COLLEGE OF SOCIAL SCIENCE AND HUMANITIES DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

DETECTION AND PROJECTION OF LAND USE LAND COVER CHANGE USING GIS AND REMOTE SENSING TECHNIQUES IN SHASHOGO WOREDA, HADIYA ZONE, SNNPR, ETHIOPIA

A THESIS SUBMITTED TO
THE SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF MASTER OF SCIENCE IN GEOGRAPHIC INFORMATION SYSTEM AND REMOTE SENSING

BY

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OCTOBER, 2019

JIMMA, ETHIOPIA

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OCTOBER, 2019

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Declaration

I hereby declare that the thesis titled "detection and projection of land use land cover change using GIS and remote sensing techniques in Shashogo woreda, Hadiya zone, SNNPRS, Ethiopia" has been done by me under the supervision of Dr. Ajay Babu and co advising of Ashenif Melese (MSc), Department of Geography and environmental studies, Jimma University, as part of master program. I further declare that this thesis is my original work and has not been presented for any other university or institution for the award of any degree or diploma and that all sources of materials used for the thesis have been dually acknowledged.

Name: Seyum Habte

Signature: _________

Date: _____________

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ACRONYMS

CSA	Central Statistical Agency
DA	Development Agent
DEM	Digital Elevation Model
EMA	Ethiopian Mapping Agency
ERDAS	Earth Resources Data Analysis System
ETM+	Enhanced Thematic Map Plus
FGD	Focus Group Discussions
GIS	Geographic Information System
GLCF:	Global Land Cover Facility
GPS	Global Positioning System
INSA	Information Network Security Agency
KII	Key Informant Interview
LUCC	Land use/Land covers Change
OLI	Operational Land Image GCPs - Ground Control Points
RS	Remote sensing
SNNPR	South Nation Nationality and People Region
SRTM	Shuttle Radar Thematic Mapper
TM	Thematic Mapper
UNFAO	United Nation Food and Agriculture Organization
USGS	United States Geological Survey
WHO	World Health Organization

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Abstract

This study mainly examines detection and projection of Land Use/Land Cover change by using of GIS and Remote Sensing techniques in ShashogoWoreda between 1990 and 2019. In order to achieve these, satellite data of Landsat TM for 1990, ETM+ for 2000 and 2010, and OLI for 2019 have been obtained and preprocessed using ERDAS Imagine.

The Maximum Likelihood Algorithm of Supervised Classification has been used to generate land use and land cover maps. For the accuracy of classified Land Use/Land Cover maps, a confusion matrix was used to derive overall accuracy and results were above the minimum and acceptable threshold level. Post classification comparison change detection method was employed to identify gains and losses between Land Use/Land Cover classes. Additionally, socio-economic assessment was conducted by using KII and FGD to investigate the driving forces of land use land cover change. The study covers a total area of 35,376.6ha. Five land use land cover classes namely; cropland, forest, rangeland, water body and settlement land were clearly identified for the study.

Subsequently, an attempt was made to predict for the next 29 years change based on the observed Land Use/Land Cover changes using Marcov Chain Model. The satellite image results show that during the last three decades, Cropland and settlement lands were increased by 51.5% and 168% while rangeland and forest lands were decreased by 56.2%, and 49.7% respectively. As the study displayed population growth, expansion of agricultural land, demand for fuel wood and construction materials and ineffective natural resource conservation practice were the main causes of LULCC at woreda .Whereas, forest degradation, land degradation, Extinctions of biodiversity (fauna and flora) and climate variability following hydrological impact and shortage of animal feeding were the main impact of land use/ land cover change in study area. Therefore, to solve the LU/LC change; effective and strong natural resource management and utilization policy should be implemented by woreda forest and natural resource office in order to insure the sustainability of natural resources in a way of participating the local community.

Keywords: Land use/Land cover, Change detection, GIS, Remote sensing

CHAPTER ONE

1. INTRODUCTION

1.1 Background of Study

The modification of Earth's terrestrial surface by human activities is commonly known as Land use/land cover change (LULCC) around the globe. Although modification of land by humans to obtain livelihoods and other essentials has been there for thousands of years, the extent, intensity and rate of LULCC are far greater now than were in the past. These changes are driving forces for local, regional and global level unprecedented changes in ecosystems and environmental processes. Thus, LULC changes play an important role in the study and analysis of global changed scenario today as the data available on such changes is essential for providing critical input to decision-making of ecological management and environmental planning for future (Fan et al., 2007).

Change detection has emerged as a significant process in managing and monitoring natural resources and urban development mainly due to provision of quantitative analysis of the spatial distribution of the population of interest. There are a lot of available techniques that serve purpose of detecting and recording differences and might also be attributable to change. Though, simple change detection is seldom adequate in itself: there is a requirement of information regarding initial and final land cover/types/uses, the ‘‘from-to’’ analysis. It is necessary to have accurate and up-to-date land cover change information for understanding and assessment of the environmental consequences of such changes (Giri et al., 2005).

To detect LULC changes Satellite based Remote Sensing and GIS are the most common methods for quantification and mapping of LULCC patterns because of their accurate geo-referencing procedures, digital format suitable for computer processing and repetitive data acquisition (Lu et al., 2004; Chen et al., 2005; Nunez et al., 2008; Rahman et al., 2011). Digital change detection process has been used widely for determination and/or description of the prevalent changes in LULC properties based on multi-temporal remotely sensed data. The basic purpose of using this data for detecting change is its ability to identify uncharacteristic change between two or more dates

In Sub-Saharan countries, due to deforestation LULCC can potentially affect regional and global climates by emitting or sequestering carbon and by altering the overall reflectance properties of the earth’s surface (Houghton and Hackler, 2006). From local to global scales, land resources play critical roles in human livelihoods, as well as in ecosystem functioning and health (Chaudhary et al., 2016). To achieve these, understanding the condition and changes through time of land resources such as forests is important. Accurate information on LULCC is critical for understanding the causes of change and for developing effective policies and strategies to slow land class variability (Kindu et al., 2015; Kibret et al., 2016).

In Ethiopia although Land use land cover change are not a new phenomenon, the speed and scale of the change, irrespective of the efforts done by different stakeholders on conservation actions, has been accelerated in the last 3-4 decades of the 21st century (Hailemariam et al., 2016). This is related to increasing population and the corresponding demand for agricultural land expansion to feed the growing population. Ethiopia resides in the list of African countries that have net loss in forest area and net gain in agricultural area in 2000-2010 (FAO 2016). In the period 2000-2005, Ethiopia’s forest and high woodland areas have changed by -9.4% and -4.3%, respectively (FAO 2010). This is due to natural forests are the main sources of wood for fuel and construction materials in the country.

In short, land use land cover changes can affects the socio-economic and living standard of the rural and urban population. According to Muleta (2009), the most important human factors which were recognized as change agents of land use are the need to supply food for rapidly growing population. This requires something to be brought about the expansion of agricultural land and the provision of land for the landless in order to fulfill self-sufficiency. Consequently, agricultural productivity that determines rural income levels and wealth can be affected by the land use change. The land use change brings tremendous impacts in the agricultural productivity.

The study area/ ShashogoWoreda is one of the exploited and degraded areas due to natural and man-made factors that influencing in land LULCC. In the past thirty years the woreda had been with in a serious problem mostly the south eastern part. There are observable signs which indicate the existence of land degradation due to over ploughing and clearing of forests for different purposes. The rural poor people have been also degrading the natural forest resources to sustain their livelihoods. Because of high population density leading deforestation of forest for housing, expanding of agricultural land and for a fuel production. The ability of the land to give production was becoming low and the peoples had started to abandon their land because it becomes incapable of even to grazing. Because of this information the researcher was facilitated to conduct the research an area. The Studies about rates, causes, and implications of LULC dynamics at study area can helps to design appropriate land management practices, strategies and policies.

1.2 STATEMENT OF THE PROBLEM

Globally, land use land cover change is one of the major causes of global change and affects many parts of global environmental system. In addition, it is problem on biodiversity, land degradation and climatic change. For instance, the number of species and forest coverage is declined from time to time (Zubair, 2006). Global deforestation rate was 3 million hectares yr-1 in 1990-2000, and 6 million hectares yr-1 in 2000-2005 (FAO 2012). This has implications to climate change and variability as well as to land degradation (Stocker and Joos 2015). For instance, deforestation induced an increase in mean temperature and the associated heat extremes and a decline in mean rainfall or rainfall frequency from local to global scales (Lawrence and Vandecar 2015).

Demographic change stimulates structural dynamics through different effect of converting forest into other forms of land cover. These types of conversions are caused by rapid population growth. Due to human activities the extent of land cover changed from dense forest to sparse or totally changed to bare land and decline in productive agricultural lands (Sharma, 2004).

The major causes LU/LC changes in Ethiopia are rapid population increase that serves deforestation, biodiversity loss and land degradation (Maitima et al., 2009). As rightly noted by Abate (2011) it is taken as a serious problem in changing the environment. Similarly, Belay (2002) stated that LU/LC changes towards cultivated land aggravate soil erosion problems unless proper management is undertaken.

This study was mainly conducted to fill the gap of the previous study those are non-Predicting of LULCC and non GIS and remote sensing based Abinate et al., (2011). Some has a limitation of applying Geo-Spatial technology Loppiso (2010). This study is significant to strength the investigation on issues because the problem is still known. It also important to fill the previous knowledge gap and to add critical knowledge through quantifying LULCC with relating some serious events by acquisition of land sat image. It also expands knowledge and initiation about current land use land cover change by quantifying LULCC detection of the location, nature and rate of change by using Geo-spatial technology (GIS and RS) for those environmentalist and others concerned bodies to participate the decision making issues.

ShashogoWoreda was witnessed remarkable LULC change, mainly as a result of deteriorating on agricultural productivity of land. This deterioration of the land is because of the nature of the topography, population size increment, over cultivation and over grazing which enforce the inhabitants to change their land use practice. Also the places are vast agricultural activities practiced and settled by agrarian populations. As a result, land covers, especially forest covers and shrub land covers are highly vulnerable from time to time due to increasing of population number that primarily cause for the expansion of agricultural lands, and charcoal production and to obtain construction materials.

1.3 Objectives of the Study

1.3.1 General Objective:

The general objective of this study was to detect and project LULC changes in ShashogoWoreda by integrating RS and GIS techniques.

1.3.2 Specific objectives

Based on the general objective, this study intends to achieve the following specific objectives.

- To produce LULCC maps of the study area for 1990-2019
- To examine trends and spatial distributions of land use land cover changes in the study area
- To predict the future pattern of land use land cover in the area
- To investigate the Cause and impact of LULCC in the study area

1.4 Research Questions

The following research questions were designed to guide the study:

- What are the LULCC maps of the study area for 1990-2019?
- What is the trend and spatial distribution of LULC class changes during the study period?
- What is the future pattern of land use land cover in the area?
- What are the major causes and impact of the LULCC in study area?

1.5 Ethical Consideration

In the case of ethical consideration the spatial scientists must make every effort to closely follow any guidelines established for human subjects' research, and beyond to these every effort to ensure the dignity and welfare of human participants in spatial science research. The researcher availed himself as one member of a society and recognized the value and norms of participants. To work with the experts of study woreda researcher explained an objective of research and agreed up on. This increased their participation and trust in the study.

1.6 Significance of the study

The research output was used to support decision making at the woreda level for sustainable land use/land cover management hence data on land use change are of great importance to planners in monitoring land use/land cover change. Such data has a value to resource managers that plan and assess land use/land cover patterns by giving tangible information about the land use/land cover changes in the woreda in the last 29 years and enable to guess the future of that woreda if things will not be changed.

1.7 Scope of the study

The scope of this study was delimited both in geographical area and issue of concern. Geographically, it was delimited to ShashogoWoreda, which is one of the Woreda's in Hadiya Zone of the SNNPRS. Regarding the issue of concern, the main focus of the study was detection and projection of LULC change in the Woreda.

1.8 Limitation of the study

Detecting land use land cover changes requires considering of the socio economic data, but assessing all these data requires more time and cost. Due to restricted finance and time the constraint was occurred during implementation of the study. In specifically arising from data collection problems like, unwillingness of some key informants in giving permission and lack of organized document about LULCC in study area. The other one was the problem of satellite image accessibility, quality and resolution. In this study the searcher doesn't used the high resolution satellite images because of expensiveness of the images, but as a solution the Landsat serious used according freeness of data. To restrict the limitation different data confirmation and validation methods were employed at some extent.

1.9 Organization of the study

This thesis was organized in to five chapters. The first chapter deals with the introduction part of the paper, the second chapter focuses on review of related literature, the third chapter materials and methods, the chapter four deals about result and discussion, and chapter five was deals about the overall conclusion and recommendation of the thesis.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 The Concept and Definition of Land Use and Land Cover

Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures. Land use is a more complicated term. Natural scientists define land use in terms of syndromes of human activities such as agriculture, forestry and building construction that alter land surface processes including biogeochemistry, hydrology and bio diversity. Social scientists and land managers define land use more broadly to include the social and economic purposes and contexts for and within which lands are managed (or left unmanaged), such as subsistence versus commercial agriculture, rented vs. owned, or private vs. public land. While land cover may be observed directly in the field or by remote sensing, observations of land use and its changes generally require the integration of natural and social scientific methods (expert knowledge, interviews with land managers) to determine which human activities are occurring in different parts of the landscape, even when land cover appears to be the same (Ellis, 2007).

Moreover, Land cover depicts original and introduced vegetation cover, rocks, sand and other surface and human induced structure that are seen on the surface of the earth. Land use shows a multitude of activities carried by human beings with the motive of setting products and benefits from land resources like soil and vegetation cover De Bie, et al (1996) cited in Tulu (2017). It is a common understanding that land use affects land cover in different ways. Hence, land cover change is the conversion of the land surface for different purposes Lemlem (2007). The rapid increase in population size and the booming socio economic needs create a pressure on land use and land cover. Furthermore, the pressure resulted in unplanned and uncontrolled changes in LULC (Seto, 2002).

The LULC conversion are mainly the outcome of improper use of agricultural, urban, range and forest lands that can in turn result harsh environmental problems like land degradation and flooding, etc. different land types do have various land covers for unique purpose. LULC are different but they are closely interdependent features of earth’s surface. Land use includes grazing, agriculture, urban development, forestry and mining. According to Meyer (1995) cited in Tulu (2017)the word land cover basically refers to the type and level of plant cover like forest or grass and it further stretches to human made structures like building, roads and so forth. As Riebsame et al, (1994) state land use affects land cover and changes in land cover affects land use. Conversion of land cover through land use processes cannot necessarily reflect land degradation. Yet, several land use practices motivated by social reasons resulted in bringing about land cover changes that negatively affects bio diversity, water resources, climate, the atmosphere and other natural set up of the land.

2.2 Causes of Land Cover Dynamics

There are two main causes for LU land cover dynamics all over the world. These are natural causes and anthropogenic causes (Prakasam 2010). Natural causes include atmospheric change, glaciations, tsunamis and fires. On the other hand, an anthropogenic cause which is the main driver of land cover change includes population growth, infrastructure development, deforestation, urban sprawl, and expansion of agriculture land. Hence, human beings are the major contributors to land cover changes and more rapidly affecting the livelihoods of societies. In Ethiopia, inappropriate agricultural practices, deforestation and overgrazing are affecting the rural poor population. This alteration of ecosystem is due to changes in LC and negatively affects the ability of the biological systems to support the human need (McClelland, 1998).

2.2.1 Population Pressure

The impact of rapid population growth on the land use- land cover change is one of the most widely accepted factors among intellectuals. For instance, Tulu (2017) citing Turner and Meyer (1994) fast population growth, distribution and the resultant demographic changes are taken as the key elements that are responsible for land use- land cover change. Solomon (2016) clarifies the case in point starting that when population booms the demand for farming land, pasture land, fire wood, and settlement and consequently increases. Moreover, spatial and demographic changes in Ethiopia cause a severe effect on the farm lands and land cover of an area (Kebrom, 1999 cited in Solomon on 2016). On the top that Kinfe (2011) referring Erle(2007) states that although humans have been using the land for food and non-food products, the present need and demand level and intensities of land use- land cover changes are much greater than any human history in the world highly affecting ecosystem and environmental resources at local, regional and global scales. Furthermore, Ebrahim and Mohammed (2017) high light that population increase poses a formidable impact on land resources due to the rising need for agricultural lands, settlements, energy consumption and building materials.

2.2.2 Expansion of Agricultural Land

Human environment interaction is continual at different spatial and temporal scale due to different social and bio-physical changes occurring across a sequence of time. This is due to human’s extraction of goods to satisfy their needs which cannot be fulfilled without the conversion of land covers. Now days, the impact of human activities on land has grown enormously because of population increase, technological development, economic factors and cultural factors altering entire landscapes, and ultimately impacting the biodiversity, soil and climate, especially in the developing world. Thus, simple land cover modification grown into overall complicated land cover conversion that cause a significant impact on land capacity at local and global level to support the whole ecosystem.

Human beings have increased agricultural production mainly by expansion of farm lands. Consequently agricultural lands has expanded into forests, woodland, shrub land and grass land in all parts of the world to meet the demand for their basic need of household (Sherbinin, 2002). According to FAO (2010) estimation, Ethiopia lost 13 million hectares of forest per year during the 1990s and 1.4 million hectares lost per year between 1990 and 1997. The annual rate of net cover change in tropical forest was 0.43 % during that period. Similarly, FAO (2012) has indicated a net decrease in global forest area of 1.7% between 1990 and 2005 at an annual rate of change 0.11%. This shows an annual shift from forest land cover to other land cover of 3 million hectares per year 1990 2000 and of 6 million hectares per year between 2000 and 2005. In contrast, the area of agricultural land has increased globally from an estimated 300-400 million hectare in 1700 to 1500-1800 million hectare in 1990, 4.5 -5.0 increase in the Centuries and a 50% net increase just in the 20th Century (Lepers et al., 2003).The increase in agricultural land led to the clearing of forest and transformation of wood land, shrub land and grass land to agricultural land.

Several researches in Ethiopian highland showed that agricultural and settlement land have increased rapidly at the expense of forest land, wood land and grass lands. The fact that human beings are the major contributors to land cover change and are the ones experiencing the consequences of these changes. Land cover dynamics has gone under continuous change for a long period of time because of humans' production demands (Sherbinin, 2002).

2.2.3 Demand for Fuel Wood and Construction Materials

Deforestation is the outcome of forest resources to a different type of land cover or when the remaining tree cover drops below a minimum threshold of 10% according to the UN- Food and Agriculture Organization (FAO) (Lambin, et.al 2003). The causes for forest loss vary from area to area. For instance, in Latin America, it is the high level of forest processing and pasture for grazing animals that are the main reasons, while crop production by small scale holder is the great concern in Africa. In line with this, Warra, et.al(2013) portray about 73.3% of sample households in Kasso catchment in Bale

Mountain rely on wood for cooking, heating and light and consequent loss of original forests and the conversion of forest lands in to crop, settlement and grass lands. A higher figure is seen in the Gumera watershed of Lake Tana basin by Wubie, et al (2016) represents that about 80% of the sample households depend on wood as a sorts of all energy. Both studies express that wood is the source of energy for nearby urban areas and the means of generating income for the rural households.

2.2.4 Deforestation

Forest is the life bearer and conserver for flora and fauna including human beings. According to Sherem(1993) as cited in Tulu(2017) the forest-which covers almost one third of the land surface of earth- render various environmental advantages like soil conservation, prevention of climatic change and biodiversity and balances hydrologic cycle. However, due to economic and social changes the interaction between human and forest has changed through time in the world (FAO, 2012).

