RATE OF LAND USE LAND COVER CHANGES AND ITS DRIVING FORCES IN SETEMA DISTRICT JIMMA ZONE, ETHIOPIA

MSc. THESIS

BY: TADESSE LETA JIRU

THESIS SUBMITTED TO SCHOOL OF GENERAL FORESTRY, HAWASSA UNIVERSITY WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES, HAWASSA UNIVERSITY, WONDO GENET, ETHIOPIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF

MASTERS OF SCIENCE IN FOREST RESOURCE ASSESSMNET AND MONITORING

WONDO GENET, ETHIOPIA

OCTOBER, 2020

RATE OF LAND USE LAND COVER CHANGES AND ITS DRIVING FORCES IN SETEMA DISTRICT JIMMA ZONE, ETHIOPIA

MSc. THESIS

BY: TADESSE LETA JIRU

THESIS SUBMITTED TO SCHOOL OF GENERAL FORESTRY, WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES, SCHOOL OF GRADUATE STUDIES, WONDO GENET, ETHIOPIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF

MASTERS OF SCIENCE IN FOREST RESOURCE ASSESSMNET AND MONITORING

OCTOBER, 2020

WONDO GENET, ETHIOPIA

APPROVAL SHEET I

This is to certify that the thesis entitled "Rate of land use land cover changes and its driving forces in Setema district Jimma zone, Ethiopia" submitted in partial fulfillment of the requirement for the degree of Master's with specialization in Forest Resource Assessment and Monitoring, the graduate program of the school of General Forestry Studies, and has been carried out by Tadesse Leta Jiru Id.No MSc/FrAm/R019, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

Name of Advisor	Signature	Date
___________________________	______________________	______________

APPROVAL SHEET II

We the undersigned members of the Board of Examiners of the final open defense by Tadesse Leta Jiru have read and evaluated his thesis entitled “Rate of land use land cover changes and its driving forces in Setema district Jimma zone, Ethiopia “and examined the candidate. Accordingly this is to certify that the thesis has been accepted in partial fulfillment of the requirement for the degree of Master of Science.

________________________	__________________	_______________________
Name of the Chairperson	Signature	Date
________________________	________________	_______________________
Name of Major Advisor	Signature	Date
________________________	________________	_______________________
Name of Internal Examiner	Signature	Date
________________________	__________________	____________________
Name of External Examiner	Signature	Date

ACKNOWLEDGEMENT

First of all I would like to thanks the Almighty God. Next I would like to express my deepest gratitude and sincere thanks to my advisor Dr. Mikias Biazen for his immeasurable and priceless support, constructive criticism and devoting precious time in reading, guiding, as well as correcting of this research, without whom this paper would not be in its present form.

Finally I would like to thanks the Ethiopian Biodiversity Institution for allowing me to study my Msc, Hawassa University Wondo Genet College of Forestry and Natural Resources for allowing me to study my MSc, the MRV project for the whole financial support for this thesis, farmers of the study area, DAs of the study area, Forest expert of the study area, expert of OFWE, Kebele administrator of the study area, youths of the study area for their immeasurable and priceless support during data collection and I thankful my mother W/ro Keneni Hordofa and my brother and my sister Chela Leta and Gelane Leta for their endless support and encouragement during the study.

Table of Contents

DEDICATION

I dedicate this work for my beloved mother Keneni Hordofa and for people those abhor deforestation of forest, corruption and racism.

LIST OF ABBREVIATIONS

ANN=Artificial Neural Network

AOI=Area of Interest

ASL=above sea level

°C$^{=}$ Degrees Celsius

CA= Cellular Automation

CRGE=Climate Resilient Green Economy strategy

CSA=Central Statistical Agency

CSV=Comma Separated Value

DA=Development Agents

DGVMs= Dynamic Global Vegetation Models

ESMs=Earth System Models

GPS=Global Positioning System

FAO=Food and Agriculture Organization

FGD=Focus Group Discussion

GIS=Geographical Information System

GTP= Growth and Transformation Plan

HHs=House hold Survey

Ha^{-1} =Hectare

IPCC=Intergovernmental Panel on Climate Change

KII=Key Informant Interview

KML=Keyhole Markup Language

KM=Kilometer

LR=Logistic Regression

LULCC= Land Use Land Cover Change

LULC=Land Use Land Cover

LU=Land Use

LC=land cover

M=Meter

MCE =Multi-Criteria Evaluation

MLC= Maximum Likelihood classifier

MOLUSCE= Modules for Land Use Change Evaluation

NPFAs =National Forest priority areas

OFWE=Oromia forest and wild life Enterprise

OIES=Office of Interdisciplinary Earth Studies

OLI/TIRS= Operational Land Imager/Thermal Infrared Sensor PA

QGIS=Quantum Geographical Information System

RGB=Red, Green and Blue

RS=Remote Sensing

SCP=Semi-automatic Classification Plug-in

TM=Thematic Mapper

UTM=Universal Transverse Mercator

WoE=Weights of Evidence

LIST OF TABLE

LIST OF FIGURES

LIST OF PLATES

LISTS OF APPENDIXES

Abstract

LULCC is the result of the long-time process of natural and anthropogenic activities that has been practiced on the land..The study intended to carry out rate of land use /land cover changes, trends and their magnitude over the last 30 years (1988-2018), its driving forces and simulation for coming ten years (2028) using remote sensing and GIS. The study has initiated due to, loss of biodiversity (used for food, fuel wood, construction medicine, etc.) and wetland expansion to agricultural land. The General objective of this study was concentrated on rate of land use land cover changes and its driving forces of Setema district South west Ethiopia.. The study area was classified into seven LULCC categories on the basis of field study, geographical conditions, and remote sensing data. For the identification of land use/ land cover change land sat imagery of 1988, 1998, 2008 and 2018 were used to determine the change in land use/land cover using Semi automatic classification plug-in. In establishing the main drivers of land use/land cover change, the study utilized household survey, Key informant interview and focus group discussion. A total of 384 respondents were selected from the four kebeles by stratification and purposely based on the criteria of Coffee grower kebeles, cereal crop grower kebeles, kebeles changes wet land to agricultural land illegally, the most kebeles proximity to forest land by more discussion with kebele administrator "kabines" and DAs. From the kebele's Masimano, Kimiso, and Done and Setema Kecha were selected which satisfies the criteria. The study has used QGIS software 2.18.3, SCP plug-in extension version 5.4.2 and MOULUSCE plug-in extension version.3 for image detection, classification and Simulation whereas for social survey interpretation Mini Minitab software version 19.1.and Microsoft excel 2010 were used. The LULCC classification result revealed that at the base period of 1988 Land sat imagery, forest land (56.22%), grass land (15.7%), Agricultural land(23.13%) ,Bare land(0.03%),wet land (2.18) and Settlement land(1.58%) were identified with their respective percentage. On the contrary in the recent period of 2018 land sat imagery forest land, grass land, wet land were decreased to (39.71%), (6.53%), (0.87%) ,(23.13%) respectively. The result analysis of households survey, Focus group discussion and key informant interview were used and identified the major proximate drivers and underlying drivers such as fuel wood extraction, illegal wetland conversion to agricultural land, and illegal timber production, and agricultural expansion, extraction of wood for house construction population growth and corruption. The maps of 1998 and 2008 were used to simulate the LULC for 2018 using MOLUSCE available in QGIS software. The predicted result was compared with the classified LULC map of 2018 to validate the model. Finally, based on this, the prediction of future LULC for years 2028 was performed. The outcomes of this study shows that there would be decreasing of forestland; grassland and increasing of agricultural land and settlement area. Lastly, further study is required to identify role of wetland for LULCC.

Keywords*: Cellular Automata, Geographical Information system, Land use land cover change, Modules for Land Use Change Evaluation, Quantum Geographical Information system, Semi-automatic Classification Plug-in.*

1. INTRODUCTION

Land use and land cover (LULC) system are a fundamental part of the Earth's surface, and LULC changes (LULCC) has significant impacts on human society, climate, biodiversity, hydrological cycles, biogeochemical processes (Baldyga *et al.*, 2008; Lambin *et al.*, 2001; Were *et al.*,2014). Land use/land cover (LULC) information is seriously utilized for mapping environmental conditions and monitoring changes such as deforestation, land degradation, drought or urbanization (Binyam *et al.*,2018).

LULCC are being mostly influenced by government policies for economic development that promotes the expansion and promotion of agricultural production as well as the infrastructure and urban growth (Fujita *et al.*, 2007; Meyfroidt and Lambin, 2008). Land is essential natural resources which has numerous social, economic, and bio-physical uses as well as create wealth, employment, grow economies and also use as a source of water, food and energy (Adane Mezgebu, 2016).LULC is a complex matter, which is caused by numerous bio-physical, socio-economical and economic factors (Verfasser and Arsanjani,2011).

LULCC represents one of the key drivers of global environmental change. LULCC processes and anthropogenic drivers are still implemented in Dynamic Global Vegetation Models (DGVMs) and Earth System Models (ESMs), which assess processes and impacts of global environmental change such as the reports of the Intergovernmental Panel on Climate Change (IPCC) (Prestele *et al.*, 2017). Knowledge about lands and LC has become increasingly important as the nation plans to overcome the problems of disorganized, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels. One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time (Anderson *et al.*, 1976). Land is a mother for every living and non-living entities on the earth. LULCC is the result of the long-time process of natural and anthropogenic activities that has been practiced on the land. There are various natural events which alter the LULC such as weather, flooding, climate fluctuation, and fire and ecosystem dynamics (Adimasu Woldesenbet, 2016).

Land use/land cover (LULC) information is very important for planning environmental condition and monitoring changes such as deforestation, land degradation, drought or urbanization (Alemayehu *et al*.,2017;Husen Ali,2009). In Ethiopia, deforestation of forest land and changed to agricultural is one of the major processes of LULC change. Fuel wood collection, timber extraction, commercial agriculture and charcoal production are the primary direct drivers whereas indirect drivers of land use land cover are population growth, essential for commodities, governance and economic growth (Negasi *et al.*,2018;Mengistu *et al.*, 2013).Though LULC change in Ethiopia a major problem on agricultural development; the country develop the strategy of Growth and Transformation Plan (GTP) developed by Ministry of Finance and Economic Development (MoFED) and the 2011 Climate Resilient Green Economy strategy (CRGE) (MoFED, 2010).

Remote sensing data integrated with geographic information systems (GIS) and statistical analysis are effective tools to identify, analyze and understand LULCC patterns (DeFries *et al.*, 2010; Long *et al.*, 2007; Serneels and Lambin, 2001; Verburg *et al.*, 2004). Many studies have proved to achieved a good spatial modeling and prediction of the future LULCC through the several models such as logistic regression, Cellular Automata and Agent-based (Swart, 2016; Araya and Cabral, 2009; Serneels and Lambin, 2001; Jaimes *et al.,* 2010; Lambin and Geist, 2006; Serra and Pons, 2008; Seto and Kaufmann, 2003; Were *et al.,* 2014). Therefore, this study focuses on applying remote sensing data and GIS technique integrated with the variables and LULCC model to analyze the LULCC patterns and the driving forces in Setema district over 30 years from 1988-2018 in order to predict LULCC in 2028.

1.1. Statement of the problem

Like many other developing countries across the globe, significant LULCC also occurred in Ethiopia since the last century. These changes were primarily due to anthropogenic activities, in connection with the population increase and due to land use changes, including deforestation, overgrazing, and improper cultivation of agricultural land, settlement, expansion of agricultural land which led to accelerated soil erosion and associated soil nutrient deterioration (Binyam Alemu, 2015). Most studies at different parts of Ethiopia have indicated that natural forest, bush and shrubs, grass land and wetlands are decreasing whereas agricultural land and build up area are increasing (Eleni *et al.,*2013;Getachow *et al.,*2011;Mengistu *et al.*,2013). As several studies revealed that due to high population growth and pressure, expansion of agricultural practices, illegal settlement, poor land use policy and its implementation leads to the conversion or modification of land use system in Ethiopia (Adane Mesgabu,2016;Ashebir Mengistu and Muluneh Woldetsedik,2018;Fasika *et al.,*2018; othow *et al.,*2017), which can affect the socio-economic status of the rural population (Lambin *et al.,* 2003).The something is true in Setema district the natural environment is degraded over time due to several factors. The main challenges related to land cover changes are rapid population growth and scarcity of land for agriculture, loss of biodiversity (used for food, medicine, etc.) during the expansion of agricultural land coverage from forest land coverage, illegal wetland expansion to agricultural land, deforestation of forest, illegal logging, and illegal Settlement around the forest as the result of population pressure. Detail research investigations are required in order to understand the problems and take correction policy and other measures on the above mentioned problems. Thus, the above problems are motivated me to conduct this research study. Besides, there is no research conducted by other researcher on rate of land use land cover changes and its driving force in the study area; the research was conducted by integrating RS and GIS, by using primary data of social survey such as HHs, FGD, KII and GCP and secondary data of satellite image which should give relevant information for decision-makers, stakeholders and concerned body for sustainable resource management.

1.2. Objectives of the study area

1.2.1 General objectives

- The general objective of this study is rate of land use land cover changes and its driving forces of Setema district Jimma zone, Ethiopia.

