LAND USE LAND COVER CHANGE DETECTION AND MODELLING OF GALEMA MOUNTAIN AND ITS SURROUNDING,ARSI ZONE, OROMIA REGION FROM (1991-2021)

Addis Shimellis Abebe

A Thesis Submitted to the Department of Geomatics Engineering, School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirements for the Degree of Master's of Science in Geo-Informatics

Office of Graduate Studies

Adama Science and Technology University

September, 2022

Adama, Ethiopia

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DECLARATION

I hereby declare that this Master Thesis is entitled "Land use and land cover change detection and modeling of Galema mountain and its surroundings, Arsi zone, Oromia region, Ethiopia." is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that were used for this thesis have been duly acknowledged through citation.

Addis Shimellis Abebe ______________________ ______________________

Name of Candidate Signature Date

RECOMMENDATION

I, the advisor, of this thesis, hereby certify that I have read the revised version of the thesis entitled "Land use and land cover change detection and modeling of Galema mountain and its surroundings, Arsi zone, Oromia region, Ethiopia." Prepared under my guidance by Addis Shimellis Abebe submitted in partial fulfillment of the requirements for the degree of Masters of Science in Geo-informatics Engineering. Therefore, I recommend the submission of a revised version of the thesis to the department following the applicable procedures.

Dr. Getachew Birhanemeskel ______________________ ____________________

Advisor Signature Date

APPROVAL SHEET

I, the advisors of the thesis entitled "Land use and land cover change detection and modeling of Galema mountain and its surroundings," Arsi Zone, Oromia region, Ethiopia, and developed by Addis Shimellis Abebe hereby certify that the recommendation and suggestion made by the board of examiners are appropriately incorporated into the final version of the thesis.

____________________	____________________	____________________
Advisor	Signature	Date

We, the undersigned , members of the Board of Examiners of the thesis by Addis Shimellis Abebe, have read and evaluated the thesis entitled "Land Use Land Cover Change Detection and modeling of Galema Mountain and its Surrounding, Arsi Zone, Oromia Region, Ethiopia." and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirements for the degree of Master of Science in Geo-informatics Engineering.

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Addis Shimellis Abebe

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ACRONYMS

CSA	Central statical Authority
FGD	Focus Group Discussion
ERDAS	Earth Resources Data Analysis System
GPS	Global Positioning System
GIS	Geographic information system
KII	Key Informant Interview
LULC	Land Use Land Cover
LULCC	Land use land cover change
MCM	Markov Chain Model
Rs	Remote sensing
SIDA	Swedish International Development Agency
Sq.km	Square kilo meter.
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 84

Abstract

Land use and land cover change detection refers to the qualitative and quantitative differences in the area extent of a certain type of land use and land cover. Land use and land cover change have been highlighted as a major environmental change driver in Ethiopia. As a result, a regular investigation of land use and land cover change is critical in determining the degree of change and determining the appropriate measures. The problem of the study area is deforestation, Farm land expansion, Forest fire and use for pasture land. The objective of study area is to determine the land use and land cover change detection of the research area from 1991–2021, to identify the major driving forces of land use change on Galema mountain, and its environment to determine the impact of changes in land use and land cover. and to forecast the detection of change over the next 30 years in the study areas. The analysis was done with remote sensing and geographic information systems method in conjunction with field verification, and the study used consecutive satellite photos (1991, 2001, 2011, and 2021). In addition, socioeconomic surveys are being used to identify the causes of land use and land cover change and their resulting detrimental impact on both the biophysical and local communities. The result of this research investigation shown as the Land Use Land Cover Change Study, Forest , Grassland and Shrub land have been steadily declining over the three comparative periods (1991–2001), (2001–2011), and (2011–2021), with (0.3%7), (13.38%),(0.13%) and (2.26%), (1%), (0.71%), and (1.46%), (0.68%), (4.18%), respectively. Cropland and Wet land, on the other hand, increased by (3.17 %), (14.51 %),(2.96%) and (0.92%), (0.55%),(1.53%) respectively, over the three years. This causes natural resource distractions such as decreased availability of vegetation and wildlife, soil degradation, and climate change. It also has a detrimental impact on the surrounding community by reducing livestock numbers, increasing reliance on chemical fertilizer, and causing scarcity of water and wood,. Thus, in order to ease the problem, measures such as population growth management, agro-forestry, forestation and reforestation, developing off-farm job opportunities, and so on must be implemented. Land use and land cover change, satellite images, remote sensing, and geographic information systems are some of the key phrases.

Key words; GIS, Land use land cover change detection , RS and Satellite image.

CHAPTER I: INTRODUCTION

1.1. Background of the study

Lands and their assets are being used to meet human needs in terms of material, social, cultural, and spiritual fulfillment. Land is a basic component of manufacturing, and it has always been closely linked to economic development throughout human history (Briassoulis,2000).

Human activities that is agriculture manufacturing, forestry, energy generation, settlement, recreation, and water diversion have all had an impact on the land.

Forest on LU and LC are two separate but linked features of the earth's surface; land use encompasses, among other things, forestry, grazing, agriculture, and urban expansion. Land cover classes include cropland, woodland, wetland, pasture, roadways, and urban areas (Briassoulis,2000).

Man's existence on the globe and his usage of land have a significant impact on the natural environment (Opeyemi, 2006). This is due to the increasing population and socioeconomic demands, which put pressure on land use and coverage. As a result of this energy, unforeseen and unpredictable changes in LULC occur (Seto, 2002). Different human driving forces, driven by the socioeconomic context, culminate in the intentional change of an existing land cover by influencing the biophysical conditions of the land (Hussien, 2009). Ethiopia is the location of this research aria. Ethiopia is therefore a mountainous area with adequate geographical features such as mountain ranges carved by river valleys and sharp gorges, flat-topped plateaus, undulating hills, and lowlands. The country is about 1.12 million square kilometers in size.

Crop land (19.62 percent), grass land (12.44 percent), bare ground (13.78 percent), woodland (26.93 percent), shrub land (21.3 1 percent), forest (4.3 percent), wetland (0.67 percent), water body (0.73 percent), and urban (0.02 percent) are the primary land-use forms in the country (raw data cited in Messay, 2011). Galema mountain is located in Ethiopia's south-eastern Arsi zone and is bounded by nine weredas: Tiyo, Digalunatijo, Lemuf Bilbilo, Shirka, Tenna, Robe, Diksis, Lode Hetosa, and Hetosa wereda, as well as forty-five kebeles.

According to examine previous and current LU and LC dynamics in the Galema mountains, as well as to identify the causes of the transformation and the primary consequences of it. LULC analysis lays the foundation for understanding how land has been used in the past and predicting future changes. Examining the connection B/n humans and the global environment is thus critical in order to improve the area's economic situation while minimizing further damage to the biophysical environment. It is becoming more important as LULCC becomes more rapid, affecting society's livelihoods more frequently and frequently (Alex, 2002).

In this research, Galema mountain and its surrounding was chosen as a case study, which has experienced a very rapid dispersed LULCC over the last 30 year . This change results in fast continuing other land cover changing to Crop lands. Generally, this research is to examine LULCC detection and modeling of Galema mountain and its surroundings.

1.2. Statement of the Problem

Land use in East Africa has evolved dramatically during the past half-century, with farmlands, grazing lands, human settlements, and urban centers replacing natural vegetation. These shifts are linked to deforestation, loss of biodiversity, and land degradation (Maitima, et al, 2009).

Ethiopia's rapid environmental conversions and alterations are ascribed to a variety of negative human behaviors, such as the expansion of farm fields into vegetated areas, huge fuel wood and charcoal production, overgrazing, and encroachment of farmsteads into vegetated grounds (Messay, 2011). According to historical texts, forests originally covered more than 40% of the country's entire territory. Currently, less than 3% is estimated. This has led to significant soil degradation, altered hydrologic regimes, local and regional climatic perturbation, biodiversity loss, and the development of desert ecological conditions (EFAP, 1994 cited in Kidane, 2002).

Changes in LULC have been identified as a major cause of environmental change in the country (Masterarbeit, 2012). Although land cover changes may not always imply deterioration, numerous changes in land use patterns, combined with inefficient use of natural resources, have resulted in rapid and massive land degradation. As a result, land degradation has become a severe issue that has impacted many aspects of the population's social, economic, and political lives. It has become one of the country's primary challenges in terms of agricultural development and food security. The issue worsens as the majority of people in rural areas are dependent on agriculture (Masterarbeit, 2012). Poor natural resource management, conversion of natural habitat to farming, overgrazing by livestock, and unsustainable fuel wood and timber exploitation are causing water system disruption as well as deforestation and forest degradation (Teshoma, 2010; Hailemariam et al., 2015).These factors, together with climate change consequences, are affecting the region's distinctive plants and animals, as well as the environmental services provided by both lowland and highland communities (FARM Africa, 2008).

Rapid agricultural land expansion and rapid population growth characterize the research area. Because of the potential agricultural importance of the area, the activity is more likely to spread to other LU and LC sectors, particularly forested upland regions. As a result, sections of the mountain's gradient may be used for agricultural purposes in the future. The key environmental issue is the loss of original vegetation and other forms of land degradation.

Galema Mountain, which is the source of many streams and rivers as well as the home of endemic animals, has recently come under threat as a result of LU and LCC produced by deforestation and fire hazard. Crop production and grazing are done in high-altitude areas next to forest remnants. It has had a major influence on the environment and has caused an environmental problem.

All of the aforementioned environmental and socioeconomic issues, on the other hand, necessitate a comprehensive investigation into the current state, causes, and rate of LULCC in the country as a whole, as well as in the research area specifically. Furthermore, because some of the factors and processes that are able to contribute are likely to be area-specific and the outputs generated in one area may not be applicable in other areas, it is still critical to generate site-specific information on LU and LC dynamics.

The main problems of LU and LCC detection of the Galema mountain and its surrounding areas are: Deforestation, fire hazard, farm land expansion, and use for pasture land.

This research focuses on detecting LULCC of the Galem Mountain and its surroundings. Because the area is changing in terms of LULC, it is an important study location because it is surrounded by highlands. This research area might very well concentrate on resolving all of the aforementioned problems as well as forecasting the future situation and complications of the LULCC of the Galem Mountain and its surroundings to control and monitor significantly show the effect and consequences for local administrative bodies for using measurement as a tool in this investigation.

1.3. Objectives

1.3.1.General Objective

The main objective of this study is to assess the Land Use and Land Cover Change of Galema Mountain and its surroundings from 1991–2021 G.C. and modeling for the next 30 years using GIS and Remote Sensing data.

1.3.2. Specific Objectives:

- Determine the LU and LC change of the study area from 1991–2021,
- Identify the major driving forces of LULC change in the study area,
- Determine the impacts of LULC changes in the study area,
- Predict LULC change of the study area for the next 30 years.

1.4. Research Questions

In order to achieve the research objectives, the research questions were formulated as the following:

1.4.1.How much of the LU and LC Changed from one form to other in the study area?

1.4.2.What are the major driving forces of the LULC change in the study area?

1.4.3. What are the impacts of land use and land cover changes?

1.4.4.What will happen to LULC in the study area in the next 30 years?

1.5. Significance of the Study

The study's goal is to examine past and future land use land cover changes, both of which have become common in recent years. The final output of this study will provide information for managing natural resource projects in the study region, land administration, and environmental protection office, Forest management administration office, peoples live in study area and it can also be utilized as a stepping stone for other studies who want to do more research on the subject: To form and implement more coherent and sustainable land administrations strategies regarding existing and future land use. To Planning, management and monitoring of natural resources. To serve as an input parameter in many fields as geology, hydrology, and environmental studies. Further researcher will be interested in the findings of this analysis because it will add to the current realistic and theoretical knowledge base on the past and future LULCC. Fill in the awareness gap by running simulations and proposing adaptable LULC change model.

1.6. Scope of the Study

The Geographical scope of this study area is cover 9646.73 Ha. Conceptually, this research focus mainly on LULC change analysis from 1991-2021 and prediction of the future land use land cover change detection of Galema mountain and its surrounding for 2051 using Geo spatial technologies and giving clue about the importance of changing land use land map and also the accuracy assessment was 5 carried out for classified image , change analysis ,validation and future prediction of land use land cover change and finally conclusion and recommendations were raised based on the findings.

1.7. Limitation of the Study

The high spatial resolution of remote sensing data interpretation is required to obtain better simulation results (Chaudhuri & Clarke, 2013). In this study, 30 meter Land sat satellite images obtained from USGS earth explorer website (https://earthexplorer.usgs.gov/) has been used. Generating accurate land use the land cover map was a challenge from such images due to a coarse resolution. It was difficult to make a clear distinction between different land use features classes. using High Spatial resolution Satellite image such as Quick bird, IKONOS, Geo Eye, World view, and SPOT will provides better and detail information with good quality to map Land use land cover classes and overall accuracy may greater than the value obtained. The incorporation of major social, economic and political factors which can drive significant changes in LULC into identified models is limited by the availability of data.

1.8. Organization of the Thesis

The whole thesis is divided into five chapters. The first chapter lays the background of the study providing general introduction about the research work including the problem statement, questions and research objectives, the scope and limitations of the study were also highlighted. The second chapter deals with literature survey in which the related works as have been performed by various other researchers are presented. In the third chapter, information about the chosen study area is given and how the several data layer maps are generated, also outlining the methodology of carrying out the task and the data sources utilized. Chapter 4 presents the findings of this research work and a detailed discussion on the results obtained. Finally, in the fifth chapter, a conclusion is drawn based on the results obtained along with future research possible and recommendations.

CHAPTER II: LITERATURE REVIEW

2.1. Land use land cover Change Detection

One of mankind's mega-scale concerns is how to best exploit land resources and balance land cover capability with anthropogenic stress (Milanova et al; 2007). Planners and resource managers require a reliable mechanism for assessing the impact of changes caused by natural resource stress by immediately detecting, monitoring, and analyzing land use changes. As a result, precise data on land-cover changes, as well as the causes and processes that cause them, is critical for developing solid environmental planning and management. Land-cover analysis gives the necessary baseline data to fully comprehend how land was used in the past and what types of changes might be predicted in the future. In addition, investigations of land-cover changes provide useful data for analyzing the environmental effects of human activities, climate change, and other factors (Belay, 2002).

The application of multi-temporal datasets to quantitatively examine the temporal influence of the phenomenon is required for land cover change detection. Because it provides a synoptic picture and multi-temporal data, RS has become a useful data source. Land use data on land cover that is frequently required Bhagawat, 20 11). Land SAT, TM's multi-temporal data may be better suited to identifying and tracing substantial changes in land cover. As a result, satellite imagery is a good source of data for doing landscape structural studies and can provide information about the state of a region by finding differences B/n two or more points in time using change detection techniques (Gessesse, 2007).

RS and GIS are increasingly being combined in spatial analysis. RS and GIS are widely utilized and regarded as powerful and effective methods for detecting the spatiotemporal dynamics of LU and LC, and GIS databases are used to improve the extraction of useful information from RS imagery (Lambin et al;2001).

2.2. Causes of Land use land cover Change

Changes in LU and LC are the result of a complex interaction of causes. The basic assumption that changes in LU and LC are caused by a few factors is incorrect. Rather, the processes of LU and LCC are better explained by a number of interconnected, complicated elements. Understanding how people make land-use decisions and how diverse elements interact in specific situations to influence land-use decision-making is required to identify the causes of LU change (Geist &Lambin, 2002).

Despite the fact that natural processes may also play a role in changing land cover, human-induced land uses are the primary driving force. Different studies have divided the reasons for LU and LCC into two major categories: proximal direct and underlying indirect or root causes. These human-induced causes of land cover change are significant and are currently expanding at an alarming rate.

2.2.1. Proximate causes of Land use land cover Change

The proximate causes of LU change explain how and why humans alter local land cover and ecosystem processes. These variables have an impact on the local level (individual farms, households, or communities). As a result, proximal factors vary depending on the context and region. These are the factors that result in immediate changes in land cover, whereas driving causes are the causes that drive the immediate causes (Geist and Lambin, 2002).

The growth of agricultural areas, together with timber extraction and infrastructure construction, has been the dominant historical proximate driver of change in land cover. Because of population growth, technological development, and subsequent requirements, the impact of human activities on land has increased dramatically in the last two centuries, altering entire landscapes and, as a result, affecting biodiversity, nutrient and hydrological cycles, as well as climate. Today, close to a third of the earth's land surface is devoted to pastures or cropland, affecting biodiversity, nutrient and hydrological cycles, and climate (Houghton, 1994).