Of the sub-Saharan African countries Ethiopia is the country in which deforestation problem is highly intensified. "In the late 19th century about 40% of Ethiopia was covered with forests"(Teshome, 2012). However, due to population growth, demand for construction materials and fire wood, to generate income and expansion of farm lands forest lands coverage is mitigated in the country. According to Birhan (2007: 10). Large forests have been transformed for farm and settlement developments. This shows that people have assumed that rich vegetation is a sign of the fertile soils that lie under the forest, and this has led to rapid forest clearance for agriculture as well as timber supply.

2.2.5 Institutional Factors

The understanding of institutional causes (i.e. political, legal, economic, and traditional) and their interaction with individual decision making are important in explaining land use changes. Institutional causes need to be considered at micro and macro levels because the implementation of macro policies is practiced at the local level. Land-use and land-cover changes are influenced significantly when macro policies undermine local policies in that the structure of local and national polices may determine local people's access to land, capital, technology, and information (Lambin and Geist, 2003) as cited in Bireda(2015).

Lack of well-defined policies and weak institutional enforcement may facilitate changes of land use. On the other hand, restoration of land use is possible if there are appropriate land use policies in place. In most developing countries communal (traditional) land holding systems have been shifted to a formal (state) holding system The policy in developing countries of price control on agricultural in-put and out-put and self-sufficiency in food have all influenced land use changes(Lambinet al., 2003).

2.3 The Impacts of Land Cover Dynamics

2.3.1 Biodiversity losses

Biodiversity is often reduced dramatically by LULCC. When land is transformed from a primary forest t o a farm,the loss of forest species within deforested areas is immediate and complete. Even when unacco mpanied byapparent changes in land cover, similar effects are observed whenever relatively undisturbed lands aretransformed to more intensive uses, including livestock grazing, selective tree harvest and even fire prevention.The habitat suitability of forests and other ecosystems surrounding those under intensive use are also impactedby the fragmenting of existing habitat into smaller pieces (habitat fragmentation), which exposes forest edges toexternal influences and decreases core habitat area. Smaller habitat areas g enerally support fewer species(island biogeography), and for species requiring undisturbed core habitat, fragmentation can cause local andeven general extinction. Research also demonstrates that species invas ions by non-native plants, animal's anddiseases may occur more readily in areas exposed by LULCC, es pecially in proximity to human settlements (Ellis and Robert, 2007).

2.3.2 Climate Change

LULCC plays a major role in climate change at global, regional and local scales. At global scale, LULC C isresponsible for releasing greenhouse gases to the atmosphere, thereby driving global warming. LUL CC canincrease the release of carbon dioxide to the atmosphere by disturbance of terrestrial soils and ve getation,

andthe major driver of this change is deforestation, especially when followed by agriculture, which caus es the furtherrelease of soil carbon in response to disturbance by tillage. Changes in land use and land co ver are also behindmajor changes in terrestrial emissions of other greenhouse gases, especially methane (altered surfacehydrology: wetland drainage and rice paddies; cattle grazing), and nitrous oxide (agricult ure: input of inorganicnitrogen fertilizers; irrigation; cultivation of nitrogen fixing plants; biomass comb ustion).Though LULCC certainly plays a critical role in greenhouse gas emissions, the complexity and d ynamic interplayof land use processes favoring net accumulation versus net release of carbon dioxide an d other greenhousegases makes it a poorly constrained component of our global budgets for these gases; an active area of current research (Ellis, 2007).

A further source of uncertainty in estimating the climate change caused by LULCC is the release ofsulf ur dioxide and particulates by biomass combustion associated with agriculture, land clearing and human settlements. These emissions are believed to cause regional and global cooling by the reflection of sunlig ht fromparticulates and aerosols, and by their effects on cloud cover.Land cover changes that alter the re flection of sunlight from land surfaces (albedo) are another major driver ofglobal climate change. The pr ecise contribution of this effect to global climate change remains a controversialbut growing concern. Th e impact of albedo changes on regional and local climates is also an active area ofresearch, especially ch anges in climate in response to changes in cover by dense vegetation and builtstructures. These changes alter surface heat balance not only by changing surface albedo, but also by alteringevaporative heat trans fer caused by evapotranspiration from vegetation (highest in closed canopy forest), andby changes in sur face roughness, which alter heat transfer between the relatively stagnant layer of air at Earth'ssurface (th e boundary layer) and the troposphere. An example of this is the warmer temperatures observedwithin ur ban areas versus rural areas, known as the urban heat island effect (.Robert, 2007).

2.3.3 Soil Degradation and Erosion

The removal of original cover of land without taking any mitigation measures results in the physical, chemical and biological loss of soil. The loss of the natural land cover the land, the steepness of the slope, and bad farming practices all together exacerbate the erosion of the soil (Wubie, et al, 2016). Furthermore, as Warra, et al, (2013) point out the removal of land cover accelerates run off and soil erosion along steep slopes, formation of gullies in many cultivated. And grass lands around the hills and water logging in plain areas. On the top that Wubie, et al(2016) indicate that in the lower areas of gentle slopes, the gullies get narrower and smaller in depth due to the accumulation of sediments transported from higher grounds. Moreover, the deposition of sediments and water logging particularly in the rainy season and soil depletion due to over cultivation are the most identified agricultural difficulties in the plain areas. According to Warra et al (2013), the removal of original forests to agricultural production results in reduction of soil organic nutrients, carbon and drastic change in soil structure.

2.3.4 Hydrological Effects

The hydrological cycle is closely interrelated with the biochemical cycles. Different researchers show that land use changes like a forestation, reforestation, change of forested to agricultural lands the conversion of grass lands by trees, drought and increasing urbanization affect surface and sub-surface hydrology of river basins at local and regional levels(Tayler,1977; Bannister, 1979) cited in Tulu, (2017). Change in the hydrological cycle of a river basin can result in variation in the rate of flooding and its amount, reduction or increase in basin yield and ground water recharge (run off), the decrease in the water quality with increase in sediment transportation and soil erosion(Walkinson,1992) cited in Tulu,(2017). Moreover, Batra,et al (2007) state that land use land cover change highly affects the hydrological condition of the watersheds, water resources and the environment at small and large scales. Furthermore, according to Warra et al, (2013) human activities like deforestation and intensive cultivation can decrease the amount of water that percolate into the ground and recharges streams, springs and underground water. The same authors point out that the reduction of the volume of locally available streams and rivers through time in the kasso catchment area of Bale Mountain. The drying up of several springs and streams is reported by the authors affecting the socio- economic life of farmers in the area.

2.4 Application of Remote Sensing and GIS on Land Cover Dynamics

Remote sensing is a science and art of obtaining information about an object or phenomenon without any physical contact with the object and thus in contrast to site observation. It is defined as the use of electromagnetic radiation sensor to record images of the environment which can be interpreted to yield useful information while GIS is a computer based system which used to capture, manage, analysis and interpret data in land cover dynamics study (Samuel et al., 2009).Relating the quantitative remote sensing data with social science analysis and socializing the pixels is the main challenge in land use land cover change studies. But GIS enable us to understand the determinants of land use land cover change and to understand the cause-effect relationship between the change and the driving forces of the change (Mugagga, 2011). GIS data bases are used to improve the extraction of relevant information from remote sensing imagery, where as remote sensing data provide periodic pictures of geometric and thematic characteristics of terrain objects, improving our ability to detect changes and update GIS data bases. Satellite imagery provides a good source of data for performing structural studies of land space. Simple measurements of pattern such as the number, size and shape of patches can indicate more about the functionality of land cover type than the total area of cover alone (Janssen,1993).

2.5 Land cover and land use classes and its definitions

Mostly common Land use and land cover classes are, Agricultural land, Settlement, Forest, Grazing land and water body those were identified and the description of each land use and land cover type was given based on FAO (2010).

Table 1: Description of Land use and land cover classes

LULC categories	Land use/cover description
Crop land	It is the land cover under the crop cultivation of annual crops. Scattered settlements surrounded by agricultural lands are classified as agricultural lands, since the low spatial resolution land sat imagery fails to separate the scattered rural settlements with agricultural lands
Settlement	Small rural communities and other built up area
Forest	Land covered with trees reaching 5 m in height, 0.5 ha in area and a canopy cover of >10% without other land use. It also includes the area of land covered with sparsely populated forest, riverine trees and artificially planted indigenous and nonindigenous groups of trees like eucalyptus globules (Nech Bahiezaf), Eucalptus Comanduleses (Key Bahirzaf), Eucalyptus Saligna (Girar Bahirzaf), Cordia Africana (Wanza), Sasbania Sesban (Yemeno Zaf), etc
Rangeland	It is the area covered with both communal and private pasture lands which Retain the grass cover for a year and above. Here it is most time includes grasslands, shrub lands, woodlands,wetlands,desert that are grazed by domestic livestock or wild animals.
Water body	All water bodies including freshwater lakes, rivers, and streams, ponds as well as marine water environments.

2.6 Integration of Remote Sensing and GIS in Digital Change Detection

Integration of GIS and remote sensing technologies can be used to develop decision support systems for planners and decision makers. Remote sensing is a raster based data collection and analysis system; while GIS is vector data based system even though raster based GIS data also exist. The different sectors such as urban planning, natural resource management, forestry, agriculture sector and environmental management needs spatial data tools to work efficiently and effectively (Reddy, 2008).

These days' great improvements have been made in the integration of remote sensing and GIS. Advanced computer hardware & software have permitted the expansion of current GIS and remote sensing capabilities in dealing with data structure conversion. The main important area of GIS integration with remote sensing lies in combining vector information in image classification for the selection of training areas. The integrated system is able to perform a raster-vector intersection query (Yeung, 2003). This is used to find which pixel fall within which polygon, given an image polygon file, without the need of data format conversion. To be valued in GIS environment, remote sensing data need to be digital in format (Reddy, 2008).Remote sensing images and information extracted from these image together with GPS data are the main data source of modern GIS. The combination of these fields will continue to transform the quantification and monitoring of land cover changes. From remote sensing data there are two methods of data extractions for GIS input. These are computer processing of remotely sensed digital images and visual interpretation of satellite imageries in pictorial format.

The output of both analysis methods provide data input for GIS that used to any applications. A fully integrated system requires two way flows of data between vector data sets and raster images. Image statistics within a polygon are generated and then returned directly to the GIS data base as attribute of the polygon.

2.7 Change Detection Analysis

Change detection can be defined as the process of identifying differences in the state of object or phenomena by observing them at different times by using remote sensing techniques. Essentially, it also involves the ability to quantify temporal applications of remotely-sensed data obtained from Earth-orbiting satellites There are four aspects of change detection which are important when monitoring natural resources such as detecting the changes that have occurred, identifying the nature of the change, measuring the area extent of the change and assessing the spatial pattern of the change (Singh, 1989).

Change detection has a wide range of applications in different disciplines such as land use change analysis, forest management, vegetation phenology, seasonal changes in pasture production, risk assessment and other environmental changes (Singh, 1989). The main objective of change detection is to compare spatial representation of two points in time frame by controlling all the variances due to differences in non-target variables and to quantify the changes due to differences in the variables of interest (Lu et al, 2004). A change detection research to be good, it should provide the following vital information: area change and rate of changes, spatial distribution of changed types, change trajectories of land-cover types and accuracy assessment of change detection results. Quantifying land use and land cover changes and applying suitable change detection methods highly depend on the type of changes that happened in landscapes and how those changes are noticeable in images. The changes could be continuous or categorical. According to Abuelgasimet al., (1999), change detection in continuous land cover changes focuses on measuring the degree of changes in amount or concentration through time.

However, in the case of categorical land cover changes, the goal of change detection is to identify new land cover classes and changes between classes through time.

2.8 Marcov Chain Model

Markov chain models are relatively simple and more powerful to model complex processes and changes in land use for planning purposes. They provide better information for analyzing time series of system evolution (Levinson and Chen, 2005). A Markovian process is one in which the state of a system at time t2 can be predicted by the state of the system at time t1given a matrix of transition probabilities from each cover class to every other cover class.

A stationary property is one of the importances of this model since it integrates a transition probability matrix. This property is critical to Markov chain model especially for future predictions of land use. The stationary of the transition matrix in turn helps to inspect the validity of the model (Iaconoet al., 2012). The Marcov module in IDRISI can be used to create such a transition probability matrix (Eastman, 1995).

Markov Chain model to be considered as a system, it has to satisfy the following properties:

- The sum of the rows of the probability matrix must be one
- The probabilities of the transition matrix must be the same for any two periods (time homogeneous).
- Probabilities have no memory, that is, the state tomorrow depends only on the state today (the Markov condition)
- Time periods must be uniform in length or duration.

Markov chain model has a good quality of simplicity. It can also describe complex and long-term process of land use conversion in terms of simple transition probabilities. The advantages of Markov chain model may be summarized as follows.

i. Markov models are relatively easy to derive (or infer) from successional data.

ii. The Markov model does not require deep insight into the mechanisms of dynamic change, but it can help to indicate areas where such insight would be valuable and hence act as both a guide and stimulant to further research.

iii. The basic transition matrix summarizes the essential parameters of dynamic change in a way that is achieved by very few other types of model.

iv. The results of the analysis of Markov models are readily adaptable to graphical presentation and, in this form, are frequently more readily presented to, and understood by, resource managers and decision makers.

v. The computational requirements of Markov models are modest, and can easily be met by small computers, or, for small numbers of states, by simple calculators.

The disadvantages of Markov chain model are also summarized as follows.

i. The lack of dependence on functional mechanisms reduces their appeal to the functionally orientated ecologist.

ii. Departure from the simple assumptions of stationary, first-order Markov chains while, conceptually possible, makes for disproportionate degrees of difficulty in analysis and computation.

iii. In some areas, the data available will be insufficient to estimate reliable probability or transfer rates, especially for rare transitions. For example, it may not be possible to observe sufficient transitions from a given transient set of states to a closed state where this transition is dependent on a rare climatic event, even though the value of this parameter is of vital importance in the dynamics of the community.

3. Land use/Land cover change in Ethiopia

In Ethiopia, the availability of natural resources as well as their dynamics and management vary considerably from area to area. For instance, different parts of the Ethiopian highlands receive between 600 and 2700mm of rainfall annually. Besides high rainfall variability and water shortage is prevalent in the highlands (Hussien Ali, 2009).Land use/land cover (LULC) change is one of the challenges which strongly influence the process of Agricultural development and the food security situation in Ethiopia. With an area of 1,130,000 km2 and as one of the most populous countries in Africa, Ethiopia is experiencing huge land use/land cover dynamics from natural vegetation to farming practices and human settlement. This problem is more severe in the highlands which account nearly 44% of the country’s landmass and which has been cultivated for millennia (Mengistie et al., 2013).

Research conducted in Ethiopia has shown that there were considerable LULC changes in the country during the second half of the 20th century. Most of these studies indicated that deforestation and encroachment of cultivation into marginal areas were the major causes of land degradation, particularly in the highland part of the country (Daniel Mengistu, 2008). Studies have been conducted to estimate and monitor land use/land cover change in different parts of Ethiopian highlands. According to Mengistie et al (2013), these reports shown heterogeneity in direction and/or magnitude of land use/land cover changes in the country.

For instance, according to their review, Zeleke and Hurni (2001) reported a sharp decrease of forest cover in their respective study area in Ethiopia while Woldeamlak and Sterk (2005) found the opposite i.e an increasing trend by 19 % from 1957-1982 and 27% from 1982 -1998. Even the magnitude of the change with the same direction varies considerably like zeleke indicates increase of cultivated land by 38% in 38 years (1957- 1995) on the other hand Tegene reported an increase in crop lands only by 5.5% in 43 years (1957-2000). Mengistie et al. (2013) have examined LULC change using object-based classification of multi- temporal remotely sensed data (Landsat and Rapid Eye) from four reference years followed by post classification comparisons using recent advancements of remote sensing and GIS technologies. This approach in object-based methods increased the classification accuracy. This is new for the case of Ethiopian landscapes having diverse features and ragged topographies. The approach has the potential to be extended across other parts of the country for improved classification results. According to Mengistie et al. (2013) findings, there are few studies which are undertaken in an integrated analysis which means analyzing the changes in relation to other geographic aspects on LULC change in the Ethiopian high lands.

CHAPTER THREE

3. Methods and Materials

3.1 Description of the Study Area

3.1.1 Location of the Study Area

Shashogo is one of the woredas in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. Part of the Hadiya Zone. Its relative location is on the south by the KembataTembaro Zone, on the west by Limo, on the northwest by Ana Lemo, on the northeast by the Silt'e Zone, and on the southeast by the Alaba special woreda. The absolute location of woreda lies between latitudes 7 º 25`- 7 º 39` North and between longitudes 37 º 56`-38 º 10` east. The woreda covers a total area of 35,376 ha. It is situated 224 km from the capital city of Addis Ababa, 117 km from Hawassa, the capital of SNNPRS, and 52 km from the zonal capital Hosanna (CSA, 2007).

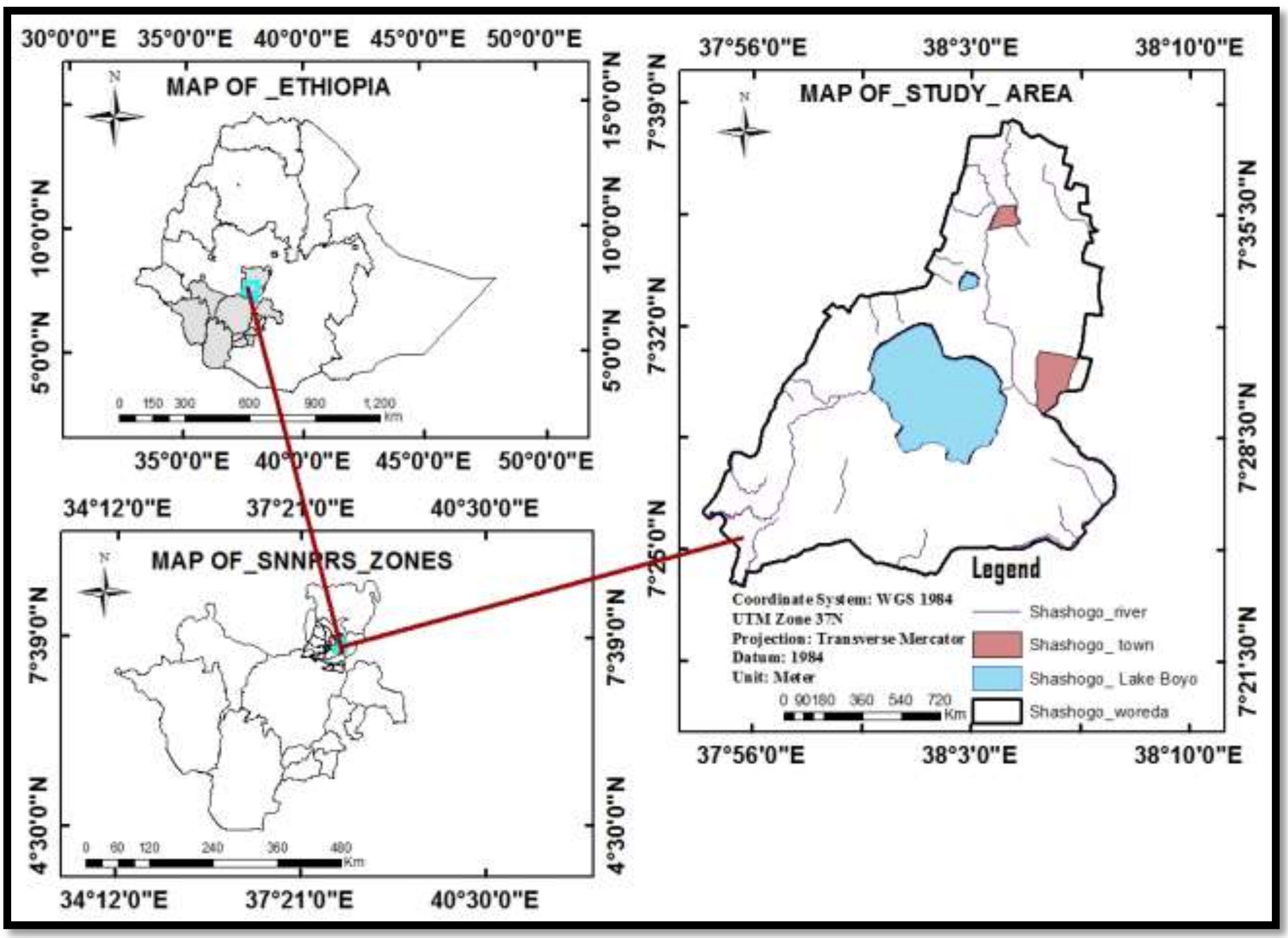


Figure 1: Location Map of the study area

3.1.2 Demography

Based on the 2009 Census conducted by the CSA, the study woreda has a total population of 103,722, of whom 52,435 are men and 51,287 women.The majorities of the inhabitants were Protestants, with 51.96% of the population reporting that belief, 42.48% were Muslim and 4.96% practiced Ethiopian Orthodox Christianity. In woreda, there are 36 kebeles from which 34 rural and two are urban kebeles (CSA, 2007).