1.2.2 Specific objectives

- To investigate the trends and magnitude of land use-land cover change in the study area,
- To investigate the major drivers of land use land cover change in the study area,
- To predict future 2028 land use land cover change conditions,

1.3 Research questions

- What is the historical trend of land use-land cover changes of the last 1988-2018 years
- What are the major drivers of land use-land cover changes in the study area
- What changes will occur within the next 10 years on the existing LULCCs

2. LITERATURE REVIEW

2.1. Definition and Concepts of LULCC

Land is a delineable area of the earth's terrestrial surface, embracing all attributes of the biosphere directly above or below the surface, including, climate, soil, terrain forms, shallow lakes, rivers, marshes, swamps, plant and animal populations, human settlement pattern ,physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.,(Caetano, 2013).

According to Briassoulis,(2009) FAO defines land as "a delineable area of earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the near-surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.,..)".

Land cover corresponds to bio-physical categories to be distinguished basically, areas of vegetation such as trees, bushes, fields, lawns, bare soil, hard surfaces (rocks, buildings) and wet areas and bodies of water such as sheets of water and water courses, wetlands (Ellis, 2007b; Milenov,2008).

Land use is territory characterized according to its current and future planned functional or socio-economic purpose, for instance, a piece of land can have only one land cover(forests),but can have more than one land use (recreational, educational, and conservational) (Milenov,2008).

Land Use is the term that is used to describe human uses of the land, or immediate actions modifying or converting LC which includes broad categories as human settlements, protected areas and agriculture, urban and rural settlements, irrigated and rain-fed fields, national parks and forest reserves, transportation and other infrastructure (De Sherbinin, 2002).The term LULCC identifies all kinds of human modification of the earth's surface (Jokar Arsanjani, 2012a).

LULCC can be characterized as the conversion and modification land from land category to other land category for instance change of farmland to urban land is example of conversion of land whereas degradation of forest land is land modification of land within a land cover category in which change in phenology, biomass, forest density, canopy closure, insect infestation, flooding, and storm damage (Meyer and Turner, 1994).Consequently, LULCC became prominent as a research topic on the global environmental change several decades ago with the idea of processes in the earth's surface influence climate (Bireda Alemayehu, 2015).

2.2. Land use land cover change at Global Scale

Land use land cover change is a phenomenon starting from ancient time in which rapid and extensive land cover change was the major element of global environmental changes of the past three centuries. Globally cropland showed a fivefold increase from 1770 up to 1990 and pastureland also increased by above six-fold from 1700 to 1990 (Gebrekidan *et al.,* 2014). Also, between the years 1700 and 1990, the area under cropland and pasture has increased from an estimated 300-400 million ha^{-1} to 1500-1800 million ha^{-1}, and 500 million ha^{-1} to 3100 million ha^{-1} respectively (Adane Mezgebu, 2016).In the early 1980's the significant impact of LULCC on the global climate via carbon cycle was understood where terrestrial ecosystems acted as a source and sinks due to the changes. Following this, the forthcoming volume of the 1991 Global Change Institute of the Office of Interdisciplinary Earth Studies (OIES) dedicated to LULCC at global level by explaining the major recent trends of changes, their consequences in environment, human causes on it as well as data and modeling of changes (Meyer and Turner, 1992).

LULCC is responsible for releasing green house gases to the atmosphere, by driving global warming and increase the release of carbon dioxide to the atmosphere by disturbance of terrestrial soils and vegetation (Erle, 2011). Most human-associated sustenance activities, such as food production, shelter, infrastructure development and extraction of natural resources, depend on land. However, land resources are becoming increasingly scarce on a global scale, as a result of continued exploitation and mismanagement (Belay Haile, 2018).

Human alterations in LC as a result of the use of land-based natural resources not only have local and regional impacts, but can also have important effects at the global level (Cheng *et al.*, 2005). For example, man-made changes in LU over the last 150 years have contributed too much carbon dioxide to the atmosphere which has come from fossil fuel combustion. Therefore the LULCC Science/research plan is an important document for the global change research community and those interested in the subject (Cheng *et al.*, 2005). Spatially and economically important human uses of land globally altered by human beings in various forms such as various forms of cultivation in, livestock grazing, settlement and construction, reserves and protected lands, timber extraction and other land uses have cumulatively transformed land cover at a global scale (Turner *et al.*,1994).

2.3. Land use land cover changes studies in Ethiopia

In Ethiopia, there are several studies on land use and land cover change by different researchers which were changed from one land use to another land use by different proximate and underlying drivers. For instance, Mikias Biazen, (2014) reported that between 1973 to 2010, there was a dramatic decrease in the area of grazing/grass land which is about 348.1 ha^{-1},285.7 ha^{-1} and 94.9 ha^{-1} of land were converted into cultivated, shrub/bush and acacia woodland respectively because of population growth and agricultural expansion and fuel wood which is associated with population growth in Arsi Nagelle district the Central Rift Valley region of Ethiopia. Adane Mezgebu, (2016), reported that during the 30 year period between 1986 and 2016 the proportion of area covered by wood land was continually decreasing as it was 565147 ha^{-1} (36%) in 1986 and 268455 ha^{-1}(17%) in 2016 whereas ,in contrast agriculture/settlement was continuously increasing as it was 270976 ha^{-1}(17%) in 1986 and 444345 ha^{-1}(28%) in 2016 which is caused by expansion of agriculture, fire, illegal logging and fuel wood extraction ,overgrazing ,expansion of illegal and unplanned settlements, urban expansion and construction of infrastructures such as school and road, population growth, poverty, insecurity, unemployment, weak low enforcement, drought, and lack of awareness in bale Eco-region, Ethiopia. Similarly study by Ashebir Mengistu and Muluneh Woldetsedik,(2018) stated that the proximate and underlying drivers of land use land cover change of south west Ethiopia were agricultural expansion, infrastructural expansion, fuel wood extraction, charcoal production ,wood for house construction ,logging and political (corruption, weak institutional performance, insecure tenure),demographic growth, economic (increased access to market ,increased in crop price increased in annual income),socio-cultural (change in public attitude, intensification ,and religion respectively. Fasika *et al.,*(2018) reported that between 1985-2017 forest land showed the largest decline with a rate of 60.57 ha^{-1} and home garden agro forestry/settlement showed the highest increase inclining by an estimated 49.77 ha^{-1}in the Somodo watershed South western, Ethiopia which is caused by proximate drivers of agricultural expansion, expansion of settlement, expansion of plantation, illegal logging and fuel wood collection fire, over grazing, infrastructure and underlying drivers of demographic, economic, technological, institution and policy and biophysical factors, Temesgen *et al.*,(2017) stated that between 1985-2015 the increasing of cultivated land from 36,820 ha^{-1} (62.7%) in 1985 to 45,108 ha^{-1}(76.8%) in 2015 and build up from 35 ha^{-1}(0.1%) in 1985 to 672 ha^{-1}(1.1%) in 2015 where as the decreasing of forest, shrub land ,grassland from 2068 ha^{-1}(3.5%),15,377 ha^{-1}(26.2%), 4461 ha^{-1}(7.6 %) in 1985 to 1138 ha^{-1}(1.9%), 8992 ha^{-1}(15.3%), 2850 ha^{-1}(4.9 %) in 2015 respectively due to population growth, cultivated land expansion, fuel wood extraction, charcoal and infrastructural development drivers in the Andassa watershed, Blue Nile Basin, Ethiopia. Therefore because of illegal settlement around the forest, charcoal production, loss of biodiversity, conversion of forest land to agricultural land, conversion of wetland to agricultural land, illegal timber production, rapid population increment and scarcity of land for agriculture in study area, the study was wanted to conduct on, rate of LULCC and its drivers for sustainable resource management.

2.4. Drivers of land use land cover change

Assessing the driving forces behind LULCC is essential if previous patterns can explain and be utilized in forecasting future patterns which can be caused by multiple driving forces that control some environmental, social and economic variables (Erle, 2011). Accordingly, investigation of drivers of LULCC requires a full range of methods from the natural and social sciences, including climatology, soil science, ecology, environmental science, hydrology, geography, information systems, computer science, and anthropology, sociology, and policy science (Erle, 2011). Several researchers identifies and categorized the land use land cover change causes as proximity (in direct) and underlying (in direct).

2.4.1. Proximate (direct) drivers of LULCC

The direct causes of land use land cover comprise human activities that could arise from the continuous use of land and directly alters driven forces for instance urbanization, deforestation, agriculture expansion, wood extraction whereas the indirect causes are fundamental forces that strengthen more direct causes of LULCC include economic, biophysical, political/institutional, socio-cultural and technology (Lambin and Geist, 2002;Lambin *et al.*,1999;Turner II *et al.*,1995). The proximate drivers of LULCC are human activities and actions such as urbanization, agriculture expansion, deforestation and infrastructure development that have a direct effect on LULCC, (Lambin, and Geist, 2002; Kissinger *et al.*,2012).Many authors argue that the proximate drivers of land use land cover are agricultural expansion, fuel wood extraction, and charcoal production has high impact on land use land cover change such as forest loss/biodiversity loss, and habitat destruction, declining of productivity, soil fertility loss, and extinction of terrestrial species, over grazing, illegal logging (Adane Mesgabu, 2016;Ashebir Mengistu and Muluneh Woldetsedik, 2018;Mikias Biazen, 2014; Kissinger *et al.*, 2012;Othow *et al.*,2017).

2.4.2. Underlying (Indirect) drivers of LULCC

The underlying drivers are fundamental (social) processes which is environmental or biophysical, economic, demographic/human population, policy, technological, cultural, and institutional drivers that reinforce the proximate causes and either has an indirect impact on local and national or global level in which all are interconnected each other (Geist and Lambin, 2002).

According to Kissinger *et al.*,(2012), stated underlying drivers are complex interactions of social, economic, political, cultural and technological processes that affect the proximate drivers. According to different researchers the underling drivers of land use land cover were population growth, corruption, lack of awareness, weak law enforcement, change in farming technologies and access to agricultural inputs such as inorganic fertilizers, improved seed and herbicides (Adane Mesgabu, 2016;Ashebir Mengistu and Muluneh Woldetsedik, 2018;Mikias Biazen, 2014; Kissinger *et al.*, 2012;Othow *et al.*, 2017).

2.5. Approaches in land use land cover change detection

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 which provide vital information of area change and rate of changes, spatial distribution of changed types, change trajectories (trends) of land cover types and accuracy assessment of change detection results (Bireda Alemayehu, 2015). Change detection is the measure of the different data framework and thematic change information that can guide to more tangible understandings in to underlying process involving land cover and land use changes than the information obtained from continuous change (Ramachandra and Kumar, 2004). Change detection process is to recognize LULC on digital images that change features of interest between two or more dates which involve the procedures of data acquired by the same sensor and be recorded using the same spatial resolution, viewing geometry, spectral bands, radiometric resolution, and time of day (Duguma Erasu, 2017).

2.6. Application of RS and GIS techniques for LULCC study

Remote sensing (RS) and GIS are important tools for studying LULCC and integrating the associated driving factors for deriving useful outputs (Singh *et al.*,2015). Evaluation of LULCC detection using RS and GIS has become a central component in current strategies for managing natural resources and monitoring environmental changes (Kumar.p,Santhana, 2017). Application of RS data in combination with GIS can extract reliable information on land use dynamics which shows where and when forest disturbance happens for forest management (Dereje Likissa, 2014). Remote sensing and GIS are important for the monitoring, modeling, and mapping of land use and land cover changes across a range of spatial and temporal scales, to assess the extent, direction, causes, and effects of the changes (Daniel Ayalew,2008). RS is an essential tool of land change science because it facilitates observations across larger extents of earth's surface than is possible by ground based observations (Roy and Roy, 2010).

2.7. Modeling land use-land cover change

Modeling of LULCC is a scientific field that is growing rapidly because of its importance in identifying the effects of humans on the environment (Hadi *et al.,* 2014) and to answer at least one of the following questions: Why, where, and when do LULC changes occur? (Lambin *et al.*, 2000).

2.7.1. Cellular Automata (CA) modeling

The Cellular automata concept developed by Von Neumann and Ulam and developed in 1940s in the field of computer science for the development of robots, it is being widely applied to various other disciplines such as Physics, Mathematics, Natural Sciences, and GIS etc. and had advantage of the construction of model is simple and easy (Singh, 2003), can incorporate spatial component (Baker, 1989).Cellular automata models is provide a formal framework by simulating the present from the past using the image time-series, whereas validating by comparing reference data with simulated output data (Rocha, 2007). Cellular automata provides a powerful tool for the dynamic modeling of LULCC which estimates the taken time in transition that can generate complex spatial patterns from the simple set of rules and predicts LULCC in the future (Singh, 2003).Cellular automata models used for prediction of time (t_2) from historical LULCC process of time (t_0) and time(t_1) and predicted /simulated result is compared with the reference classified map of time (t_2),since reference map(t_2) is usually considered more accurate (Rita and Sevivas, 2018).

3. MATERIALS AND METHODS

3.1. Study area

The study area of Setema district is one of the Jimma zones located at the southwestern part, and have 21 kebeles. Setema is bordered on the south by Gera, on the west by Sigmo, on the north by the Illubabor zone, and on the south east by Gomma. The administrative center of the district is Gatira. The geographical location of the district is lying at 7°58'51"N and 36°12'36"E Southwest of Addis Ababa and Jimma at a distance of 450 km and 100 km respectively. The altitude of Setema district ranges from 2,250-3,010M a.s.l which the highest points are in the Damu Siga Mountain (Girma *et al.*, 2016).