Agriculture expansion, both through shifting cultivation and the spread of sedentary agriculture, is the proximate driver of land cover change, notably natural vegetation, in Ethiopia. Another cause is the growing need for building materials, fuel wood, and charcoal. Charcoal is commonly used in the arid, semi-arid, and dry sub-humid regions of the country. Fire is also commonly used to fumigate bees and ease hunting, resulting in forest fires and the destruction of natural forests (Kahsay, 2004).

2.2.2. Driving force of land use change

The underlying (indirect or root) causes describe the larger context and fundamental dynamics that are driving these local activities. Though complicated interplays between various levels of organization are usual, this can come from regional (districts, provinces, or countries) or even global levels of organization. As a result, underlying causes are frequently complicated, resulting from interactions among social, political, economic, demographic, technical, cultural, and biophysical elements.

Some local-scale elements are endogenous to decision-makers and so subject to local control. The underlying causes, on the other hand, are frequently exogenous (originating outside of the local groups that manage land) and thus unmanageable by these communities. In general, underlying causes work more diffusely (i.e., from afar), frequently by modifying one or more proximate causes (Geist, &Lambin 2002).

Economic considerations, institutions, technology, culture, and population change are the five key driving causes.

Institutional factors: Land use decisions are influenced directly or indirectly by formal and informal institutions. The major driving causes of cover change are 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 (Lambin et al; 2003).

Ethiopia's vast natural resources have been damaged and underutilized for decades. The fundamental causes of this state of affairs are, for the most part, policy and institutional difficulties, such as inadequate governance, incorrect policies, and an inefficient legal and institutional framework that is constantly changing. Over the last many decades, poor policy implementation, human resource mismanagement, and ineffective bureaucracy have resulted in low implementation and management capacity (SIDA, 2003).

The imperial government (1930–1975), the Derg dictatorship (1975–1993), and the Federal Democratic Republic of Ethiopia (FORE) are the three most noteworthy land tenure regimes in Ethiopia (1993–recent).

The Imperial government's land policy, while it varied geographically, favored private landowners' amassing and possessing land indefinitely. This may have encouraged landowners to care for their land and the resources on it, resulting in rather steady LULC fluctuations over time. The Military Government, on the other hand, nationalized the land and its natural resources under the famous motto "Land to the Tiller." As a result, land and resources were distributed among peasants or smallholder farmers, resulting in the significant destruction of vegetated regions intended for diverse purposes. This could have resulted in significant LULC shifts across the country (Messay, 20 11).

Furthermore, the extent to which farmers can benefit from land-improvement investments is determined by tenure security. Farmers with the severe expectation of just holding land for the current season will have little reason to invest; instead, their motive will be to get the most out of the land, even if it means jeopardizing its future productive capacity. Farmers can expect to use land for an indefinite period of time, but they should be aware that there is a chance they will lose this right in the future. The higher the risk of losing the right, the less likely they are to invest or preserve the land's productive capability (Feder et al; 1988 cited in Mesfin, 20 10). Cultural factors; -A variety of cultural elements can impact land use decisions. Their attitudes, values, beliefs, and individual perceptions all have an impact on land-use decisions, such as how they perceive and react to risk. Land-use decisions affect ecosystems in both intentional and unforeseen ways, depending on the knowledge, information, and management skills available to land managers (Lambin et al; 2003).

Demographic factors: Increases and decreases in a particular population owing to natural growth or immigration are another driving element that has a stronger impact on land usage and land cover over longer durations. The majority of its explanatory strength comes from inter linkages with other underlying forces, particularly when all five key drivers are in play (Lambin et al; 2003).

In most developing countries, population increase has been a more important factor in changing land use and cover than other factors.

Though people are Ethiopia's most precious resource, unrestrained population increase places undue strain on all other natural resources, including land. At the turn of the twentieth century, the country's population was projected to be 11.8 million, with an annual growth rate of barely 0.2 percent. In 1950, the population had risen to more than 19 million people, with an annual growth rate of 2.1 percent.

The population grew at a moderate pace until 1970, when it began to rise. Ethiopia's overall population was 42.66 million in 1984 (CSA, 1985, quoted in Carla et al., 2001). By 1994, the population had risen to 53.5 million, and by 2003, it had risen to almost 67 million (CSA, 1985, cited in Carla et al., 2001). (NBSAP, 2005). Furthermore, based on the results of Ethiopia's 2007 Housing Census, the population prediction for 2012 is 84,32 million people.

Furthermore, as the world's population grows, arable land per capita decreases, while land fragmentation and degradation due to overuse increase. The average farm size in the country is 0.97 hectares, according to the CSA agricultural sample survey conducted in 1999/2000, with 29 percent of farming households owning half a hectare or less. As a result, there will be more people in both rural and urban areas as the population grows. Pressure was exerted on both forest and agricultural fields, resulting in unfavorable changes in land use and cover.

2.2.3. Soil degradation

Water erosion, wind erosion, biological degradation (reducing humus), physical degradation (increasing bulk density, decreasing permeability), chemical degradation (acidification, toxicity), and excess salt are some of the ways that soil degradation can occur (Tizale, 2007).

Ethiopian soils are naturally fertile, but they have been eroded and aggravated by soil nutrient depletion due to a variety of causes (Tizale, 2007). Unwise land use change is one of the key causes of land degradation in the country, among the causes and driving factors. The most productive forest tracts have already been turned over to agriculture. Further growth of agriculture and grazing on marginal lands, as well as cultivation of rough topography and steep slopes, particularly in Ethiopia's highlands, has become widespread practice, increasing surface runoff and soil erosion, which hastens land degradation. Furthermore, the country's population increase causes deforestation and the conversion of pasture land to crops, which leads to overstocking and further deterioration. Rather than mulch, crop leftovers are increasingly being used as fuel. Instead of manure, dung is used as a fuel. All of these variables contribute to nutrient loss and erosion (Worku, 2012).

Soil erosion is one of the most significant challenges to the country's agricultural system's long-term viability. As a result, Ethiopia could be a good example of the massive depletion of soil resources and one of the world's most severely degraded countries. Water erosion was identified as the most important process of soil degradation in the (EHRS) study.

2.2.4. Hydrological Cycle

The hydrological cycle has many connections with land use and land-cover characteristics (Hougton, 1995). Rivers and streams are decreasing in flow as a result of widespread LU and LCC around the world. The two components of stream flow are surface runoff and groundwater flow. Surface runoff is mostly influenced by rainfall, whereas groundwater flow is influenced by infiltrating water. During the wet months, however, surface runoff is the primary source of stream flow, but during the dry months, ground water is the primary source of stream flow. Following the drop in precipitation, LU and LC type can change both infiltration and runoff amounts, which has a substantial impact on surface runoff and groundwater flow (Hougton, 1995).

Different types of land cover react differently to the hydrological cycle. This is due to a variety of factors. For starters, natural LC has a variety of qualities that aid in the regulation of water flows both above and below ground. Forest canopy and leaf litter, for example, reduce the impact of rains on the earth's surface, minimizing soil erosion. Roots also keep the soil in place, especially on steeper slopes, and they absorb water. Openings in leaf litter and soil pores boost the soil's infiltration capacity, allowing water to pass through the soil and into the ground water, allowing for year-round stream flow in both rainy and dry seasons (Alex, 2002).

Increased cropland and decreased forest, on the other hand, result in increased stream flow during the wet season. This is because crop soil moisture demand is lower than forest soil moisture demand, so rainfall satisfies the shortage of soil moisture in agricultural lands more quickly, resulting in more runoff. As a result, stream flow increases during the rainy season (Legesse el al; 2003).

Generally speaking Conversion of forest to other land uses, particularly crop land, is projected to increase surface runoff and limit the amount of rainfall penetrating the soil and eventually percolating into ground water aquifers, resulting in reduced levels of infiltration and water shortages in the soil.

2.2.5. Climate change

The statistical interpretation of precipitation and temperature data for a certain region or place over a lengthy period of time is frequently used to characterize climate. Human activity, on the other hand, is drastically affecting the Earth's vegetative cover right now. Such changes have major implications and, through a variety of processes, contribute to anthropogenic climate change. Surface vegetation degradation, forest conversion and burning for farming, and forest harvesting for timber and fuel wood all result in a net release of carbon dioxide from the biota to the atmosphere, resulting in variations in global carbon dioxide concentrations; and variations in regional weather and climatic patterns will occur when the global mean temperature rises, as will changes in land surface temperature (Gregg Marland, 2003)

The mean annual rainfall distribution in Ethiopia is marked by significant regional variance, ranging from nearly 2000 mm in isolated pocket areas in the southwest to less than 250 mm in the Afar and Ogaden lowlands.

The baseline climate was created using historical temperature and precipitation data from selected stations from 197 to 2000.Over the last 55 years, the country has seen both dry and wet seasons. 1952, 1959, 1965, 1972, 1973, 1978, 1984, 1991, 1994, 1999, and 2002 were dry years, while 1958, 1961, 1964, 1967, 1968, 1977, 1993, 1996, 1998, and 2006 were wet. Similarly, the yearly lowest temperature variation was expressed as temperature deviations from the mean and averaged over 40 locations from year to year. Over the last 55 years, the country has seen both hot and cold weather. In comparison to the early years, recent years have been the warmest. The yearly minimum temperature has been warming during the past 55 years. It has risen by approximately 0.37 °C every ten years (Abebe, 2007).

2.3. Socioeconomic impacts of Land use land cover Change

All human communities depend on land and its uses. Land use changes 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. 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 areas because many people are directly dependent on land for their livelihood and because how land is used plays a central role in defining the identity of an area and its community (Schirmer et al, 2008).

A shortage of fuel wood and construction materials for the farming community is one of the immediate effects of forest thinning and destruction. Farmers are increasingly burning crop waste and organic manure for cooking and heating as a result of this situation, which causes them to travel vast distances to acquire wood. The latter has serious implications for farmland fertility and productivity, as it causes organic matter in cultivated soils to deplete (Belay, 2004). In addition, land degradation occurs as a result of forest clearance and destruction, as well as soil erosion and loss of fertility. As a result of these factors, agricultural productivity suffers, resulting in lower yields (Yonas, 2004). To compensate for the loss of organic matter, artificial fertilizers are used to boost crop yields (Kassu,2011).

Furthermore, a shortage of fuel wood as a result of forest distraction usually results in a rise in the price of this commodity in both distant urban and rural locations. As forests recede from village centers, the number of fuel wood harvesting places increases. Due to the rise in distance, women and children must now carry large loads over long distances. Women must also get up early in the morning to collect firewood, leaving them unable to attend to other household responsibilities. Furthermore, they are unable to engage in other income-generating activities, and their health, particularly that of their children, will suffer as a result (Kiunsi, 1994).

2.4. LULC Studies in Ethiopia

Land is the most important natural resource for economic, social, infrastructure, and other human activity. Smallholders who farm for subsistence use the majority of the land in Ethiopia. Despite the fact that smallholders demand more space to grow crops and earn a living as a result of rapid population expansion and the lack of agricultural intensification, this leads to deforestation and land conversions from other types of land cover to farmland. As a result, significant LU and LCC occurred in Ethiopia in the second half of the twentieth century.

LU and LCC documentation is becoming one of the most important issues for environmental change monitoring and natural resource management because it provides information for a better understanding of historical LU practices, current LC patterns, and future land use trajectory. As a result, identifying, defining, and mapping the many forms of LU and LC are crucial operations for sustainable natural resource management.

Actually, some research has been carried out in several parts of the country (Belay,2002; Messay,2011; Mesterarbeit,2011; Husen,2009; Woldemedhin,2011;Binyam,2012;

Netsanet,2007; Behailu,2010; Kahsay,2004; Merkebu,2010; Muleta,2009; Lemlem,2007; Wallelign,2007).The findings of this research revealed a significant change in LU and LC during the last 30 to 50 years.

According to (2002), between 1957 and 1986 and 1986 to 2000, "shrub land" decreased at a rate of 1.6 and 0.31 percent per year, respectively. The selective harvesting of woody biomass for fuel wood and charcoal manufacture in the Derekolli catchment of the south

Wollo zone of the Amhara area resulted in a gradual thinning of the shrub and its transformation to shrub grassland, then grassland. Shrub land shrank at a rate of 3.5 and 8.8 percent per year in Nanna district, central Ethiopia, from 1984 to 2002 and 2002 to 2007, respectively, according to Similarly Messay (2011), Between 2002 and 2007, a major conversion from natural vegetation cover to agriculture was noted, with cultivated land expanding by 26.5 percent. However, the resettlement location was only visible in the satellite image of 2007.

However, a research conducted by Mesterarbeit (2012) in the Ketar catchments of the Zeway watershed revealed that the spread of small-scale agriculture and rural settlement, but not the spread of agricultural land and the depletion of natural vegetation, increases the risk of land degradation in the research area. Lemlem (2007), vegetation cover decreased by 168.7 km2 between 1973 and 1986 and increased by 108.1 km2 between 1986 and 2000, whereas agricultural land increased by 143 km2 B/n 1973 and 1986 and by 100 km2 between 1986 and 2000. In the Awassa catchment in southern Ethiopia, the built-up area increased from 6 km2 in 1973 to 8 km2 in 1986 and 13 km2 in 2000.

Similarly, in a research conducted by Binyam (2012) on carbon stock potentials of woodlands and LU and LCC in Ethiopia's northwestern lowlands, specifically in Kafta Humera District, Metema District, and Sherkole District, the results of LULCC analysis revealed that the classes of agricultural and bare land have increased at an average rate of 2,322.94 and 726.58 ha/year, respectively, in all study sites, while woodland coverage in the three districts has decreased (1985-2010).

Woldemedhin (2011) found that cultivation has been spreading on the unprotected land during 1986 (13.1%) to 2009 in the Guassa community conservation area, Menz central Ethiopia (15 .6 percent). In addition, forest cover in the unprotected region has declined from 12.2 percent in 1986 to 3.3 percent in 2009. In contrast, agricultural activity in the protected area has decreased from 9.8% in 1986 to 6.0 percent in 2009.However, due to plantation in the GCCA Guassa community conservation area, forest cover increased slightly (from 1.1 percent in 1986 to 1.2 percent in 2009).

Different studies on LU and LCC have been undertaken in various parts of the country, but it is still critical to generate site-specific information on LU and LC dynamics to ensure planning of sustainable and integrated land resource management.

2.5. Application of RS and GIS Techniques for LU/LCC Study

They Weng, 2002; Rimal, 2011; Abdullah et al, 2013) have identified (GIS) and (RS) as powerful and useful tools in LULCC research. They provide reliable, cost-effective, and timely information and methodologies for LULCC monitoring, modeling, and mapping at various spatial and temporal scales. GIS and RS data also aid in determining the LU/scope, the LCC's direction, causes, and impacts (Reis, 2008; Oumer, 2009; Rimal, 2011). Some research used RS approaches in their LULCC assessments, whereas others combined remote sensing and GIS. GIS is a technique for viewing and analyzing data from a geographical standpoint (Reis, 2008; Oumer, 2009; Rimal, 2011).

It is a helpful tool for comparing LULCC trends over time, utilizing statistical and analytical methods (Abdullah et al., 2013). It offers a flexible environment for gathering, saving, displaying, and analyzing digital data for LULCC detection, as well as land use planning and modeling tools (Reis, 2008; Rimal, 2011). RS refers to the ability to detect change on the earth's surface using space-based sensors in the context of LULCC (Abdullah et al., 2013). Regardless of the underlying reasons, RS has become a useful tool for studying landscape changes over time and space. Because it delivers multi-temporal and multi-spectral remotely sensed data, this is the case (Oumer, 2009; Rimal, 2011).

The use of RS for LULCC analysis is influenced by the following factors: (i) sensor capabilities; (ii) amount of data recorded; (iii) study goal; and (iv) spatial and spectral features of satellite images acquired by different versions of a single sensor instrument (Oumer, 2009). Land sat imagery aids in the comprehension of land resources. The most fundamental reason for this is that image radiometric and spectral properties have been steadily improving over time (Oumer, 2009). Land sat Multi spectral Scanner (MSS), Thematic Map per (TM), and Enhanced Thematic Map per Plus (ETM+) data have been widely used in LULCC research since the program's inception in 1972, mostly in forest and agricultural areas (Reis, 2008).

