is high rainfall variability in study area within different period, which is the rainfall may be high in one period or very low in other period. The figure below show that the study area received the maximum rainfall (1041mm) in 1977 and the minimum rainfall is obtained from the record of 1985 that is (596.3mm) where as the remaining record fluctuate between 700mm and 950mm. the fluctuation highly affect the local farmers whose entirely depend on rainfall. But most of the record is become low and it is less than the annual Fig

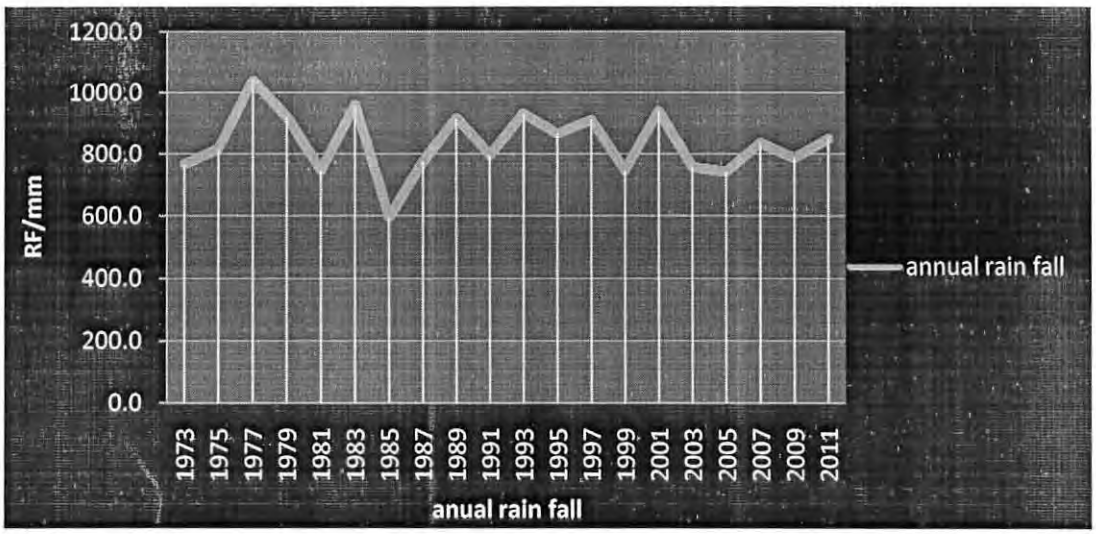

Fig22 average rainfall of the study site.

4.6.2 Negative Socio-economic effect of LULCC in the study area

Changes in land use can have a profound impact on the personal, family, work and social lives of people living in rural communities, as well as those living in rural and regional towns (Schirmer et al, 2008).Concerning the impact of land use/ land cover change of Chilalo Mountain and the surrounding areas participants of FGDs and sampled household respondent articulated that land use/ land cover change is seriously affecting the livelihood of the local community in many aspects.

4.6.2.1 Scarcity of wood increased

In Ethiopia, wood is the main energy source for urban and rural people (Kidane, 2002). According to the respondent one of the immediate impacts of land use/land cover change in the study area, particularly expansion of agricultural land at the expense forest land is shortage of fuel wood and construction materials for the local community.

The respondent also point out that scarcity fuel wood leads to increase in price of fuel wood both in study area and in nearby Asela town. The reason behind the rise in price of this commodity is that, in the past three decade fuel woods were collected from nearby forest but know fuel wood located far away from our village and it need longer times in order to gain fuel wood. According to the view of local community before 30 years ago one load of donkey firewood was less than three birr but at this moment it more than 60 birr. This condition forces farmer to increasingly burn crop residues and organic manure for cooking and heating. Moreover, this suggestion is supported by (Kidane, 2002) Scarcity of firewood has causing a continuous rise in prices, and thus increasing the economic burden on the household budget. Thus animal dung and crop residues are increasingly being used to meet household energy requirement, but dung and crop residues need to be returned to the land to maintain soil fertility.

Table 17 Source of energy for household in the study area

House hold energy source		Frequency	Percent
Wood	**Yes**	112	81.2
	No	26	12.8
Animal dung	**Yes**	102	73.9
	No	36	26.1
Crop residues	**Yes**	51	37
	No	87	63
Charcoal	**Yes**	30	21.7
	No	108	78.3

Source: Field survey, (February 2014).