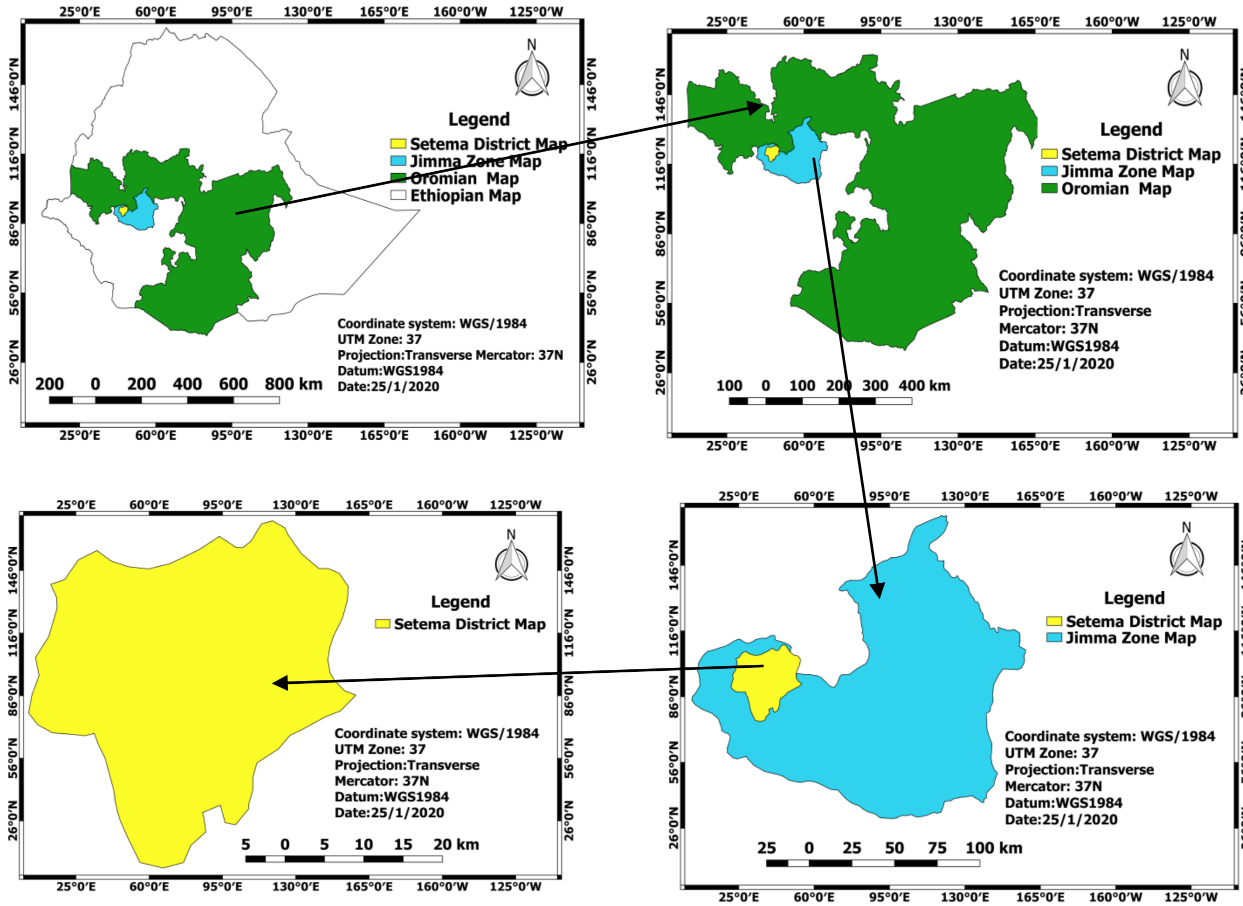


Figure: 3.1. Map of Study area

3.1.1. Demographic and socio economic characteristics of study area

According to CSA, (2007), the total population of the district is 103,221, of whom 50,744 were men and 52,477 were women; 4,729 or 4.58% of its population were urban dwellers. The majority of the inhabitants were Muslim, with 96.91% of the population reporting they observed this belief, while 2.67% of the population said they practiced Ethiopian Orthodox Christianity (CSA, 2007). The study area is located at about 450 kilometers away from Addis Ababa, capital city of Ethiopia and 100 km in North west of Jimma town (Girma *et al.*, 2016). The farmers those found in this district grow crops Teff (*Eragrostis teff*), Maize (*Zea mayes*) for domestic consumption as well as coffee (not grown extensively) is also an important cash crop which is less than 20 square kilometers (7.7 square miles). Agriculture is the main economic activity and is dominated by small-scale and mixed crop and livestock farmers. More than 90% of the district population depends on agricultural activities. Crop production is mainly rain-fed. Coffee plays a major role in income generation in the areas. Maize (*Zea mayes*), Teff (*Eragrostis teff*) and sorghum (*Sorghum bicolor*) are the major crops grown in the area. Pulses crops, such as beans and pea are grown to a lesser extent in the area (Dechassa Lemessa, 2000). Maize (*Zea mayes*) and Enset (*Ensete ventricosum***)** are the major staple food crops and it is strategic crop substantially contributing to the food economy for the district (Dechassa Lemessa, 2000). Industry in the district includes 32 grain-mills. There were 18 farmers associations with 17,623 members and 5 farmers Service cooperatives with 7,562 members. Setema district has 35 kilometers (22 mi) of year-round road, for an average road density of 31.6 kilometers per 1,000 square kilometers (5 mi / 100 sq. mi). About 60% of the urban and 9.6% of the rural population has access to drinking water (https://en.wikipedia.org/wiki/setema).

3.1.2. Biophysical characteristics of the study area

The mean annual rainfall of Setema district is 1665 mm/year and annual average maximum and minimum temperature is 27.9°c and 11.9°c respectively; whereas it has perennial rivers such as Onja, Salako, Gidache, Gabba (Girma *et al.,* 2016). Land coverage of the district is 27.2% is arable or cultivable (20.8% was under annual crops),13.1% pasture,55.1% forest, and the remaining 4.6% is considered degraded, build up (Girma *et al.*,2016). Western and South western parts of the country experience a unimodal rainfall pattern in which is October to January ("Birra") denotes the time when the long rain fall season comes to an end to be followed by a medium to short dry season during the same period and February to May ("Bona") is the start of the long rainy season (Girma *et al.,* 2016). Over the western parts of the country in the region also the rainy season starts during March/April. June to September (Main season) is a long and heavy summer rain, normally called the big rain or “Gannaa,” which falls from June to September. Study area annual average maximum temperature is 27.9°c and minimum temperature is 11.9°c (Girma *et al.*, 2016).

3.1.3. Land use system of the study area

As other many developing country most rural people of Ethiopian are depend on land for their livelihood and they grow rapidly and bring effects on resource base/natural vegetation by changing to other land use as the result of population growth and scarcity of land (Wolde amlak Bewket and G. Sterk, 2005). The percentage of land used for agriculture in Ethiopia has been increasing since the beginning of the 20th century (Woldeamlak Bewket and G. Sterk, 2005). Though the land use of the study area is found in Jimma zone which grow coffee more; the study area not focus on production of coffee, it produce cereal crops and the most of the land used for agricultural production such as Teff (*Eragrostis teff*), Sorghum (*Sorghum bicolor*) and pulses crops, such as, beans and pea which are grown to a lesser extent in the area (Dechassa Lemessa, 2000).

3.1.4. Vegetation status of the case study area

The vegetation’s are categorized under montane moist forest ecosystem which comprises high forests of the country and mainly in the southwest forests. The vegetation canopy cover of the study is recognized as a closed continuous canopy cover and contains natural forest vegetation and plantation vegetation which has different species diversity and used as habitat for different fauna. It is designed under National Forest priority areas (NFPAs) before for protection and conservation of natural forest, which now designed and protected by OFWE. Even if the forest is designed under OFWE the vegetation is still under the problem.

3.2. Methods of data collection

Both primary (house hold survey, Focus group discussion, key informant interview, ground control point gathering) and secondary (remote sensing satellite image and Google earth data) were used to accomplish the objectives of the study area.

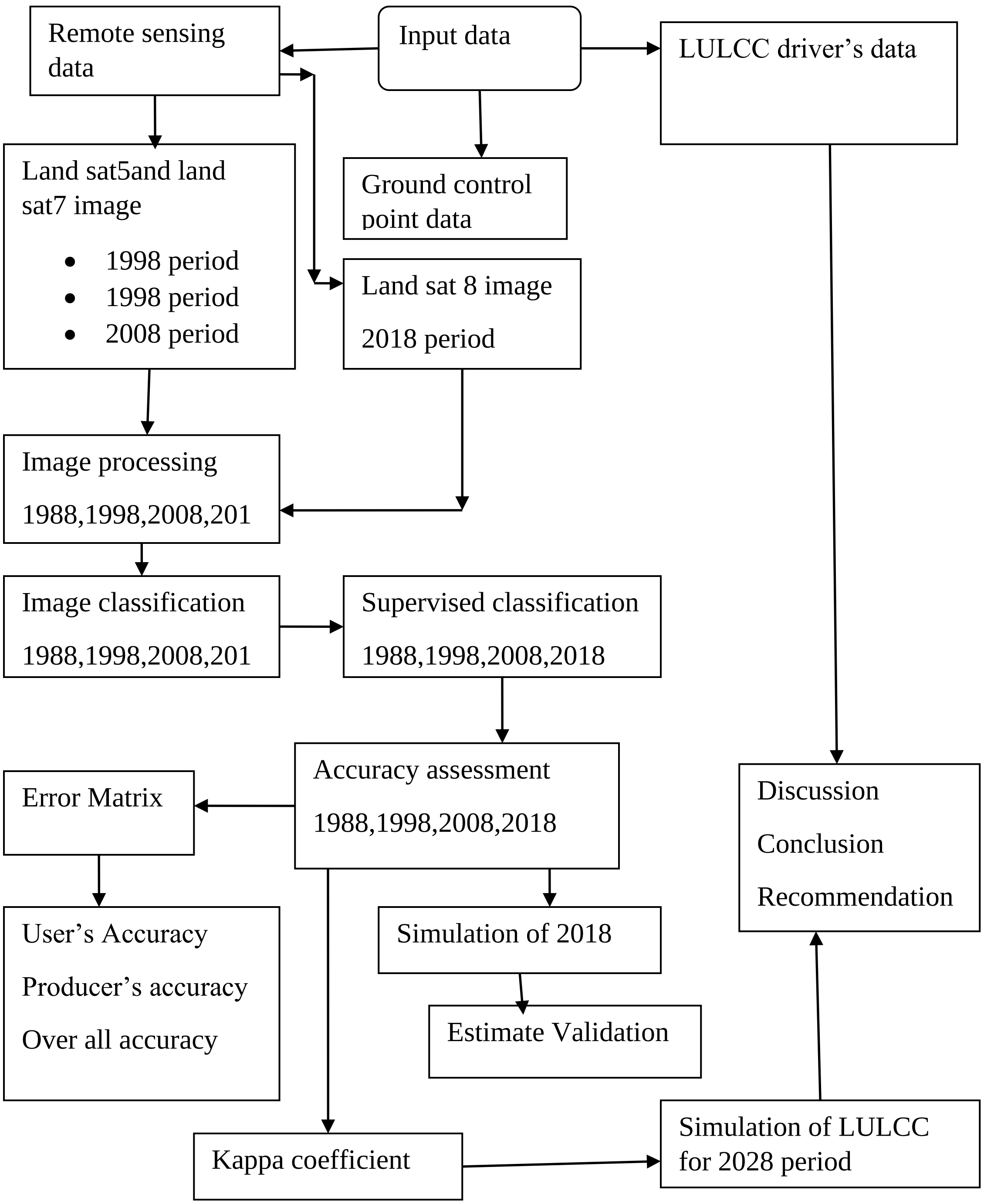


Figure.3.2.Research methodology flow chart of the study area

3.2.1. Remote-sensing data types and sources

Remote-sensing data was collected at different spatial and temporal scales. For this study, satellite imageries were downloaded from the United States Geological Survey (USGS).

Table 3.1 Remote sensing images data's used in the study area

Satellite	Path	Row	Spatial Resolution (meter)	Year
Land sat5	170	54	30M	1988
Land sat7	170	54	30M	1998
Land sat 5	170	54	30M	2008
Land sat8	170	54	30M	2018

Source: earthexplorer.usgs.gov

3.2.2. Google earth data collection

Google earth is a computer program that renders a three dimension representation of earth based on satellite imagery (https://en.wikipedia.org/wiki/Google earth).Consequently the Google earth was used for extract information where the location is inaccessible to take sample point, to take the information for previous downloaded information whereas for overlaying of sample point collected from the study area which was first converted to CSV and KML by showing and moving time slider of Google earth.

3.2.3 Field data collection methods

During field observation informal discussion and interview were carried out with Kebele administrator, DAs, elder peoples those have more information about the study area and land use classes were identified such as forestland, agricultural land, grassland, wetland, bare land, bush land and settlement/build-up (See appendix B.Table1) to assess the existing land use and land cover types and other environmental conditions in the study area. According to rule of thumb the minimum number of sampling units that should be collected is 50 sampling points for each land cover class, and although if land use land cover class area are exceeds 500 km^2 and more than 12 land cover classes, or area is greater than 1million acres (404685.642 ha^{-1}) the minimum number of sampling units that should be collected, should be between 75 and 100 (Congalton, 1991). Consequently, because of the land use land cover of the study area is less than 12 classes, and 272950.133acres (110459 ha^{-1}) 30,30,30,15,20,21 and 30 sampling points were collected for each forest land, agricultural land, grassland, wetland bare land, bush land and settlement /build-up respectively for each purposively selected kebeles (Plate 3.1) depending on the size of land use land class by using Garmin GPS 72H from the field with the help of DAs and Kebeles administrator and by using high resolution of Google Earth, for classification and accuracy assessment whereas photos were taken by using SONY Digital camera.