2.6. Modeling LULCC

Models are utilized in a wide range of applications, including LULCC research (Brown et al., 2004). Models have been established in LULCC investigations to answer the questions of when, where, and why LULCC develops (Brown et al., 2000). They usually entail empirically fitting the models to some historical pattern of change, then extrapolating those patterns into the future to make predictions. Modeling LULCC is important for understanding the causes that induce LULCC as well as the consequences of the alterations (Araya, 2009; Adedeji et al., 2015). Models are important for separating the diverse groups of socioeconomic and biophysical elements that influence the rate and spatial pattern of LULCC, as well as evaluating the effects of LULCC changes (Verburg, 2004).

Furthermore, based on recent data (Verburg, 2004; Chang-Martnez et al., 2015), models can enable the prediction of future LULCCs under various scenario situations. Models can also be used to forecast the future consequences of government policies aimed at resource conservation and utilization. Assessing and projecting LULCC could aid in environmental management and resource sustainability. It would also aid in better understanding the LULC system's operation, as well as land use planning and policy, development plans, and decision making (Araya, 2009). Different literatures have detailed a variety of LULCC modeling methodologies (Veldkamp and Lambin, 2001). Their spatial and temporal scope, data availability, technical knowledge, and so on all depend on the reason for which they were created.

Different LULCC modeling methodologies exist, and they may differ from one another (Araya, 2009).There are some models that are technically complex and need sophisticated programming and professional knowledge, while others are simple and provide user-friendly tools that anyone with limited experience may implement, such as the markove chain model (Veldkamp and Lambin, 2001; Araya, 2009).

2.6.1. Markov Chain Modeling

The Markov chain model (MCM) has been widely utilized in LULCC modeling in both urban and rural settings (Brown et al., 2000; Arsanjani, 2012). It is a discrete-time stochastic model (Arsanjani, 2012; Sayemuzzaman and Jha, 2014; Iacono et al., 2015) that describes the probabilistic transition of one state (LU/LC type) to another one (LULC type). MCM views LULCC as a stochastic process, with different LULC categories representing chain states (Weng, 2002). As discrete values, the model specifies both time and a finite collection of states (Weng, 2002). Because of its ability to: I represent all of the conceivable directions of LULCC among all of the land use categories, (ii) quantify the states of conversion between LULC types, and (iii) measure the pace of conversion among the LULC types, MCM's usefulness in LULCC modeling seems promising (Sang, 2011; Han et al., 2015).

Using two historic LULC images as input, MCM generates a transition probability matrix, a transition area matrix, and a set of conditional probability images for LU/LCC prediction(Eastman, 2006; Sayemuzzaman and Jha, 2014). The former represents the likelihood that each land use/land cover category will change to every other category over the specified number of time units, while the latter represents the expected number of pixels that will change from one land use/land cover type to another over the specified number of time units (IDRISI Seva help system; Sang, 2011; Arsanjani, 2012). The conditional probability graphics show the likelihood of finding each land cover type at each pixel after a certain number of time units (IDRISI Selva help system)

2.7. LULCC at Global Perspective

Local, regional, and global scales are all affected by LULCC, and small alterations can have large-scale consequences (Burka, 2008). The origins of LULCC can be traced back to the dawn of civilization (Gebreslassie, 2014). Beginning with the management of fire and the domestication of animals and plants, human land use activities cover nearly half of the ice-free land surface (Lambin and Geist, 2006). Human land use activities displaced the majority of forest lands, reducing global forest cover from 50% to less than 30% (Lambin et al., 2003). Total farmed land expanded by 46 percent on a global scale between 1700 and 1980, according to Turner et al. (1992), Muluneh (2003) cites this. Furthermore, between 1700 and 1990, the area under crops and pasture increased from 300-400 million ha to 1500-1800 million ha and 500 million ha to 3100 million hectares, respectively. from 300-400 million ha to 1500-1800 million ha. Forests decreased from roughly 5000–6200 million ha in 1700 to 4300–5300 million ha in 1990, whereas natural grasslands, steppes, and savannas decreased from around 3200 million ha in 1700 to 1800–2700 million ha in 1990 (Lambinet al., 2003).

However, LULCC is not uniformly distributed over the globe (WIREs Climate Change, 2014). Parts of the tropics and the polar regions, for example, still have relatively undisturbed land cover. Other regions saw significant LULCC, primarily due to the growth of agricultural fields at the expense of vegetated lands. This is especially true in areas with a recent history of human growth, such as Africa, South and Southeast Asia, and Latin America. Since 1850, cropland in these areas has increased dramatically, particularly in the second half of the twentieth century (Lambin et al., 2003; WIREs Climate Change, 2014). In Europe, on the other hand, agricultural land expansion has slowed (WIREs Climate Change, 2014).

CHAPTER III: MATERIAL AND METHOD

3.1. General Description of the study area

3.1.1. Location

Galema Mountain and its surroundings are located in the Arsi Zone of the Oromia Region. It is an isolated, extinct volcanic mountain in southeastern Ethiopia. It covers 9646.73 ha. Its highest point (4036 m or 13,241 ft m.s.l.), in the Arsi Zone of the Oromia Region, is located in Arsi Mountains National Park on the border between the Hitosa , DigalunaTijo, Shirka, and Tiyo woreda .

Mount Galema rises with gentle slopes for more than 1500 meters from the top of the plateau. The center of Galema Mountain is Boraluku. It's about 200 kilometers south of Addis Abeba and 40 kilometers east of Asella, at 7° 50' 00" N and 39° 25' 00" E. (http://en.wikipedia.org/wiki/Tiyo_woreda) show Figure 1.

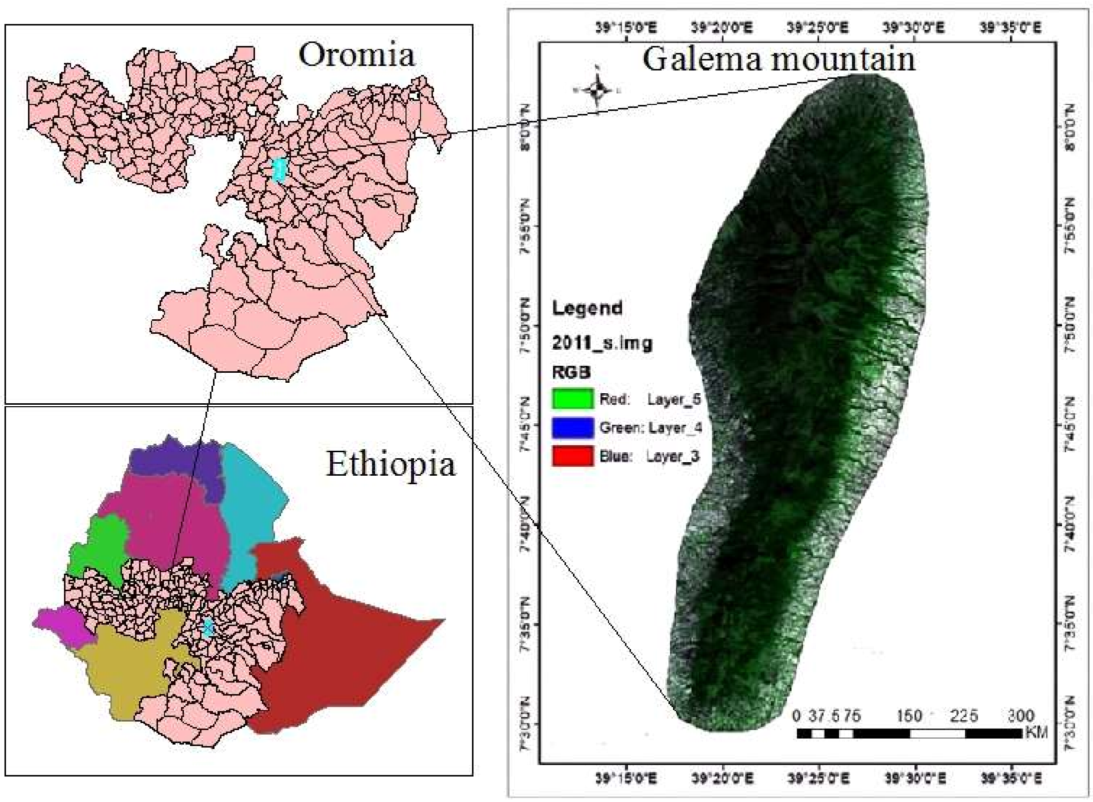

Figure 3.1: Map of the research area

3.1.2. Relief

The study section includes a wide range of landscapes. Elevated and rocky mountainous ridges, flat-topped raised ground, a vast caldera, and a few raised slopes make up this landscape. It also includes steeply rising and falling steep hills, as well as frequently crossed gorges along streams and rivers. It rises from the surrounding flat plain to a height of 4,036 meters. The rivers flowed down from the Galema Mountain to the Ketar River. These rivers are mostly used for drinking water, as well as contemporary and traditional irrigation activities on the Ketar River. (Tiyo_woreda)

3.1.3. Climate

The climate in the research area is tropical, with strong erosive rainfall and a cool to moderate temperate. The average yearly temperature and rainfall vary based on the area's elevation. The yearly mean temperature below 3,300 ml is less than l00 C, whereas the yearly mean temperature above 3,300 ml is 17-21.6 C. Rainfall is moderate at high elevations, particularly near Galema Mountain. The annual rainfall ranges from 878 to 2,231 millimeters. The rainy season is divided into two parts: a short rainy season and a long rainy season (Alemayehu, 2010).

3.1.4. Soil

The study area's soil types are divided into two categories: the district's total area is made up of 80% black clay soil, 15% red clay soil, and 5% loamy clay soil. The soil fertility ranges from fair to excellent. However, water lodging susceptibility to water erosion is a limitation (http://www.oromiyaa.com).

3.1.5. Vegetation

The research area contains a diverse range of flora types, with Asta and Grass dominating the landscape. Steep, rocky outcrops and limited vegetation characterize this sort of habitat (Yenenesh hailu 2014).

3.1.6. Wildlife

Ethiopian wolves, mountain Nyala, bushbuck, warthog, leopard, and hyena are among the area's wildlife. Starck's hare, grass rat, swamp rat, and common mole rat are also included (Malcolm and Sillero-Zubiri, 1997 cited in Alemayehu, 20 10).

3.2. Socio-economic condition

3.2.1. Population

The total population of wereda 27 is 100,237, with 50,199 men and 50,038 women, according to population outcrop figures based on the results of Ethiopia's countrywide population and housing survey conducted in May 2007. The entire population is spread out over a 605.38 km2 region. The average population density is 165.6 people per square kilometer (CSA, 2012).

3.2.2. Occupation

Agriculture is the primary source of livelihood for the residents, and both crop production and farm animals (cattle, goats, and sheep) are skilled in this area. It is the primary source of income for rural residents and the primary employer in the region.

3.2.3. Crop Production

The study region contains a wide range of climatic conditions, which has contributed to the presence of a large variety of plant species. Barley, beans, peas, potatoes, and wheat are examples of cold-temperature crops. Hot-land crops such as maize, wheat, and sorghum, on the other hand, are supplemental crops. Also widely planted are vegetables (Berhanu, 2010).

3.3. Research Methodology

The nature of research problems frequently dictates the study's methodology. The goal of this research was to determine the trend of LU and LCC over the last 30 years, as well as the potential drivers and key impacts of LU and LCC. The study used qualitative and quantitative data methods to analyze and examine the data because this method can help to better understand, clarify, and interpret changes in LU and LC.

This study methodology is a LU and LC research. As a result, satellite image interpretation with appropriate software was used to analyze the LU and LCC of the study site. The research method used the following research tools, sample methodologies, and study methods listed below figure 2.

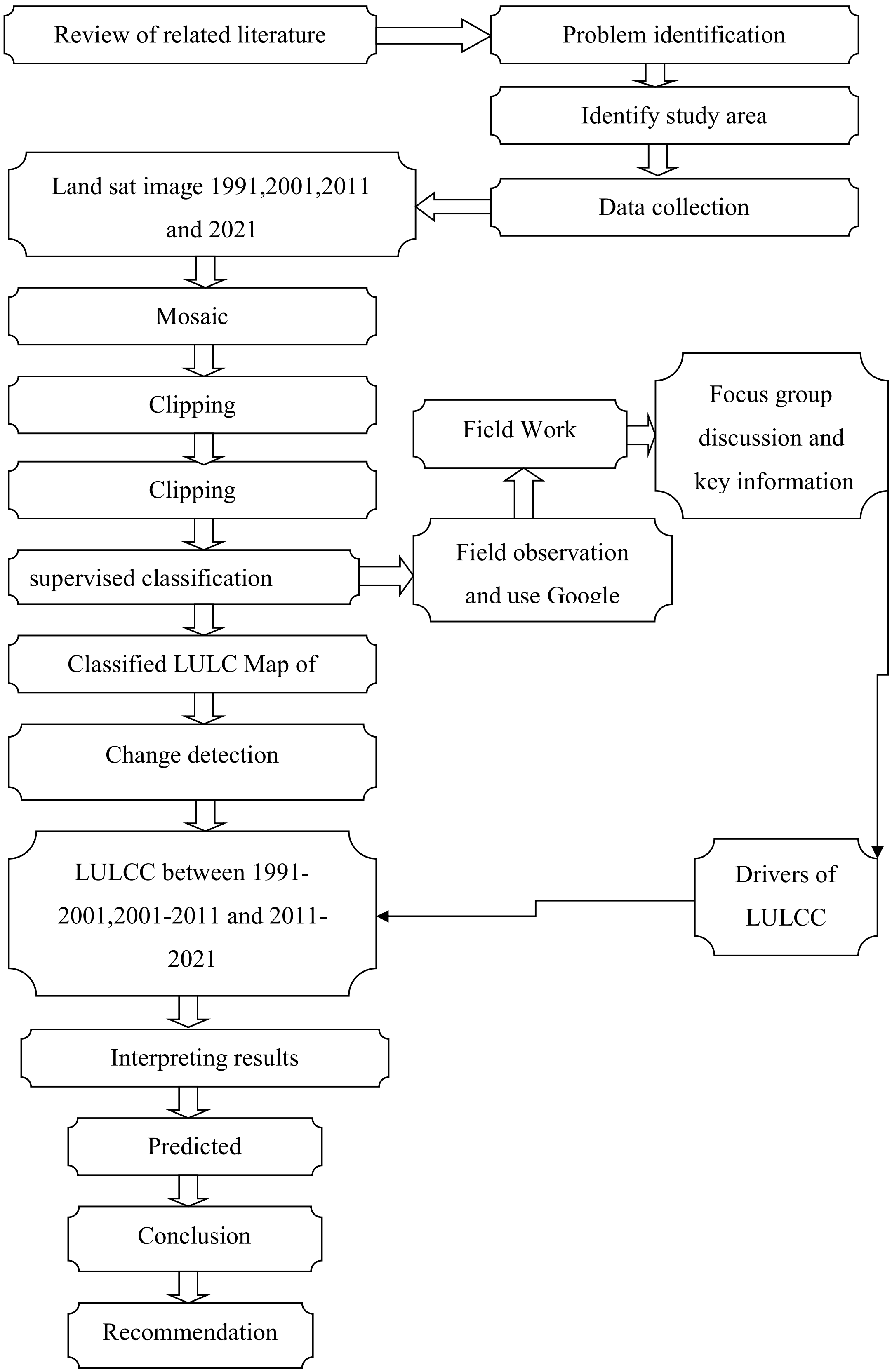

Figure 3.1: Flow of chart

3.4. Sources and Types of Data

Different types of data were collected from both primary and secondary data sources to suit the goals of this study. Satellite images and field data are primary data. Secondary data was acquired from the Ethiopian Central Statistical Authority (CSA), as well as the offices of Agricultural and Rural Development and Land and Environmental Protection. Past research papers were also utilized as secondary data sources.

3.4.1. Data Acquisition

3.4.1.1. Satellite Image and GIS Data Collection

Timeline The LULCC of the entire of Galema mountain and its surrounding was calculated using Land sat images from 1991–2001, 2001–2011, and 2011–2021. Images from these years were chosen to correlate the RS data with key events that occurred during those years. Land sat images from 1991–2021 were used for LULCC analysis under various institutional arrangements. The Land sat Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Operational Land Imager/Thermal Infrared Sensor (OLI/TIRS) were used to capture all the data. All of the satellite images utilized in this investigation had a spatial resolution of 30 meters and less than 10 % cloud cover.

The study attempted to consider land sat images from the same season to limit the effect of cloud cover and seasonal variation on the categorization result (December to February). As a result, photos taken during this season have a minimal amount of cloud cover. In LULCC analysis, land sat image data was favored above alternative multispectral data, such as spot pictures (Bakker et al., 2001). This is due to its open availability and addition of middle infrared bands, as well as the legal exchange of data among government departments and donor agencies (Bakker et al., 2001; Gilani et al., 2014).