In addition scarcity of fuel wood increase the work load of women, since women have to wake up early in order to collect fire wood and they travel long distance, so that it add household responsibilities.

Fig 23 women collecting fire wood in the study area photo: field survey, February, 2014

4.6.2.2 Increased Shortage of water

Due to land use/ land cover change specifically conversion of forest land into other land use the flow of rivers and streams have decreased or dried up completely. The loss of water sources in turn, affects large number population living on the upstream as well as people living downstream, who need the water for domestic uses and farm irrigation. In the study area the loss of water source affects local communities in different aspect. According to the outlook of focus group discussion at Oda dawota kebele before a few years ago there were irrigation in their locality because they got enough water from Kulumsa river, but at this moment the river flow is reduced very much and it also dry during winter.

During field survey the researcher observed there is constructed canal on Kulumesa River which water passes through from the river to Asella malt factory, furthermore some respondent complained that even if the factory helps to gain clean water by constructing water supply for domestic use and livestock use. We couldn't get water for irrigation. And there is no fair distribution of water between the factory and local farmers. Others explain that the factory totally depend on this river as a source of water and there is no any alternative source therefore the action is right, or else the factory may not functioning well, this may in turn affect the country economy as large.

4.6.2.3 Increased reliance on chemical fertilizer:

Land use/ land cover change, principally change in vegetation cover to other land use leads to land degradation through soil erosion and loss of soil fertility. In the study area the participants of focus group discussions pointed out that, due to the removal of vegetation at Chilalo Mountain followed by soil erosion on the farm land found at down slope of the mountain. These, in turn, have an effect on soil fertility. The loss of soil fertility requires the use of chemical fertilizers to compensate the loss of organic matter to maximize crop yield. However the use of artificial fertilizers poses a challenge to farmers to cover the cost of chemical fertilizers each year (Kassu, 2011).

Moreover sample household also depicted that the soil fertility of the farm is declined, due to flood that come out from the upland which accelerate the washing up of the top soil from the farm land found at lower altitude of the mountain.

4.6.2.4 Reduced the availability of traditional medicinal plant:

According to WHO *et al.* (1993) report the majority of the world populations depend on herbal medicine for primary health care needs which are mainly derived from forests. The consequences of deforestation affect the availability of medicinal plants, therefore many poor people who depend on traditional medicinal plant suffered, because of lack of cash to buy modern medicine. Likewise in the study area there were wide ranges of useful medicinal plant, the most important plant used as traditional medicine in the study area is Hagenia abyssinica. But nowadays as result of agricultural expansion in the marginal areas which would lead to deforestation, with decrease in number or loss of medicinal plant from the surrounding area.

The sampled respondent also indicated that land use land cover change of Chilalo Mountain and the surrounding area reduce the availability of medicinal plant around the study area Accordingly, majority of the respondent (52.9%), depicted that the land use/ land cover change affect accessibility of this commodity severely

Table 18 decrease availability of traditional medicinal plant

Extent	Frequency	Percent
Severely	73	52.9
Moderately	61	44.2
Low	4	2.9
Total	138	100.0

Source: Field survey, (February 2014).

4.6.2.5 Reduced number of livestock per householder

The focus group discussion participants pointed out that livestock holding per household is declined very much. According to participants view before thirty year ago majority of household possess more than fifteen, but at this moment the number is turn down. The information obtained during household survey also show even though 93.5% of the respondents have livestock their number is very small Among the respondent who have livestock in their home were asked to indicate the number and type of their livestock. Accordingly majority of the respondent have 1 to 2 cow, 3 to 4 oxen, 6-10 sheep, 1 donkey and some household having sheep and horse with maximal number of 1 and 1to 5 respectively.

Table 19 Trend of livestock holding size and of grazing land over time

Trend of livestock holding	**Frequency**	**Percent**
Increasing	12	8.7
Decreasing	125	90.6
No change	1	0.7
Total	138	100.0
Size of grazing land over time	**Frequency**	**Percent**
Increasing	3	2.2
Decreasing	135	97.8
Total	138	100.0

Source: Field survey, (February 2014).