Plate 3.1.GCPs collection from the study area (photo 2019)

3.2.4. Socio-economic data collection

Household Surveys

The semi-structured questionnaires were conducted to gather the type of LULC increased/decreased, the drivers of LULCC and what would be happen in future with local language “Afan Oromo” communication to cross-check and to support downloaded image. Consequently, to carry out household surveys a total of four DAs enumerators were recruited and trained to administer the questionnaire because of the HHs know them and to obtain clear information from HHs. Before the activity carry out the pre-test interviews were carried out with DAs to make some comments and make work more clearly for them.

Sampling techniques for household survey

For gathering of depth information and drivers of LULCC of the of study area, two stage sampling method/design were used which is stratification methods (four strata for each kebeles) and purposively methods depending on the criteria of Coffee grower kebeles, cereal crop grower kebeles, kebeles changes wet land to agricultural land illegally, kebeles proximity to forest land by more discussion with kebele administrator “kabines” and DAs. Then from the stratified kebele four kebeles were selected purposely depending on the most proximity to the forest land, the most deforest forest land for farmland expansion (Masimano, Kimiso, and Done) and the most grower of coffee and changing wetland to agricultural land illegally (Setema Kecha) kebeles. Finally, for the study area, the samples of size for household survey were calculated from purposively selected kebeles for representation of study areas HHs. For social research 50% population proportion to maximize the sample size and 5% margin of error to increase level of confidence is acceptable (Bartlett *et al*., 2001). 50% of population proportion (to maximize variance or number of sample size) and 5% margin of error (levels of precision) and 95 level of confidence were used to calculate sample size of HHs by the following equation is which is 384HHs (Taherdoost,2017).

$n= \frac{p(100-p)z^2}{E^2}$ where,

n is the required sample size

P is the percentage occurrence of a state or condition

E is the percentage maximum error required

Z is the value corresponding to level of confidence require

Therefore, $n = \frac{p(100-p)z^2}{E^2}$ $n=\frac{(0.25)3.8416}{0.0025}$

$n=\frac{50\%(100-50\%)\ (1.96)^2}{(5\%)^2}$ $n=\frac{0.9604}{0.0025}$

$n=\frac{50\%(50\%)\ 3.8416}{(0.05\%)^2}$ $n=\frac{0.5(0.5)3.8416}{0.0025}$

n=384.

Table 3.2: The study population and sample size

S.No	Kebele	Total HHs	Sample size	Sample in %
1	Masimano	1300	128	33
2	Kimiso	900	89	23
3	Done	895	88	23
4	Setema Kecha	804	79	21
	Total	3899	384	100

Source: Author (2019)

Key informant interviews

KII involves interviewing a select group of individuals who are likely to provide needed information, ideas, and insights on a particular subject to obtain depth information which contain as a rule of thumb,15 to 35 key informants (Kumar, 1989).Therefore 15 Key informant people such as (four DAs, four kebele leader/ kebele administrator, four elder's peoples were selected from each purposively selected kebeles of Setema Kecha, Masimano, Kimiso, and Done whereas one district land use land administrator expert, one forest expert, one OFWE expert from study district (Table 3.3) depending on their criteria of depth knowledge what is going in the kebeles, those live for a long period time around study area to collect the detail information of LULCC of the past, present, future condition of LULC and the drivers of the study area with the help of DAs and kebeles administrator.

Table 3.3: Number of key Informants participants

S.no	Type of KII	No of KII participants/Kebeles				
		Setema Kecha	Masimano	Kimiso	Done	Total
1	DA,	1	1	1	1	4
2	kebele leader/administrator,	1	1	1	1	4
3	Forest Expert,	1	0	0	0	1
4	Woreda land use land administration expert	0	0	1	0	1
5	OFWE expert	0	0	0	1	1
6	Elder's peoples who live for a long	1	1	1	1	4
	Total					15

Source: Author, 2019

.

Plate 3.2. Key Informant interview in Setema district, Photo (2019)

Focus group discussion

Focus Group discussion is a group of individual carefully participated (5-10), but (6-8) is preferred per group, similar types of people, environmentally comfortable and circle seating (Krueger, 2002).Therefore, to accomplish the objectives of the study areas one FGDs were selected for each four kebeles selected purposively which have three elder people members, two youths members and one religious members to cross check and validate the information collected from KII and household survey depending on the criteria of the knowledge about the area and longevity time around the study area, ability to respond the question, group proximity to the forest area with help of Kebeles administrator and DAs deeply discussion. The participant's members of the FGDs were asked to provide drivers of LULCC, land use management system of the study area, management system of LULCC and what will happen in the future.


.

Plate 3.3. FGDs of the study area, Photo taken by Author, (2019)

Table 3.4: Number of FGD participants

No	Type of FGD	Members of FGD participants/Kebeles				
		Setema Kecha	Masimano	Kimiso	Done	Total
1	Elder people,	3	3	3	3	12
2	Youths	2	2	2	2	8
3	Religious leader	1	1	1	1	4
	Total	6	6	6	6	24

Source: Author (2019)

3.3. Method of Data analysis

3.3.1. Data analysis for GIS and Remote Sensing

Before the actual image classification process, pre-processing was performed using QGIS image analysis software (Congedo,2016).Therefore for this study image pre-processing such as radiometric and geometric correction; image enhancement, image classification (supervised classification), and finally LULCC detection analysis were carried out in order to generate and detect the individual land cover classes on the image.

Image pre-processing

According to Karsidi,(2004) remote sensing has constraints such as spatial, spectral, temporal, and radiometric resolution. Consequently, this has an influence on data quality during data acquisition. Therefore, it is usually necessary to pre-process the remotely sensed data before analyzing it to remove some of the errors. This correction model involves the initial processing of raw image data to correct geometric distortions, to calibrate the data radio metrically and to eliminate the noise present in the data (Reddy, 2008).Therefore the downloaded image from earth explorer were preprocessed (stripe error were corrected for each bands of land sat7, stacked/merged of bands, clipped/sub setting to study area and enhanced) by using open/free QGIS software version 2.18.3.

Image enhancement

The basic goal of image enhancement is to process the image so that we can view and assess the visual information it contains with greater clarity. According to Verne, (2016) image enhancement is used to optimize for specific feature measurement methods, rather than fix problems. Familiar image processing enhancements include sharpening and color balancing. Accordingly, image enhancement was carried out to improve the appearance of the imagery to assists in image analysis, classification and visual interpretation by making the down loaded image 432 (RGB) and 543 (RGB) false color composite for Land Sat5 and land sat7 and Land Sat8 respectively (Bakker *et al.,* 2001) using linear contrast stretch/contrast enhancement with the help of QGIS software version 2.18.3.

Image classification

Different Studies showed that image classification is an important process for quantifying the location, extent, and trends of LCLUC (Hano, 2013). Similarly, Reddy (2008) reported that image classification is a procedure to automatically categorize all pixels in an image of a terrain into land cover classes. So, image classifications were conducted for the study area in order to classify all pixels of satellite imagery into land use land cover based on reflectance characteristics of feature by using the basic visual image interpretation elements (color, tone, texture, size, shape, structure, association, shadow) and the prior knowledge of the area. Accordingly, supervised classification was employed to classify the study area into different land use land cover categories and to assess the trend and rate of change of the LULCC.

Supervised classification

Supervised classification usually requires a priori knowledge about the region/area, where ground truth data are collected for each land-use class (Kim, 2016). In supervised classification, an analyst uses previously acquired knowledge of an area, or a prior knowledge, to locate specific areas, or training sites, which represent homogeneous samples of known land use land cover types such as cropland, grassland, salt-affected and water logged etc., (Polisgowdar *et al.*,2018). Therefore to accomplish the objectives of classification supervised classification (Semi-automatic classification) was used MLC algorithm to classify the downloaded clipped image of the study area by using three band combination of Red, Green and Blue of (4, 3, and 2) false composite color for Land Sat5, land sat7 and three band combination of Red, Green and Blue (5, 4, 3) false composite color for land Sat8 respectively. The objective of the classification is to classify false composite color satellite image in to Macro classes (Built-up,vegetation, water body and soil) and micro classes (forest land class, grass land class, agricultural land class, bush land class, Settlement/build up class, bare land class and wet land class) by selecting region/area of interest (AOI) based on ground truth point/field data, reflection characteristics of the image, high resolution (Google Earth,) in which training point/ region/area of interest were gathered from satellite image of 1988,1998,2008 and 2018 by using free software QGIS 2.18.3 version with SCP.

3.3.2. Data analysis for socio-economic survey

The land-use history data, driving force data for LULCC of the whole period (1988, 1998, 2008, and 2018), data collected through HHs, KI, and FGD were identified and ranked using Minitab software version 19.1.1,Microsoft excel 2010. The results were presented by descriptive statics of tables, frequencies, and percentages to interpret and analyze the collected data

3.4. Prediction of LULCC of 2028

For LULC simulation the LULCC classification of 1998, 2008, proximity to river, proximity to road population density of 2000, 2005 and 2010 and 2015 were used to simulate LULC for 2018 whereas,2008 LULC classification ,2018 LULC classification, proximity to river, proximity to road population density of 2010 and 2015 were used to simulate LULC for 2028 (See Appendix A.map 1-3). It is important to estimate the predictive ability and reliable of the model. Therefore, simulated LULC in 2018 was conducted from the transitional potential of LULC map for time t1 (1998) and for time t2 (2008) to predict LULC for time t3 (2018). Then the result was validated between the simulated LULC in 2018 and the reference map in 2018 (classified LULC map of 2018). Therefore, the validated result achieved an acceptable accuracy, and then 2028 LULCC would be simulated and conducted. The simulated LULCC of 2018 and 2028 were carried out in QGIS MOLUSCE extension plug-in.

Proximate to water and road sources

The proximate to water sources and proximate to road were digitized using open street map and Google satellite which is used for livestock and for population living in the study area and connecting kebale to kebale in the study area respectively. Then digitized river and road were rasterized using 30m*30 m cell size resolution and its distance was calculated by Euclidean distance using Grass tools.(see Appendix A. map 1-2)

Population density data

The population density is an important variable for LULCC analysis Verburg *et al.*(2002). Therefore, the population density data was downloaded from Socio economic Data and Application Center (SEDAC) site using Gridded population of world Version 4(GPWv4) for Global UN- Adjust Population Density in the years of 2000, 2005, 2010 and 2015 with a cell size 1x1 km resolution (SEDAC, 2018) were re-projected to WGS 84 UTM zone (EPSG: 32637) using QGIS 2.18 software. Then the population density data was clipped and resized to 30x30m pixel size resolution and resized population density data were classified using QGIS 2.18 to estimate number the population density of the study area per square kilo meter. Therefore the minimum and maximum population density per square kilo meter for the period 2000,2005,2010,2015 were showed in (See Appendix A. map 3) which red color shows minimum population density per square kilometer and blue color shows maximum population density per square kilometer .

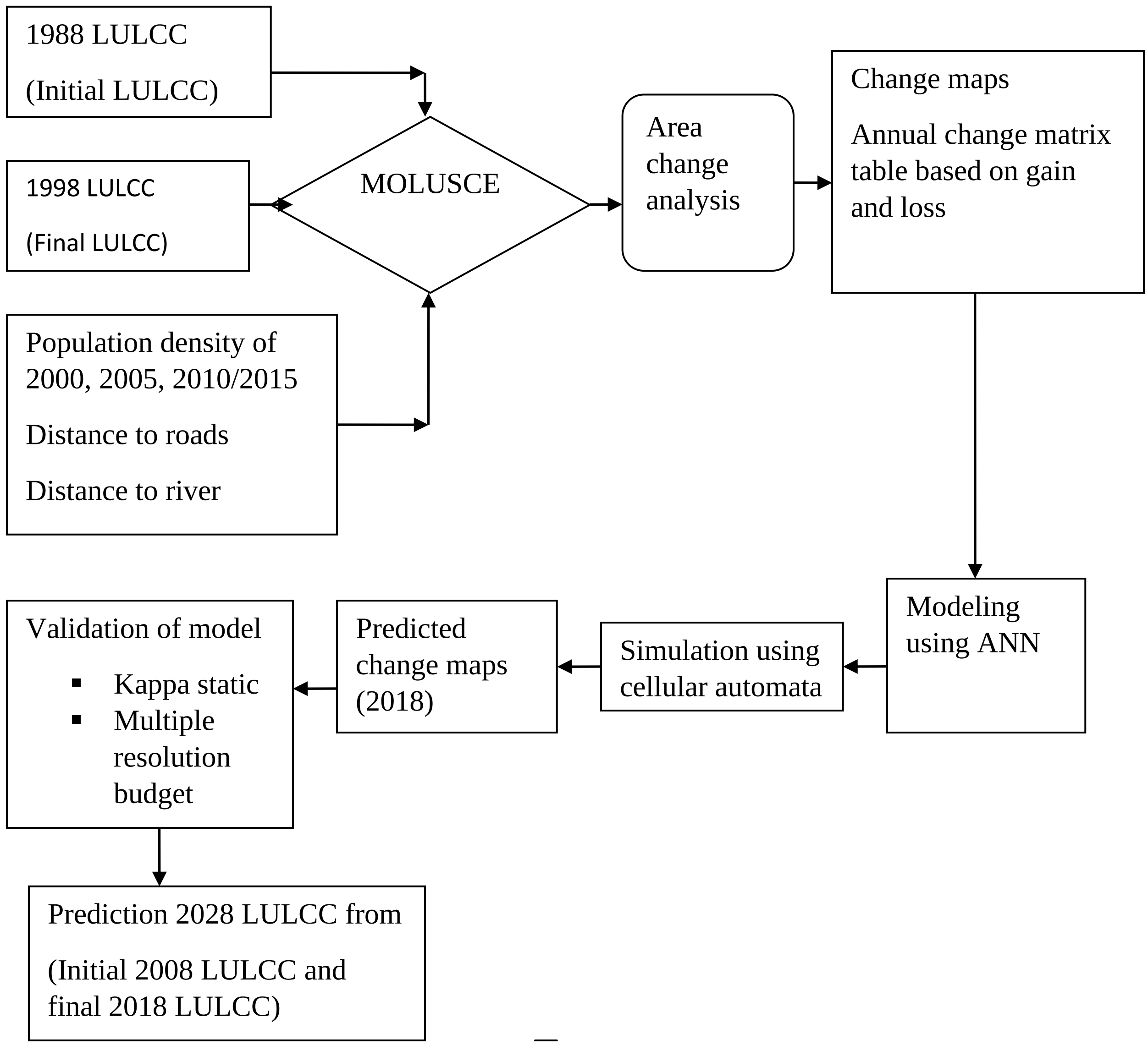


Figure 3.3: Methodological flow chart for future land use land cover prediction

4. RESULTS AND DISCUSSION

4.1. Analyzing the trend, magnitude, and rate of LULCC of the study area (1988-2018)

Four LULC maps were produced for the years 1988, 1998, 2008 and 2018 and seven LULCC were identified and classified: forestland, grassland, agricultural land, settlements, bush land, wet land cover and bare land cover (Fig. 4.1).