3.1.3 Climate

The rainfall of the study area is highly influenced by the movement of inter-tropical convergence zone (ITCZ) and the development of tropical easterly Jet (TEJ) Stream. The rain fall type is Bi-modal type-1(the central and most of the eastern half of the country) which is categorized under region A. i.e. continuous occurrence of rainfall over a period of time dominated by two rainfall peaks. The months from May to September are marked by a relatively higher rainfall, while the months from November to February are dry. The long rainy season is between June and September, during which crop cultivation takes place. The total annual rainfall reaches 1005.1 mm. The area has predominantly dry kola (hot low land) agro ecology. The mean maximum daily temperature is 21.6 °C (February), while the mean minimum daily temperature is 18.5 °C (July) (NMA, 2017).

3.1.4 Topography, Soil and Hydrology

The altitude ranges from 1876m to 2257 m.a.s.l. The woreda has an agriculturally suitable land in terms of topography. Flood is a series problem in the flat topography areas. According to FAO classification system, the most dominant soil in the area is Vitric and osol covering the whole Woreda (FAO, 2012). The Woreda has four rivers such as Bilate, Guder, Metenchose, and Meranche. All rivers (except, Bilate) are seasonal. Bilate is a perennial river, even though the volume of water decreases substantially during the dry season. Recent studies have indicated that the water table of the ShashogoWoreda is shallow. There is also Boyo Lake covering more than 1,210 hectares. Especially it surrounds two of the kebeles and acts as a potential mosquito-breeding site, particularly during the dry season (Gone, 2001; Abinet, 2011).

3.1.5 Geology

The study area is mainly covered with Cenozoic volcanic and tertiary quaternary sediments. There are two main sedimentary sequences. These are Holocene lake beds and recent alluvial fluvial deposits (Loppiso, 2010).

The Holocene lake beds formation covers small area surrounding the Boyo Lake. They are mainly constituted by poorly compacted, well sorted, yellowish clay and silt materials, but recent alluvial fluvial deposits formation covers most part of ShashogoWoreda especially at Boyo plain. The main sources of these alluvial deposits are mainly Guder River. Outwash debris is found widespread in the area particularly along the foothills of the major fault scarps. Recent deposits in the area include soils, alluvial sand deposits particularly along the foothills of the major fault scraps such as foot of DoishaAmbaricho. The recent deposits in the area include soil and alluvial sand deposits. Sand mining is the common activity in the area which may affect the river morphology and sediment transport (Loppiso, 2010).

3.1.6 Natural vegetation

The spatial distribution of natural vegetation depends on many factors among which, climate, drainage pattern and soil types play a key role. In Ethiopia, temperature and rainfall, which largely are altitude dependent, determine the type and density of vegetation (Tewolde et.al,1991). The commonly observed remnant tree species in the area are Acacia species, Cordiaa fricana, and Eucalyptus species. These tree species are observed throughout the Woreda mostly scattered in the cultivated landscape. Because of long history of agriculture and high population in the area, vegetation cover is very low. Consequently, erosion hazards on the steep slope areas are enormous (Abinet, 2011).

3.1.7 Agriculture

In the study area agriculture is the dominant economic activity, which includes crop farming and livestock production. Cropping patterns in the area follow rainfall. Maize, teff, wheat, pepper, haricot bean, sorghum and millet are the dominant crops with regard to area coverage. Other than these crops, many other crops are also grown, but economically less important. In most cases, maize is grown in more than 50% of the cultivable land in the woreda, while all other crops account for the remaining 50% of the area. Hot Pepper is the main cash crop in the area (Abinet, 2011).

ShashogoWoreda being one of the commonly drought affected areas in SNNPR, livestock production is poor. Grazing lands are converted into farmlands due to human population pressure, and hence crop residues are important feed resources.

3.2 Methods and Materials

3.2.1 Research Design

In this study mixed explanatory sequential approach of the research design was employed. As pointed out in Creswell (2009), explanatory sequential approach gives more focus for quantitative data than exploratory sequential approach that gives priority for qualitative data. Mixed method enables to better understand the problem more comprehensively and it is the most popular application method in conducting research. Because of this the researcher was initiated the integrating of both Quantitative and qualitative methods to add value to the arguments from different perspectives, and it enables to answer research questions more deeply.

It is understood that to generate the required data for study of LULCC the researcher encompass observational and experimental or mixed research methods. The research was carried out using the observation through exploratory, descriptive or analytical methods. The exploratory study, it needs small scale study of relatively short duration, which is conducted when little things known about the problem. In the case of descriptive study, the researcher simply by describing the distribution of spatiotemporal land use/ land covers change of the study area. Lastly, the study will be attempted to investigate the correlation possible causes and effect of land use land cover change. In similar way, experimental or intervention study also followed to detect analysis of land use/ land cover change.

Generally the research design was followed by using both quantitative and qualitative research type based on types of data. This mixed design approach uses widely numbers of writings.

3.2.2 Data Types and Sources

The data types that were used for this study are includes both primary and secondary data's. Primary data was collected the information captured from field observations, socio economic data that collected from selected key informant interviews and focus group discussions. The tool of primary data collection for this study was focus group decisions and key informant interview questions. The satellite based data was obtained from Landsat series especially TM, ETM+ and OLI for current LULCC were used.

3.2.2.1 Key Informant Interview (KII)

The key informant interview was significant to get first-hand information about socio economic, biophysical (based on their perception of change) and policy related to land use land cover change information of the study area in order to strength the findings of satellite images. In this case the key informant interview was conducted from four sectors according to significant data may be available for study of LULC change. Therefore, interviews was conducted from four sectors those were an experts from Agricultural Office five, woreda Communication office two, Chair persons of Kebeles two and District Forest Office five totally fourteen persons were selected in the study area by taking purposively people those who live a long time and they can give enough information about past land cover dynamics over taking place of back of 29 years.

3.2.2.2 Focus Group Discussion (FGD)

The focus group discussion was conducted by grouping in to three groups. Each group consists of nine persons and it includes elderly men and women, poor and rich farmers of the study area. The identification of data was obtained from agricultural office of the Woreda and the discussion points may be translated into local study area language. The information collected from this groups discussion were summarized to strength the findings of quantitative satellite image data so it was used to add a confidence for researcher.

3.2.3 Field data collection

In this study observing and capturing of the field works related to land use land covers change was done by using digital camera in order to check the current feature of the study area and each sampling location is recorded by using GPS 72 and Google earth services. Thus, overall number of sampling points of land use land covers classes which were adequate and statistically accurate for accuracy assessment.

Secondary data includes data that was obtained from woreda agricultural office, reports from different offices in shashogo woreda, published and unpublished materials such as internet, books, topographic and thematic layers, journals, reports of National Meteorological Agency (NMA), Ministry of Agriculture (MOA), Ethiopia Mapping Agency (EMA), data from satellite imagery and Central Statistical Agency (CSA) as well as other publications and scientific works.

3.2.4 Satellite Imagery Acquisition

Present and past information about land cover and land use changes for the study area was generated from remotely sensed data. Landsat satellite images that were acquired for four periods; 1990 (TM), 2000(ETM+), 2010(ETM+) and 2019(OIL) with path 169 and raw 55 are obtained from the global land cover facility (GLCF) /USGS (United State Geological survey).The images are extracted from Tiff formats for processing and that was acquired nearly similar seasons at sunny day in a case of correction.

Table 2. Landsat images for study

Sensor	Spatial Resolutions(m)	Data of acquisition	Path and row
TM	30m×30m	1990/01/28	169 / 055
ETM+	30m×30m	2000/02/30	169 / 055
ETM+	30m×30m	2010/02/28	169 / 055
OLI	30m×30m	2019/01/27	169/055

3.2.5 Tools and software's

Table 3: Tools and software's used for study

Tools and software's	Their applications
ERDAS Imagine 2015	It is used for displaying and subsequent processing and enhancement of the land sat image. It is also used for the carving out of the study area from the whole scene imagery using administrative boundary data. The land LULC classes are also developed using this software.
Idrisi17.00	It is also used for projecting future LULC
ArcGIS 10.5	Used to compliment the display and processing of the data. This is also used for change detection analysis of the study area.
Microsoft Word 2010 and Microsoft Excel 2010	Used to create charts, graphs and making some quantification, etc.

3.3 Methods of Data Analysis

3.3.1 Land use/land covers change analysis

The GIS and RS technique particularly in supervised classification the maximum likelihood algorism was used for study. Maximum likelihood algorithm assumes that the statistics for each class in each band is normally distributed and calculate the probability that a given pixel belongs to a specific class where each pixel was categorized to class that has the highest probability.

Thus technique was selected because it has greater probability to weight minority class that can be swamped by the large class during samples training from images. The assumption of this technique is that the minority classes in the image have the opportunity to be included in to their respective spectral classes thereby minimizing the problem of uncategorized pixel from entering in to another class during the classification process. In supervised classification techniques for determining LULCC detection was suggested that in order to use supervised classification effectively then it's very crucial for the analyst to have a prior set of some knowledge of the classes in mind and then develop the signatures accordingly.

The ERDAS imagine 2015 software to process image, Idrisi 17.0 to project future LULC and ArcGIS 10.5 was used to reclassify and calculates the pixel values of all LULC classes and complement the display and preparation of maps. The layer stacking of bands 1-7, (where bands 8 and above are omitted from layer stack due to high reflectivity), radiometric calibration particularly atmospheric correction, haze and noise reduction was utilized in ERDAS imagine for prior to analysis and Google earth was used to check the land use and land covers in the area prior to field observation. The overall processes allowed the investigators to better enhance and improve the images for classification and interpretation.

The post classification change detection method is found to be the most suitable for detecting land use/land cover change. Post classification comparison can provide a complete matrix of change directions (Abiy, 2014). The classified images were compared in four periods i.e. 1990-2000, 2000-2010, 2010-2019 and 1990-2019. The Change of statistics was computed by comparing values of area of one data set with the corresponding value of the second data set in each period. The value was presented in terms of hectares and percentage. Quantification of the rate of change was applied to generate information about the land use/land cover dynamics of the study area.

3.3.2 Accuracy Assessment

Image acquired from Remote sensing has always contains some errors due to several factors which ranges from classification technique to method of satellite data capture. Because of these produce of land use land cover maps were derived from remote sensing the errors should be quantitatively explained in terms of classification accuracy.

In this study observing and capturing of the field works related land use land covers was done by using digital camera in order to check the current feature of the study area and each sampling location was recorded by using GPS and Google earth. Thus, overall number of sampling points of land use land covers classes was adequate and statistically accurate for making accuracy assessment. It is better to determine the quality of the data that was collected in the field and then make the accuracy assessment, and finally by help of each image the agreement and disagreement of the analysis was evaluated by using an error matrix that was describes user, producer and overall accuracy; and kappa coefficient results. An interpretation was to identify how close the newly produced map from the remotely sensed data matches the reference (source) map (Congalton, 1999).

$$\text{Over all Accuracy} = \frac{\text{Total number of correctly classified pixel (diagonal)}}{\text{Total number of reference pixels}} \times 100$$

$$\text{User Accuracy} = \frac{\text{Number of correctly classified pixel in each category}}{\text{Total number of classified pixel in that category (the row total)}} \times 100$$

$$\text{Producer accuracy} = \frac{\text{Number of correctly classified pixel in each category}}{\text{Total number of reference pixel in that category (the column total)}} \times 100$$

$$\text{Kappa coefficient (T)} = \frac{(TS \times TCS) - \sum (\text{Col .tot} \times \text{Row. tot})}{TS^2 - \sum (\text{Col .tot} \times \text{Row. tot})} \times 100$$

3.3.3 Socioeconomic Data Analysis

In this study, the major concern of integrating socioeconomic data was obtained supplementary information from the local community that explains the results of the study in depth. The socio-economic data collected from KII and FGD were significant to strength quantitative remote sensing data in terms to identify according understandings and perceptions of local community about the study of land use land cover dynamics. Finally the data that was taken form key informant interviews and focus group discussions was analyzed by paraphrasing and quoting or explained in qualitatively in the form of statement.

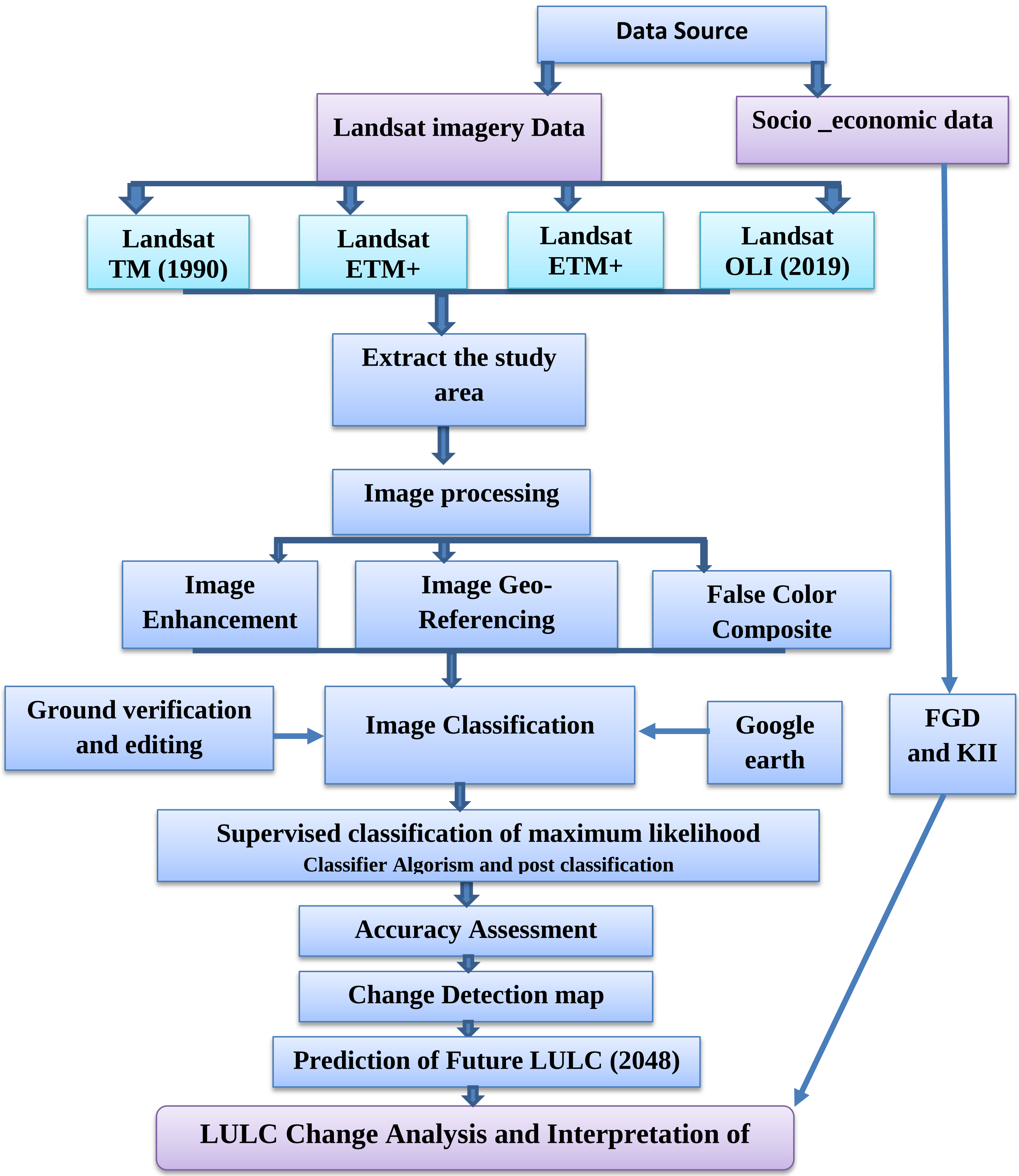


Figure 2: Methodological Flow of the study

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1. Results

4.1.1 Land use/Land Cover Change Detection

For the study area five land use land cover classes were identified. These were settlement, cropland, water body, forest and Range land. The land use land cover classification result for the study year 1990, 2000, 2010 and 2019 indicated in (Table 4). In 1990, the largest area was covered by Crop land and small area by water body, which constitutes 41.6% (14,732.1ha) and 2.5% (887.87ha), respectively. The settlement, forest and range land were covered 3.7 %(1,3233ha), 15.7 %(5,538.7) and 36.4 %(12,894.7ha) respectively. The land use land cover classification for the year 2000, as a year of 1990, the largest area was covered by crop land and small area by water body which accounts 55.5 %(19,621.8ha) and 2.53 %(896.5ha), respectively. settlement, forest and range land were accounted 7.9 %(2,806.97ha), 7.6 %(2,671.60ha), and 26.5 %(9,379.73ha). The land use land cover classification for the year 2010, the largest area was covered as a year 2000 by crop land ,but small area not as 2000 water(it was increased) in this case forest is highly valuable which accounts crop land 58 %(20,519.20ha) and forest 3 %(1,065.80ha). settlement, water and range land were accounted 8.8 %(3,123.60ha), 4.4 %(1,560ha), and 25.7 %(9,108ha). In final year (2019) land use land cover classification analysis shows that the same classes of change as fourth observation year, but covering different quantity of area: settlement 10% (3,542.7), crop land 63.1% (22,321.20ha), water body 3.01% (1,083ha) ,forest 7.9% (2,785.6ha),and rang land 16% (5,644.1ha).

Table 4: Land use land covers (1990, 2000, 2010 and 2019).