3.4.2. Field Survey and Data Collection

Field data on existing LU/LC types, historical trends in prevalent LULCC, and potential LU/LCC causes in the research area were collected using a variety of data collection strategies, including (FGD), Field Observation, and (KII). There were two phases to the field survey. The first phase was a reconnaissance survey, which took place on 2 weredas of the Galema mountain and its surrounding between March 29 and April 3, 2021. The primary goals of this survey were to gain a broad picture of the research area and to use the FGD and KII checklists as a baseline. The reconnaissance survey data was utilized to pick sample Weredas and Kebeles, as well as redesign the FGD and KII checklists. The second part of the field survey took place from April 10, 2021, until the end of May, 2021.

I). Reconnaissance Survey

A reconnaissance survey was conducted in March before beginning the fieldwork. During the reconnaissance survey, Galema mountain and its surrounding, elderly people were interviewed informally. During the reconnaissance survey, information on present land use patterns, natural resource management institutional setups, forest and land resource status, and population and livelihood strategies in terms of their pressure on land resources was gathered**.**

II). Focus Group Discussion (FGD) on major driving forces

The number of members in a focus group can range from 4 to 10 Bhawana (2015), Robinson (1999), and Jayasekara (2012), As a result, this study included groups of 8–10 elderly people. From the two kebeles, I took four female and four males by using focus group discussion for this study. The FGD participants were chosen using two purposive criteria. The first was the age of the participants, who were mostly elderly people who had lived in the research area for a long time and knew a lot about the past and present conditions of the study locations. The ability to understand the topics and clear their ideas and opinions is the second requirement. The focus groups were directed by a checklist of questions (Appendix 5).

The purpose of the focus group discussion was to identify the major driving force of the research area that discussants thought to have occurred on their lands and in their surroundings during the previous 30 years, from 1991 to 2021.This can be used to compare the perceptions of the participants with GIS and RS analysis.

III). Key Informant Interview (KII)

A few key informant interviews were conducted with the goal of gathering more detailed information and cross-checking the data gathered from focus group discussion. Ten elders from two sampled Kebele, digeluna Tijo Wereda, natural resource conservation and management expert. There were a total of 15 key informants chosen (5 from 3 Wereda). Key informants were chosen with the participation of FGD participants utilizing the increase sampling method. The purpose of the key information interview was to identify the major driving force and effects of the research area

IV). Field Observation

To obtain knowledge, some of the examined kebeles were visited by one local assistant from two kebele. Throughout the data collection time in the field, field observation was conducted constantly. During field observation, pictures of existing LULC types were acquired during field observation utilizing a handheld GPS (Global Positioning System) and digital camera to help image processing, categorization, and accuracy assessment. This field observation also aided in the validation of data collected from FGD and other sources.

3.4.3. Remote Sensing Data Acquisition and material used.

To generate LU and LC dynamics of the study area, multi-temporal Land SAT images of four periods (1991, 2001, 2011 and 2022) of remote sensing data were used. These images were processed with the help of image processor tools like Erdas, Arc GIS 3.5, and a geo-referenced satellite image was also used for geo-referencing satellite images. The Ethiopian Mapping Agency was to provide land sat.

3.5. Image Analysis

3.5.1. Image pre-processing

There are four scenes in the research area (Table 1). As a result, the four scenes were initially downloaded from USGS using the path and rows specified in the table below (Table 1). Second, the panchromatic bands in each picture were stacked to create a multispectral image for that scenario. Finally, using the mosaic technique, a mosaic of four scenes covering the study region was constructed by combining the stacked images. After that, geometric and radiometric corrections, as well as image augmentation, were performed. Prior to picture classification, ERDAS IMAGINE 9.3 software was used to do all of the previously described preprocessing.

Geometric correction involves removing distortions from sensor geometry and converting data to ground coordinates, such as UTM. Radiometric correction, on the other hand, entails removing unwanted sensor or ambient noise and adjusting data for sensor abnormalities (Seyoum, 2012). Image enhancement (Bakker et al., 2001) is the process of enhancing the appearance of imagery to aid image analysis, categorization, and visual interpretation. To have all data in the same coordinate system and maintain consistency between datasets throughout the analysis, all maps and satellite images used in this study were projected to the Universal Transverse Mercator (UTM) projection system Zone 37N and the data of World Geodetic System 84 (WGS84).

Radiometric modifications such as haze reduction and dark area cutting were also carried out. Two enhancement functions, contrast stretching and spatial filtering, were used to raise the tonal differentiation between various aspects in the image and to enhance specific spatial patterns in an image. Finally, each image is trimmed using the Galema mountain and its surrounding border and selected kebeles for institutional analysis after passing the aforementioned steps.

Image classification

Image categorization is the process of dividing raw remotely sensed satellite images into a smaller number of LULC classes based on reflectance values (Adedeji et al., 2015). This study combined unsupervised and supervised image classification approaches in a hybrid classification algorithm. Before beginning field work, an unsupervised classification was conducted to determine the study area's general LULC classes and to choose sample training sites for data collection during field work.

This is due to the fact that unsupervised classification is automatic and only requires a basic understanding of the research topic. Following that, maximum likelihood supervised classification was used to categorize the photos utilizing training sites following the field work. Original photos, the outcomes of unsupervised categorization, field study expertise, and auxiliary data were used to define training sites (Google Earth). The ERDAS IMAGINE 9.3 and GIS programs were used to classify the images. Training sites for the current image Operational Land Imager/Thermal Infrared Sensor (OLI/TIRS) categorization were defined using Ground Truthing Points and supplementary data (Google Earth). The outcome of unsupervised classification, spectral values of current photos, and information gathered from elderly people were used to construct training sites for the classification of older images.

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

The satellite photos of the Galema Mountain and its surroundings taken from 1991 to 2001, 2001 to 2011, and 2011 to 2021, five major land use/cover types were identified. Forest, shrub land, wetland, cropland, and bare land or degraded land are the different types of land.

Forest:-It consists of both natural and planted forests. A plantation forest refers to land that has been covered with man-made forests of eucalypt and conifer species, whereas a natural forest is a multi-strata ecosystem with overlapping canopies that includes canopy, sub canopy, shrub, and herb layers. In the research region, this LU/LC class provided wood and other items for house construction, fuel wood, farm equipment, and fencing.

Shrub land:-Areas dominated by shrubs and other tiny plant species have several stems, but none is dominant. mixed with grass in some circumstances. It's smaller and less dense than wood. This land cover class is used for grazing during the winter in the research region, while the wooded part is used for fuel wood.

Wetland:-Simply put, wetlands are areas of our landscape defined by the presence of water. Wetlands are areas where the presence of water defines or influences the majority, if not all, of an area's biogeochemistry—that is, the biological, physical, and chemical properties of a single site.

Grass land:-They are non-woody landscapes with grasses and herbs as their primary vegetation. It's land that's been set aside for the purpose of providing animal feed. Grazing and browsing are common in the research area. It contains grazing pastures that are both privately and communally held.

Crop land:-Land that is currently under cultivation, uncultivated ground, or land that has been prepared for planting. This category includes areas assigned for the production of seasonal crops in the research area, with the majority of cultivated lands dedicated to seasonal rain-fed crops. Crop cultivation takes place on ground with a variety of slopes, from gentle to steep. There are also a variety of food crops, the most common of which are cereals like barley and wheat, as well as peas and pulses like beans.

Accuracy Assessment

It is necessary to assess the accuracy of classification results in order to determine whether the created classification is compatible with what actually exists on the ground. An error matrix was created for each image in this investigation. The link between the classes in the classified and reference data is represented by an error matrix, which is a square array of rows and columns. As a result, the Land sat TM of 1991 and 2001, Land sat ETM+ of 2011, and Land sat OLI/TIRS of 2021 all achieved overall accuracy of 87.50 %, 90 %, 91.5 %, and 92.55 %, respectively. This implies that land sat picture classifications are excellent.

LULCC Detection analysis

3.5.2. Data Analysis for Driving Forces of LULCC

To determine the driving force of LULCC, data from FGD and KII were evaluated qualitatively. Techniques for speech transcription and comprehension were used. The assessment and analysis of LULCC drivers were structured using Geist & Lambin's (2001, 2002) LULCC drivers category.

3.6. Land Use Land Cover Change predictive

The predictive power of the model was initially validated by forecasting the LULC for the year 2021 and projecting future LULC into 2051. Using the LULC maps from 1991 and 2021, the LULC for the year 2051 was forecasted. This allowed us to compare the prediction's outcome to the actual LULC in 2021. Following the validation of the model's performance, a true "forecast" for the year 2051 was made.

The land demand in 2051 was predicted using LULCC maps between 2011 and 2021. This is because the model predicts the outcome based on the observed trend between the beginning and base years (2011). (2021). Because the Markov chain model required the time interval between the base year (2021) and the projected year (2051) to be equivalent to the time period between the beginning year (1991) and the base year (2021), the year 2021 was chosen for prediction (2051).

CHAPTER IV: RESULT AND CONCLUSION

4.1. Land Use and Land Cover

4.1.1. LULC classification Accuracy assessment

The results of the LULC classification have been assessed to see how well they represent reality. This is significant because remote sensing-derived LULC maps could contain mistakes. As a result, an accuracy classification evaluation was conducted to examine how well the constructed classification matched the reality on the ground.

According to Lilesand and Kiefer (2000), the minimum level of accuracy for identifying land cover categories from remote sensor data should be at least 80 %. The accuracy assessment result of this study revealed that the minimum overall classification accuracy was 86 % with a Kappa coefficient of 0.8125, while the maximum overall classification accuracy was 90 % with a kappa coefficient of 0.877. As a result, the study's categorization accuracy satisfies the standard criteria. The datasets used to test the classification accuracy are presented in below.

Table 4.1: land use land cover accuracy assessment 1991 year

Class name	Reference	Classified	Number	Producers	Users
	Totals	Totals	Correct	Accuracy	Accuracy
Shrub land	15	16	15	100.00%	93.75%
Wetland	16	16	14	87.50%	87.50%
Forest	18	16	14	77.78%	87.50%
Grassland	15	16	13	86.67%	81.25%
Cropland	16	16	14	87.50%	87.50%
Totals	80	80	70		
Overall Classification Accuracy = 87.50%					

Table 4.2: land use land cover accuracy assessment 2001 year

Class Name	Reference	Classified	Number	Producers	Users
	Totals	Totals	Correct	Accuracy	Accuracy
Shrub land	15	16	15	100.00%	93.75%
Wetland	17	16	15	88.24%	93.75%
Forest	18	16	15	83.33%	93.75%
Grassland	14	16	13	92.86%	81.25%
Cropland	16	16	14	87.50%	87.50%
Totals	80	80	72		
Overall Classification Accuracy = 90.00%					

Table 4.3: land use land cover accuracy assessment 2011 year

Class Name	Reference	Classified	Number	Producers	Users
	Totals	Totals	Correct	Accuracy	Accuracy
Shrub land	15	16	15	100.00%	93.75%
Wetland	17	16	15	88.24%	93.75%
Forest	18	16	15	83.33%	93.75%
Grassland	14	16	13	92.86%	81.25%
Cropland	16	16	14	87.50%	87.50%
Totals	80	80	72		
Overall Classification Accuracy = 91.00%					

Table 4.4: land use land cover accuracy assessment2021 year

Class Name	Reference	Classified	Number	Producers	Users
	Totals	Totals	Correct	Accuracy	Accuracy
Shrub land	15	16	15	100.00%	93.75%
Wetland	17	16	15	88.24%	93.75%
Forest	18	16	15	83.33%	93.75%
Grassland	14	16	13	92.86%	81.25%
Cropland	16	16	14	87.50%	87.50%
Totals	80	80	72		
Overall Classification Accuracy = 92.00%					

4.2. The temporal land use land covers (LULC) change.

The LULC change analysis results illustrate the historical LULCC and the change dynamics in each land cover class. The study results would significantly help Forest administration and decision makers determine the nature, position, and rate of change in the study area. The classified land use land cover maps of 1991, 2001, 2011, and 2021 were generated using the supervised classification. Five LULC classes were identified in the study area for the specified period 1991–2021.Training samples for each class were collected from each image. The outcome displays that the land use land cover pattern of Galema mountain has changed radically between 1991 and 2021, with the Crop land areas experiencing continuous growth over the last study periods, and Forest land, Grass land, Shrub land wet land decreased during the period. Table 4.5 displays the spatial distribution of each LULC in 1991, 2001, 2011, and 2021. The quantitative result is presented in Figure 4.1, which shows the statistics of the five LULC classes and the change dynamics during the four-time periods.

4.1.3. LULC class and area coverage of the study area in 1991-2021.

Table 4.5: LULC classes, and their corresponding areas in Hectare and percent at different periods.

1, Statistical Value of LULC

	1991		2001		2011		2021	
Class Name	Area_ha	%	Area_ha	%	Area_ha	%	Area_ha	%
Crop land	2427.45	25.16	2732.69	28.33	4132.40	42.84	4320.35	45.80
Forest land	3804.52	39.44	3769.35	39.07	2478.17	2478.17	2411.50	25.56
Grass land	2014.95	20.89	1797.50	18.63	1700.91	17.63	1631.96	17.30
Shrub land	1275.45	13.22	1134.31	11.76	1069.26	11.08	665.24	7.05
Wet land	124.37	1.29	212.89	2.21	266.00	2.76	404.50	4.29
Total	9646.73	100.00	9646.73	100.00	9646.73	100.00	9646.73	100.00

The study of Galema mountain Crop land area and significant changes in other LULC classes between 1991 and 2021. It indicates an increase in Crop land area in 1991 to 2427.45ha in 2001 to 2732.69 ha in 2011 to 4132.40 ha in 2021 increased to 4320.35 ha in ,this is an increased from 25.16% to 28.33% to 42.84% to 45.80% of the total area during 1991, 2001, 2011 and 2021 respectively. The Crop land, Forest land, Grass land, Shrub land and bare land perceived an inconsistent change during the study period. The Forest land decreased from 3804.52 ha (39.44%) in 1991 to 3769.35ha (39.07%) in 2001 to 2478.17ha (2478.17%) in 2011 and 2411.50 ha (25.56%) in 2021. This indicates a decrease from 39.44% of the total area in 1991 to 25.56% in 2021. The Grass land also decreased from 2014.95 ha in 1991 to 1797.50 ha in 2001 to 1700.91 ha and 1631.96 ha in 2011 and 2021 respectively. This indicates Shrubs also reduction but Bare land is increase. The historical land use/land cover results in 1991, 2001, 2011, and 2021 are illustrated graphically in Figure 4.1 and 4.2.

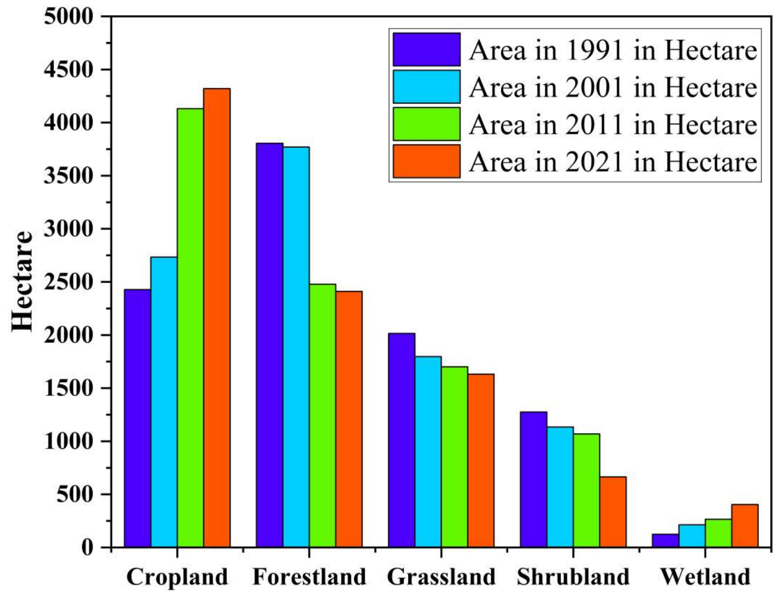

Figure 4.1: Area coverage from 1991 up to 2021 in Hectare

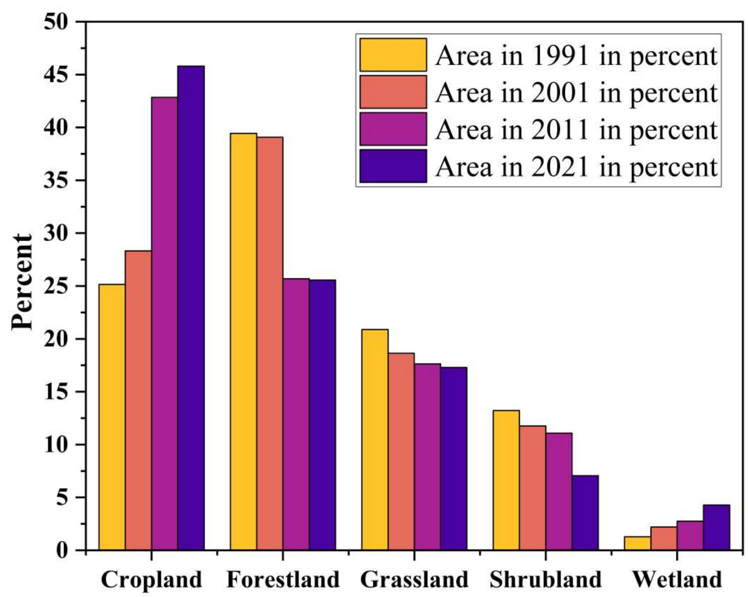

Figure 4.2: Area coverage from 1991 up to 2021 in percent

4.1.3.1. LULC of the study area in 1991.

Forest, wet land, shrub land, grassland land, and crop land are some of the LU/LC categories identified in the research area. There are 9646.73 ha in this LU/LC category. The LU/LC classification for 1991 generated from satellite images indicated that forest covered 3804.52 ha (39.44 %) of the study area, and wetlands was another land cover identified from the satellite image, accounting for 124.37 ha (1.29 %), while shrub land, grass land, and crop land accounted for 1275.45 ha (13.22 %), 2014.95 ha (20.89 %), and 2427.45 ha (25.16 %) respectively (figure 4.3 and 4.4).