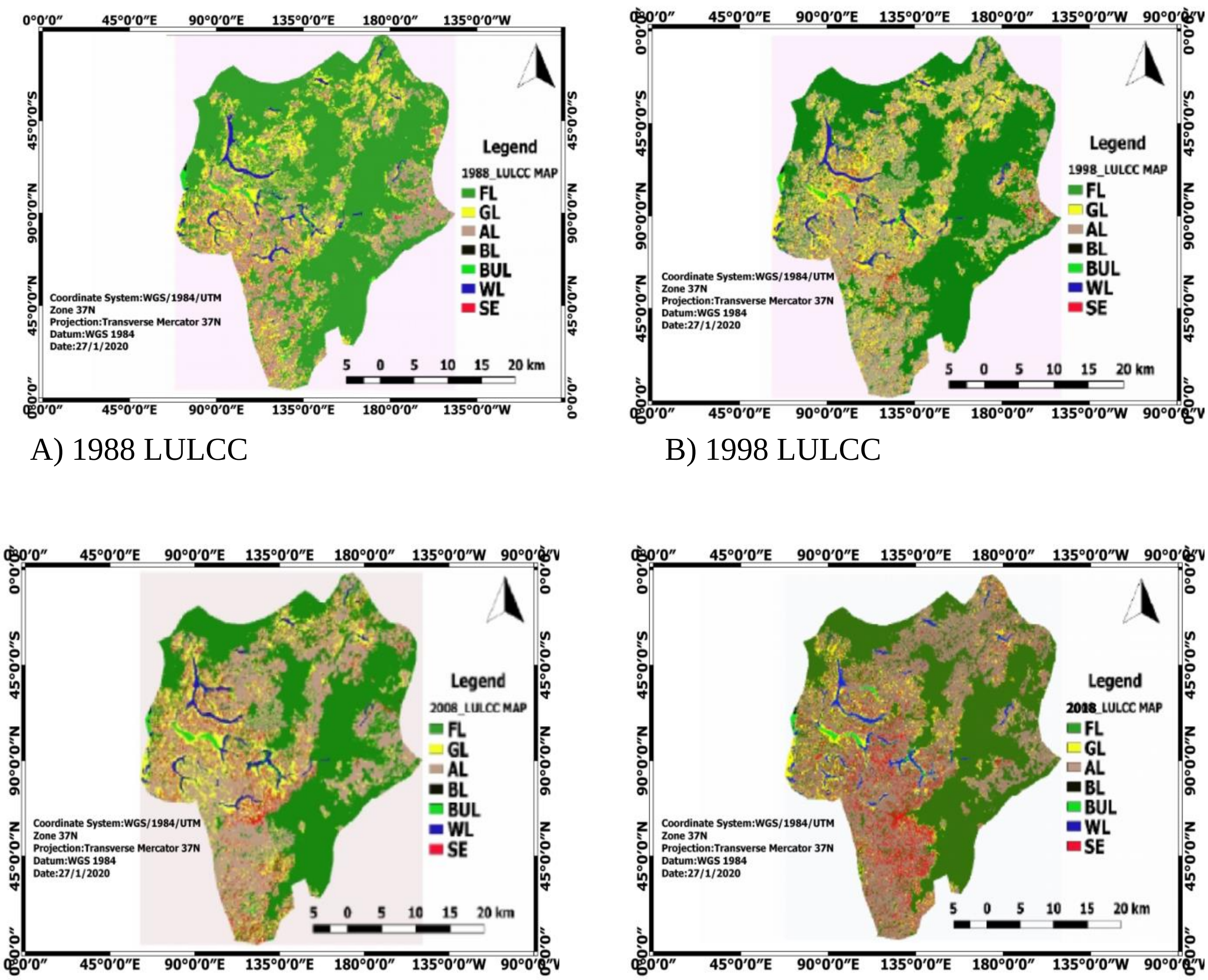


Fig 4.1 Spatial distribution LULCC of Setema district (1988- 2018).

Generally, over thirty years (1988-2018), the gross changes in hectares (loss and gain) and percentage change in the study area varied from one LULC class to another whereas transition matrix were also varied from period to period which is computed by using MOLUSCE Plug-in extension version 3 (Figure. 4.2 and 4.3).

In the study area at the base year (1988) from the total area of 110458 hectare the area were covered by dense forest 62104.4 ha^{-1} (56.22%) followed by grassland 17416 ha^{-1} (15.77%) and wetland 2409.48 ha^{-1} (2.18%); the other LULC of bare land, agricultural land, settlement land, bush land together accounted for 28,528.72 (25.82%);however in the recent year (2018) forest cover 43867 ha^{-1} (39.71%) were declining in alarming rate followed by grass land cover 7208 ha^{-1} (6.53%) and wet land 2335.23 ha^{-1} (2.11%) (Table.4.1).

The analysis of land use and land cover change during the period of 1988–1998 and 2008-2018 showed that there was significant decrease of forest, with a consequence of increase in agricultural land and settlement land (Table 4.2).

Between 1988-2018 period there were increasing of agricultural land, settlement area and bare land from (23.13%) to (43.89%), from (1.58%) to (6.85%) respectively (Table 4.1). During the same period agricultural land, settlement land and bare land were changed from (23.13%) to (43.89%), from (1.58%)ha^{-1} to (6.85%).

In the period between 1998-2008 (Table 4.1) the total area of forest land cover, grass land cover bush (15.66%), from (1.03%) to (0.97) and from (2.18%) to (2.17%) with magnitude area and percentage change of -5156 ha^{-1}(-4.66%),-1399 ha^{-1}(-1.26%,),and-63.09 ha^{-1} (-0.04%) respectively (Table 4.2).The annual decreasing rate of forest land cover and grass land cover change between 1998-2008 were (-0.466%), (-0.126%) respectively per year in the study area.

(Table 4.3).Similarly during the period between 1998-2008 (Table 4.1) agricultural land cover, Settlement land cover and bare land were increased from 34718.0 ha^{-1} to 38853.3, from 3442.23 ha^{-1} to 5928.62ha^{-1} and from 39.06 ha^{-1} to 42.48ha^{-1} in which the magnitude trend of 413.53ha^{-1} (0.373%),248ha^{-1} (0.225%) and 0.342 ha^{-1} (0.0%) respectively with annul increasing per year (Table 4.3).

Table (4.1) in the time period from 2008 to 2018 the change of land use land cover of the study were shows that there is an increase in area coverage/proportion of agriculture land cover, Settlement/build up and bare land cover from 38853.3 ha^{-1} (35.17%) to 48480.5 ha^{-1} (43.89%), from 5923.62 ha^{-1}(5.37%) to 7562.79 ha^{-1}(6.85%) and 42.48 $ha^{-1}$to 44.82 ha^{-1}respectively.During this period there is also decline of forest land cover, grass land cover, bush land cover and wet land cover (Table 4.1) changed from 46259.9 ha^{-1} (41.88%) to 43867 ha^{-1} (39.71%),from 15899.5 ha^{-1} (14.39%) to 7208 ha^{-1} (6.53%), from 1075.05 ha^{-1} (0.97%) to 959.40 ha^{-1} (0.87%) and from 2398.59 ha^{-1} (2.17%) to 2335.23 ha^{-1} (2.11%) with the area change and percentage change of -2392 ha^{-1}(-1.30%),-8691 ha^{-1}(-4.74%),-115 ha^{-1}(-0.06%) and-63.36 ha^{-1}(-0.03%) respectively (Table 4.3).Between 2008 and 2018 the annual decreasing rate of forest land cover, grass land cover, bush land cover and wet land cover were -239.2ha^{-1}(-0.216%),-869.1ha^{-1}(-0.786%),-11.5ha^{-1}(-0.01%)and-6.336ha^{-1}(-0.0053%) respectively; whereas annual increasing rate of agricultural land cover, and settlement cover were 962.72 ha^{-1} (0.875%), 163.91 ha^{-1}(0.1480%), 204.88 ha^{-1} (0.111%) and 0.292 ha^{-1} (0.0%) respectively per year.(Table 4.3). The expansion of wetland and bush land between 1988-1998 and 1988-2008 were insignificant (table 4.3.) which were absent. Generally, forest land is the major LULC of the area in 1988 period in relation to total coverage area of the land whereas, agricultural land is the major LULC of the area in 2018 period in relation to total area coverage of LULCC.

Table 4.1: Categories and patterns of Land Use/Land Cover of study area.

Land use	1988		1998		2008		2018	
Land cover Classes	ha^{-1}	(%)	ha^{-1}	%	ha^{-1}	%	ha^{-1}	%
FL	62104.4	56.22	51415.9	46.55	46259.9	41.88	43867	39.71
GL	17416	15.77	17298.1	15.66	15899.5	14.39	7208	6.53
AL	25553.5	23.13	34718	31.43	38853.3	35.17	48480.5	43.89
BL	37.98	0.03	39.06	0.04	42.48	0.04	44.82	0.04
BUL	1196.91	1.08	1138.14	1.03	1075.05	0.97	959.4	0.87
WL	2409.48	2.18	2406.15	2.18	2398.59	2.17	2335.23	2.11
SE	1740.33	1.58	3442.23	3.12	5928.62	5.37	7562.79	6.85
Total	110458	100.	110458	100.	110458	100	110458	100.

Note: FL= Forest land, GL=Grass land, AL=Agricultural Land, BL=Bare Land, BUL=, Bush land, WL=Wetland, SL=Settlement land

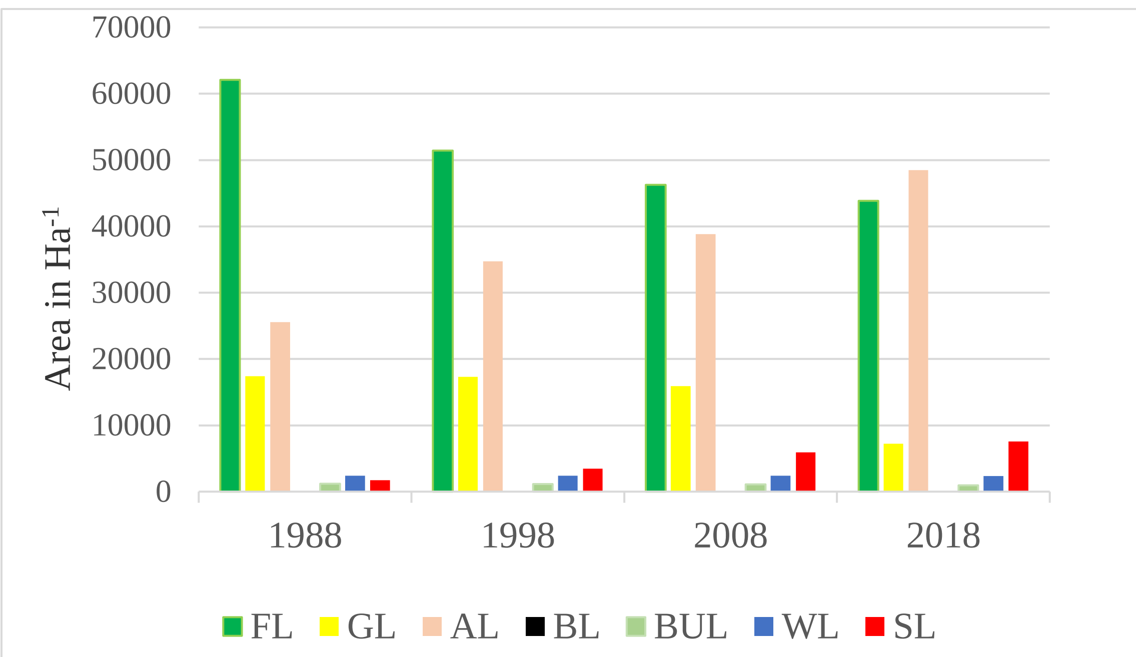


Figure.4.2 Chart of Land use land cover classification map of 1988, 1998, 2008 and 2018.