LULC Classes	Land use land cover area coverage							
	1990		2000		2010		2019	
	Hectare	%	Hectare	%	Hectare	%	hectare	%
Settlement	1,323.30	3.74	2,806.97	7.93	3,123.60	8.83	3,542.70	10.01
Crop land	14,732.10	41.64	19,621.80	55.47	20,519.20	58.00	22,321.20	63.10
Water body	887.80	2.51	896.50	2.53	1,560.00	4.41	1,083.00	3.06
Forest	5,538.70	15.66	2,671.60	7.55	1,065.80	3.01	2,785.60	7.87
Range land	12,894.70	36.45	9,379.73	26.51	9,108.00	25.75	5,644.10	15.95
Total Area	35,376.60	100.00	35,376.60	100.00	35,376.60	100.00	35,376.60	100.00

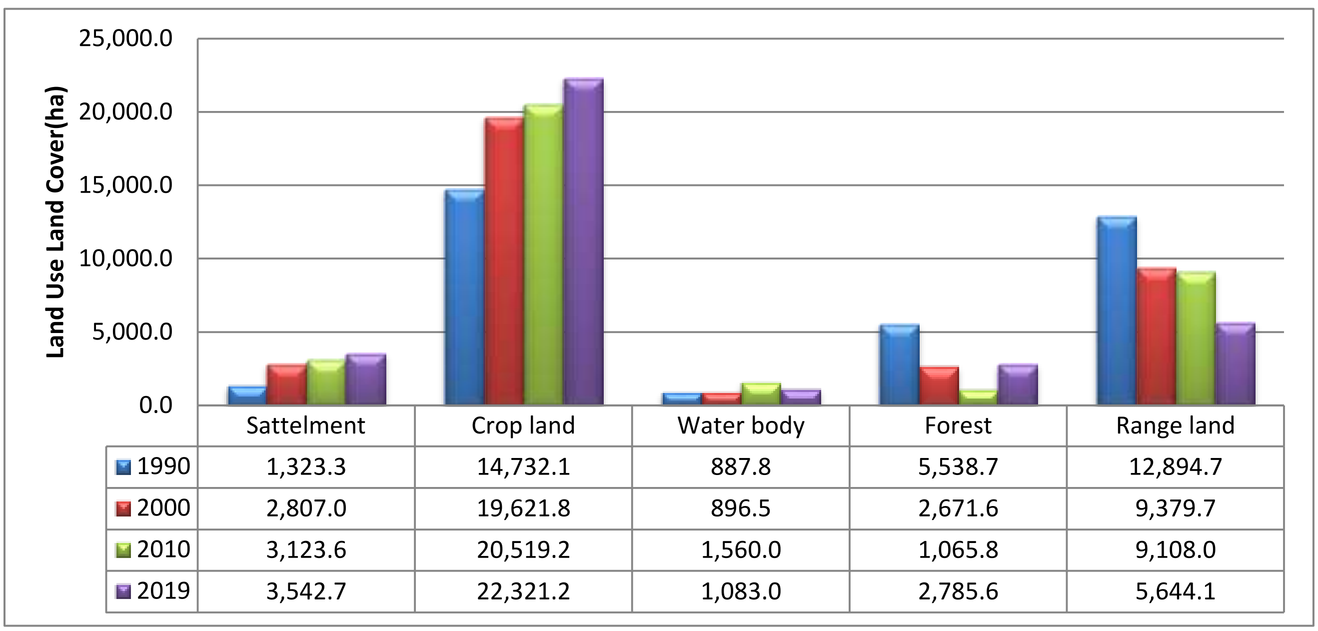


Figure 3: Land use land cover classes1990-2019

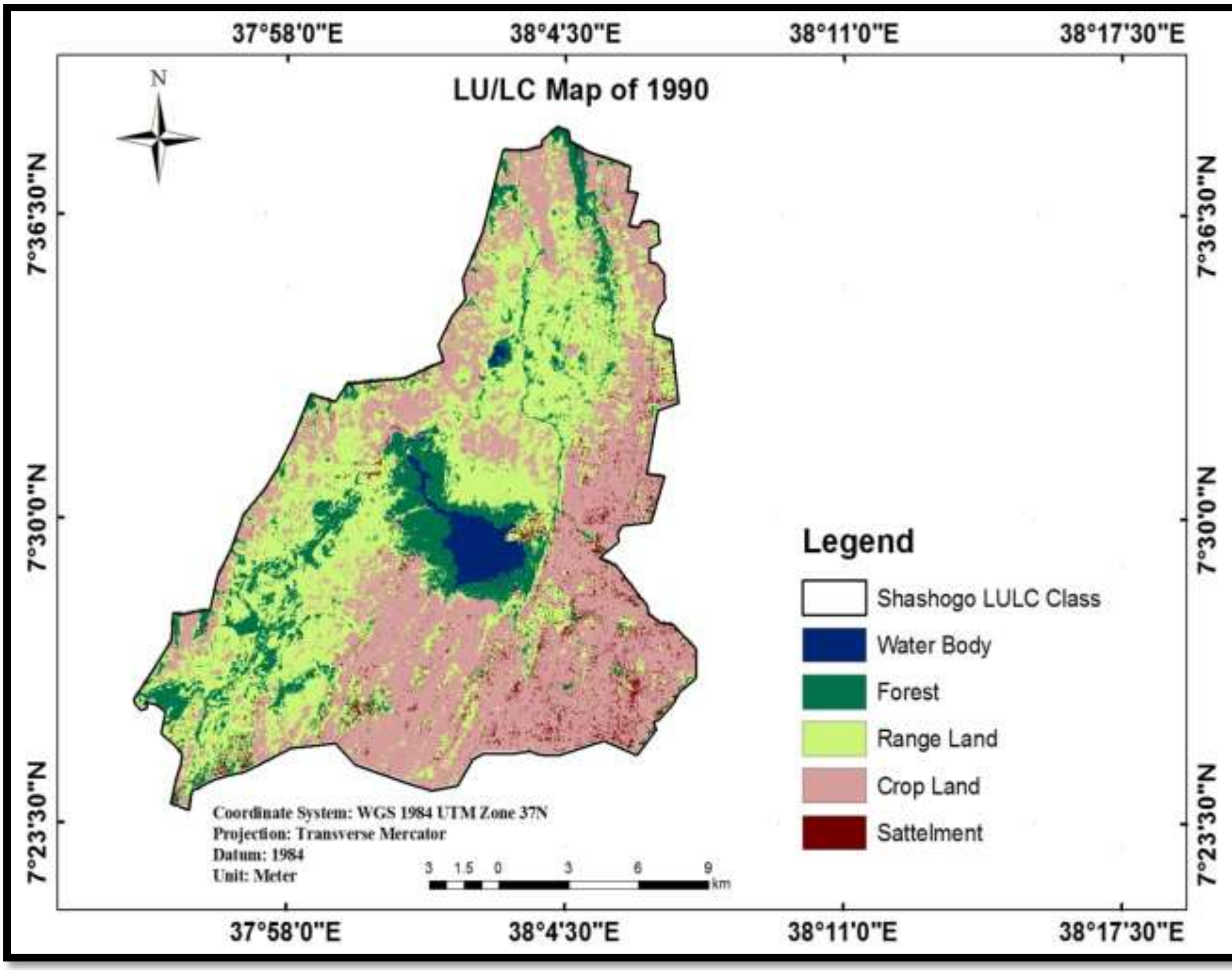


Figure 4: **LU/LC classification map of study area for 1990**

Source: 1990 Image interpretation

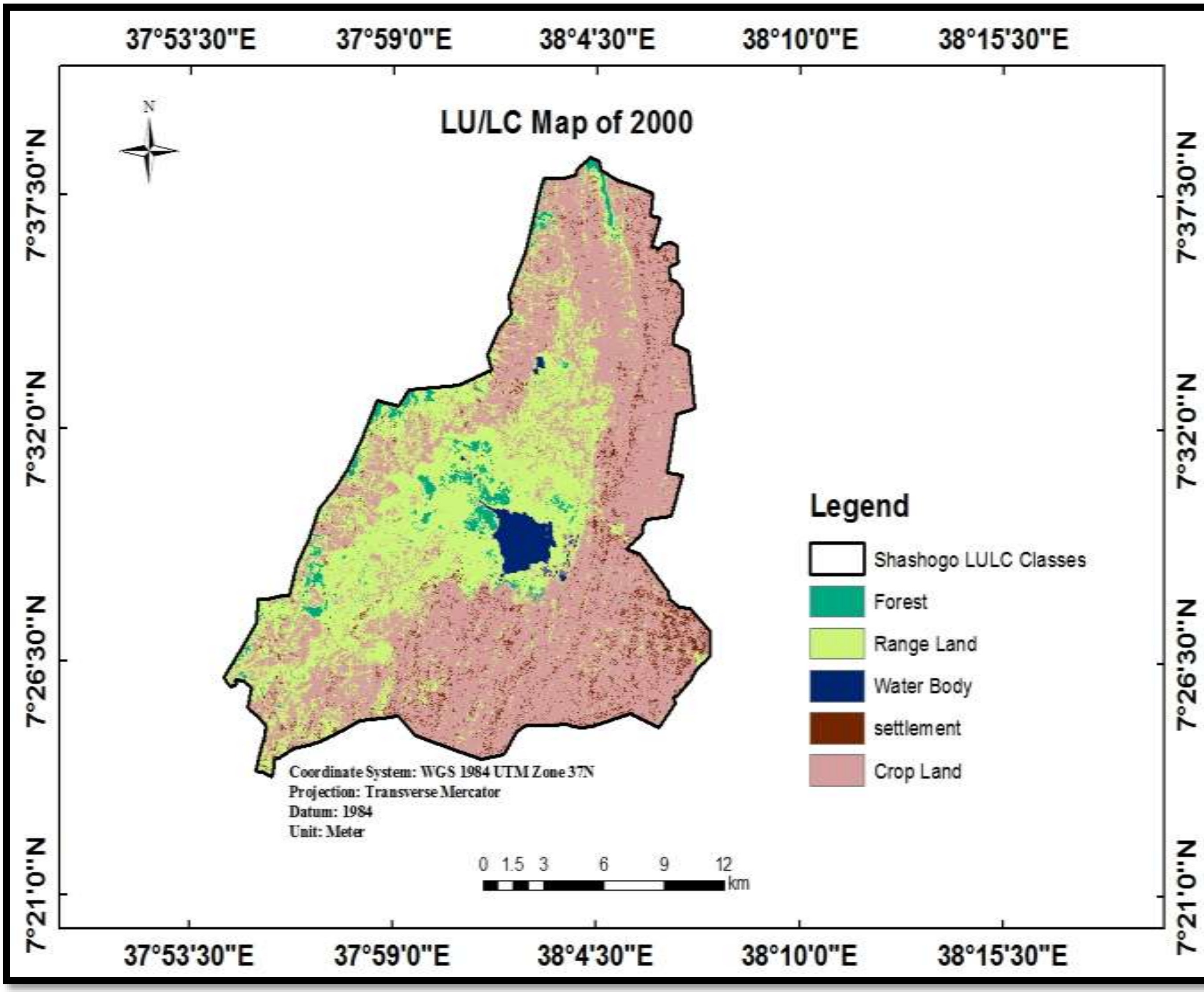


Figure 5: LU/LC classification map of study area for 2000

Source: 2000 Image interpretation

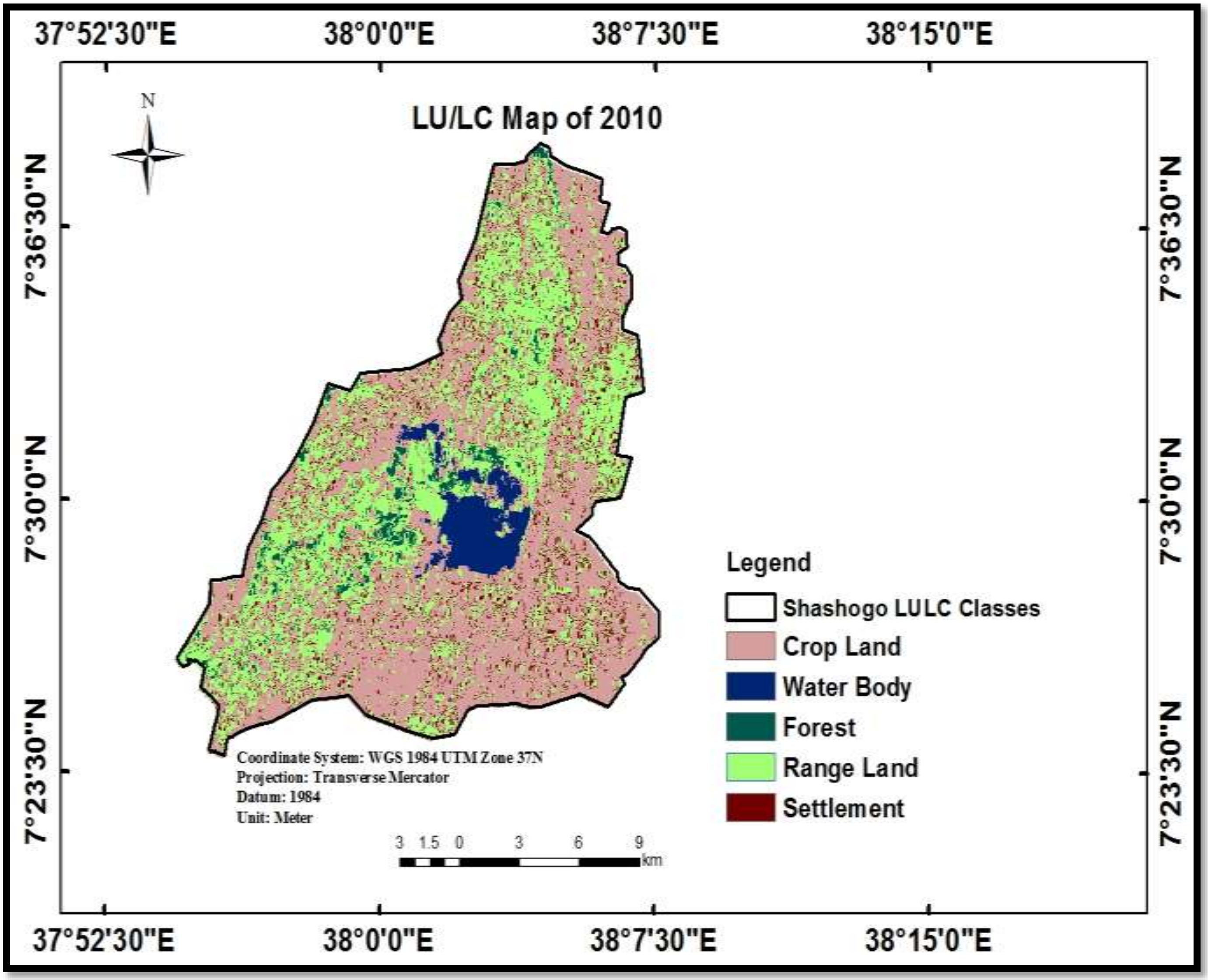


Figure 6: LU/LC classification map of study area for 2010

Source: 2010 Image interpretation

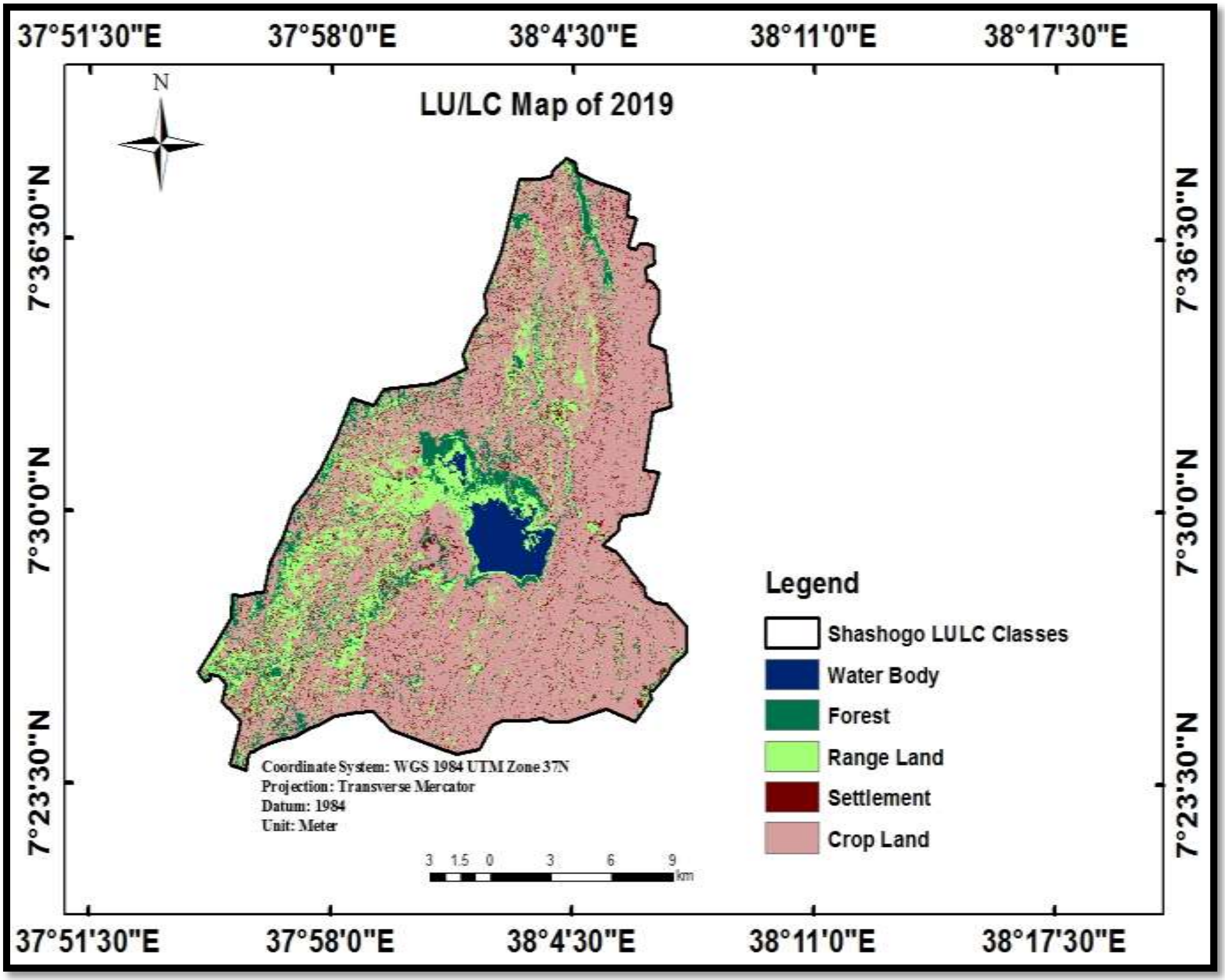


Figure 7: LU/LC classification map of study area for 2019

Source: 2019 Image interpretation

4.1.2 Classification Accuracy Assessment

The Accuracy assessment of the LULC classification was indicates that in 1990, 2000, 2010, and 2019 classification retained 80.2%, 82%, 85.9%, and 86 % respectively indicated in (Table.6). In land use land cover classification, accuracy assessment and kappa statistics values are important to quantify the accuracy of the classification. The Kappa coefficient lies typically on a scale between 0 and 1 and usually multiplied by 100 to give a percentage measure of classification accuracy. In this study its value varies from 0.75 to 0.83.This implies that the Kappa value of 0.75 to 0.83 represents a probable of 75 to 83% better accuracy (Anderson, 1971) respectively. As a result, the overall accuracy and kappa values for the study year are acceptable.