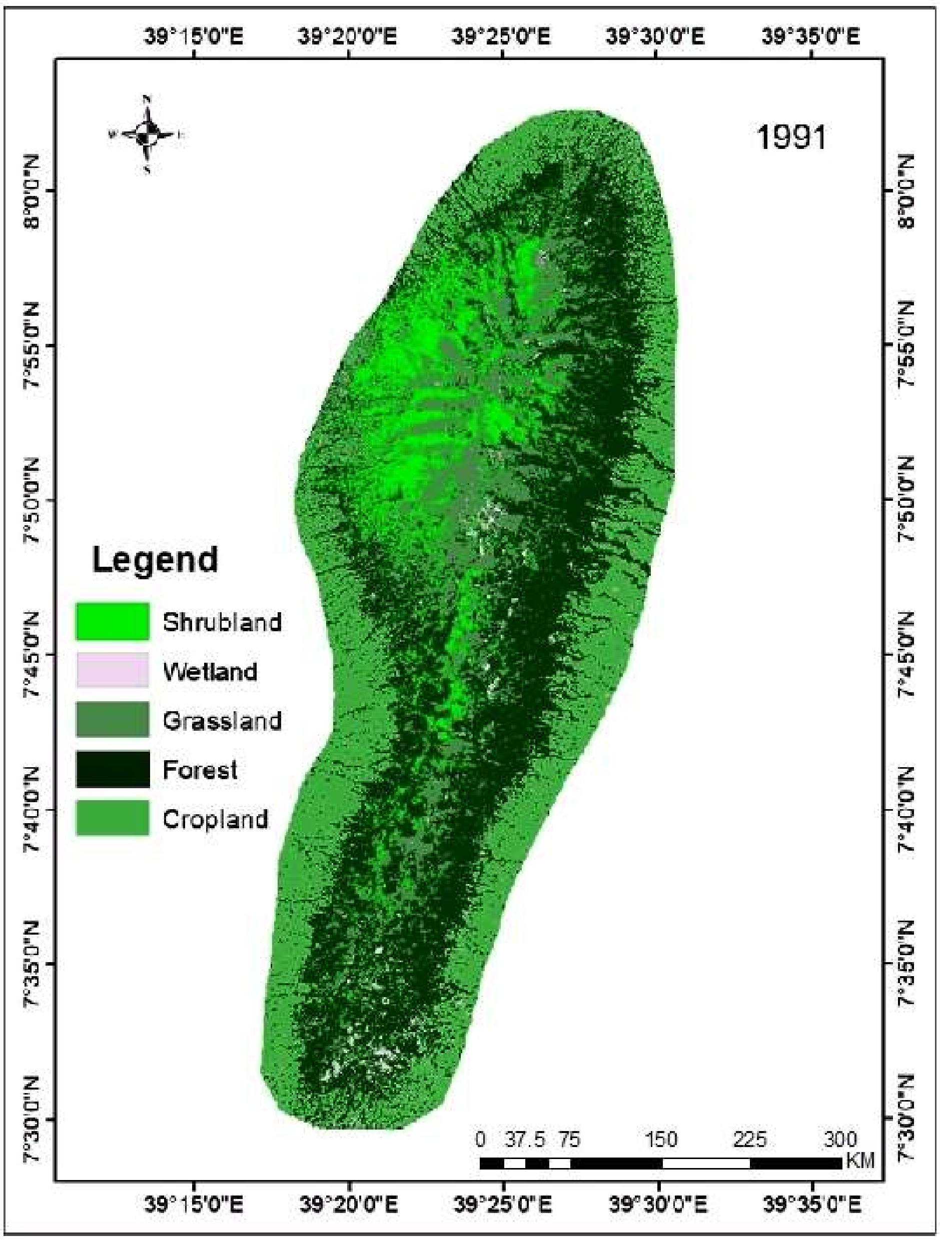

Figure 4.3: LULC map of the study area in 1991

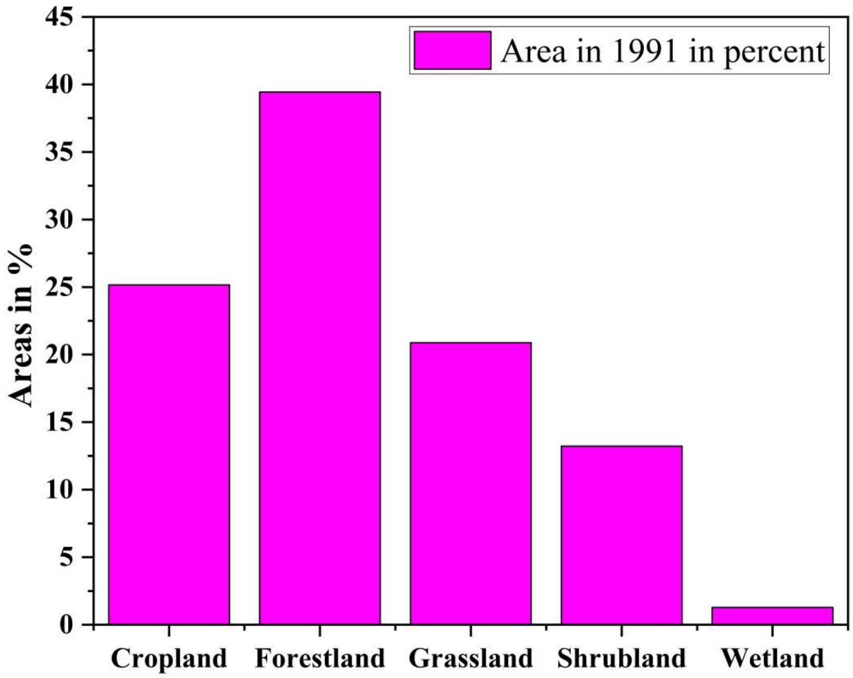

Figure 4.4: LULC class in 1991 and their corresponding areas in %

4.1.3.2. LULC of the study area in 2001.

The majority of the research area was covered by forest and crop land, accounting for 3769.35 ha (39.07 %) and 2732.69 ha (28.33 %), respectively, according to the LULC analysis for 2001 from satellite images. Wet land, shrub land, and grassland land totaled 212.89 ha (2.21 %), 1134.31 ha (11.76 %), and 1797.50 ha (18.63 %),respectively, as shown in figures 4.5 and 4.6.

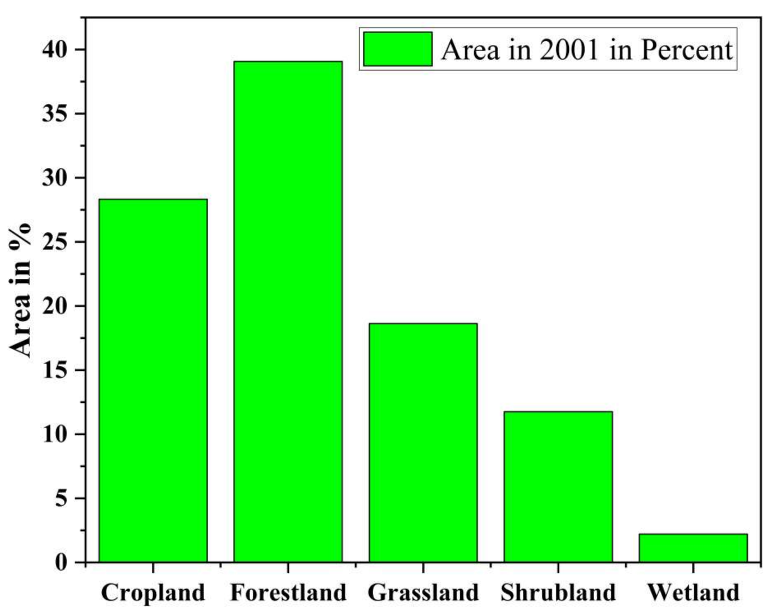

Figure 4.5: LULC class in 2001 and their corresponding areas in %

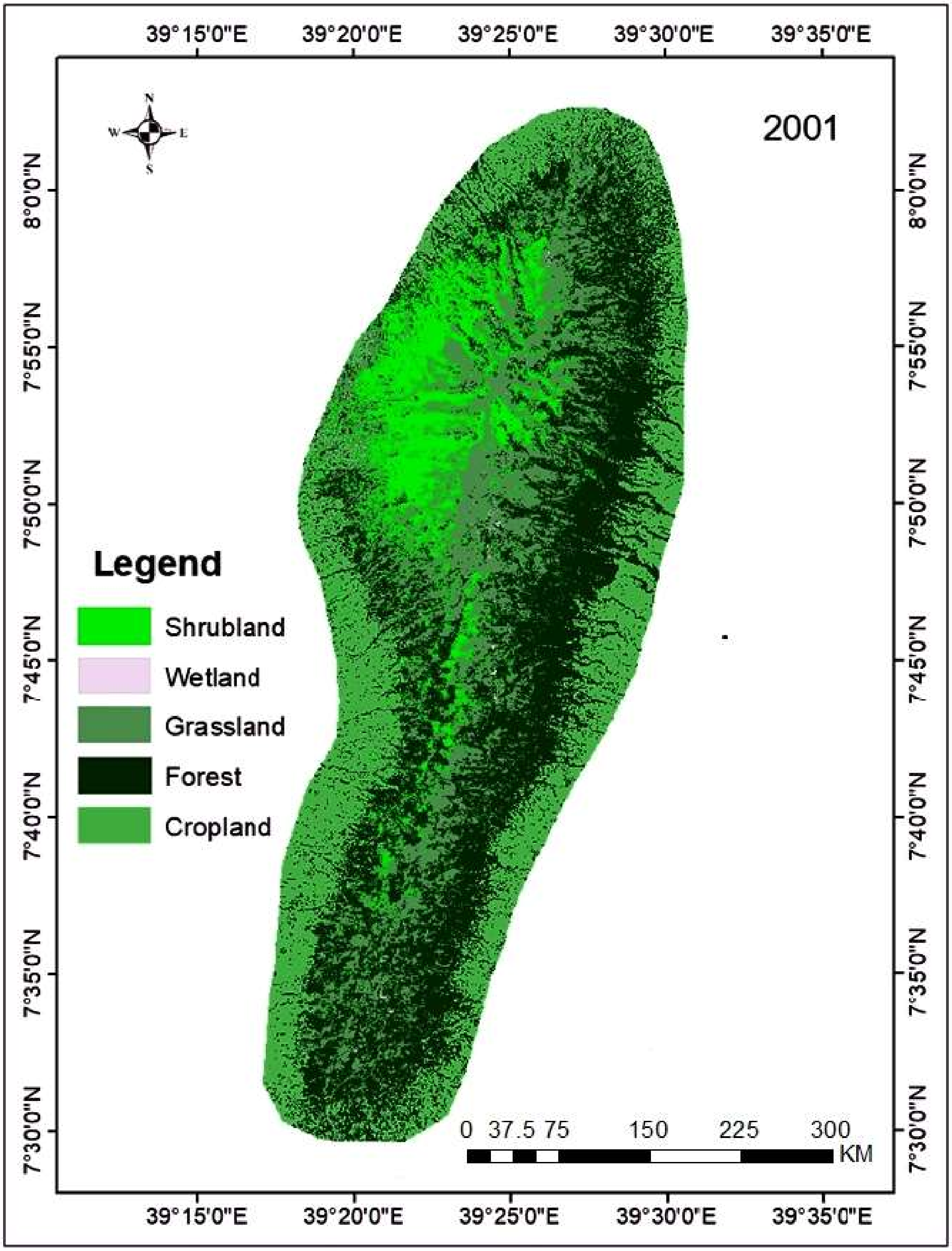

Figure 4.6: LULC map of the study area in 2001

4.1.3.3. LULC of the study area in 2011.

Land cover analysis based on satellite images for the year 2011 discovered that among other land cover. Forest land, shrub land, Wetland, Grassland and crop land were estimated to be 2478.17 ha (25.69 %), 1069.262 ha (11.08 %), 266.00 ha (2.76 %), 1700.91 ha (17.63 %) and 4132.40 ha (42.84 %), respectively show figure 4.7 and 4.8.

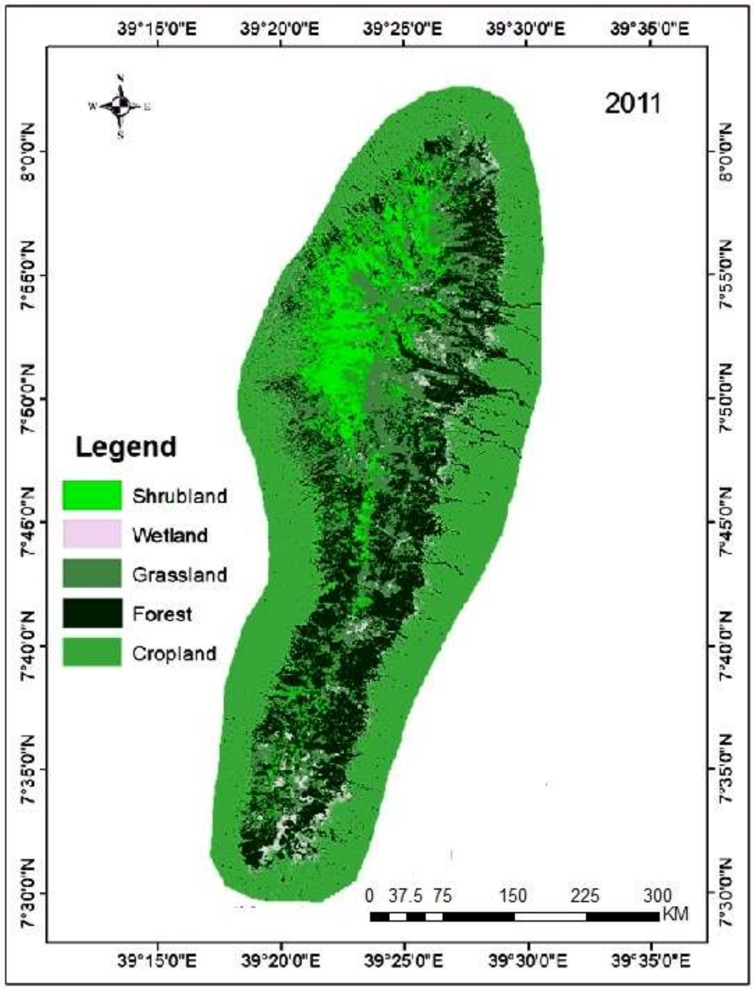

Figure 4.7: LULC Map of the study area in 2011

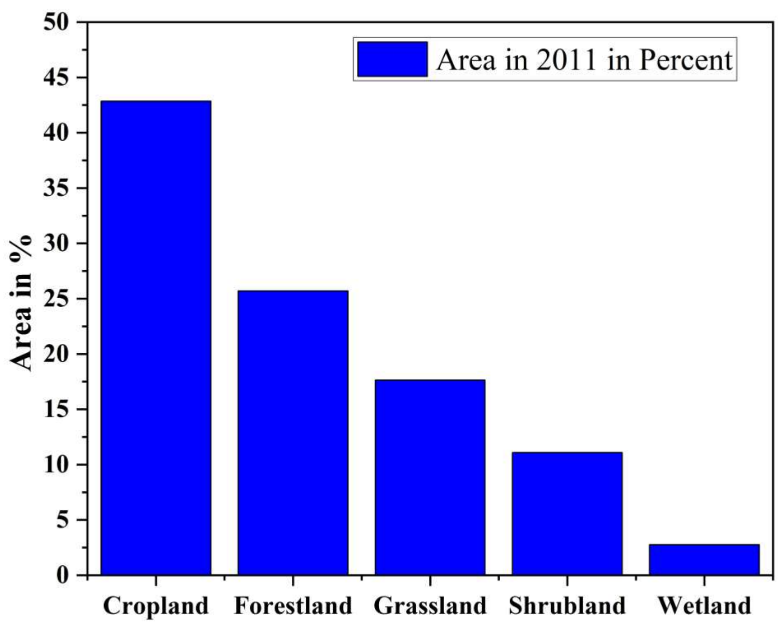

Figure 4.8: LULC class in 2011 and their corresponding areas in %

4.1.3.4. LULC of the study area in 2021.

Cropland, which occupied 4320.35 ha (45.80 %) of the LULC classes in the research area in 2021, was followed by forest land (2411.50 ha (25.56 %) and grass land (1631.96 ha) (17.30 %). From the total extent of the study area, shrub land and wetland have the least area coverage, with 665.24 ha (7.05 %) and 404.5 ha (4.29 %), respectively, show Figure 4.9 and 4.10.