Table 4.2: Trend and Magnitude of Land Use /Land Cover change in 1988-1998, 1998-2008, 2008-2018, 1988-2018

Land Cover classes	1988-1998		1998-2008		2008-2018.		1988-2018	
	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Net Δ Area(ha)	Net Δ %
FL	-10688.4	-9.96	-5156	-4.66	-2392	-2.16	-18237.06	-16.5
GL	-117.9	-0.1	-1399	-1.26	-8691	-7.86	-10207.53	-9.2
AL	9164.52	8.1	4135.3	3.73	9627.2	8.75	22927.05	20.78
BL	1.08	0	3.42	0	2.34	0	0.020716	0.0062
BUL	-58.77	-0.05	-63.09	-0.04	-115	-0.1	-237.51	-0.21
WL	-3.33	0	-7.56	0	-63.36	-0.05	-74.25	-0.077
SL	1701.9	1.54	2481	2.25	1639.1	1.48	5822.46	5.28

Note: FL= Forest land, GL=Grass land, AL=Agricultural Land, BL=Bare Land, BUL=, Bush land, WL=Wetland, SL=Settlement land

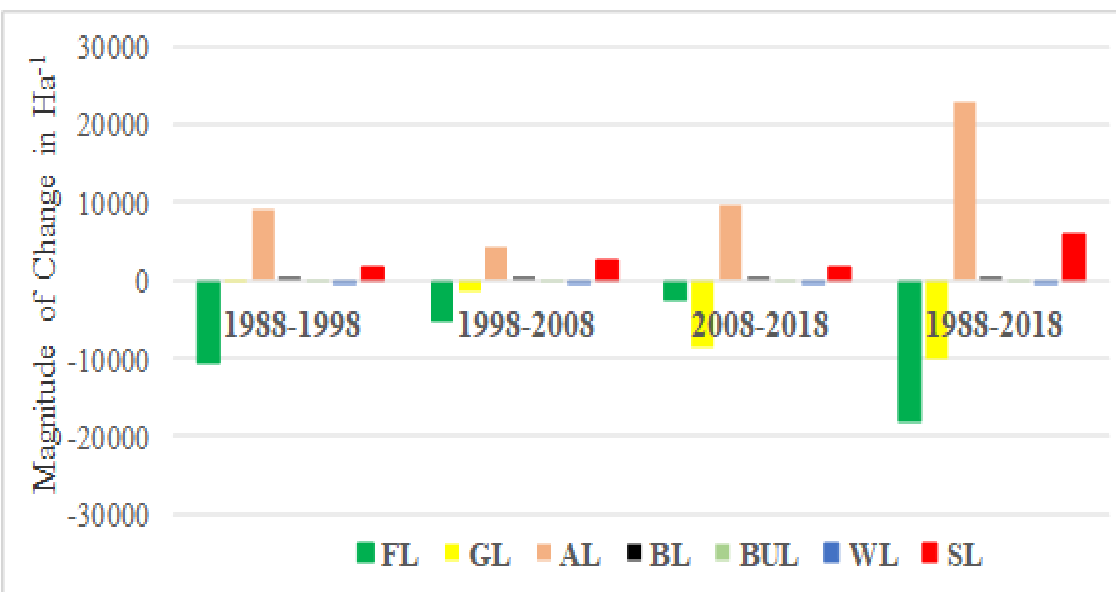


Figure 4.3. Changes of LULC classes between 1988-1998, 1998-2008, 2008-2018, 1988-2018

Table 4.3: Rate of Land Use/ Land Cover Change in 1988-1998, 1998-2008, 2008-2018, 1988-2018

Land Cover classes	1988-1998		1998-2008		2008-2018.		1988-2018	
	Δ Area(ha)/ year	Δ in%/ year.	Δ Area(ha)/ year	Δ in %/ year	Δ Area(ha) /year	Δ in %/ year	Δ Area(ha)/ year	Δ in %/ year.
FL	-1068.84	-0.996	-515.6	-0.466	-239.2	-0.216	-1823.706	-1.65
GL	-11.79	-0.01	-139.9	-0.126	-869.1	-0.786	-1020.753	-0.92
AL	916.452	0.81	413.53	0.373	962.72	0.875	2292.705	2.078
BL	0.108	0	0.342	0	0.234	0	0.00207	0.00062
BUL	-5.877	-0.005	-6.309	-0.004	-11.5	-0.01	-23.751	-0.021
WL	-0.333	0	-0.756	0	-6.336	-0.005	-74.25	-0.0077
SL	170.19	0.154	248.1	0.225	163.91	0.148	582.246	0.528

The overall accuracy of the classified image 1988, 1998, 2008 and 2018 were 82.6%, 85.5%, 87.6%, and 91.06% respectively with kappa coefficient of 0.796, 0.829,0854 and 0.984 which is attained kappa coefficient perfect (0.81-1.00) according to Congalton, (1991).(See Appendix B.Table 2-5) The reason why the producers accuracy and users accuracy were computed becouse of the overall accuracy of the map not always represent the accuracy of individual class. For instance in (Appendix B.Table.2) the higher users accuracy of agricultural land (87.5%) and lower producer accuracy implies that there the gain of agricultural land in map classification and loss in reference data whereas, the higher producers accuracy of forest land (93.8%) and the lower user’s accuracy (89.2%) implies that the more forest gain in map classification and lost in reference data.

(see Appendix.B.Table 6-8) shows the conversion matrix of land use land cover in which pixels change from one of LULC type to another (from the period of 1988-1998, 1998-2008 and 2008-2018).

4.2. Major driving forces of LULCC of study area

4.2.1. Proximate drivers of the study area

In the study areas, house hold reported and ranked that the most proximate drivers of land use land cover change were agricultural expansion (13.9%) followed by expansion of settlement (13.4%) and fuel wood extraction(12.9%) which is confirmed by 379 respondents,363 respondents and 351 respondent out of 384 house hold respondents. Table.(4.4) according to house hold respondents reports the extraction fuel wood has been used for heating, cooking and selling. In addition to HHs according Key informant's interview and deep discussion with FGD the proximate causes of land use land cover change in the study area were agricultural expansion, fuel wood extraction, and expansion of settlement, illegal logging, charcoal production and wood for house construction in which agricultural land expansion from wetland and forest land is the serous land use land cover change followed by fuel wood extraction, expansion of settlement illegal logging and charcoal production. This agricultural expansion, expansion of infrastructure (road and settlement) and fuel wood extraction result was in lined with the findings of Adane Mesgebu,(2016) which reported that agricultural expansion and fuel wood extraction is the proximate drivers of Bale eco regions ,Ashebir Mengistu and Muluneh Woldetsedik,(2018) reported that agricultural expansion, settlement expansion and fuel wood extraction was the serious proximate drivers of land use land cover change of south west Ethiopia, whereas Fasika *et al*.,(2018) noted that fuel wood extraction is the proximate drivers of land use land cover change of Somodo water shade south west Ethiopia.

Also according the house hold reported the change of forest land to agricultural land was because of wild animals (pigs, monkey and ape) destruct their crops which is inlined with the findings of Kefelegn Getahun *et al.,*(2017)

Table 4.4. House hold responses on Proximate Drivers of LULCC

Proximate drivers of LULCC	Frequency	Percentage	Rank
Agricultural Expansion	379	13.9%	1
Fuel wood extraction	351	12.9%	3
Expansion of settlement	363	13.4%	2
Illegal Logging	341	12.5%	4
Charcoal production	333	12.3%	5
Wood for House construction	322	11.8%	6
Wild animals	311	11.4%	8
Wet land allocation	318	11.7%	7
Total Respondents	384	100	

Source: Field Survey, 2019

Plate 4.1. Illegal timber production and Fuel wood extraction of study area (left and Right) (Photo, 2019)

In addition to purposively selected kebeles for study key informant and FGD reported that in Gido Beri kebele charcohol production was the top one of proximate drivers of LULCC which they degrade the forest land by producing charcoal and finally, they changed to agricultural land This is associated with the economy of the household of the study area in which they don't have enough farmland they use charcoal production as an alternative solution for their low income. Similarly, forest deforestation and illegal wood/illegal timber production are top LULCC of the study area in which it was practiced in Satagono, Damu, Seka, Kimiso, Chefeta, Salako and Sheni Chemeri kebele associated with corruption, coffee plantation ,population increments and unemployment. Similarly in Setema kecha and kimiso kebele there is serious change of wetland to agricultural land which is associated with corruption and lack of land for agriculture. For instance, KI and FGD respondents stated that farmers those deforest forest land and change wetland cover to change to agricultural land give bribe for the district court and kebele administrator and expand the size of agricultural land by deforesting forest land and changing wetland cover illegally the findings are in lined with Fasika *et al.*,(2018).

In addition to illegally changing wetland to agriculture by farmers, the government also allocates wetland for unemployed youth by taking an alternative solution for unemployed youth. Due to this wetland was changed to agricultural land through exposing of water from the area by cutoff drain; the grass which was used for the construction of hatch was disappeared whereas the bird species of "Dolle" which feed same insects and the animal species of "Kellejje" which feeds were also disappeared.

Plate 4.2.Wetland ready to allocate and allocated for unemployment youth for Agricultural expansion. (Left and right)(Photo, 2019)

4.2.2. Underlying drivers of LULCC in the study area

In the study areas, house hold reported and ranked that the most serious underlying drivers of land use land cover change were population growth (30.29%) followed by corruption(29.81%) inappropriate government strategy (22.05%) and, lack of institutional collaboration which is confirmed by 375 respondents, 369 respondents, 273 respondents and 221 respondents out of 384 house hold respondents(Table 4.15). According to deep discussion with KI and FGD in the study area the underlying drivers of land use land cover were population growth in which due to polygamy marriage practiced in the study areas and leads high fertility without family planning, corruption, lack of institutional collaboration and inappropriate government strategy. This underlying drivers of LULCC of the study area were in lined with previous finding of Adane Mesgabu,(2016); Ashebir *et al.*,(2018) Fasika *et al.*,(2018); Helene Megersa,(2017);which population growth is the underlying drivers of Bale eco-regions, Somodo water shade and Merti district respectively.

Table 4.5. House hold response on underlying drivers of LULCC

Underlying Drivers of LULCC	Frequency	Percent	Rank
Population growth	375	30.29%	1
Corruption	369	29.81%	2
Lack of institutional collaboration	221	17.85%	4
Inappropriate Government strategy	273	22.05%	3
Total	384	100.00%	

Source: Field Survey, 2019

4.3. LULCC prediction using Cellular automata

Cellular automata is simple way of modeling type which allow detailed mathematical analysis to estimates the taken time in transition that can generate complex spatial patterns from the simple set of rules and predicts LULCC in the future (Singh, 2003).(Figure 4.4) shows modeling of land use cover of the study area by using Cellular Automata modeling which were used distance to road rasterized input data, distance to river rasterized input data, population density map of 2000,2005 and 2015,classified satellite image map of 1998 and 2008.Then training artificial neural networks (ANN) with the help of Multi-Layer Perceptron (MLP) were used in which using neighborhood feature was preferred 3pixel size, learning rate 0,1, the iteration number is 200 and the maximum moment is 0.05 which is powerful than linear regression (Jogun 2016). At the end of the training artificial neural networks process, the minimum validation error was calculated as 0.01172 and the validation kappa value was 0.81150.

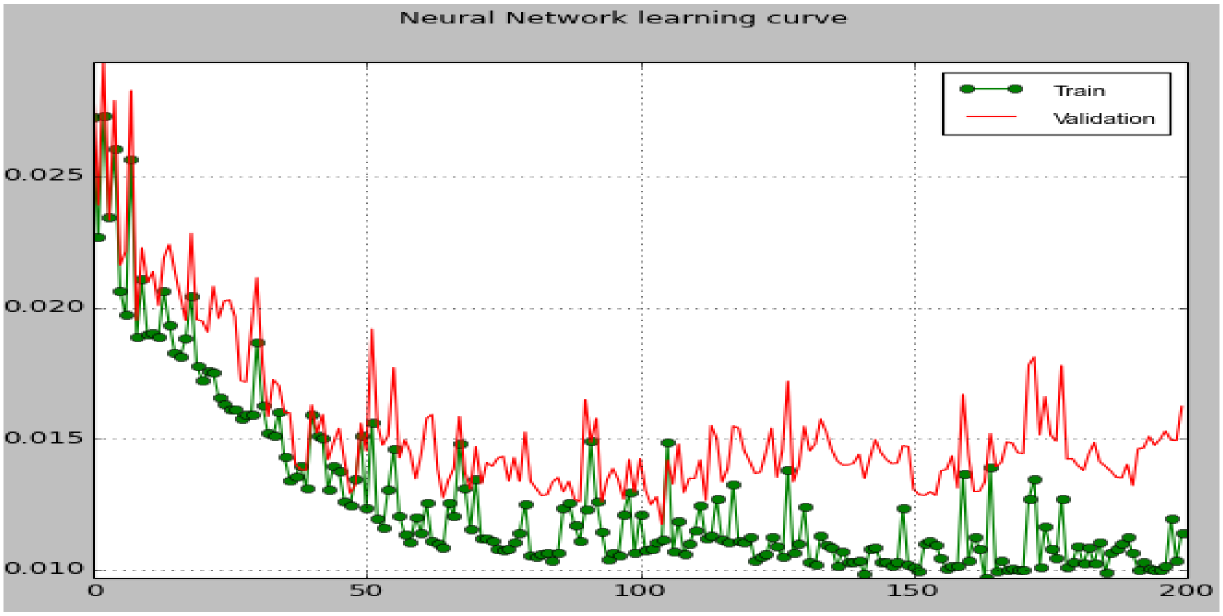


Figure 4.4. Neural Network learning curve

4.3.1. Prediction of 2018 LULCC

Table (4.17) shows the 2018 LULCC which was simulated from the initial period (1998) and final period (2008) for calculation of accuracy and kappa statics which is used for prediction of LULCC for the year of 2028 by using MOLUSCE plug-in extension (Figueiredo T, 2018). Then simulated map of 2018 and classified map 2018 which was used as reference was compared for validation and for the prediction of 2028.