Table 5: Confusion Matrix for the LULC Map of 1990

LULC 1990	Water Body	Forest	Range land	Crop Land	Settlement	Totals	User accuracy (%)	
Water Body	45	2	2	0	0	49	91.84	Over all accuracy = 80.2
Forest	1	50	3	8	0	62	80.65	
Range Land	0	9	75	7	3	94	79.79	
Crop Land	3	1	8	74	8	94	78.72	
Settlement	0	1	12	9	67	89	75.28	Kappa statistics = 0.75
Totals	49	63	100	98	78	388		
Producer Accuracy (%)	91.84	79.37	75.00	75.51	85.90			

Table 6: Confusion Matrix for the LULC Map of 2000

LULC 2000	Water Body	Forest	Range Land	Crop Land	Settlement	Totals	User accuracy (%)	
Water Body	40	5	1	0	0	46	86.96	Over all accuracy = 82
Forest	1	55	3	6	0	65	84.62	
Range Land	0	9	70	5	0	84	83.33	
Crop Land	2	0	5	71	8	86	82.56	
Settlement	0	1	10	9	60	80	75.00	Kappa statistics = 0.77
Totals	43	70	89	91	68	361		
Producer Accuracy (%)	93.02	78.57	78.65	78.02	88.24			

Table 7: Confusion Matrix for the LULC Map of 2010

LULC 2010	Water Body	Forest	Range Land	Crop Land	Settlement	Totals	User accuracy (%)	
Water Body	49	4	1	0	0	54	90.74	Over all accuracy = 85.9
Forest	1	56	6	1	0	64	87.50	
Range Land	0	7	80	5	0	92	86.96	
Crop Land	1	0	5	66	3	75	88.00	
Settlement	0	1	9	8	68	86	79.07	Kappa statistics =0.82
Totals	51	68	101	80	71	371		
Producer Accuracy (%)	96.08	82.35	79.21	82.50	95.77			

Table 8: Confusion Matrix for the LULC Map of 2019

LULC 2019	Water Body	Forest	Range Land	Crop Land	Settlement	Totals	User accuracy (%)	
Water Body	51	1	1	0	0	53	96.23	Over all accuracy = 86
Forest	2	53	1	2	0	58	91.38	
Range Land	0	3	72	3	4	82	87.80	
Crop Land	1	2	4	67	8	82	81.71	
Settlement	0	1	7	11	70	89	78.65	Kappa statistics =0.83
Totals	54	60	85	83	82	364		
Producer Accuracy (%)	94.44	88.33	84.71	80.72	85.37			

Data obtained from Land sat images, user's accuracy and producers' accuracy also explained for all the four classified images. Users' accuracy measure the percentage of pixels or points mapped as a given class is included belongs to that class on the ground and producers' accuracy measure the percentage to which the ground reference data itself was correctly classified. Image 1990 was classified at maximum and minimum producers' accuracy 91.8 %(water) and 75 %(range land) and Users' accuracy at maximum 92 %(water body) and minimum75.3 %(settlement) respectively. Image 2000 was classified at maximum and minimum producers' accuracy 93 %(water) and 78 %(cropland) and Users' accuracy at maximum 87 %(water body) and minimum 75 %(settlement) was classified. Image 2010 was classified at maximum and minimum producers' accuracy 96%(water) and 79.2 %(range land) and Users' accuracy at maximum 90.7 %(water body) and minimum 79%(settlement) was classified. Similarly, for image 2019 all land use land cover classes were classified. Land use land cover class that classified producers' accuracy maximum was 94.4 % (water) and minimum 80.7 %(crop land), rangeland (84.7%), forest (88.3%) and settlement (85.4%) Users' accuracy of maximum 96.3 % (water) and minimum settlement (78.7%) and the others classes cropland (81.7%), rangeland (87.8%) and forest (91.4%).

4.1.3. LU/LC Change Detection for 1990 to 2000

In the case of the year 2000, the area covered by settlement increased by 2,806.97ha from 1990 which was 1,323.3ha. The area covered by cropland was increased by 19,621.8 ha from 1990 which was 14,732.1ha. The forest cover decreased in 2000 by 2,867.1ha from 1990, 5,538.7ha. In other words, from the analysis, it was found that, the forest cover declined from 15.66% in 1990 to 7.55% in 2000. The rangeland cover decreased that means it was reached in 2000 about 9,379.73ha from 1990, 12,894.70ha. In other words, from the analysis, it was found that, the rangeland declined from 36.45% in 1990 to 26.51% in 2000. In the study area, forest coverage and range land was decreased and the push factors were expansion of land for agriculture and settlement. The trend was similar the study conducted by Abinet (2011) stated the quest for agricultural land is the one that made the deterioration of forest cover significant. Loppiso (2010) discussed the effects of crop land increase on the dramatic decrease of forest cover and rangeland. The total loss of forest and the decline of rangeland area between 1990 and 2000 were 2,866.1ha and 3,515 respectively. According to informants extensive deforestation occurred during past years because of miss protection of bio-diversity by government and local community in study area.

Table 9: Land use land covers change for 1990- 2000

LULC Classes	Study years					
	1990		2000		Change	
	hectare	%	Hectare	%	Area in (ha)	%
Settlement	1,323.30	3.74	2,806.97	7.93	1,483.67	112.1
Crop land	14,732.10	41.64	19,621.80	55.47	4,889.70	33.19
Water body	887.80	2.51	896.50	2.53	8.70	0.98
Forest	5,538.70	15.66	2,671.60	7.55	-2,867.10	-51.76
Range land	12,894.70	36.45	9,379.73	26.51	-3,514.97	-27.26
Total Area(ha)	35,376.60	100	35,376.60	100		

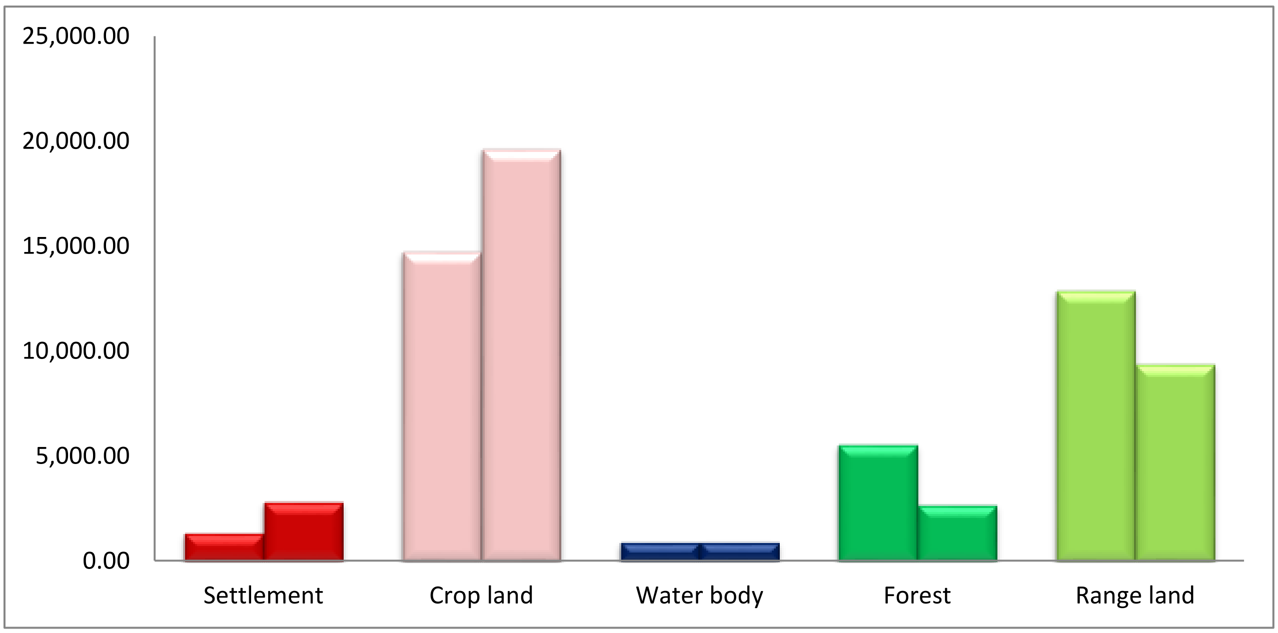


Figure 8: Land cover change from 1990-2000

4.1.4 LU/LC Change Detection for 2000 to 2010

From 2000 to 2010 the forest coverage decreased by 1,605.8ha and reached 1,065.8ha in 2010. In this study, the expansion of agricultural land 19,621.8ha in 2000 to 20,519.20ha in 2010 and settlement expanded from 2,806.97ha in 2000 to 3,123.6ha in 2010 and resulted in the decline of forest coverage from 2,671.6 ha in 2000 to 1,065.8ha in 2010. The group discussion and interview result also indicated, the forest cover was decreased from year to year due to timber production, fence, house construction wood, charcoal production, fuel wood and expansion of crop land. Gasses' and Johan (2007), in their study found that, the forest cover mainly lost by expansion of agricultural land. The respondents also emphasized that the increase of expansion of agricultural land and settlement leads the decline of the forest cover and the rangeland an area. The cropland area was also increased from 1990 in 2010 by 897.4ha .With regard to settlement, in 2000 and 2010 constitutes 7.93% and 8.83%, respectively. Settlement coverage in 2000 was 2,806.97ha from which reached to 3,123.6ha in 2010.

Table 10: Land use land covers change for 2000- 2010

LULC Classes	**Study Period**					
	2000		**2010**		**Change**	
	hectare	**%**	**hectare**	**%**	**Area in (ha)**	**%**
Settlement	2,806.97	7.93	3,123.60	8.83	316.63	11.28
Crop land	19,621.80	55.47	20,519.20	58.00	897.40	4.57
Water body	896.50	2.53	1,560.00	4.41	663.50	74.01
Forest	2,671.60	7.55	1,065.80	3.01	-1,605.80	-60.11
Range land	9,379.73	26.51	9,108.00	25.75	-271.73	-2.90
Total Area(ha)	35,376.60	100	35,376.60	100		

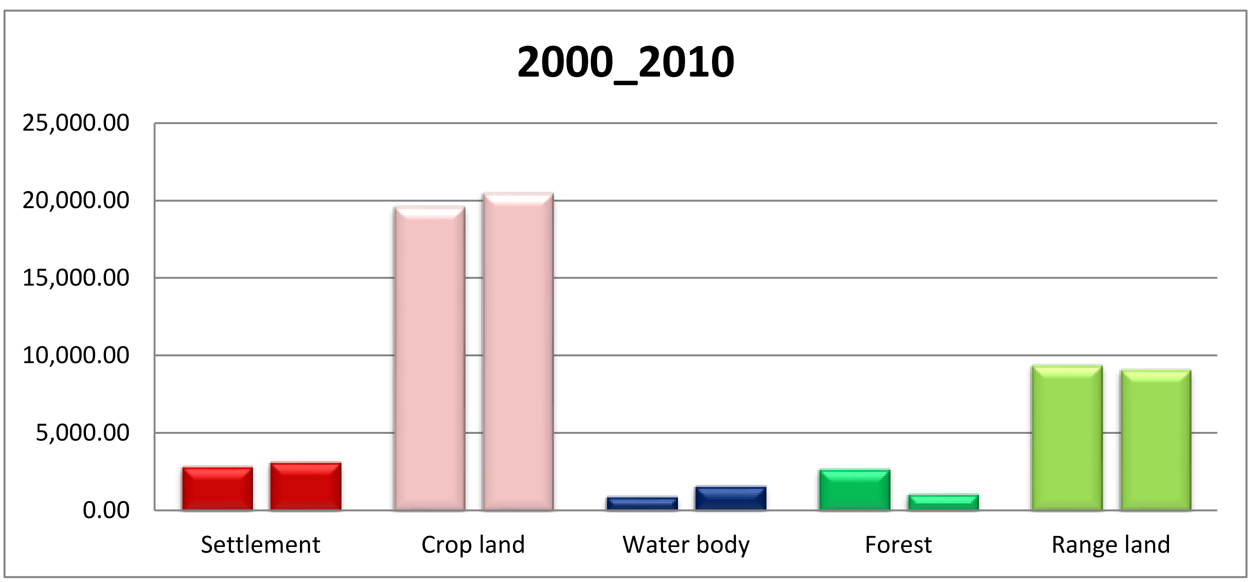


Figure 9: Land cover change from 2000-2010

4.1.5 LU/LC Change Detection for 2010 to 2019

From 1990 to 2010 the forest coverage was decreased, but in the case of 2019 (after reach of the lowest point in 2010, it was only 3%) forest converge was increased 7.9%, But never substitute past coverage 1990 (15.7%). The current increment was related according the data collected to shashogo woreda forestry office the forest coverage is now increasing after year of 2000 E.C/ Ethio_mineleoum (the slogan:" two tree for 2000") and following yearly seasonal reforestation Practice. The agricultural land expanded 20,519.2ha in 2010 to 22,321.2ha in 2019 and settlement expanded from 3,123.6ha in 2010 to 3,542.7ha in 2019. It was resulted in the decline of rangeland from 9,108ha in 2010 to 5,644.1ha in 2019. Also the change in a water body indicates from 1990 to 2010 has an increments in water by coverage, but shallowest because of the sand content occupying the largest area of internal water body. Due to this in 2010 flooding was exceeded with affecting people in study area. After that to minimize negative impact of flooding artificial project was conducted on small Lake Boyo (Boyo project) .This project was about outflowing of water out of Shashogo woreda because of this more recently the probability of water coverage is now decreasing.

Table 11: Land use land covers change for 2010- 2019

LULC Classes	Study Period					
	2010		2019		Change	
	hectare	%	hectare	%	Area in (ha)	%
Settlement	3,123.60	8.83	3,542.70	10.01	419.10	13.42
Crop land	20,519.20	58.00	22,321.20	63.10	1,802.00	8.78
Water body	1,560.00	4.41	1,083.00	3.06	-477.00	-30.58
Forest	1,065.80	3.01	2,785.60	7.87	1,719.80	161.36
Range land	9,108.00	25.75	5,644.10	15.95	-3,463.90	-38.03
Total Area(ha)	35,376.60	100.00	35,376.60	100.00		

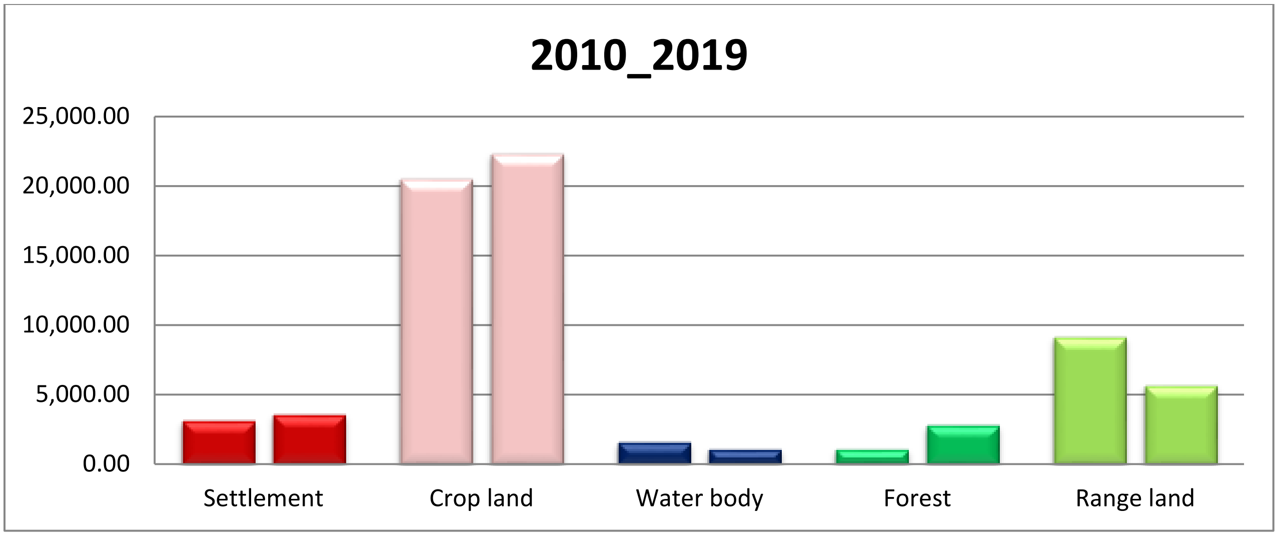


Figure 10: Land use land covers in percent 2010-2019

4.1.6 LU/LC Change Detection for 1990 to 2019

From initial to final year, settlement was increased by 2,219.4ha. The settlement category result showed there was a change in coverage or settlement expanding from 1990 to 2019. Statistically, the area used for settlement in 1990 was 1,323.3ha and this was increased by 2,219.4ha and cover 3,542.7ha in 2019. During this time land use also showed the change that existed in the study area. In the case of cropland, the north eastern and south eastern part of the study area was dominated by extensive farming system and the change by the explanation of crop land is more present to past, but in the south western and north west part indicates the previously known by range land and forest, but recently an expansion of cropland area was more increased. From the year 1990 the crop land 14,732.1(41.64%) ha to in a year 2019 crop land 22,321.2(63.1%) ha or 7,589.1(51.5%) ha was changed. The range land coverage in1990 and 2019 was 12,894.7ha and 5,644.1respectively. Between these years, range land was decreased by 7,250.6ha. The forest land covers in 1990 and 2019 was 5,538.7(15.67%) ha and 2,785.6(7.9%) ha respectively; it has some increment from 2010, but when we compere from 1990 coverage it was decreased by 2,753.1(49.7%) ha.

Table12: Land use land covers change for 1990- 2019

LULC Classes	**Study Period**					
	1990		**2019**		**Change**	
	hectare	**%**	**hectare**	**%**	**Area in (ha)**	**%**
Settlement	1,323.30	3.74	3,542.70	10.01	2,219.40	167.72
Crop land	14,732.10	41.64	22,321.20	63.10	7,589.10	51.51
Water body	887.80	2.51	1,083.00	3.06	195.20	21.99
Forest	5,538.70	15.66	2,785.60	7.87	-2,753.10	-49.71
Range land	12,894.70	36.45	5,644.10	15.95	-7,250.60	-56.23
Total Area(ha)	35,376.60	100.00	35,376.60	100.00		

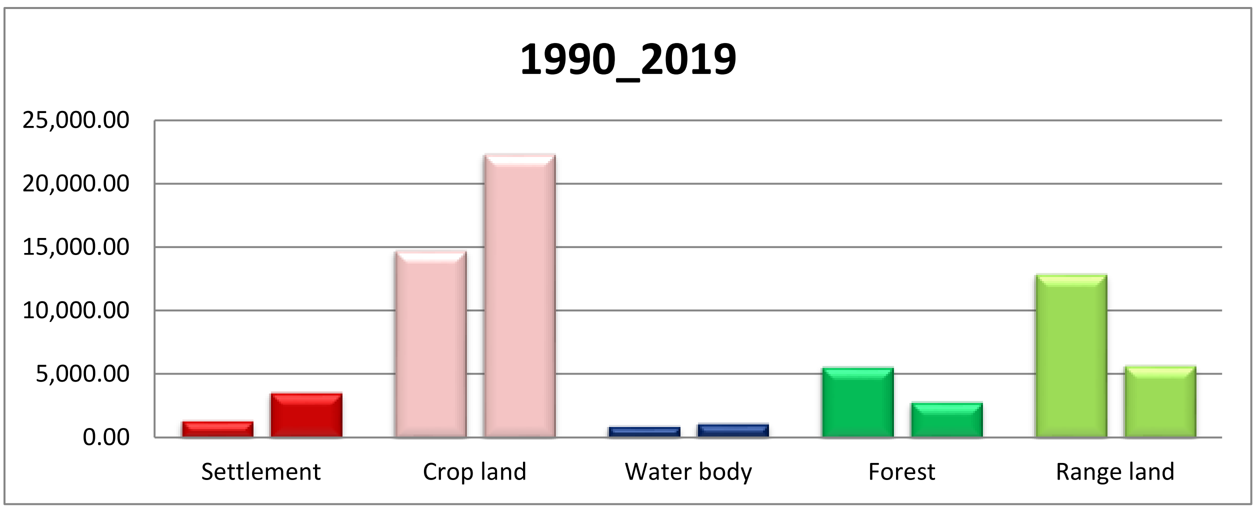


Figure 11: Land use land covers in percent 1990-2019

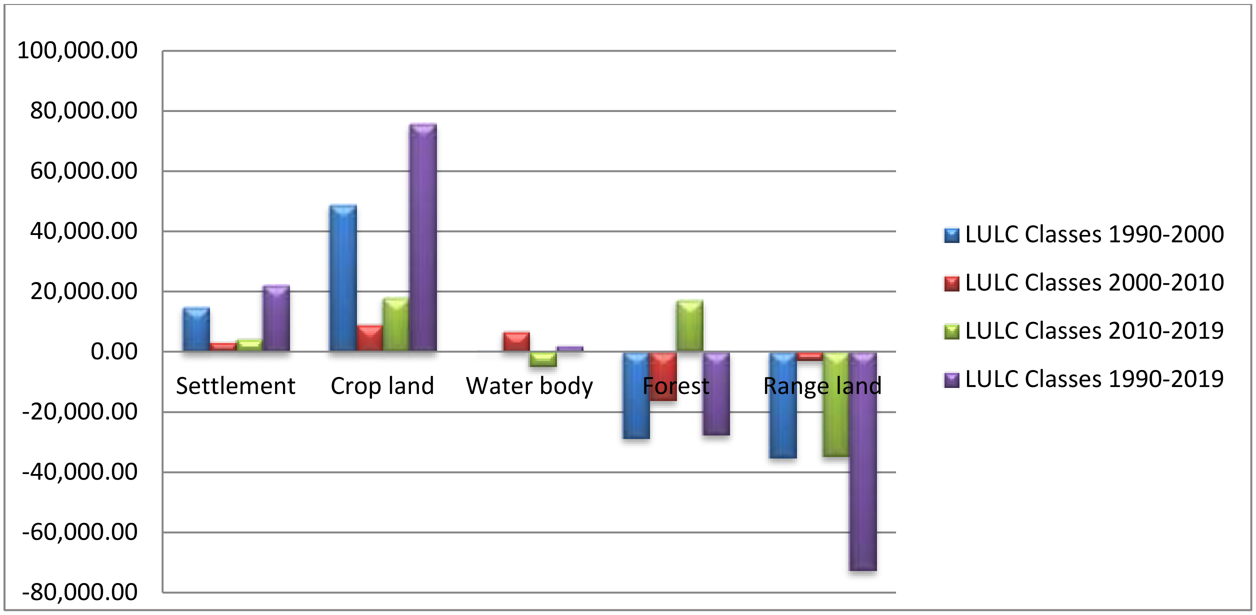


Figure 12: Land use land covers in percent 2010-2019

4.1.7 Land use land cover matrix

The Land use land cover matrix was produced by overlaying two land use land cover maps of the same area to show the probability that one particular land use land cover category changed in to other land cover category. It is used to predicting the likely possible change between different particular states. In this study, from initial to final year land use land cover transitional matrixes were produced .It is important to identify and compere more probability varying land use land cover classes. From which the column stands for the initial state of land use land cover categories and the row stand for the final state of land use land cover categories.