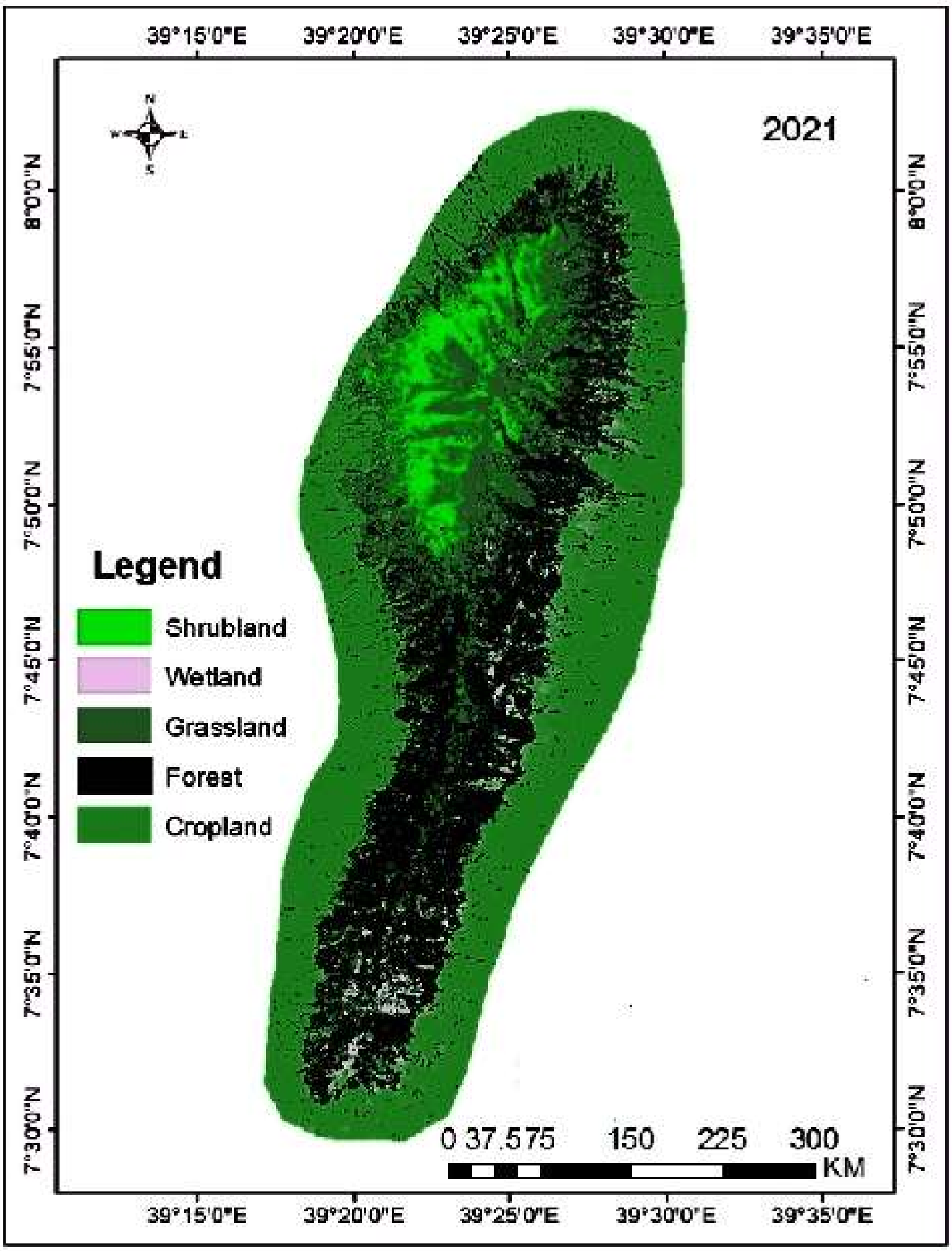

Figure 4.9: LULC Map of the study area in 2021

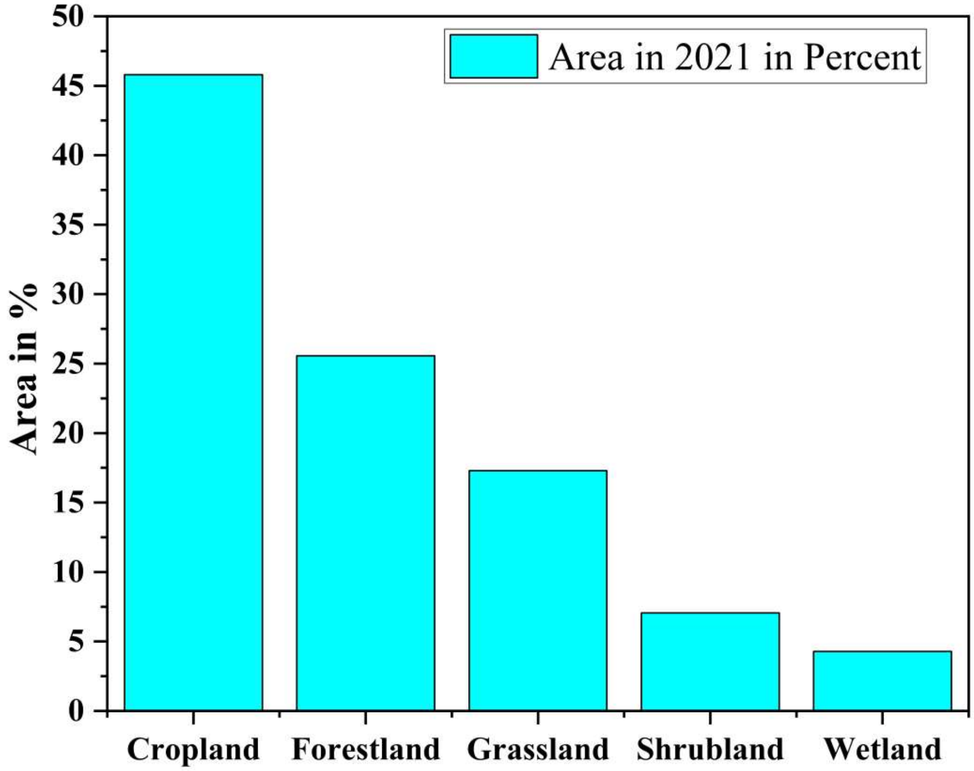

Figure 4.10: LULC class in 202 1and their corresponding areas in %

4.2. LU and LC change detection of the study area

4.2.1. LULC Change Detection between 1991 and 2001 G.C.

Between 1991 and 2001, the area under forest, grassland and shrub land decreased by -35.17 ha (-0.37 %), -217.45 ha (-2.26 %) and -141.14 ha (-1.46 %), respectively and where as those under crop land and wet land increased by 305.24 ha (3.17 % and 88.52 ha (0.92 %) (Table 2 ,figure 13).

Table 4.2: Extent and trends of LULC changes between 1991 and 2001

LU/LC Type	**1991-2001**	
	Change in ha.	change in %
Cropland	305.24	3.17
Forest land	-35.17	-0.37
Grassland	-217.45	-2.26
Shrub land	-141.14	-1.46
Wetland	88.52	0.92

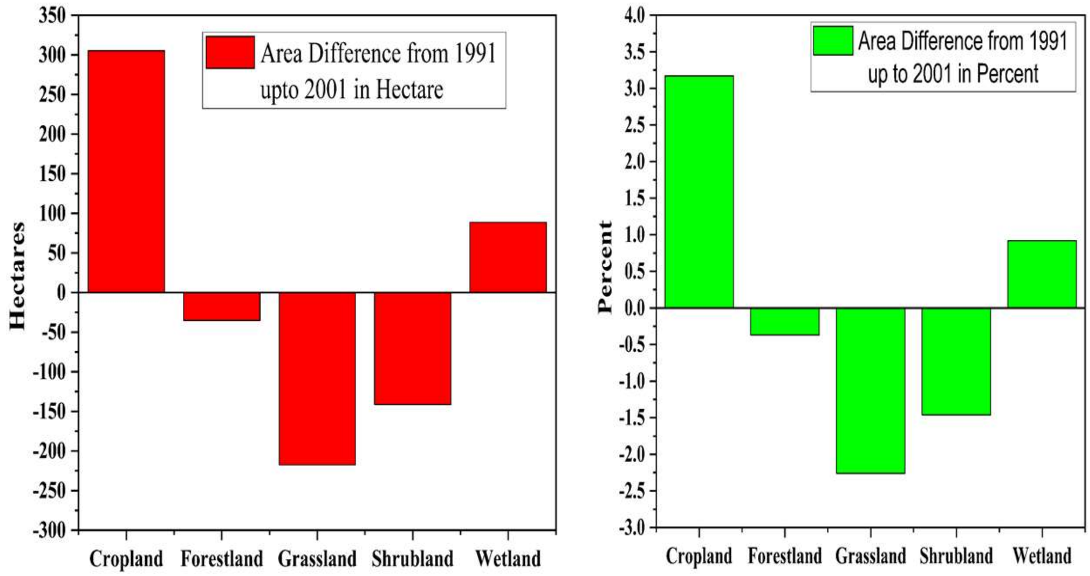

Figure 4.11: LULCC difference in 1991-2001 in Hectares and percent

4.2.2. LULCC Detection between 2001 and 2011

The results of LU/LC change detection between 2001 and 2011 show that forest, grassland, and shrub land decreased by -1291.18ha (64.76%), -96.59 ha (1%), and -65.05 ha (0.68%), respectively. Cropland and wetlands, on the other hand, increased by 1399.71ha (14.51%) and 53.11ha (0.55%), respectively show Table 3 and Figure 14.

Table 4.6: Extent and trends of LU and LCC between 2001- 2011

LULC Type	**2001-2011**	
	Change in ha.	change in %
Cropland	1399.71	14.51
Forest	-1291.18	-64.76
Grassland	-96.59	-1
Shrub land	-65.05	-0.68
Wetland	53.11	0.55

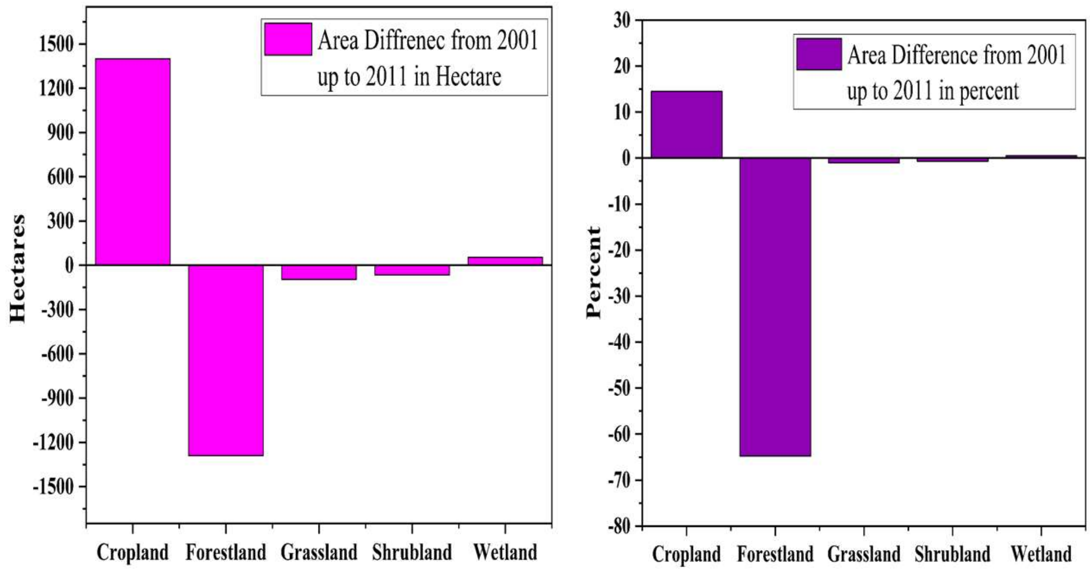

Figure 4.12: LULCC difference in 2001-2011 in Hectares and percent.

4.2.3. LULCC Detection between 2011 and 2021

Table 4 and figure 15 shows that cropland, and wetland expanded substantially between 2011 and 2021, with cropland expanding. The area under cropland, and wetland increased by 187.95 ha (2.96 %) ,and 138.5 ha (1.53 %), respectively, over a ten-year period. On average, forest, grassland and shrub land were reduced by 66.67 (0.13 %), 68.95 ha (0.33 %) and 404.02 ha (4..3 %) over ten years.

Table 4.7: Extent and trends of LULCC between 2011 -2021.

LULC Type	**2011-2021**	
	Change in ha.	change in %
Cropland	187.95	2.96
Forest	-66.67	-0.13
Grassland	-68.95	-0.33
Shrub land	-404.02	-4.3
Wetland	138.5	1.53

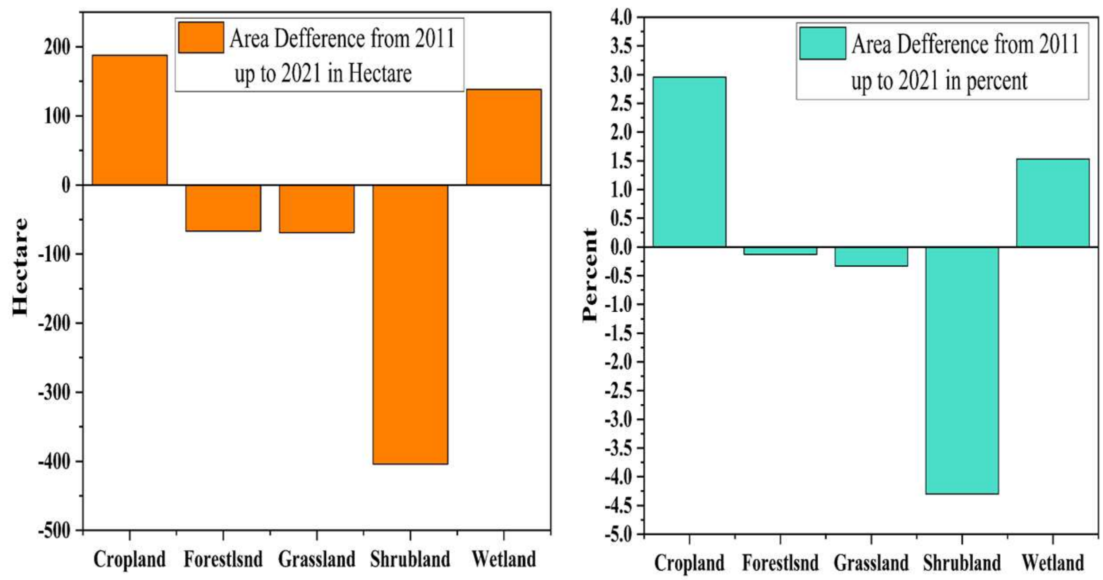

Figure 4.13: LULCC difference in 2011-2021 in Hectares and percent.