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Respondents were also asked to give reasons for the decreasing trend of grazing land size. The FGD Participants pointed out that Expansion of cultivated land at expense of grazing land is the major reason for shortage of grazing in the study area. Sample household respondents also support the information gained from focus group discussion, the shortage of grazing land is resulted from different reason. The majority respondent (99.3%) indicated that shortage of grazing land is resulted due to agricultural expansion, (56.5%) stated that, it is due to over grazing of range land. The other 8 (5.8%) stated that it is due to area closure for conservation purpose.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

This study has attempted to investigate the land use/ land cover change detection of Chilalo Mountain and its surrounding, the divers behind the change and the effect of land use / land cover change on biophysical resource and local community.

In order to analysis the land use/ land cover change sequential satellite images proved to be valuable sources of information for the investigation, The study carried out using GIS technologies and remotely sensed data in conjunction with field observations, that have been used to investigate the LU/LC changes in the study area.

Six major land use/land cover types were identified for the 1973, 1986, 2000 and 2011 satellite images of the Chilalo Mountain and its surrounding .These were forest, wood land, shrub land, pasture, degraded/bare land and crop land.

The LU/LC change detection analysis revealed that there are great differences in spatial and area coverage between different land use/land cover classes /categories during the three periods, i.e. (1973 -1986),(1986 – 2000) and (2000 – 2011) the first, second and third comparison period respectively.

Accordingly it was observed from the result of land use/ land cover change detection, forest land showed a continuous decrease during the three comparison period i.e. (1973-1986), (1986-2000) and (2000-2011 with 6670.20 ha (20.54 percent), 5060.29 ha (19.61percent), and 5858.46 ha (28.24 percent) respectively. On the other hand crop land showed continuous increment by 1436.14 ha (9.87 percent), 946.31 ha (5.92 percent), and 10137.69 ha (59.86pecent) during the three period.

The other land use/land cover showed variation in different period, this mean they might increased one period or decreased in other period. Wood land increased (33.15 %) during the second compassion period from 1986 to 2000 .but it decreased by (7.05%) and

(38.31%) during initial and the last comparisons period that 1973-1986 and 2000-2011 respectively. while Shrub land increased during (1973-1986) and (2000-2011) with (3.70 %) and (1.57 %) respectively and it decreased between 1986 and 2000 by (10.31 %). Other land use type that is, degraded land increased during (1973-1986) and (2000-2011) by (10.49 %) and (33.62 %) respectively but between 1973 and 1986 the area showed decrease amounted to (4.40 %). Whereas Pastoral land increased during (1973 -1986) by (23.39 %), however this land use class decreased during the second and the third comparison by (0.24%) and (0.42 %) respectively.

The cause of land cover change of Chilalo Mountain, indicate that many interrelated complex factors are contributed; among the factors those affected the land use/ land cover change of the study area. The majority of them are stimulated by the activity of man and it's responsible for massive conversion of forest land cover into other land cover and land use units.

According to the result obtained from Socio- economic survey deforestation and agricultural expansion are the major immediate/proximate causes of land use/ land cover change in the study area. on the other hand the underlying causes behind the proximate causes of land use/ land cover change as identified by the study are: population growth, scarcity of farm land, scarcity of grazing land, demand for wood, dependency of poor on forest as source of income, tenure system, lack adequate of governance, and fire hazard.

The result of this study also indicated that, the land use land cover change of Chilalo Mountain and its surrounding affect the biophysical resource as well as the livelihood of the community in the study area. The biophysical impacts identified through the field survey and observations are: loss of biodiversity, land degradation (loss of soil fertility, gully formation, distraction of vegetation), reduction and/or drying up of stream and river. Moreover, the land use/ land cover change of the study site also affect the local community by aggravating: scarcity of wood, scarcity of water, increased consumption of chemical fertilizer, reduce the availability of traditional medicinal plant and reduced number of livestock per householder. So the these vulnerable resources need sustainable mechanism to save them for future use and to overcome community problems.