As table 11 explained that the land use/ land cover matrix from years of 1990 to 2019 change in the study area was indicates that , the change in the land use/ land cover enlarge attributed to expansion of crop land area. This class has expanded at the expense of rang land (9,716ha), forest land (2,127.74ha) and water body (492.14ha) classes. There was also significant change of crop land to rangeland in this period in 640.74ha and 1,386.25ha of ranges land was also changed to forest land. Generally the continuous increment of crop land and settlement was the result of the decline of range land and forest covers.

Table 13: Land use land cover matrix

Conversion matrix from 1990 to 2019		2019					Total area(ha)
		Water Body	Forest	Rangeland	Settlement	Crop Land	
1990	Water Body	492.14		4.66	0.13	0.18	497.10
	Forest	323.82	881.44	1,408.35	205.72	2,127.74	4,947.07
	Range land	238.97	1,386.25	3,361.72	995.68	9,716.00	15,698.61
	Settlement	28.13	152.69	172.41	742.64	78.90	1,174.77
	Crop Land	0.04	245.54	640.74	649.82	11,522.92	13,059.05
Total area(ha)		1,083.09	2,665.92	5,587.87	2,593.99	23,445.74	35,376.64

Source: Land use/cover classification maps of 1990 and 2019

4.1.8 Transition Probability Matrix

For the 5 by 5 matrix table represented below, the rows represent the older land cover categories and the column represents the newer categories. The transition probability matrix used in predicting land use land cover of 2048.

Table 14: Transition probability matrix derived from the LULC Map of 1990 and 2019

Year		**2019**					
1990	**Class**	**Water**	**Forest**	**Range land**	**Crop land**	**Settlement**	**Total**
	Water	0.6999	0.0225	0.1425	0.1325	0.0025	1
	Forest	0.0125	0.3494	0.2513	0.3613	0.0255	1
	Range land	0.0121	0.0215	0.3531	0.3599	0.2534	1
	Crop land	0.0213	0.0131	0.2123	0.3712	0.3821	1
	Settlement	0.0021	0.0013	0.0012	0.0041	0.9913	1
	Total	0.7479	0.4078	0.9604	1.229	1.6548	4.99

Source: Land use/cover classification maps of 1990 and 2019

As seen from the table, water body which will be reached 0.6999 probability of remaining as water body and a 0.3001 probability of changing to other land classes. Forest during this period will likely maintain its expansion with a 0.3494 probability of remaining forest and 0.3613 probabilities to be changed to crop land categories in 2048. Range land during this period will have 0.3531 probabilities to remain range land and 0.3599 probability of changing to crop land. This implies that in addition to its reduction the majority of range land will changed to other classes. Crop land has a 0.3712 probability of remaining crop land, 0.0131 of changing to forest and 0.3821 changing to settlement in 2048. This shows the reduction, with a probability of change which is lower than stability. Settlement area also has a probability as high as 0.9913 to remain as settlement in 2048 which signifies stability.

4.1.9 Land Use/Land Cover Change Projection

The table below shows the statistic of LULC projection for 2048. The year 2048 is selected for projection because the model uses time series data and the difference between the initial year (1990) and base year (2019) was 29. When this value is added from the base year it gives 2048.As indicated from table below, Crop land still maintains the highest position in the class whilst water body retains its least position. Range land takes up the second position, followed by settlement and finally, forest area. Generally the model is based on the observed pattern between the initial and a base year determines the prediction result.

Table 15 : Projected LULC for 2048

	Classes	Water body	Forest	Range land	Crop land	Settlement	Total
2048	Area in ha	1,147.1	4,258.3	9,212.90	16,230.60	4,527.7	35,376.6
	Area in %	3.24	12.04	26.04	45.88	12.8	100

Source: Land use/cover classification maps of 1990 and 2019

The predicated result was obtained from the above discussed transition probability matrix which had the characteristics like: the sum of the rows of the probability matrix is one; the probability of the transition is same for the base and predicted years; the state of 2048 LULC depends only on the state of 2019 and the time periods uniform in duration between 1990-2019 and 2019-2048.

Therefore, researcher believes as the prediction result is valid because the input data fulfills the requirements of Marcov Chain model listed from the previous chapter.

4.2 Discussions

The spatial distribution, trend, pattern and the change of each land use land cover classes in the study area were summarized as follows for the four study periods. Most of the area occupied by this land use land cover class was located in North West and south west part of study area. The analysis of TM, ETM+ and OLI satellite images showed that in first study period from 1990 to 2000 the total size of land area covered by forest was 5,538.7ha and 2,671.6ha respectively. In the second observation year (2000), it decreased 2,867.1ha in of the study area due to the conversion forest to cropland and range land. In the year 2000 to 2010 forest decline by 1,605.8ha and from the years 2010 to 2019 it increased 1,719.8ha this was because of after year of 2000 (Ethio_ Mineleum) forestation movement, but never reached optimum level; between 1990 to 2019 declined by 2,753.1ha.The result was similar to previous study of woldeamlk and sterk (2005) there are an increment of forest coverage at some amount, but never comparable to past 30 years. The entire period of the study considered, this land use land cover class declined and transformed to other land use land cover. According to CA_Markov projection LU/LC for 2048 will be reached that water body exceeded 1,147.1ha (3.2%), forest 4,258.5ha (12.04%) rangeland 9,212.90ha (26%), cropland 16,230.60ha (45.9%) and settlement 4, 527.7ha (12.8%).

4.3 Analysis of Socioeconomic Data

For this study socio economic data was conducted in the first two weeks of March 2019 and it involved FGD, key informant interview and observation with selected elders, agricultural officers, land management experts, forestry and environmental protection of the woreda, and woreda communication bureau to get past and current information about land use land cover changes. The causes and effects of land use land cover change was also accessed to get insight on various political, social and environmental factors that influence decision on land use/land cover in Shashogo woreda. The time horizon considered for the trend analyses using the socio economic study corresponding with the time bounded considered above were for the remote sensing analysis. Generally, the data collected through observation, key informant interview and FGD and different woreda officers from different offices helped the researcher to identify about 29 years, LULCC classes such as crop land, forest, settlement, range land and water body in the woreda.

Again the main Couse of land use land cover change were also identified as; population pressure, expansion of agricultural land, need for fuel wood and construction materials, and absence of natural resource tenure policy enforcement body. Another point that the research uncovered was the effect of land use land cover change in the woreda. These effects, according to the informants, are land degradation, Loss of plants and animal's species, hydrological impact and animal feed shortage.

4.3.1. Major causes of land cover dynamics

4.3.1.1 Population Pressure

In Shashogo woreda there is rapid population growth due to high fertility and demand for crop land because the study area is suitable for crops such as hot pepper production, maize sorgum, etc. According to the woreda health office, family planning is not properly implemented and due to lack of awareness majority of people of the woreda are not in a right track to use long family planning. The woreda health experts explain that the short family planning is not effective to balance the number of population with plan of woreda health office which was planned to control the rapid population growth in the study area. However, as a result of continuous birth rate without using any family planning program the woreda especially in the south west and north eastern part of the woreda, the woreda health office was failed to reduce the number of population even the family planning program is Present to past. The crop land was increased from time to time to balance the increasing demand of food with growing population this condition leads the decrease of continuously land classes such as forest and range land.

Generally, rapid population growth in the study area is the main driving force of LULCC. Population growth in the woreda resulted in shortage of farming land and grazing land, forest degradation, decline in agricultural productivity, shortage of fuel wood and construction materials, climate change, drying up of source of river, decrease in number of livestock due to lack of grazing land and conflict on land

4.3.1.2 Expansion of Agricultural Land

Agriculture is back bone of economic development of the study area. According to key informants of the study expansion of agricultural land, one of the main causes of LULCC in the study area is mainly caused by rapid population growth, lack of job opportunity in nonagricultural sector, lack of modern agricultural practices, problem on natural resource management, and lack of interest of woreda officials to support farmers (Abinat, desta, Kemal, and et.al, personal interview, March 2019). In short, expansion of agricultural practices in the woreda negatively affects natural environment in many ways such as land conversion (forest to crop land through deforestation(See figure 22), rangeland to crop land and water body to range land), deforestation, soil erosion, and climatic change, decrease the volume of water, soil infertility, extinction of wild animals and natural forest.

Figure 13: Expansion of agricultural land by cutting forest at kemacho kebele, shashogo woreda (photo by Author)

4.3.1.3 The Demand for Fuel Wood and Construction Materials

According to data collected from key informants and the FGD, the main source of energy in Shashogo woreda is fuel wood - fire wood and charcoal- which is the leading cause for deforestation next to agricultural expansion in the woreda. As Desta (one of the informant) explained people cut the trees for agricultural land expansion, to use it as a fire wood, to produce timber, for charcoal, for illegal wood trading, for fence and house construction. In addition to this, many people in the woreda use fire wood and charcoal as a source of income they sell it out to their neighbors in the rural areas and for urban dwellers. As the number of people has been increasing from time to time, the need for shelter was increased; the demand for construction materials was also increased and this resulted in deforestation in the study area (FGD2, March 2019).Furthermore, the key informants stated that forests close to settlement (urban and rural) areas were vulnerable to great extraction of construction woods and timber products and resulted in fast deforestation .Generally, the people of Shashogo woreda are using forest and its products as a source of energy by cutting trees and use it as income by selling in both rural and urban areas to improve their livelihood condition.

4.3.1.4 Ineffective natural resource conservation

The data collected according to key informant's population pressure and agricultural land expansion considered as main Couse that enforced local communities to extraction forest to increase food production for their household needs in study area. This distraction of forest and other natural resource such as range land for agriculture were occurred due to ineffective protection and conservation of natural resources of the study area.

As FGD discussant expressed....

"Forest resource conservation practice and planning was low. Therefore, the conservation method should be applied to recycle the coverage of forest by creating awareness to the societies, government and other stakeholders such as NGOS must be take more responsibility, nowadays even if the guard and other authorized persons itself know participating in timber selling activates if this situation is continued we never see forest even as tourist so the Conservation activity must be started with individual levels by Afforestation and Reforestation, the government itself must be strengthened the forest conservation policy .we know some movements in year of 2000E.C. It used as rising of forest at some level, but it can't upraise as past 1990's level. In addition to this, the numbers of save guards are very small and they have no training regarding forest conservation methods. Therefore, giving awareness for guards, local communities, and others those participated on buying and selling of forest products are significant regarding natural resources conservation and improvement. The government must revise strategies and policies related to forest and other natural resources require additional investigation because during Derg regime there was better forest resources management in the area."

4.3.2 Impacts of Land Cover Dynamics on the Study Area

Land Use Land Cover change has negative impact on natural environment and cultural landscape such as Forest degradation, land degradation, Loss of plants and animal's life's, local climatic change, hydrological impact, and other socio economic and political conflict among local communities. These can affect significantly food security and rural livelihood system of Shashogo woreda. According these the main potential environmental effects of LULCC in the study area are as follows.

4.3.2.1 Forest Degradation

According to discussion with FGD and key informants the main causes for forest degradation in the woreda are; population pressure, expansion of crop land, illegal seizure of land, fire wood and charcoal production, increasing need for construction materials and settlement expansion. People's clearing of forests for agricultural purposes brought deficiency of big trees for building of houses and shadow for humans and livestock, and finding wood for fire become worsening in the woreda (Abinet and Tegese, personal interview, March 7,2019). The other informants described about large forests which are diminishing from time to time in the woreda. Those are shafi, Alemu, miriatab, temesgen, and others (FGD2, March, 2019). They were cleared out by the people of the woreda for searching of cultivation, timber, grazing of their cattle, for fire wood and for construction. According to Desta erjabo, the former Developmental Agent of the woreda, "forest lands were cleared and changed to crop land. The main effects of forest degradation in Shashogo woreda are; soil erosion, flooding particularly near to Boyo lake of the woreda, drying up of water source in northern part of study area, extinction of indigenous tree and wild animals(especially crocodile and hippopotamus) , climatic change, land slide, shortage of fire wood and construction materials and others.

4.3.2.2 Land Degradation

The data collected from FGD and key informant explain that the main causes of land degradation are; rapid population growth, deforestation, over cultivation, overgrazing, natural resource management, backward farming system. Due to population pressure land degradation in forms of soil erosion is common in the central part pert of the woreda as a result, there is reduction in agricultural production and productivity because of this people in local area are not food self-sufficient. From the KII an expert from Agricultural and Rural development office- explained that the excess soil erosion that has happened by runoff and gully erosion is the effect of clearing of tree. This back effect is loss of soil fertility and productivity of the woreda. Furthermore, "In order to replace or afforest the area, people are planting trees of foreign origin like tid and behar zef. These plants that has long root have the capacity to deplete the soil fertility" (FGD1, March, 2019). Hence, the study area land cover has been affected by different human activities. Miss understanding about the natural resource conservation, deforestation, over grazing and population growths are the major factors that brought land degradation in the area. As alternative way introducing effective implementation of new mechanized technologies on farming in the woreda is significant for controlling soil degradation and infertility.

Figure 14: Degraded land in bonsha keble in shashogo woreda (photo by Author)

4.3.2.3 Impacts on Extinctions of biodiversity

In study area especially around Lake Boyo (which is found central part of shashogo) Wildlife diversity was totally declined. The area previously well known by hyena, hippopotamus, crocodile, etc., but recently according data collected from KII especially hippopotamus doesn't seen an area. The reasons for losses of biodiversity are the expansion of agriculture by affecting forest, Grass and other land cover classes. In FGD similarly stated that the decline of forest cover caused a decline in the number of wild animals in study area. For example, animals such as hippopotamus and crocodile which were commonly found in the study area now disappeared.

4.3.2.4 Impacts on climatic variability

Climate change affects water resources and soil formation systems directly and indirectly. Land cover dynamics have also different impacts on local and regional climate of the world (Solomon, 2016).Similarly in study area agricultural officers and forestry experts agreed that the local communities' deforests the forest area to obtain different forest products that affects local climates. The study area exhibited a gradual warming with decreasing rain fall and most times the area was attacked by unseasonal rain fall it following expansion of previously unknown dieses expanding at fast rates such as malaria other animal diseases. Furthermore, the climatic changes were unfavorable to agricultural activities. Therefore, recently the study area local communities are affected by shortage of rain fall as well as unseasonal rainfall. The decline in forest and unseasonal rainfall courses in decline in agricultural production and productivity.

According the woreda agricultural experts because of climate change hydrological impact is one of the main effects of LULCC in shashogo woreda, which was mainly resulted from deforestation and expansion of agricultural land. According to 98 years old elder (Imam shafi, March, 2019) due to climate change previously deep water bodies were changed to shallow (e.g. Lake Boyo) also most of water bodies were dried because of this recently watering of cattle and animals became worse.

Figure 15: previously deep Boyo Lake now shallow in shashogo woreda (photo by Author)

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

In study area LULC change effects and influences has become a major problem for environmental change as well as natural resource planning and management. Identifying the complex interaction between changes and its drivers over space and time is important to predict future developments and set decision making mechanisms.

This study provides four land cover maps from quantitative analysis of satellite images (TM, ETM+ and OLI) that used to detect the land use land cover and its transitional matrix. There are five land cover classes identified during satellite image classification namely: forest land, range land, crop land, water body and settlement land. The quantitative analysis of satellite images of the study area showed that the presence of significant land use land cover change in the study area between 1990 and 2019. The land use land cover classification result for the reference year 1990, the largest area was covered by crop land and small area by water body, which constitutes 41.6% (14,732.1ha) and 2.5% (887.8ha) respectively. The rangeland, forest and settlement were covered 36.4 %(12,894.7ha), 15.67 % (5,538.7ha) and 3.74 %(1,323.30ha).

The land use land cover classification for the year 2000 area was covered by crop land 55.5%(19,621.8ha), water body 2.53%(896.5ha),rang land 26.5%(9,379.73ha) forest land were accounted 7.6% (2,671.6ha) and settlement 7.9%(2,806.97ha). In 2010 area was covered by crop land 58 %(20,519.2ha), water body 4.4 %(1,560ha), rang land 25.6 %(9,108ha) forest land was accounted 3% (1,065.8ha) and settlement 8.8 %(3,123.6ha). In final year (2019) land use land cover classification analysis the study showed that the cropland 63.1% (22,321.2ha), water body 3.1% (1,083), range land 16 %(5,644.1ha) forest 7.9% (2,785.6ha), settlement 10% (3,542.7ha) respectively. In the last section, land use land cover projection was applied using Marcov Chain model to show changes in the future.

The data collected from satellite image that strengthened by KII and FGD, indicates that change was continuous on forest and range land due to high population growth, high demand for crop land, charcoal making and fire wood. Crop land and settlement land increased year to year continuously during the study periods to balance the increasing demand of food for the rapidly growing urban and rural population. In addition to this, the main Couse of land use land cover change in shashogo woreda are population growth, expansion of agricultural land, need for fuel wood and construction materials and charcoal, and ineffective natural resource conservation practice from woreda to kebele level.