When comparing early period LULC classes of the research area to following period LULC classes, there is generally a change that shows a decrease or increase in specific LULC.

Cropland increased continuously from 1991 to 2001, 2001 to 2011, and 2011 to 2021, with 2427.45 ha (25.16 %), 2732.69 ha (28.33 %), and 4132.40 ha (42.84 %) and 4320.35 ha (45.80 %) respectively. Wetland also increased continuously from 1991 to 2001, 2001 to 2011, and 2011 to 2021, with 124.37 ha (1.29 %), 212.89 ha (2.21 %), 266.00 ha (2.76 %) and 404.5 ha (4.29 %). Forest ,Grassland and shrub land, on the other hand, decreased 3804.52 ha (25.16 %), 3769.35 ha (39.07 %), and 2478.17 ha (25.69 %), 2411.50 ha (25.56 %) and Grassland from 1991 to 2001, 2001 to 2011, and 2011 to 2021, respectively, and 2014.95 ha (20.89 %), 1797.50 ha (17.63 %), and 1631.96ha (17.30 %) shrub land also decreased by 1275.45 ha (13.22%), 1134.31 ha (11.76%) , 1069.26 ha (11.08%), 665.24 ha (7.05%) respectively to show.

4.3. The major driving forces of LULCC in the study area

A variety of proximate and underlying factors contribute to change (LULCC) in the Galema mountain and its surrounding.

Changes in LU and LC are the result of a complex interaction of causes. The basic assumption that changes in LU and LC are caused by a few things is incorrect. Rather, the processes of LU and LCC are better explained by a number of interconnected, complicated elements (Lambin & Geist, 2007). Various causes activate LU and LCC, notably forest cover change, in the research area.

Even while natural processes can contribute to changes in land cover, human-induced land uses are the primary driving force. These human-induced causes of LCC are significant and are expanding at an alarming rate. Similarly, most of the factors that influence LU and LCC in the Galema Mountain and surrounding areas are influenced by human activity, which is responsible for the massive conversion of Forest land into other land forms and land use units in the Galema Mountain and surrounding area. Different studies have classified the reasons for LU and LCC into two broad categories: proximate (direct) and underlying (indirect or root) (Habtamu, 2011).

4.3.1 Proximate (Direct) driving forces

Five significant proximate (direct) driving forces appear to explain a large part of the LULCC in the Galema and its surrounding mountain, according to a series of conversations and interviews performed with Focus Group Discussion (FGD) participants and key informants in the research region. These include (i.) agricultural growth (ii.) fire (iii.) criminal classification and fuel wood extraction (iv.) overgrazing, and (v.) illegal and unplanned settlement expansion.

4.3.2. Proximate cause of LULCC in the research area

4.3.2.1 Crop land expansion

Agricultural land expansion is one of the primary causes of LCC in Ethiopia, particularly natural Forest deforestation (Kahsay, 2004).. The study areas' LU and LCC detection results showed an increasing trend of Crop land from 1991 to 2021. Other LU and LC classes have been converted to crop lands as a result of increased agricultural land coverage in terms of area.

Furthermore, data from the field survey and information from the sample respondents revealed that agricultural land expansion at the expense of other LULC types is one of the major factors driving LU and LCC, in order to meet food demand for the ever-growing human population and house construction for newlyweds.

Because the area is potentially essential for agriculture, the activity is more likely to expand into other LU and LC sectors such as grazing land and forest land, according to the respondents. As a result, most private grazing property has been converted to farmland.

Furthermore, this activity spread to forested upland areas. As a result of increased conversion of forest land for cultivation and greater advance of farming on mountain forest borders, the area's forest cover continues to decline.

Figure 4.14: Cultivation of crop on steep slope Photo: Author field survey, Jun, 2022

4.3.2.2 Deforestation

The main cause of forest loss is deforestation for agricultural purposes. Deforestation is mostly caused by extensive agricultural activity and an increased demand for firewood due to population growth. It is one of the most common reasons for LU and LC. There is evidence that forest resources are decreasing in the research area. The result of LU The forest land is continuously decreasing, per the cover change detection.

During the three comparative periods, the forest land declined by 35.17 ha (0.37 %) from the original forest between 1991 and 2001. Between 2001 and 2011, it decreased by 1291.18 ha (64.76 %), and between 2011 and 2021, it decreased by 66.67 ha (0.13 %), indicating a shift in land use.

Furthermore, information gathered from elders during FGD revealed that the entire research region was covered in dense forest, and they are living witnesses to the fact that forest cover has been declining. Forests are being cleared and turned to agriculture and grazing land show Figure 4.15.

Figure 4.15: Forest degradation on Galema Mountain once under vegetation photo: Author field survey, April, 2022

4.3.2.3. Fire Hazard

According to the field observation, fire hazards were one of the key factors that contributed to the destruction of forest in the study area. Fire hazards are caused by both human activities and natural hazards. The most serious hazard to the ecosystems of the Forest in the Galema Mountains is uncontrolled vegetation burning to encourage the production of grasses, bushes, and trees used by cattle.

This is because large Erica plants have closed canopies that prevent grasses and forbs from growing. Therefore, in order to enhance feed and open the landscape for animal grazing, the respondents also noted that locals set fire to extinguish the wild life. As a result, residents frequently light fires. Natural phenomena, in addition to human activity, contribute to fire hazard, according to the group discussion, observation, and key source Figure 4.16 .

Figure 4.16: Fire hazard on Galema Mountain photo 2020.

4.3.2. Economic factor

The information gathered from focus group discussions discovered a scarcity of agricultural and grazing land. This is due to the fact that, as previously said, most individuals have large families, and this recently married family member must share his family land in order to survive. This idea was backed up by sample respondents, who stated that the amount of their farm land has been decreasing over time.

This is due to the fact that their children share their farmland, and the current land hold is much smaller than the previous one. According to the key informant, the largest land holding in the study region is five hectares and the least is zero (there are fans without land), but the bulk of the people in the study have an average land holding size of one and a half hectares. Furthermore, the majority of respondents in the research area state that their existing land holdings are insufficient to sustain their family. As a result, farmers are forced to use pressure on surrounding forest and grazing land in order to obtain extra land to extend their farm area.

Table 4. 8: Current land holding on the respondent to support the household

Current land holding	Frequency	Percent
Excess	6	4.62
Sufficient	46	35.38
Insufficient	78	60
Total	13 0	100.0

field survey February 2021

On the other hand, demand for forest products for house and fence building has increased, resulting in increased forest loss in the studied areas. Cutting trees to meet the demand for firewood and construction materials is clearly one of the causes of deforestation in the research area, according to the participants' perspectives in the FGD.

According to a key informant from Jemo kebele, poor people's dependence on the forest for their income is also one of the significant issues affecting the LULCC of Galema Mountain and the surrounding area. Because the sale of wood and wood products is a source of income for resource poor individuals, notably landless teenagers and women in the study region, forest cover change is triggered show below figure 4.17.

Figure 4.17: women collecting fire wood in the research area photo: field survey, February, 2021

4.3.3. Institutional factor

Natural resources in Ethiopia, such as natural forests, have been degraded. The root reasons for this state of things are, for the most part, policy and institutional difficulties, including bad governance. Over the past many decades, incorrect policies, a constantly shifting and ineffective legal and institutional framework, poor policy implementation, misuse of human resources, and ineffective bureaucracy have resulted in low implementation and management capacity (Sida, 2003).

The Imperial Government (1930–1975), the Derg government (1975–1993), and the Federal Democratic Republic of Ethiopia (FDRE) are the three most well-known land tenure systems in Ethiopia (1993–recent).

Participants in the focus group discussion were asked about the impact of the land tenure system on LU and LCC in the research area. According to their responses, the bulk of the participants observed the three regimes, and, in their opinion, huge changes in LU and LC on Galema Mountain occurred during military rule. The military administration nationalized "Land Use the Tiller". As a result, land and resources were divided into portions among smallholding farmers, resulting in significant destruction of vegetated fields intended for diverse reasons, according to Messay (2011). As a result, large LULC variations occurred across the country in general and in the research area in particular.

Furthermore, during the Derge rule, the peasant association established communal land and resources for the community, which resulted in a tragedy of the commons in which everyone needed to maximize the benefit received from that land resource. Land tenure instability also contributed to LCC and degradation in the research area, with repeated redistribution of cultivated land, notably during the Derge regime, causing farmers to lose their sense of ownership and confidence in their farmland.

Farmers with the excessive expectation of just holding land for the current season will have little reason to conserve; instead, their incentive will be to gain the most advantage from the land. In principle, farmers may expect using land for an indefinite period of time, but they must also consider the possibility of losing this right in the future. The higher the risk of losing the right, the less likely they are to preserve the land's productive capacity.

Concerning the Galema Mountain and its surrounding Protection Rule and Regulation System was a focus group and a key informant participant. As a result, all of the participants agreed that even while there are rules and regulations in place to prevent unwanted modification and degradation of the mountain, there is still room for development. However, there were no or are currently no firm norms and regulations in place, and the measures taken to punish those who break them are insufficient. As a result, some of the study area's protected areas and natural woodland have been turned to cropland.

The majority of sample home respondents (64.5 percent) agreed that the Galema Mountain and its surrounding is not regularly monitored and regulated.

Even though the Galema Mountains and its surrounding was designated as one of Ethiopia's 39 forest priority areas to be managed for the production, protection, and conservation of its forests, forest cutting, uncontrolled burning, and agricultural expansion continue to have a significant impact.

Because it incorporates portions of various Arsi Zone weredas, management of the Mountains forest right of way area is particularly difficult. Furthermore, at higher elevations, the boundaries of these weredas meet and are not clearly defined. This ambiguous understanding of wereda boundaries has quiet any effective mountain management and produced a system in which significant natural resource extraction can occur without restriction.

4.3.4. Scio-cultural factor

When asked about the importance of conserving Galema Mountain and its surrounding area, all of the sample respondents (100%) had a positive attitude toward the conservation of the research area and said that conserving the natural resources of the mountain was very important.

The importance of protecting the Galema Mountain and its surrounding from the standpoint of consumption and all of its environmental benefits was justified by the responders. Consumptive uses include grazing, obtaining firewood and building materials, and earning money by selling firewood.

All of the respondents also explain the importance of conserving Galema Mountain and its surrounding from the perspective of environmental services, stating that Galema Mountain is the source of many streams and rivers, so conservation is necessary to ensure a continuous flow of rivers and streams, as well as the home of diverse plants and fauna that attract tourists.

4.4. Impact of LULC Change in the study area

Galem Mountain's and its surrounding changing land cover has an impact on both the biophysical resources and the lives of the local population.

4.4.1. Biophysical impacts of LULC change

Participants in the focus discussion were asked to recognize and discuss the biophysical impact of Galema Mountain's LU and LCC. The principal effects of LU and LCC seen in the research area, according to the debate, are a reduction in flora and fauna, reduced soil fertility, gully development, declining or drying up of river and stream water, less rainfall, and an increase in the area's temperature.

4.4.2. Affected vegetation and fauna diversity

Changes in LU and LC, particularly the conversion of forest land to other LU and LC, result in the extinction of both species and fauna as a result of reduced food production caused by the loss of green cover.

Galema Mountain, the research region, is home to a variety of plant and animal species. According to information gathered from participants, hyena, bushbuck, leopard, monkey, and 'Karkaro' are the most common wild creatures in the study region. There are endemic creatures such as Mount Nyala and the Ethiopian Wolf (red fox), but the LU and LCC caused by deforestation and fire hazard has radically reduced wild animal numbers in the last 30 years.

Furthermore, the respondent names the most common tree species in the research area as: Hagenia abyssinica, PodocCi/pus gracillors, Olea Africana, Juniperus procera, and Erica areborea. Even if they are all now available, their supply has drastically decreased, according to group discussion.

4.4.3. Enhanced drying up of stream and river

According to the findings of FGD, Galema Mountain is the source of many streams and rivers. Ketar, Ashebeka, Aleltu, Dosh, and Walkesa are the primary permanent rivers that spring from the Galema Mountains and flow to Lake Ziway. The quantity of these river flows has greatly decreased and has become seasonal, according to participants in the FGD. The elderly in particular emphasized that the rivers used to run in huge quantities and without interruption throughout the year, but that now the rivers' flows are dependent on seasonal rainfall. That is, river flows are better in the summer, but significantly reduced or completely dry in the winter.

The two components of stream flow are surface runoff and groundwater flow. Surface runoff is mostly influenced by rainfall, whereas groundwater flow is influenced by infiltrating water. During the rainy months, however, stream flow is primarily from surface runoff, whereas during the dry months, stream flow is primarily from ground water. LU and LC type can influence both infiltration and runoff amounts by following the falling of precipitation.

According to key informants and focus group talks, the main contributing factor to the reduction or drying of rivers and streams in the research region is the change in land use and land cover of Galema Mountain, particularly the conversion of forest to agriculture and other land uses.

4.4.4. Change of local climate

Local climate change is seen in the research area, according to participants in FGD. Despite the fact that worldwide climate change has an impact on regional and local climate change, it is clear that changes in LC in a given area at the local level contribute to local, regional, and worldwide climate change (Gregg Marland, 2003 cited in Nestanet, 2007).

Participants in the focus group discussion, particularly the seniors, provided firsthand proof of climate change by comparing current conditions to those in the past. According to them, the agro-climatic zone that they saw in the recent past was largely cold (Worch) and temperate (dega), but that it is now transitioning to warm (Woina dega) and hot and desert type (Kola). The reason for their response is because before thirty years ago, farmers in the research area primarily sowed cold temperature cereal crops such as barely, bean and wheat, because the area is more conducive to the aforementioned cool temperature crops.

Whereas before, hot-temperature crops were only grown infrequently, hot-temperature crops such as maize are now widely grown in the study. This indicated that the temperature has risen. Furthermore, the majority of sample household participants (90%) stated that the local temperature in the research area has increased somewhat, while the remaining (10%) stated that it has increased significantly.

Table 4.9: Trend of temperature in the study area

Increasing temperature	Frequency	Percent
Severely	5	10
Moderately	45	90
Total	50	100

Field survey, (February 2021)

4.4.5. Scarcity of wood increased

One of the immediate implications of LULCC in the research area, notably growth of agricultural land at the expense of forest land, according to the respondent, is a lack of fuel wood and construction materials for the local community.

The responder also mentioned that scarcity of fuel wood leads to a rise in fuel wood prices in both the research area and nearby Asela town. The reason for the increase in price of this commodity is that, in the previous three decades, fuel wood was taken from nearby forests, but now that fuel wood is located far away from our village, it takes longer to obtain it. According to the local community, a load of donkey firewood cost less than sixty 60birr years ago, but now costs more over 200 birr. This situation forces fanner to cook and heat with crop leftovers and organic compost more frequently.

Furthermore, the scarcity of firewood, prices have been steadily rising, putting further strain on household budgets. As a result, animal dung and agricultural wastes are increasingly being used to meet domestic energy needs, but these materials must be returned to the land in order to maintain soil fertility.

Table 4.10: Source of energy for house hold 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

Field survey, (February 2021).

4.4.6. Increased Shortage of water

The flow of rivers and streams has slowed or dried up altogether as a result of LULCC, particularly the conversion of forest area to other LU. The loss of water sources impacts a huge number of people living upstream as well as others living downstream who rely on the water for domestic and agricultural purposes. The loss of a water source in the study region has a variety of effects on local residents. According to the results of a FGD in Jemo kebeke, irrigation was available in their area a few years ago because they had enough water from the Gurach river, but the river flow is now much reduced, and it is also dry during the winter

During the field survey, the study observed a constructed canal on the Ashebeka River through which water flows from the river to the Asella town for drinking water; We were unable to obtain water for irrigation. Furthermore, there is no fair water allocation rural farmers.

4.5. Predict LULCC of the study

Forest land, grassland, crop land, Wet land and shrub land will cover 844.84 ha (8.76%), 1248.97 ha (12.95%), 6813.25 ha (70.63%), 684.63 ha (7.1%), 55.03 (0.57%) respectively. This means that by 2051 forest, grassland and Shrub land will cover less than half of the research area (22.2836%.). When compared to the first year of coverage (1991), this is down by around 51.36%.

The LULCC in the future time period can be recognized. As a result, in 2051, crop land is expected to rise by 45.47%, while Forest land, grassland, and shrub land are expected to decrease by (30.68 %), (7.94 %), (12.65 %), and (7.1 %),respectively, as compared to the base year of 1991.