5.2 Recommendations

On the basis of the present findings the following recommendations are suggested

- Controlling the rate of population growth It is clear that increased population is causing LUCC in the Chilalo Mountain and its surrounding area in particular and in the country in general. Thus, to prevent population pressure on natural resource and reduce continues conversion of forest land into crop land, strong family planning should be given due attention widely and continuously through formal and informal educations in schools and social gatherings to use contraceptives.

- Agro-forestry: scarcity of farm, grazing land and demand for wood are the major factor affecting the land use/ land cover of the study area. Thus agro-forestry, practice will enable them to fulfill demand for wood, food and fodder products, thus reducing competition for this scarce resource. Agro-forestry practice can also serve as a means to alleviate problems of soil erosion and land degradation so that it helps to reduce relies on chemical fertilizer. Therefore developing the knowledge and awareness of the local community about agro-forestry should be done by concerned bodies,

- Afforestation and Reforestation: in order to restore the degraded part of the study area afforestation and reforestation is very important. During afforestation and reforestation program priory should given for indigenous species such as (*Hagenia abyssinica), (Podocarpus* gracillors), (*Olea Africana)*, (*Juniperus procera)* and *(Erica* ereborea) other than planting exotic species such as eucalyptus tree.

- Deforestation and burning of dung and crop residues are increasing by local community in the study area due to lack of alternative fuel sources. Thus alternative energy sources and improved stoves, such as the improved biomass fuel-saving stove, biogas, solar energy and electricity should be developed to minimize dependency on wood, crop residue and dung cake energy.

- Creating off farm job opportunity: When people lack access to alternative sources of livelihood, there is a tendency to exert more pressure on the few resources that are available to them, therefore landless, poor people who depend on forest for their livelihood and the youths, should be involved in other jobs like service provision for tourism, weaving, poultry, beekeeping and agro-forestry.

- In order to protect the study area from further degradation and promote sustainable use of the resources, enhancing or strengthening the management of Chilalo Mountain is very crucial, and this will be effective through collaboration all districts those are found at the boundary of the mountain. .

- Chilalo Mountain with its available forests and wildlife and the beautiful landscape scenery with its suitable climatic conditions and accessibility; the beautiful cultural heritage and practices are the most important tourists' attraction sites. Thus In order to develop the tourism economy of the study area and attract tourist, promotion have to be done by the concerned body.

- Since Chailalo Mountain is the home for diverse flora and fauna as well as endemic species, it should take account of as national park.

- Finally, this study suggest that the study area needs furthers research therefore additional study should be done in the study area, especially on the impacts resulted due to the land use/ land cover change, transition of land cover ''from – to''.

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Appendix

Annex 1 Classification accuracy assessment report of the four periods

ACCURACY TOTALS OF YEAR 1973

Class Name	Reference Totals		Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	5	5	5	---	---	
Forest	6	5	5	83.33%		100.00%
Wood Land	2	2	1	50.00%		50.00%
Degraded Land	0	0	0	---	---	
Shrub Land	0	2	0	---	---	
Pastoral Land	4	3	3	75.00%		100.00%
Crop Land	3	3	3	100.00%		100.00%
Totals	20	20	17			

Overall Classification Accuracy = 85.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.8125

ACCURACY TOTALS OF YEAR 1986

Class Name	Reference Totals		Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	2	2	2	---	---	
Forest	4	4	3	75.00%		75.00%

Wood Land	5	4	4	80.00%	100.00%
Degraded Land	4	5	4	100.00%	80.00%
Shrub Land	2	2	2	100.00%	100.00%
Pastoral Land	0	0	0	---	---
Crop Land	3	3	3	100.00%	100.00%
Totals	20	20	18		

Overall Classification Accuracy = 90.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.8777

ACCURACY TOTALS OF YEAR 2000

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	7	7	7	---	---
Forest	5	4	4	80.00%	100.00%
Wood Land	0	1	0	---	---
Degraded Land	4	4	3	75.00%	75.00%
Shrub Land	2	1	1	50.00%	100.00%
Pastoral Land	1	2	1	100.00%	50.00%
Crop Land	1	1	1	100.00%	100.00%
Totals	20	20	17		

Overall Classification Accuracy = 85.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.8065