The effects of land use land cover change in shashogo woreda are forest degradation, land degradation loss of bio diversity and climatic variability. The result of these change the life of the people were affected by minimizing the number of their livestock, eroding of soil, changing the weather condition (rainfall and temperature) of the area. Generally, land use land cover change in shashogo woreda was mostly exceeded by population growth causing deforestation which makes the capacity to affect the life of fauna and flora.

5.2. Recommendations

Based on these findings to minimize the impacts of inappropriate land use Land cover change, the following recommendations are suggested for future studies:

- As can be observed from this study, due to the expansion of crop land and settlement, other natural resources were damaged. Therefore, the woreda's Forest and Natural Resource Conservation Office and woreda's Agriculture and Rural Development Office should give awareness and initiations the farmers about natural resources use and conservation.
- For house hold energy consumption fuel wood was the dominant energy source, but it was identified as one of factor that increases deforestation. Therefore, to increase forest coverage, the administrative office and other concerned bodies of Woreda, especially forestry and Natural Resource Management Office should give awareness for communities to use alternative energy sources such as Biogas, etc.
- The main case for land use land cover change of the woreda was abnormal population growth in the woreda. The population growth has happened due to uncontrolled birth rate so, shashogo woreda government was required to educate the society about family planning and the impact following high birth rate.
- To save and guard the sustainability of natural resources, further investigation will be required on each class of natural resources. That mean, issues of forest, rang land, crop land, water body and settlement expansion requires new research separately and in complete manner. So, hereby I call up other researchers to dig out a problem on issues to bring sustainable solution in study area.

References

Abate, S. (2011). Evaluating the land use and land cover dynamics in Borena Woreda of South Wollo highlands, Ethiopia. *Journal of Sustainable Development in Africa*, **13 (1)**: 87- 105.

Abinet ,T. (2011).Impact Of Area Enclosure On Soil Quality And Farmers Perception In Closed Area at Tachignaw Gimbichu, Shashogo Woreda,Hadiya Zone ,Ethiopia. MSC Theses, Addis Ababa University, Addis Ababa, Ethiopia

Abiy,W. (2014).Detecting Land use/Land cover Change using Remote Sensing & GIS Techniques and Analysis of its Causes, Consequences and trends in Ofla wereda, Tigray Region, Ethiopia. MSC Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Altman, D. (1991). Practical Statistics for Medical Research. London: Chapman & Hall/CRC

Anderson, J.R. (1971). Aland use and land cover classification system for use with remote sensor data (vol.964). US Government printing office. Study of Iorin and Its Environs in Kwara State

Asenafi, B.(2008). Landuse/landcover dynamics in prosopis juli flora invaded area of Metehara and the surrounding districts using remote sensing and GIS techniques. Unpubished MSc Thesis, Addis Ababa University, Addis Ababa, Ethiopia, 88pp.

Belay, T. (2002). Land-cover/land-use changes in the Dere kolli catchment of the South Welo Zone of Amhara Region, Ethiopia. *Michigan State University Press*, **18**(1): 1-20

Berhan ,G. (2010). The role of Geo-information technology for predicting and mapping of forest cover spatio-temporal variability: Dendi district case study, Ethiopia. *Journal of Sustainable Development in Africa*, **12(6)**: 9-33.

Berhan, G. (2007). Forest Cover Change and Susceptibility to Forest Degradation Using remote sensing and GIS Techniques: a Case of Dendi woreda, West Central Ethiopia. Addis Ababa: MSC Thesis , Addis Ababa University, Addis Ababa ,Ethiopia

Bireda, A. (2015). GIS and Remote sensing based land use/land cover change detection and prediction in Fagita lekoma woreda, awi zone, north western Ethiopia. MCS thesis, Addis Ababa University, Addis Ababa,Ethiopia

Chaudhary, S., Chettri, N., Uddin, K., Khatri, T.B., Dhakal, M., Bajracharya, B., Ning, W., 2016. Implications of land cover change on ecosystems services and people's dependency: A case study from the Koshi Tappu Wildlife Reserve, Nepal. *Ecological Complexity* **28**:200-211.

Chen X, Vierling L, Deering D. A simple and effective radiometric correction method to improve landscape change detection across sensors and across time. *Remote Sens Environ.* 2005;**98**(1):63–79. doi: 10.1016/j.rse.2005.05.021.

Congalton, R. G. and K. Green. (1999). Assessing the accuracy of remotely sensed data: Principles and practices. Lewis Publishers, Boca Raton.

Cres well, J.W. (2009). Research design. Qualitative, Quantitative and mixed methods approaches (3rd ed.). California: sage publication Inc.

CSA, (2007). FDRE/CSA. The 2007 population and housing census of southern nations nationalities and peoples‟ region statistical summary report, Addis Ababa.

Daniel, A. (2008). Remote sensing and GIS based Land use and Land cover change detection in the upper Dijo river catchement, Silti zone, southern Ethiopia. Unpublished MSc Thesis and Report, NTNU and Addis Ababa University,Norway,37pp.

DeBie, C. and Zuidema, A.(1996). The Land Use Database: Knowledge-based Software Program for Structured Storage and Retrieval of User-defined.

Ebrahim and Mohamed, (2017). Land use/cover dynamics and its drivers in Gelda catchment, Lake Tana watershed, Ethiopia. Department of Geography and Environmental Studies, University of Gondar. Economic and Political Weekely,July10,pp3087-89

Ellis, E.,and. Robert P. (2007). "Land-use and land-cover change." In:Encyclopedia of Earth. Eds. Cutler J. Cleveland

Estmen, J.(1995). Idrisi for Windows User Guide Version 1/0.Clark University.

Fan F, Weng Q, Wang Y. (2007). Land use land cover change in Guangzhou, China, from 1998 to 2003, based on Landsat TM/ETM+ imagery. *Sensors.* 2007;**7**:1323–1342. doi: 10.3390/s7071323.

FAO, (2012). Global forest land-use change 1990–2005. FAO Forestry Paper No. 169. FAO, Rome, Italy

FAO.(2010). Global Forest Resources Assessment 2010. Country Report, FRA2010/065. Rome, Italy. FAO. 2016. State of the World's Forests 2016. Forests and agriculture: land-use challenges and opportunities. Rome, Italy

FAO.(2016). State of the World's Forests 2016. Forests and agriculture: land-use challenges and opportunities. Rome, Italy.

Gessesse,G. (2007). Forest Decline in South Central Ethiopia: Extent, History, and Process. Ph.D. thesis, Stockholm University, Stocholm

Giri, C., Defourny, P. and Shrestha, S. (2003). Land cover characterization and mapping of continental Southwest Asia muti-resolution satellite sensor data. *International Journal of Remote Sensing.* **24(21)**: 4181-4196.

Girma, T. (2001). Land degradation: A challenge to Ethiopia. International Livestock Research Institute, Addis Ababa, Ethiopia, 815-823.

Gorman GE, Clayton, P. (2005) Qualitative Research for the Information Professional: A Practical Handbook. 2nd edn, Facet Publishing, London, UK, p: 282.

Grenier, M., Labrecque, S., Benoit, M. and Allard, M. (2008). Accuracy assessment method for wet land object based classification.In: Proceedings of the XXXVIII-4c1. ISPRS, Aug 5-8,2008.Calgary,Canada.

Hailemariam, S.N., Soromessa, T., Teketay, D. (2016). Land Use and Land Cover Change in the Bale Mountain Eco-Region of Ethiopia during 1985 to 2016. Land (5) **41**: doi: 10.3390/land5040041.

Houghton, R.A., Hackler, J.L., (2006). Emissions of carbon from land use change in sub-Saharan Africa. *Journal of Geophysical Research* **111**: G02003. doi: 10.1029/2005JG000076.

Hussein .A,.(2009). Land use and land cover change, Drivers and its Impact: A comparative Study from Kuhar Michael and Lenche Dima of Blue Nile and Awash Basins of Ethiopia. Unpublished MSc Thesis, Cornel University, Bahirdar, Ethiopia,139pp

Iacono, M., Levinson, D., El-Geneidy, A. and Wasfi, R. (2012).A Markov Chain Model of Land Use Change in the Twin Cities, 1958–2005.University of Minnesota, USA.

Jensen, J.R. (1996). Introductory Digital Image Processing: A Remote Sensing Perspective, 2nd Ed., New Jersey, Prentice-Hall.

Kebrom, T., &Lars, H. (2000). Land-cover changes between 1958 and1986 in Kalu District, Southern Wello, Ethiopia.Mountain *Research and Development* 20, no. **1**: 42-51.

Kibret, K.S., Marohn, C., Cadisch, G.,(2016). Assessment of land use and land cover change in South Central Ethiopia during four decades based on integrated analysis of multi-temporal images and geospatial vector data. Remote Sensing Applications: *Society and Environment* **3**: 1-19.

Kindu, M., Schneider, T., Teketay, T., Knoke, T.(2015). Drivers of land use/land cover changes in Munessa-Shashemene landscape of the south-central highlands of Ethiopia. *Environmental Monitoring and Assessment*. doi: 10.1007/s10661-015-4671-

Kinfe G. (2011). The impact of land use and land cover dynamics on the vegetation and soil characteristics of south omo rangelands: the case of Malle woreda, Ethiopia. MSC Thesis, Haramaya University, Ethiopia

Lambin, E.,Geist, H. and Lepers, E.(2003). Dynamics of Land Use/cover Change in Tropical

Lawrence, D., Vandecar, K.(2015). Effects of tropical deforestation on climate and agriculture. *Nature Climate Change* **5**: 27-36.

Lemlem ,A,. (2007). Assessing the Impact of Land Use and Land Cover Change on Groundwater Recharge Using Rs and Gis; a Case of Awassa Catchement, Southern Ethiopia.M. Sc. Thesis. Addis Ababa University, Ethiopia.

Levinson, D. and Chen, W. (2005).Paving new ground. Access to Destinations, pp. 243–266. Retrieved from https://books.google.com.et/books on Dec. 19, 2019.

Lillesand, T.M, R. Kiefer, and J.W. Chipman. (2004). *Remote Sensing and Image Interpretation* (5th edition).John Wiley & sons, Inc. New York. Helens, Washington. *Remote Sensing Of environment.* **64**, 91-102.

Lillesand,T. and Kiefer, R.W.(1994). Remote sensing and Image interpretation.Third ed., John Wiley &Sons, Inc., 750pp.

Loppiso ,Sh. (2010). Assessment of Land Use Land Cover Dynamics and Its Impact on soil loss: Using GIS and Remote Sensing, in ShashogoWoreda, Southern Ethiopia.

Lu D, Mausel P, Brondizio E, Moran E.(2004). Change detection techniques. *Int J Remote Sens.* **25(12)**:2365–2407. doi: 10.1080/0143116031000139863

Lu, D., Mausel, P., Brondi´zio, E. and Moran, E. (2003). Change detection techniques. *INT. J. Remote Sensin.* **25(12)**, 2365-2407.

Maitima. J, Mugatha. S, Reid .R, Lyaruu .H, Pomery. D, Gachimbi .L, Mathai .S, Mugisha .S, Majule. A .(2009). The linkages between land use change, land degradation and biodiversity across East Africa. *International Livestock Research Institute*, **3(10)**: 310-325.

McClelland, D.G. (1998). U.S. Food Aid and Sustainable Development: Forty Years of Experience.

Mengistie. K, Thomas,S., Demel.T, Thomas, K.(2013). Landuse/Landcover change analysis using Object based classification approach in Munesa Shashemene Landscape of the Ethiopian highlands. *Remote sens*.**5**:24 11- 2435.

Mesfin,A.(1991).Significance of Ethiopia coffee Genetics Resources to improvement In: plant Genetic in Resources of Ethiopia

Messay,M. (2011). Land use/Landover Change Dynamics in Nonno District, Central Ethiopia. *Journal of Sustainable Development in Africa (Volume 13, No.1, 2011).*

Meyer, W. and Turner B. II (eds.) (1994). Changes in land use and land cover: A global Perspective 713pp. Cambering: Cambridge University.

Meyer, W. B., (1995). Past and Present Land Use and Land Cover in the United States of America‟, Consequences, vol.1.

Muleta, E,. (2009). Land use/land cover dynamics and soil degradation assessment using remote sensing and GIS: a case study of Jima Arjo woreda (western Ethiopia). M.Sc. Thesis, Addis Ababa University, Addis Ababa Ethiopia.

NMSA (National Meteorological Services Agency), (2017). Initial national communication of Ethiopia to the UNFCCC. Addis Ababa

Prakasam, C.(2010). Land Use and Land Cover Change detection through Remote Sensing Approach: A Case Study of Kodaicanaltaluk, Tamil nadu. *International Journal of Geomatics and Geosciences, **1**:150–158*

Rahman A, Kumar S, Fazal S, Siddiqui MA.(2011).Assessment of land use/land cover change in the North-West District of Delhi using remote sensing and GIS techniques. J Indian Soc Remote Sens. 201

Riebsame, W., Meyer, B. and Turner, B. (1994). Modeling Land-Use and Cover as Part of Global Environmental Change. Climate Change.

Seto, K. (2002). Monitoring land use change in the Pearl River Delta using land sat TM. *International Journal of Remote Sensing*, ***23 (10),*** *1985-2004.*

Sherbinin, A. (2002). Land use and Land cover change; A CIESIN Thematic Guide. Center for International Earth Science Information Network of Colombia University.

Solomon. M. (2016). Effect of Land Use Land Cover Changes on the Forest Resources of Ethiopia. Department of Forestry, Wollo University, Dessie, Ethiopia, *International Journal of Natural Resource Ecology and Management.*

Stocker, B.D., Joos, F.(2015). Quantifying differences in land use emission estimates implied by definition discrepancies. *Earth System Dynamics* **6**: 731-744.

Tegene, B,. Land-cover/land-use changes in the dere kolli catchment of the South Welo Zone of Amhara Region, Ethiopia. East. Afr. Soc. Sci. *Res. Rev*. **18**: 1–20

Teshome, B,. (2012).Ensuring sustainable forestry management in Ethiopia from the Millennium development goals perspectives. Addis Ababa: MA Thesis, Addis Ababa University, Addis Ababa, Ethiopia

Tewolde, B., Mayakovski, W., Cabral T. (1991).Convention on Biological Diversity (CBD) Ethiopia's 4th Country report. Institute of Biodiversity Conservation Addis Ababa, Ethiopia.

Tilahun A, Takele B, Endrias G (2001). Reversing the degradation of arable land in the Ethiopian Highlands. Managing Africa's Soils No. 23.International center for research in agro forestry.

Tulu,T.(2017) Spatio-temporal land use/land cover change, driving forces and consequences in Ameya woreda, central, Ethiopia. MSC theses , Addis Ababa university, Addis Ababa ,Ethiopia

Turner, B.(1995).In Leemans, R., (eds.).Land-Use and Land-Cover Change. Report N°7. Stockholm and Geneva, IGBP and HDP.

Warra H.H, Mohammed AA, Nicolau MD (2013) Spatio-temporal impact of Socio-economic practices on land use/land cover in the kasso catchment, Bale Mountains, Ethiopia. Scientific Annals of "Alexandru Ioan Cuza" University of IAŞI, Volume LIX, no.**1**, S. II C, Geography series,1–26

Woldeamlak .B,. Sterk, G. (2005). Dynamics In Landcover And Its Effect On Stream Flow In The Chemoga Watershed, Blue Nile Basin, Ethiopia. *Hydrol.Process*. **19**:445-458.

Wubie, M,. Assen, & Melania D.Nicolau. (2016). Patterns, causes and consequences of land use/cover dynamics in the Gumara watershed of Lake Tana basin, north western Ethiopia. Department of Geography and environmental studies, BahirDarUniversity, Bahir Dar, Ethiopia

Zeleke, G,.and Hurni, H,.(2001). Implications of land use and land cover dynamics for mountain resource degradation in the northwestern Ethiopian Highlands. *Mt. Res. Dev.* **21**: 184–191

Zubair,A.(2006).Change Detection in Land cover/Land Use Using Remote sensing Data and GIS: Case.

APPENDIX I

Interview Guide for Key informants

Dear respondents

My name is Siyum Habte. I am a postgraduate student at Jimma University, Department of Geography and Environmental studies. Now I am writing my **MSc thesis on the detecting land use land cover chang**e using GIS and Remote sensing technology in a case of Shashogo woreda, Hadiya zone, SNNPRS, Ethiopia.

You have been selected purposively from experts in shashogo woreda Agricultural office, Developmental Agents, chair persons and forest management office of study area. The responses you give are important and used for the analysis of this research. You not be identified by your name in any case. If you accept to participate in this research you so voluntarily. You are also free to refuse to respond to any questions you do not feel comfortable or to withdraw from the research participation.

Thank you!

1.1 Background of Key informants

Interview guide to be organized to Chair person, Agricultural office, Forest management office and Developmental Agents of Shashogo woreda.

1. Age __________ 2. Sex ________ 3. Education level _______________________________ 4. Your position in the Office____________________ 5. Year of services in the Office____________________

1.2 Interviews about land cover dynamics and its impacts:

1. For how many years do have you been hear?

2. Please can you describe land use land cover dynamics in the area from1990-2019?

3. What do you say the main causes of land cover change?

4. Which period is remarkable for you about forest cover declining?

5. Which type of land use land cover classes increases, decrease and unchanged from year of 1990-2019? (Hint: Agricultural, Forest, Grass land, Water bodies and Settlements)

6. What are the main socio economic impacts of land use land cover change in shashogo Woreda?

7. What do you recommend to reduce the impacts?

APPENDIX II

2.1 The focus group discussion Guide: to be administered to poor farmers and rich farmers,

Elderly Men and Women of the study area.