Crop land expansion will mostly come at the expense of shrub land, forest, and grass land. This is because, as shown LULCC detection on 2051 these LULC groups have a high probability of changing to Crop land. In 2051, we estimate 30.68 percent of Forest and 7.94 percent of Grass land to loose or shift to other LULC, as shown in the table maps. This means that Forest and Grass land will suffer net losses of 30.68 % and 2%,7.94 respectively show figure 4.18 and 4.19.

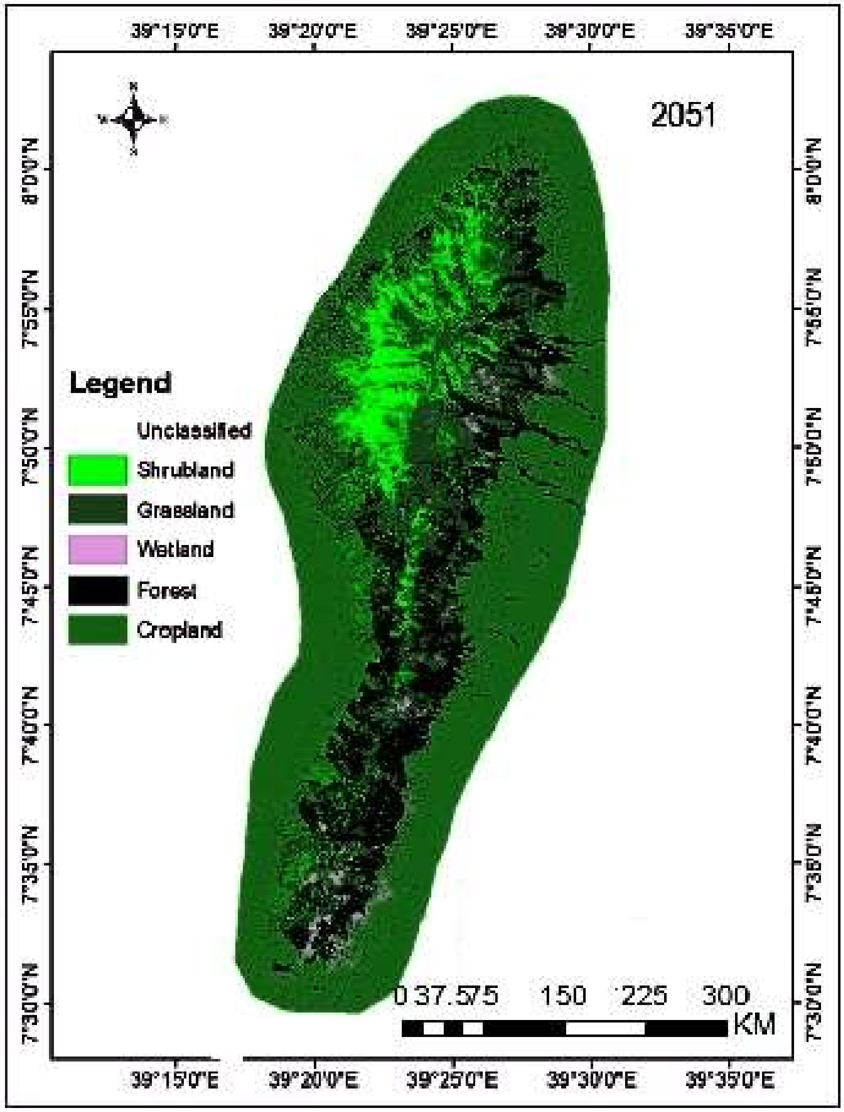

Figure 4.18: Prediction of LU/LCC map

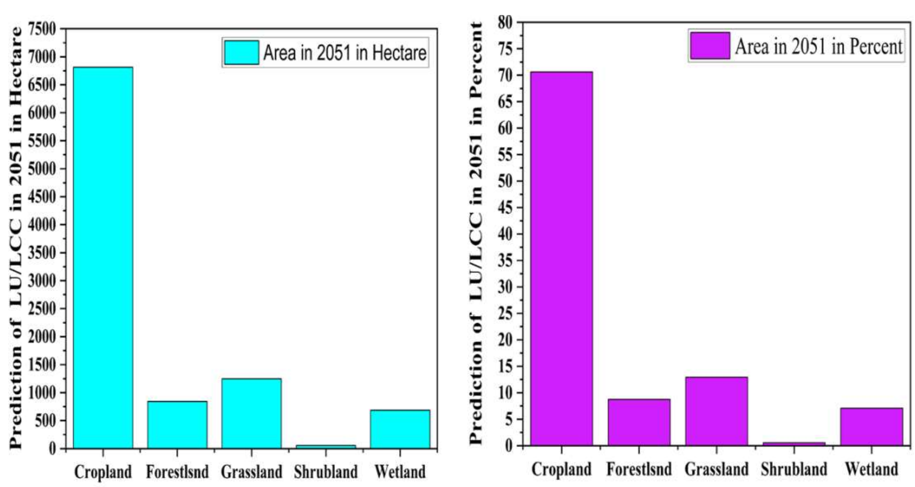

Figure 4.19: Prediction of LU/LCC chart in Hectare and percent.

CHAPTER FIVE V:

CONCLUSIONS AND RECOMMENDATION

5.1. Conclusions

This research is intended to investigate the detection of LULCC on Galema Mountain and its surroundings, the causes of the change, and the impact of LULCC on biophysical resources and the local community.

In order to analyze the LULCC, successive satellite photos proved to be important sources of information for the investigation. The study used GIS technologies and RS data in conjunction with field observations to investigate the LULC changes in the studied area.

Five distinct LULC types were detected in satellite pictures of Galema Mountain and its surroundings taken in 1991, 2001, 2011, and 2021. Forest, shrub land, grassland, cropland, and bare land were among them.

The LULCC detection analysis demonstrated that there are significant changes in spatial and area coverage across different LULC classes/categories throughout the three comparison periods, namely (1991–2001), (2001–2011), and (2011–2021).

According to the results of LULCC detection, crops and wetlands increased continuously during the three comparison periods, namely (1991–2001), (2001–2011), and (2011–2021), 305.24 ha (3.17 percent), 1399.71ha (14.51 percent), 187.95ha (1.95 percent) and 88.52 ha (0.92 percent), 53.11ha (0.55 percent), and 138.5ha (1.43 percent), respectively. Grassland and shrub land, on the other hand, decreased continuously over the three years by 217.45 ha (2.26 percent), 68.95 ha (1 percent), and 12.76ha (0.71 percent), and 141.14ha (1.46 percent), 65.05ha (0.68 percent), and 12.76ha (404.02 percent).

Forest LU and LC showed change through time, which means they may have grown in one period and reduced in the next. 1991-2001 and 2001-2011, but increased by 35.17 ha (0.37 percent), 1291.18 ha (14%), and 146.51 ha (1.52 percent) from 2011 to 2021.

The causes of Galema Mountain's and its surrounding of LCC reveal that numerous interconnected complex processes are involved; among the factors influencing the research area's LU and LCC. The majority of them are triggered by human activity, which is to blame for the huge change of forest land cover into other LC and LU units.

Deforestation and agricultural expansion are the primary immediate and proximate sources of LULCC in the studied area. On the other hand, the study highlighted the following underlying factors of LULCC: population growth, scarcity of farm land, scarcity of grazing land, demand for wood, poor reliance on forest as a source of income, tenure system, inadequate governance, and fire hazard.

The findings of this research also bare that changes in LULC on Galema Mountain and its surroundings have an impact on biophysical resources as well as the livelihood of the population in the studied region. The biophysical impacts observed through the field survey and observations include biodiversity loss, land degradation (loss of soil fertility, gully formation, vegetation distraction), stream and river decline or drying up. Furthermore, the research site's LULCC has an impact on the local population by increasing: scarcity of wood and scarcity of water.

5.2 Recommendations

- **Agro-forestry:** The shortage of farmland, grazing land, and the need for wood are the key factors influencing the study area's LULC. As a result of agro-forestry practice, they will be able to meet demand for wood, food, and fodder products, lowering competition for this limited resource. Agro-forestry practices can also help to alleviate soil erosion and land degradation, thus reducing reliance on chemical fertilizers. As a result, interested bodies should work to increase the local community's knowledge and awareness of agro forestry.
- **A forestation and reforestation:** A forestation and reforestation are critical for restoring the degraded areas of the research area.
- Due to a lack of option fuel sources, local communities in the research area are expanding deforestation and burning of dung and crop leftovers. To decrease dependence on wood, crop remains, and dung cake energy, alternative energy sources and improved stoves, such as the improved biomass fuel-saving stove, biogas, solar energy, and electricity, should be developed.
- Creating off-fan job opportunities: When people lack access to alternative sources of livelihood, they tend to put more pressure on the few resources that are available to them. As a result, landowners, poor people who rely on the forest for a living, and youths should be involved in other jobs such as tourism service provision, weaving, poultry, beekeeping, and agro-forestry.

- Enhancing or strengthening the management of forests on Galem Mountain is highly important in order to safeguard the research area from further degradation and promote sustainable use of the resources, and this will be effective through the collaboration of all districts that are situated along the mountain's boundary.
- The most major tourist attraction locations are Galema Mountain with its available forests and fauna, the stunning landscape panorama with its ideal climatic conditions and accessibility, and the rich cultural heritage and customs. Thus, in order to enhance the tourism economy of the study region and attract tourists, the concerned authorities must promote it.
- Because the Galema Mountain is home to a rich flora and fauna as well as endemic species, it should be designated as a national park.
- Finally, this research suggests that the research area requires greater research, so new research should be conducted in the research area, particularly on the impacts of LULCC and the transition of land cover "from-to."
- To solve problem by using new technology that is GIS and RS to minimize deforestation by few capital and energy the research area an d other.
- The use of high resolution imageries such as IKONOS and Quick Bird are important in generating good quality of land cover maps. Because the areas have complex and heterogonous features, high resolution imagery provides better information by mapping these areas. Moreover, the use of ancillary data as ground truth helps for better accuracy of an image classification.
- Consistent multi-temporal Land sat data for each year provides detail comparison of images, change analysis and modeling. Especially for Markov chain method, it is a requirement of equal interval of images acquisition although there have been uneven temporal availability of data.

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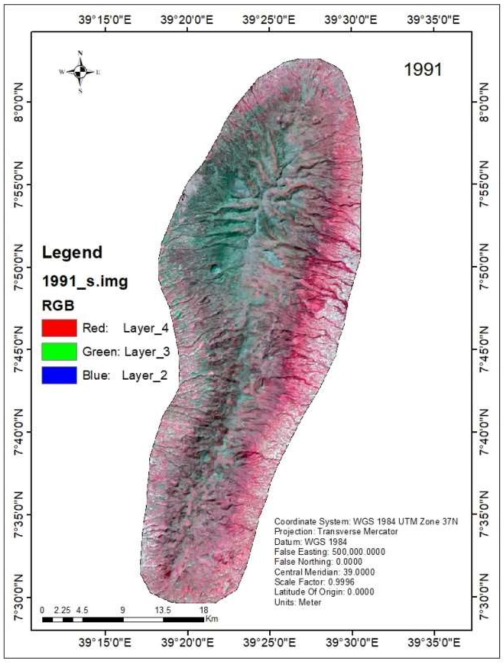
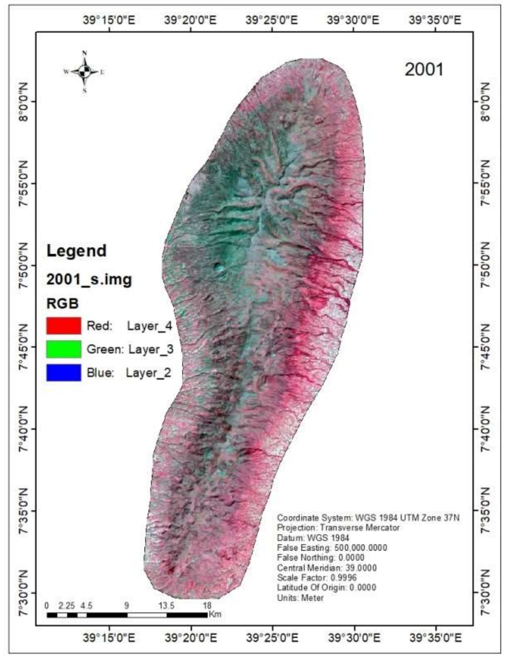
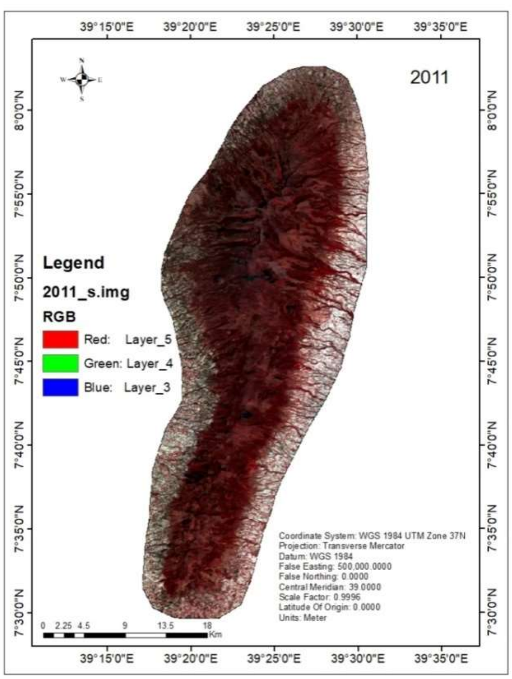
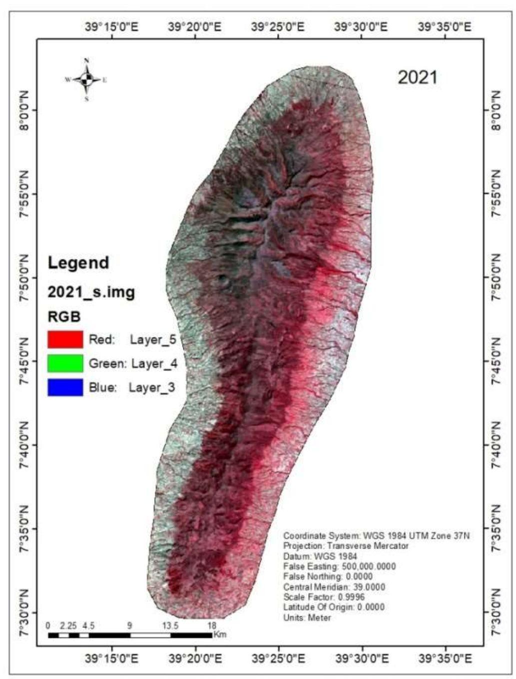
APPENDICES

Appendix 1: Band composite









Appendix: 2. Checklist for Focus Group Discussion (FDG) and Key Informant Interview (KII)

1. Checklist for Focus Group Discussion (FDG)

Administrative Unit: Region:__________, Zone:_________, Wereda: __________

Name of Rural Kebele____

Village Name ____

No. of participants____

Date ____

1. Focus Group Discussion (FDG)

1. What are the direct/proximate drivers of LULCC over the last 30 years, between 1991 -2001, 2001 - 2011 and 2011- 2021? (Options provided: forest encroachment, overgrazing, agricultural expansion, occurrence of fire and unsustainable harvest of forest products (like firewood, charcoal, logging)
2. Which land cover is highly affected by each proximate (direct) drivers of LULCC?
3. What are the underlining causes along each proximate driver?

2. Checklist for Key Informant Interview (KII)

1. Have you noted any change in the LULC in your area over the past 30 years?
   A) yes
   B) No
2. If your answer to question number 1 is yes, what changes did you observed?Increase/decrease in:

A) Agricultural land

B) Forest cover

C) Woodland

D) Bush/shrub lands

E) Grassland

3. What are the causes behind their increase/decrease?

I. Direct causes

II. Indirect (root) causes

4. Participation of the local communities, government and non-government organizations in resource conservation and management activities and how they are participating?
5. What do you think the cause for population dynamics in your area?

7. What major natural calamities occurred in your area in the last 30 years?

10. What are the main economic activities for the local communities in your area before30 years, 20 years and 10 years?

Appendix: 3. Field Observation Sheet Format

Field Observation Sheet					
Observers Name			Date and Time		
Sample ID	Location	Position	Altitude (m)	Photo taken	LU/LC type
	Region__________	Lat. (X)_______	Alt. (Z)____	_________jpeg	
	Zone___________	Long. (y)_____			
	Wereda_________				
	Kebele__________				