Table 4.6. Changed areas in hectare and in percent between the references LULC map 2018 and the simulated LULC map 2018

LULCC Classes	Reference/Classified LULCC in 2018		Predicted/Simulated LULCC in 2018	
	ha^{-1}	%	ha^{-1}	%
Forest land	43867.4	39.71	43866.4	39.71
Grass land	7208.55	6.53	7207.55	6.53
Agricultural land	48480.6	43.89	48484.6	43.89
Degraded land	44.82	0.04	43	0.04
Bush land	959.40	0.87	959.2	0.87
Wetland	2335.23	2.11	2335.13	2.11
Settlement land	7562.79	6.85	7561.79	6.85

4.3.2. Validation of Model

For the validation of the model overall kappa and multiple resolution budget and were used to check, compare and validate simulated image (2018) from 1998 and 2008 by using actual land use pattern/ classified image (2018) as reference map and simulated map of 2018 (Landis and Koch 1997) whereas image correlation coefficient (r) between two images was also calculated by MOLUSCE extension plug-in to determine the similarities between the two images. According to Evans,(1996) suggests for the absolute value of correlation:0.00-0.19 “very weak”.20-0.39 “weak 0.40-0.59 “moderate”0.60-0.79 “strong”0.80-1.0 “very strong” Therefore the results of the correlation coefficient gave a value of 0.708 which indicate strong) correlation of classified map of 2018 and simulated map of 2018., which indicates a good positive relationship between the two images and acceptable for the prediction of 2018 maps as shown in (Table.4.7.).The multiple resolution is the accuracy in location and in quantity of the reference map and the simulated map that correspond to the agreement and disagreement component between two maps (Pontius and Suedmeyer, 2004).

According to Pontius and Suedmeyer (2004),the most important plot is “perfect location, medium quantity inform” where the plot is almost 1 means the perfect location and medium quantity information are almost 100% between both maps (reference map and simulated map) in which the perfect location is a grid cell level information of the reference map that has a perfect location in the simulated map and medium quantity is the reference map that has the same quantity as the simulated map which is considered as a good agreement. Therefore for this study, because of the total value (overall correctness) is 79.1%,(Table 4.8) which indicates that the Substantial agreement of the simulated LULC map in 2018 with comparison map of 2018 and Multi-resolution budget accuracy result of 2018 reference map and 2018 comparison map are shows good agreement and perfect location, medium quantity inform” then the prediction of 2028 LULCC was acceptable (Figure.4.8).

Table .4.7. Image correlation matrix.

	2018 classified reference map	2018 Simulated map
2018 Classified reference map	1	0.708
2018 Simulated map	0.708	1

Table 4.8 Kappa and correctness of the simulated LULC map in 2018

Simulated LULC map in 2018	
Correctness	79.1%
Kappa (overall)	0.708
Kappa (histogram)	0.934
Kappa (location)	0.758

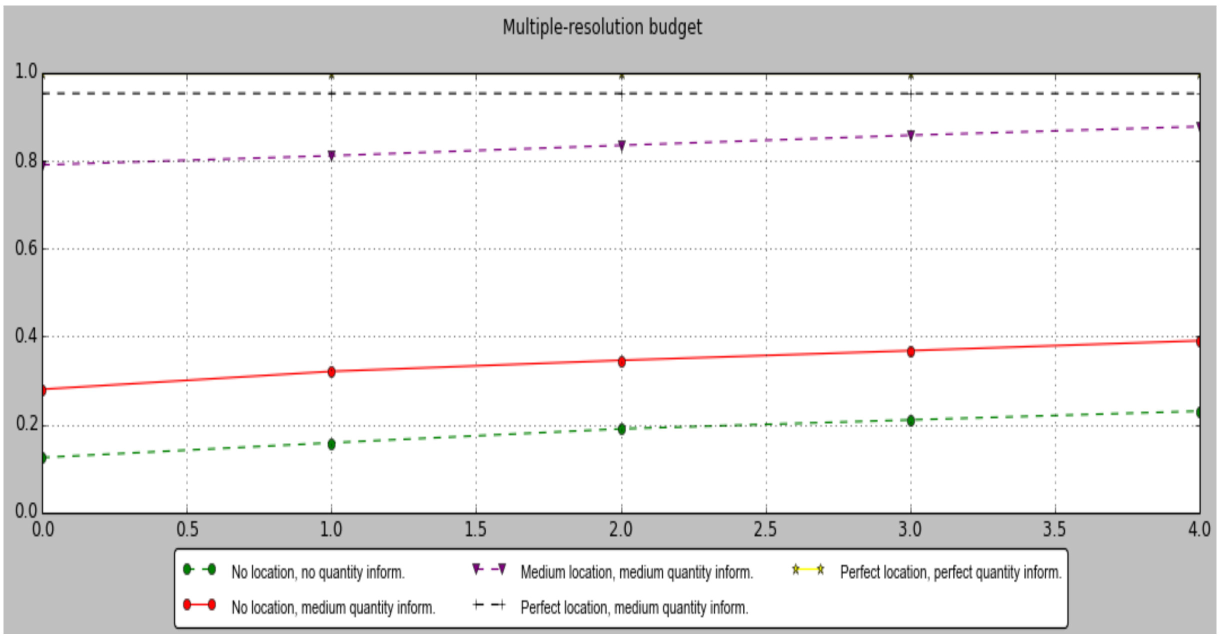


Figure 4.5: Multi-resolution included 4 plots of simulated LULC in 2018

4.3.3. Prediction of future LULC for the year 2028

After the change detection of LULC classes and validation were checked by overall correctness, correlation of the image checked (2018 classified and simulated) and Multiple resolution budget in which overall correctness and Multiple resolution budget the study was aimed for prediction of the next ten future land use land cover changes for the year of 2028 from the initial period

(2010) and final period (2018).Then future predicted land use classification map of 2028 was compared with actual classification map of the year 2018 (Figure 4.6 and Table 4.9).

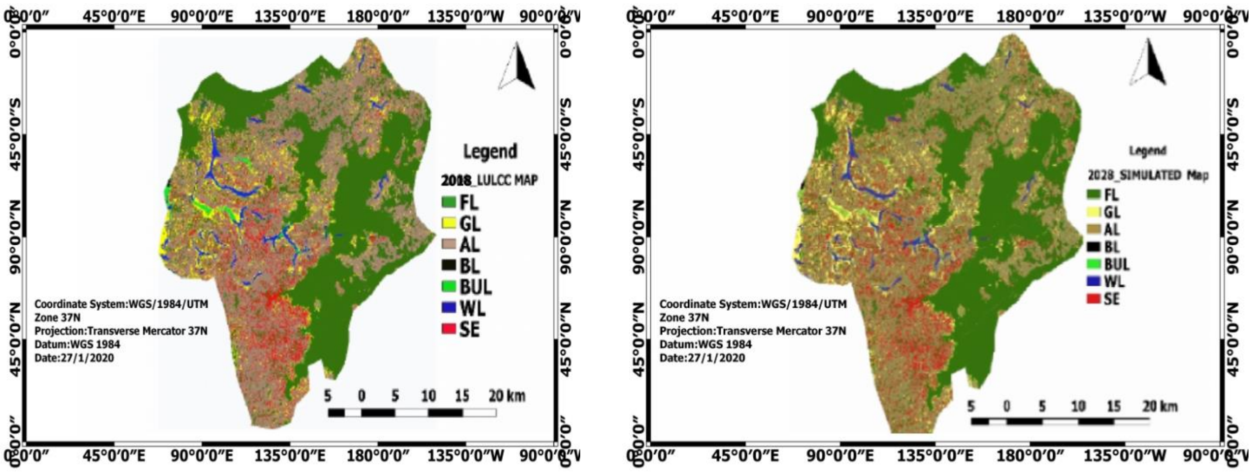


Figure 4.6. Land use land cover map in 2018 and simulated land use land cover in 2028 (Left and Right)

From the Table (4.9) the result of simulated LULCC of 2028 shows there were decreasing forest land, grass land, bush land, and wet land from 43867.35ha^{-1} (39.71%) to 43516.17 ha^{-1}(39.39%), from 7208.55 ha^{-1} (6.53%) to 4335.75ha^{-1}(3.92%),from 959.40 ha^{-1} (0.87%) to 673.92 ha^{-1} (0.6%) from 2335.23 ha^{-1}(2.11%) to1592.46 ha^{-1}(1.4%) with area decreasing changed-351.18 ha^{-1}(-0.32%), -2872.80 ha^{-1} (-2.61%),-285.48 ha^{-1}(-0.27%) and-742.77 ha^{-1}(-0.71%) respectively, whereas agricultural land, bare land and settlement land were increased from 48480.57 ha^{-1} (43.89%),51406.43ha^{-1} (46.5%),from 44.82 ha^{-1}(0.04%) to 60.39 ha^{-1} (0.05%), from 7562.79 ha^{-1}(6.85%) to8873.24 ha^{-1} (8.03%) with area change increasing 2925.86ha^{-1} (2.57%),15.57 ha^{-1} (0.01%) and 1310.45 ha^{-1} (1.18%) respectively.

Table 4.9: LULC Changed areas in Ha^{-1} and % between LULC in 2018 and 2028

LULCC Classes	LULCC in 2018		Predicted LULCC in 2028		Change in LULCC	
	Δ ha^{-1}	Δ %	Δ ha^{-1}	Δ %	Δ ha^{-1}	Δ %
Forest land	43867.35	39.71	43516.17	39.39	-351.18	-0.32
Grass land	7208.55	6.53	4335.75	3.92	-2872.80	-2.61
Agricultural land	48480.57	43.89	51406.43	46.5	2925.86	2.57
Bare land	44.82	0.04	60.39	0.05	15.57	0.01
Bush land	959.40	0.87	673.92	0.6	-285.48	-0.27
Wet land	2335.23	2.11	1592.46	1.4	-742.77	-0.71
Settlement Land	7562.79	6.85	8873.24	8.03	1310.45	1.18

5. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

Based on information of satellites classified image integrated with GIS, social survey analyses (KII, FGD, HHs field), field observation and ground control point the study was conducted to identify LULCC, to analyse rate of land use land cover change, driving force of land use land cover change for 30 years (1988-2018) as well as prediction of LULCC for the year 2028 LULCC by using spatial variables, remotes sensing satellite classified map with the help of QGIS software 2.18.3 and MOLUSCE extension plug-in of version 3. Therefore forest land agricultural land, grassland, bare land, wetland, bush land, settlement land were identified and 2018 LULCC were predicted. This understanding rate of land use land cover change, the driving forces and LULCC prediction for the study area are very important to plan LULCC processes and spatial trends, which will provide relevant knowledge that is a useful guideline for decision-makers at the national and local government, and civil society.

Therefore based on downloaded satellite image classification, social Survey analyses of KII, FGD, and HHs; forest land cover, grassland cover, bush land cover and wetland cover were decreased from 62104.4ha^{-1} (33.8%) to 43867 ha^{-1} (23.9%),from 17416.0 ha^{-1} (9.4%) to7208 ha^{-1} (3.93%),from 1196.91 ha^{-1} (0.6%) to 959.40 ha^{-1} (0.52%) 2409.48 ha^{-1} (1.31%) to 2335.23 ha^{-1} (1.27%) respectively over 30 years(1988-2018)whereas agricultural land, settlement land and bare land were increased from 25553.5 ha^{-1} (13.9%) to 48480.5 ha^{-1} (26.4 %) ,from 1740.33 ha^{-1}(0.94 %) to 7562.79 ha^{-1}(4.12%) and from 37.98 ha^{-1} (0.02%) to 44.82ha (0.02%) respectively. The decrease and increase of land use land cover were due to proximate drivers of and underlying drivers such as fuel wood extraction, illegal wetland conversion to agricultural land, and illegal timber production, and agricultural expansion, extraction of wood for house construction and population growth and corruption.

From the finding, the result showed the prediction of 2028 LULCC were carried out by using MOLUSCE extension plug-in with integrating of QGIS in which forest land, grassland, bush land and wetland will decrease to 43516.17 ha^{-1}(39.39%),4335.75 ha^{-1}(3.92%),673.92ha^{-1}(0.6%), and 1592.46ha^{-1}(1.4%) respectively compared to LULCC classified map of 2018 whereas agricultural land, Settlement land and bare land will be increased to 51406.43ha^{-1}(56.5%),8873.24ha^{-1}(8.03%), and 60.39 ha^{-1}(0.05%) respectively. Generally the changes between 2018 classified map and 2028 predicted map shown in the (Table 4.9). Therefore, the use of QGIS and remote sensing data to investigate LU/LC class pattern and to simulate the next period of LULCC in the study area suggests a quicker, cost free and cost effective technique with the advantage of covering large area.