ACCURACY TOTALS OF YEAR 2011

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Forest	2	2	2	100.00%	100.00%
Wood Land	4	4	4	100.00%	100.00%
Degraded land	2	2	2	100.00%	100.00%
Shrub Land	1	1	1	100.00%	100.00%
Pastoral Land	1	0	0	---	---
Crop Land	5	5	4	80.00%	80.00%
	5	6	5	100.00%	83.33%
Totals	20	20	18		

Overall Classification Accuracy = 90.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.8750

Annex 2 Household level questionnaires

The objective of this survey is to collect data about drivers behind land use and land cover changes of Chilalo Mountain and its surrounding their and its impacts. It is expected to generate and provide helpful information for policy makers and development practitioners about magnitude and trends of land use and land cover change and its impact on biophysical and local community Therefore, Dear respondents; your inputs as a stakeholder to fill this questionnaire is highly appreciated and information provided will stay confidential and your responses are only used for this study. If you hesitate, you are not obliged to mention your name and your right to involve or not is also respected

.

Part I-General background information

1.1 sex: _____ Age:_____ Position in the HH : _____

Wereda: _____ Kebelle: _____ Got/PA _____

1.2 What is your marital status? [1] Single [2] Married [3] Divorce [4] Widowed

[5] Other specify_____

1.3 Religion [1]. Muslim [2]. Christian [3]. Traditional belief

1.4 Total number of family member: _____F: _____M: _____

1.5 Continuous duration of stay at current place of residence (year):

[1].1-10 [2] 11 -20 [3] 21-30 [4] M0re than 30

1.6 Educational statuses attained 1.Illiterate 2.read and write 3 Primary [4] Secondary

[5] Preparatory [3] Diploma [4] other specify_____

Part II ECONOMIC ACTIVITY

Direction; Circle or fill in the blanks for the following questions; choosing more than one alternative is possible where necessary.

2.1 What is your major economic activity? [1] Crop production [2] animal rearing

[3] Mixed farming [4] others (specify)_____

2.2 Do you have your own farm land? [1] yes [2] No

2.3 If your answer is 'yes', what is the estimated total size of your farmland?

[1] Less than 1 ha [2] 1-2 ha [3] 3-4 ha [4] above 4ha

2.4 How do you see your current landholding to support the household?

[1] Insufficient [2] Sufficient [3] excess

2.5 If your answer is insufficient do you have any option of having additional land?

[1] Yes [2] No

2.6 If your answer is 'yes', what are the options? [1] lease/contract land

[2] Clearing forest [3] clearing grazing land [4] others (specify)_____

2.7 Do you use chemical fertilizer and other agricultural input for crop production?

[1] Yes [2] No

2.8 If yes, when you use for the first time?

[1]. over the last 5 years [2] Over the last 10 years [3] Over the last 20 years

[4] Over the last 30 years [5] specify if others _____

2.9 How is the trend in your landholding size in the past 30 years?

[1] Increasing [2] decreasing [3] No change

2.10 If your answer is 'increasing' what are the reasons behind the increment?

[1] Cultivation forest land [3] Cultivation of grazing land [4] others (specify)

2.11. If your answer to Q No.2.9 above is 'decreasing', what are the root causes?

[1] Increase in human population [2] Land redistribution [3] land taken away by government [4] others (specify_____

2.12 How would the newly married member(s) of the household get land?

[1]. Share the household land [2] The kebele provides him/her [3.]Other (Specify)___

2.13 Is your ownership of land secured? [1] Yes [2] No

2.14 What is your right on your land in the current tenure system?

[1] The use rights [2] The modification right

[3] The transfer right [4] other rights (specify_____

2.15 If you are allowed to sell your piece of land do you want to sell? [1] Yes [2] No

2.16. If no, why not? [1] .Not acceptable by the society [2]. Not allowed by the family

[3] Not allowed by the government [4]. Other (specify) _____

2.17 Do you have your own livestock at present? [0] No [1] Yes

2.18. If your answer is 'yes', what is the type and number of domestic animals you have?

[1]Cow_____[2.]Oxen_____[3.]Sheep_____

[4].Goat_____[5]donkey_____ [6] Others specify _____

2.19 What is the trend of your livestock holding?

[1] Increasing [2] decreasing [3] no change

2.20 How do you feed your livestock?

[1] Free grazing on communal grazing land [2] Own grazing land

[3] Cut and carry from communal pasture land [4] others (specify)___

2.21 How do you see the size of grazing land overtime?

[1] Increasing [2] Decreasing [3] remain the same

2.22 If your answer is 'decreasing', what are the reasons?

[1] Expansion of farm land [2] degradation of grazing land due to over grazing

[3] Area closure [4] other (specify)