Background of focus group discussants 1. Age __________ 2. Sex _________ 3. Level of education______________________________4. Your major source income ____________________ 5. Is there additional source of income, please mention ___________________

2.2 Focus group discussion about land use land cover dynamics and its impacts the main discussion Points

1. What are the main livelihoods you practiced to sustain your family?

2. What likes the population number of this area? Increasing or decreasing?

3. What do you think is there significantly changed land cover woreda?

4. Which land use land cover class has greatly changed over the last 30 years?

5. Which period is remarkable for you in the process of forest cover declining?

6. What does the trend of natural forest cover look like in this area?

7. What do you say about the major causes of land use land cover change?

8. Please can you describe any land use land cover types that significantly increase, decrease and unchanged?

9. What are the main socio economic impacts of land cover change in your area?

10. What do you recommended possible solutions to be taken to reduce the impacts of land cover dynamics of the area?

APPENDIX III

Sample pictures from field

Sample of settlement area

Sample of forest area

Sample of Crop Land

Range land

Water body

APPENDIX IV

Sample of GPS points for land use land cover classification

A. Crop land

X	Y	x	y
405181	836342	407025	831908
389565	823298	398846	825701
401072	835310	392139	823407
399108	825747	400254	834385
399032	825335	401551	836214
404262	834972	402142	835220
402087	831887	397064	823676
403129	831684	403586	836119
402438	830097	398973	824448

B, Range Land

X	Y	x	y
399727	830852	386199	826973
389810	829266	400066	830818
389889	826236	397447	830333
395845	833826	396623	831004
389526	827429	395589	831403
387644	829498	396747	832185
390249	826330	397611	833024
390930	826831	399694	834329
390309	827146	394843	831573

C, Forest

X	Y	x	y
400482	834742	397381	836168
395565	842148	398496	836427
395188	841576	396083	833574
398157	844148	399042	830817
387057	834061	397642	829395
402249	839125	397702	830425
400434	840538	397652	831171
396821	836063	397985	831087
396637	836036	398611	831121

D, Water Body

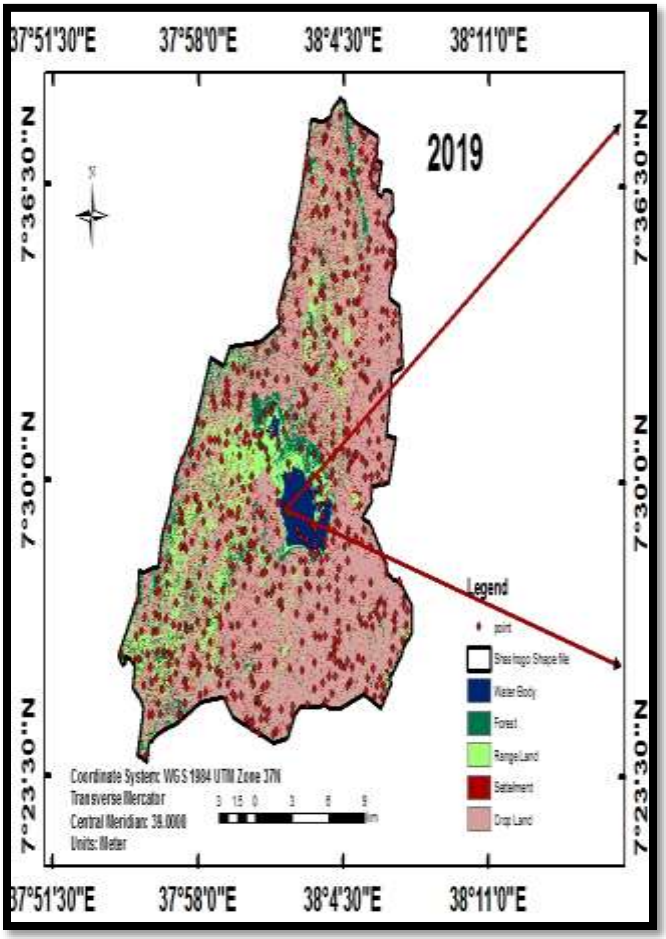
X	Y	x	y
394996	835941	393366	828856
395387	835762	393428	827822
395360	835532	394413	827545
395145	835581	393982	826774
394968	835503	394345	826825
394891	835393	394689	827354
394679	828166	395086	826591
396334	826585	396314	826483
393471	826905	395529	826875

D, Settlement

X	Y	x	y
399603	831924	399962	830491
399846	832219	399593	830192
400562	832034	399991	830189
400631	832400	399302	831065
401026	833738	396560	832871
401996	835019	395451	833600
399706	834799	393359	834081
399219	833886	398454	831755
398801	833166	390204	825769

APPENDIX V

Sample of Classified image with sampling points for accuracy



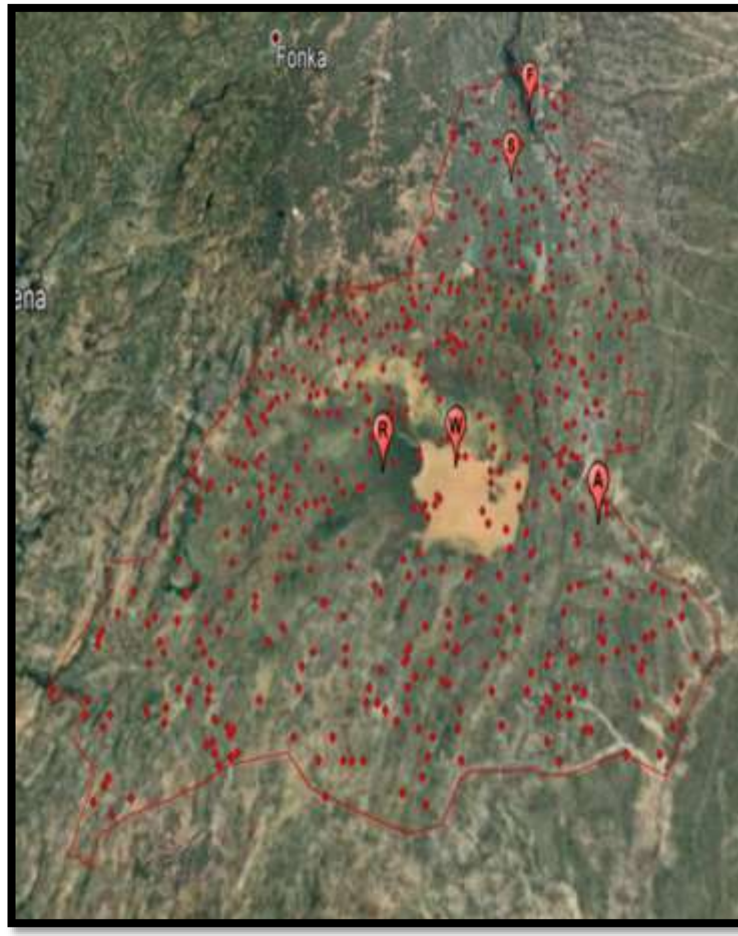


Fig. 2 Location of 364 sample points for accuracy

A= Agriculture R =Range land F =Forest W =water body S=Settlement

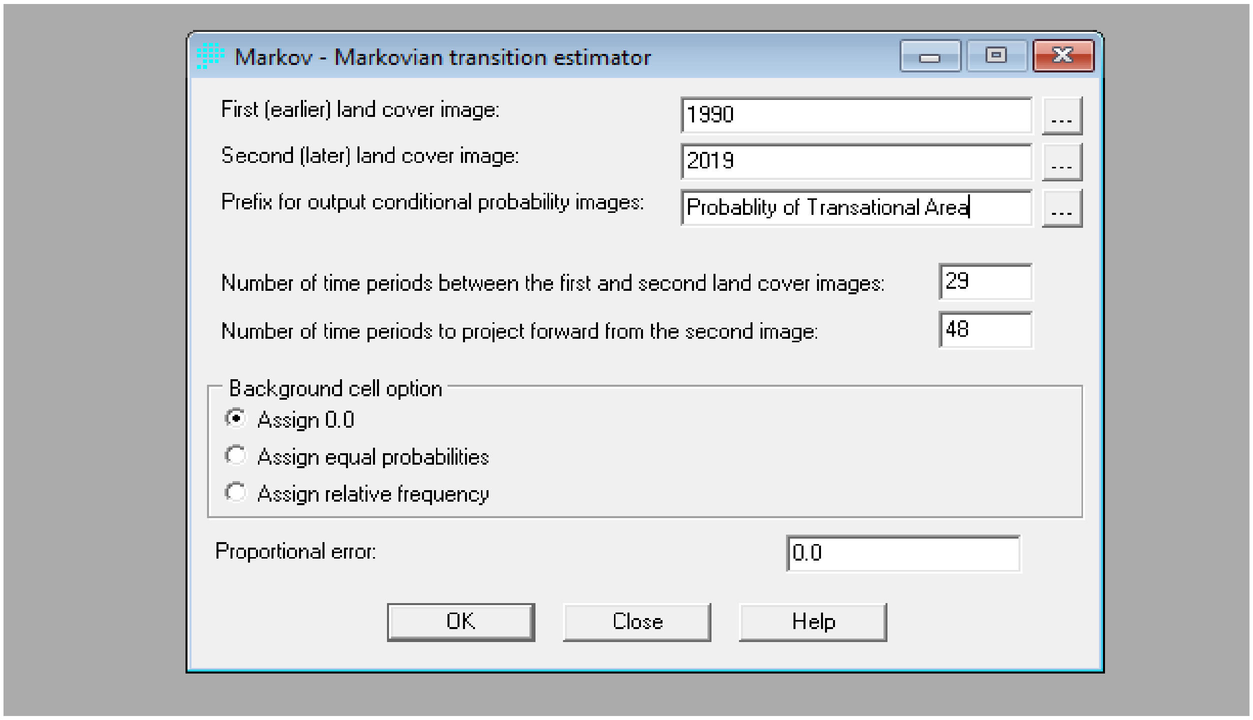
APPENDIX VI

Sample of Conversion matrix (1990-2019)

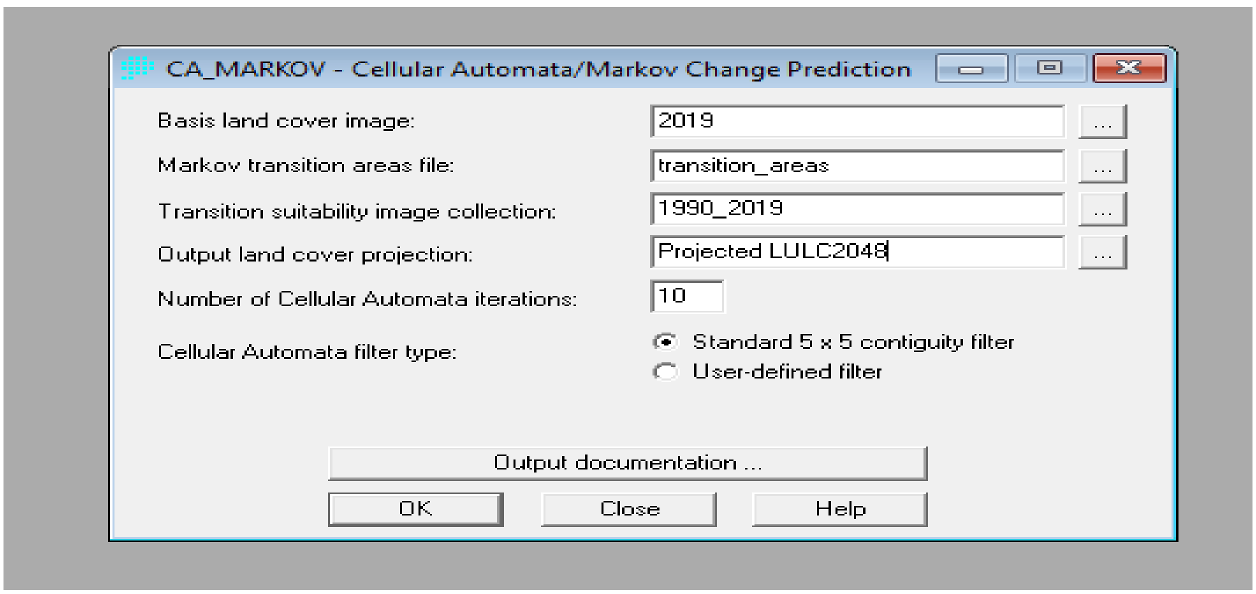
Conversion matrix from 1990 to 2000		2000					Total area(ha)
		Water Body	Forest	Rangeland	Settlement	Crop Land	
1990	Water Body	423.40	0.02	3.22	0.13	0.14	426.91
	Forest	250.30	544.32	1,260.21	234.30	2,303.48	4,592.61
	Range land	166.31	1,027.02	1,673.20	1,033.91	10,026.17	13,926.61
	Settlement	10.22	88.02	193.12	872.43	50.01	1,213.80
	Crop Land	0.15	133.90	470.50	790.65	13,821.49	15,216.69
Total area(ha)		850.38	1,793.28	3,600.25	2,931.42	26,201.29	35,376.62

Conversion matrix from 2000 to 2010		2010					Total area(ha)
		Water Body	Forest	Rangeland	Settlement	Crop Land	
2000	Water Body	501.10	0.05	0.02	0.66	0.15	501.99
	Forest	130.30	220.32	1,470.21	294.20	2,705.40	4,820.43
	Range land	79.91	998.20	1,276.20	1,238.32	11,056.20	14,648.83
	Settlement	77.23	50.43	69.97	977.50	32.19	1,207.32
	Crop Land	0.90	101.30	560.33	990.22	12,545.10	14,197.85
Total area(ha)		789.44	1,370.30	3,376.73	3,500.90	26,339.04	35,376.42

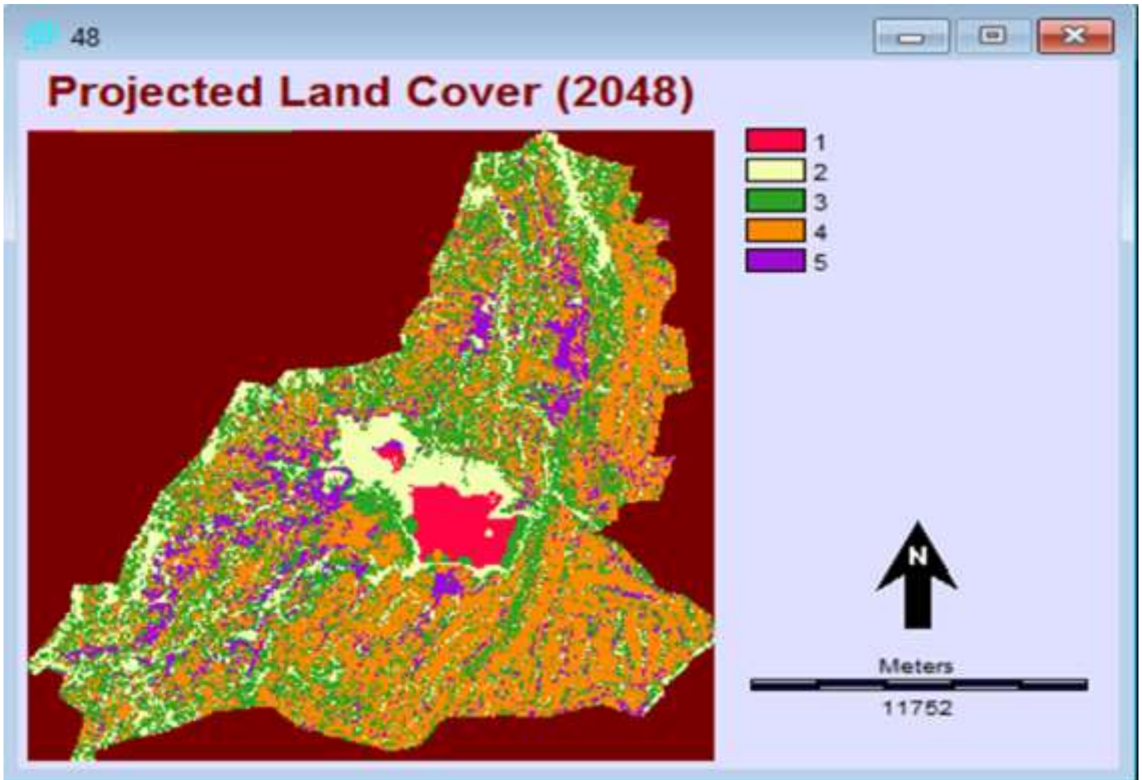
Conversion matrix from 2010 to 2019		2019					Total area(ha)
		Water Body	Forest	Rangeland	Settlement	Crop Land	
2010	Water Body	340.53		0.87	30.21	10.23	381.84
	Forest	90.30	280.92	1,110.20	120.32	1,829.39	3,431.13
	Range land	20.18	764.31	1,678.30	1,934.21	10,056.20	14,453.20
	Settlement	10.09	0.21	50.22	1,021.27	47.11	1,128.90
	Crop Land	20.84	10.23	452.37	953.01	14,545.10	15,981.55
Total area(ha)		481.94	1,055.67	3,291.96	4,059.02	26,488.03	35,376.6

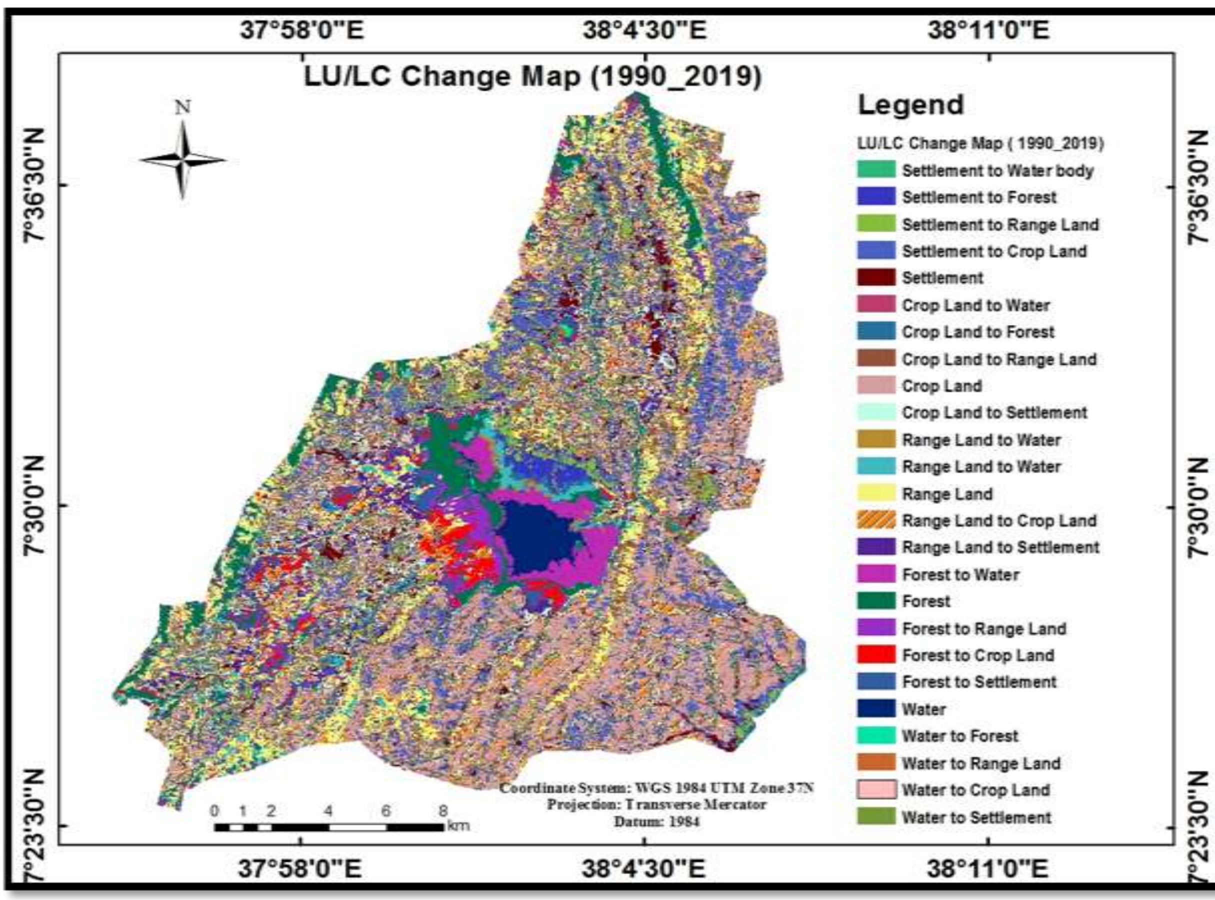


Sample of Markovian transitional area calculation



Sample of CA_Markov LULCC prediction


48
Projected Land Cover (2048)
1
2
3
4
5
N
Meters
11752


37°58'0"E
38°4'30"E
38°11'0"E
LU/LC Change Map (1990_2019)
Legend
LU/LC Change Map (1990_2019)
Settlement to Water body
Settlement to Forest
Settlement to Range Land
Settlement to Crop Land
Settlement
Crop Land to Water
Crop Land to Forest
Crop Land to Range Land
Crop Land
Crop Land to Settlement
Range Land to Water
Range Land to Water
Range Land
Range Land to Crop Land
Range Land to Settlement
Forest to Water
Forest
Forest to Range Land
Forest to Crop Land
Forest to Settlement
Water
Water to Forest
Water to Range Land
Water to Crop Land
Water to Settlement
N
7°36'30"N
7°30'0"N
7°23'30"N
0 1 2 4 6 8
km
Coordinate System: WGS 1984 UTM Zone 37N
Projection: Transverse Mercator
Datum: 1984