2.23 What are the most commonly used energy sources for your house hold?

[1]. Wood. [2]Animal dung [3] Crop residues [4].Charcoal [5] others specify_____

2.24 If your answer is wood where are the sources?

[1] Own tree [2] Natural forest [3] from market

Part III Land use change and their drivers.

Direction; Circle or fill in the blanks for the following questions; choosing more than one alternative is possible where nccessary.

3.1 What are the nearby land use /land cover type of Chilalo Mountain and its surrounding?

[1] Crop land [2] forest land [3] pasture land [4] wet land

[5] Bush land [6] settlement

3.2 What are the major shift in the land use occurred in the last 30 years? (Provide qualitative description; +, - & No change

[1] Natural vegetation_____ _ [2] Plantation forest _____

[3] Bush/wood land _____ [4] Grazing land _____

[5] Cropland – land_____

3.3 What kind of land use land cover conversion have you seen in Chilalo Mountain and its surrounding?

[1] Forest land to agricultural land. [2] Forest land to grazing land.

[3] Grazing land to agricultural land [4] Bush/wood land to grazing land.

[5] Agricultural lands to house contraction/settlement [6] Specify others_____

3.4 What were/are the direct and indirect causes of land use land cover change? and what is extent?

Causes	**Extent**		
	Severely	**Moderately**	**Low**
Deforestation			
Agricultural land expansion			
Over grazing			
Infrastructural expansion ie road			
Population growth			
Scarcity of farm land			
Scarcity of grazing land			
Specify if others			

3.5 What is the cause of population growth in the area?

[1] Immigration [2] natural increases [3] both

3.6 Do you believe that conserving Chilalo Mountain and surrounding area is important?

[1] Yes [2] No

3.7 if yes what is your reason? [1] it used as a home for different plant [2] it used as a home for different wild animal [3] it is the source of different river and stream [4] in order to safe our farm land from soil erosion [5] specify if other _____-

3.8 Is there regular monitoring system of the Chilalo Mountain?

[1] Yes [2] No

3.9 If yes, who monitor it? [1] Development agent [2] District Expert [3] Guard

[4] Kebele administration [5] Government employee [6] other (specify

3.10 have you observed Natural hazard on chilalo Mountain and its surrounding in the past 30 year? [1] Yes [2] No

3.11 If yes what were/are the major natural hazard?

[1] Flood [3] fire hazarded [3] drought [4] specify if other _____

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Part IV Biophysical and Socioeconomic impact of land use land cover change.

4.1 Is there land degradation in your area? [1] Yes [2] No

4.2. What were the major forms of land degradation in your area?

[1] Soil erosion [2] deforestation

[3]. overgrazing of rangeland [4] Gully formation [5] others (specify) _____

4.3 Can land use land cover change affect natural resources? [1] Yes [2] No

4.4. If your answer is yes how and by what extent land use land affect natural resources?

4.5 If yes what do you observe as a result of LULCC please rate it?

Biophysical impact of LULCC	**Extent**		
	Severely	**Moderately**	**Low**
Reducing the availability of flora			
Reducing the availability of fauna			
Gully formation			
Reducing soil fertility			
Seasonal flow and Drying up and streams and river			
Reducing the amount of rainfall			
Increase temperature			
Specify if others			

4.9 Does LULCC considered as a socio-economic problem in your area? [1] Yes [2] No

5 If yes please rate it

Socioeconomic impact of LULCC	**Extent**		
	Severely	**Moderately**	**Low**
Shortage of fuel wood			
Shortage of water			

Decrease availability of traditional medicinal plant	
Decrease number livestock	
Increased chemical fertilizer consumption	
Reduced the availability of medicinal plant	
Specify if others	