5.2. RECOMMENDATION

The findings of this study on assessing the rate of land use land cover changes and its driving forces shows there were increasing agricultural land, settlement, land bare land whereas there were decreasing of forest land grassland, bushland, and wetland land. Because of wetland were changed to agricultural land "Kellejje" and "Dolle" species were disappeared. This problem is caused by proximate drivers and underlying drivers factors. Based on household survey, FG and Key informants' perception, the drivers of LULCC identified and, study area results the following recommendations could be promoted:-

- "Gafo" practice will develop at all kebeles in which a small group of people around the forest tie their traditional hive on the tree and nobody can cut the tree because of forbidden as their culture, even the tree are cut by other person they report to the Kabale administrator.
- Developing proper and organized land use planning and management have a great opportunity to solve the problems of land use land cover change.
- The government will be generating off-farm activities such as by facilitate credit and cooperate on apiculture/beekeeping, dairy farms and poultry for landless youth whereas facilitate market network for them rather than distributing wetland as an alternative solution, Since unemployment is the reason for the changing of wetland to agricultural land.
- Awareness about LULCC consequence of LULCC and its effects will be given to the society.
- Encouraging farmers to grow fast-growing species around home garden and farmland boundaries which is used for the fuel wood.

- Institutions should be collaborating and integrated to identify the problem, plan and give solutions to collaborate that use the society for sustainable land use management.
- The government should aware and motivate the community about fighting corruption.
- Community should participate in Participatory forest management (PFM) in which the forest provides higher forest income benefits to the local community over the longer term and the community manage and use the forest in a sustainable way.
- Conservation activities have to be taken on rural areas of the study area and recommended to plant trees and delineate bare land areas..
- Further study is required to study the role of wetland for LULC and species disappeared because of changed to agricultural land.

6. REFERENCE

Adane Mesgebu Nigussie.2016.Land Use/Land Cover Change and Associated Driving Forces In Bale Eco-Region, Ethiopia.

Addis Getinat. 2009. Spatial-temporal land use/land cover changes analysis and monitoring in the Valencia municipality, Spain. (Doctoral dissertation).

Adimasu Woldesenbet Worako. 2016. Land Use Land Cover Change Detection by Using Remote Sensing Data in Akaki River Basin. International Journal of Environment, Agriculture and Biotechnology.1 (1).

Alemayehu Midekisa, Holl, F., Savory, D.J., Andrade-Pacheco, R., Gething, P.W., Bennett, A. and Sturrock, H.J.2017.Mapping land cover change over continental Africa using Landsat and Google Earth Engine cloud computing.

Anderson, J.R.1976. A land use and land cover classification system for use with remote sensor data (Vol. 964). US Government Printing Office.

Araya, Y. H., & Cabral, P. 2009. Analysis and Modeling of Urban Land Cover Change in Setúbal and Sesimbra, Portugal. Remote Sensing (Vol. 6).

Ashebir Mengistu and Muluneh Woldetsed. 2018. Proximate Causes and Underlying Driving Forces of Land Cover Change in south west Ethipia.20(1):232–244p.

Baker, W. L. (1989). "A review of models of landscape change." Landscape Ecology 2(2): 111-133p.

Bakker, W.H.; Gorte, B.G.H.; Janssen, L.L.E.; Pohl, C.; Prakash, A.; Reeves, C.V.; Weir, M.J.C.; Woldai, T. Principles of Remote Sensing; ITC: Enschede, The Netherlands,

2001. p:180.

Baldyga, T. J., Miller, S. N., Driese, K. L., & & Gichaba, C. M. 2008. Assessing land cover change in Kenya's Assessing land cover change in Kenya's (Vol. 46): African Journal of Ecology.

Bartlett, J. E., Kotrlik, J.W.K.J.W. and Higgins, C.C.H.C.C. 2001. Organizational research: Determining appropriate sample size in survey research appropriate sample size in survey research. Information technology, learning, and performance journal.19 (1):p43..

Belay Haile Gessese.2018. Impact of Land Use / Land Cover Change on Rural Communities Livelihood of Ethiopia.6(1).

Berhanu Nega, Berhanu Adenew and S.Gebra selassie.2003. Current land policy issues in Ethiopia. Land Reform, Land Settlement, and Cooperatives.11 (3):103-24p.

Binyam Alemu.2015.The effect of land use land cover change on land degradation in the highlands of Ethiopia. J Env Earth Sci,p: 1-12.

Binyam Tesfaw Hailu ,Mekbib Fekadu ,Thomas Naus.2018. Availability of global and national scale land cover products and their accuracy in mountainous areas of Ethiopia: a review. Journal of Applied Remote Sensing.12 (4):41p.

Bireda Alemayehu.2015.School of Graduate Studies Department of Geography and Environmental Studies GIS and Remote Sensing Based Land Use /Land Cover Change Detection and Prediction in FagitaLekomaWoreda,Awi Zone,North Western Ethiopia.

Briassoulis, H. 2009. Factors influencing land-use and land-cover change. Land cover, land use and the global change. *Encyclopedia of life support systems* (EOLSS).126-146p

Caetano, M. 2013.Theory on Land Use / Cover & Change Detection Theory on Land Cover and Land Use Monitoring.1–87p.

Cheng, C.-T., Wu, X.-Y. and Chau, K. W.2005. Multiple criteria rainfall–runoff model calibration using a parallel genetic algorithm in a cluster of computers / Calage multi-critères en modélisation pluie–débit par un algorithme génétique parallèle mis en œuvre par une grappe d'ordinateurs, Hydrological Sciences Journal. *Avialable a*t doi: 10.1623/hysj.2005.50.6.1069.

Congalton, R. G. 1991 .A Review of Assessing the Accuracy of Classifications of Remotely Sensed Data, in Epilepsy Currents.198–205p. Available at:doi: 10.5698/1535-7511-16.3.198.

CSA.2007.Central Statistical Central Statistical Agency.Population projection statistics report.

Daniel Ayalew Mengistu.2008. Remote sensing and gis-based Land use and land cover change detection in the upper Dijo river catchment ,Silte zone, Southern Ethiopia.

De Sherbinin, A. 2002 .A CIESIN thematic guide to land-use and land-cover change (LUCC) Center for International Earth Science Information Network, Columbia University.67p.Available at doi: 10.1371/journal.ppat.1003000.

Dechassa Lamessa.2000. Field Assessment Report: Jimma Zone of Oromia Region.

DeFries, R. S., Rudel, T., Uriarte, M., & Hansen, M. 2010. Deforestation driven by urban population growth and agricultural trade in the twenty-first century (Vol. 3): Nature Geoscience.

Dereje Likissa Beyene.2014. Assessing the impact of unesco biosphere reserves on forest cover change.

Duguma Erasu.2017. Remote Sensing Based Urban Land Use/Land Cover Change Detection and Monitoring. Available at doi:10.4172/2469-4134.1000196.

Eleni Yeshaneh,Wolfgang Wagner,Michael Exner-Kittridge, Dagnachew Legesse ,and Günter Blöschl.2013.Identifying landuse/cover dynamics in the Koga Catchment, Ethiopia, from multi-scale data,and implications for environmental changing. *ISPRS International Journal of Geo-Information* 2:302-323p

Ellis, E.2007b.Land use and land cover change, Land use and land cover change and Climate change.1–4 p. doi: 10.7930/J05Q4T1Q.

Erle, E. 2011. Land-use and land-cover change and Climate change.*The Encyclopedia of Earth*.1–7p. Available at:doi: 10.1623/ hysj.2005.50.6.1069.

FAO.2015.Food and Agriculture Organization,Global Forest Resources Assessment 2015. Desk reference, Desk Reference.available at: doi: 10.1002/2014GB005021.

Fasika Alemayehu, Motuma Tolera,Gizaw Tesfaye.2019.Land Use Land Cover Change Trend and Its Drivers in Somodo Watershed South Western ,Ethiopia.14(2):102–117p. Available at doi: 10.5897/AJAR2018.13672.

Figueiredo.T. 2018.Understanding the determinants of Land-Use and Land-Cover change as a basis for conservation management in the Warren River Catchment.from http://www.csa.gov.et/.

Fujita, Y., Thongmanivong, S., Vongvisouk, T., & Phanvilay, K. (2007). Dynamic Land Use Change in Sing District, Luang Namtha Province, Lao PDR". A draft report to

International Program for Research on the Interactions between Population, Development, and the Environment (PRIPODE): Faculty of Forestry, National University of Laos

Gebrekidan Worku, Amare Bantider (Ph.D) and Habtamu Temesgen.2014.Land use and land cover change in Ameleke Watershed South. 4(14):p.42–48.

Getachew Fisseha, Heluf Gebrekidan ,Kibebew Kibret, BirruYitaferu, Bobe Bedadi.2011. Analysis of landuse/land cover changes in the Debre-Mewi watershed at the upper catchment of theBlue Nile Basin, Northwest Ethiopia. Journal of Biodiversity and Environmental Sciences (JBES). (6):P.184-198

Getahun, K., Poesen, J. and Van Rompaey, A .2017.Impacts of Resettlement Programs on Deforestation of Moist Evergreen Afromontane Forests in Southwest Ethiopia', Mountain Research and Development.37(4):p.474–486.doi:10.1659/MRD-JOURNAL-D-15-00034.1.

Girma Eshetu, Tino Johansson and Wayessa Garedew.2016.Rainfall trend and variability analysis in Setema-Gatira area of Jimma, Southwestern Ethiopia.

Girmay Kassa Welela .2003. Gis Based Analysis of Land Use / Land Cover Land degradation and population change.Agricultural Research.

Hadi, S. J., Shafri, H. Z. M. and Mahir, M. D. 2014.Modelling LULC for the period 2010-2030 using GIS and remote sensing: A case study of Tikrit, Iraq in IOP Conference Series: Earth and Environmental Science. doi: 10.1088/1755-1315/20/1/012053.

Hano, A. I. A. 2013 . Assessment of Impacts of Changes in Land Use Patterns on Land

Degradation / Desertification in the Semi- arid Zone of White Nile State , Sudan , by Means of Remote Sensing and GIS.12–16p.

Helen Megersa. 2017.Spatiotemporal analysis of land cover dynamics: a case of merti woreda , oromia region, Ethiopia.

Husen Ali.2009.Land use and land cover change, drivers and its impact: a comparative study from Kuhar Michael and Lenche Dima of Blue Nile and A wash basins of Ethiopia.

Jaimes, N. B. P., Sendra, J. B., Delgado, M. G., & Plata, R. F. (2010). Exploring the driving forces behind deforestation in the state of Mexico (Mexico) using geographically weighted regression. (Vol. 30): Applied Geography.

Jokar Arsanjani, J. 2012a. Dynamic land use/cover change modelling. doi: 10.1007/978-3-642-23705-8.

Jokar Arsanjani, J. 2012b. Dynamic land use/cover change modelling, Dynamic land use/cover change modelling. doi: 10.1007/978-3-642-23705-8.

Karsidi, A. 2004. Spatial analysis of land use / land cover change dynamics using Remote sensing and Geographic information sytems : A Case Study in the down stream and surroundings of the Ci Tarum watershed.24p.

Kefelegn Getahun Poesen, J. and Van Rompaey, A. 2017. Impacts of Resettlement Programs on Deforestation of Moist Evergreen Afromontane Forests in Southwest Ethiopia, Mountain Research and Development.37(4):474–486p.doi: 10.1659/MRD-JOURNAL-D-15-00034.1.

Kim, C. 2016.Land use classification and land use change analysis using satellite images in

Lombok Island, Indonesia, Forest Science and Technology.Taylor & Francis, 12(4): 183–191p. doi: 10.1080/21580103.2016.1147498.

Kissinger, G., Herold, M. and De Sy, V.2012.Drivers of deforestation and forest degradationEra-Mx.Org.48p. doi: 10.1016/j.rse.2010.01.001.

Krueger, R. A.2002.Designing and conducting focus group interviews University of Minnesota, (October).17p.doi: 10.1136/bmj.311.7000.299.

Kumar, K. 1989. Conducting key informant interviews in developing contries A.I.D. doi: 10.1190/segam2013-0137.1.

Kumar.p, Santhana, V. seelan. 2017. Evaluation of land use and land cover change detection.720–727p.

Lambin, E. F. and Geist, H. J. 2002.Proximate Causes and Underlying Driving Forces of Tropical Deforestation BioScience. 52(2):p.143–150.

Lambin, E. F., Baulies, X., Bockstael, N., Fischer, G., Krug, T., Leemans, R., Vogel, C. 1999. Land use and land-cover change (LUCC): implementation strategy,Stockholm and Bonn.

Lambin, E. F., Geist, H. J. and Lepers, E. 2003. Dynamics of Land-use and land-cover change in tropical regions', Annual Review of Environment and Resources, 28(1):p205–241. doi: 10.1146/annurev.energy.28.050302.105459.

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., & ... & Xu, J. (2001). The causes of land-use and land-cover change: moving beyond the myths (Vol. 11

Lambin, E., & Geist, H. 2006. Land-use and land-cover change: local processes and global impacts. Springer, Berlin, pp 1–8. Berlin: Springer.

Landis, J. R., & Koch, G. G. 1997. The measurement of observer agreement for categorical data. Biometrics 33(1):159-174p

Long, H., Tang, G., Li, X., & Heilig, G. K. 2007. Socio-economic driving forces of land-use change in unshan, the Yangtze River Delta economic area of China (Vol. 83): Journal of Environmental Management.

Mengistu Kindu, Schneider T, Demel Teketay, Knoke,T.2013. Land use/land cover change analysisusing object-based classification approachin Munessa-Shashemene landscape of theEthiopian Highlands.

Meyer WB and Turner BI.1994. Changes in land use and land cover: a global perspective: Cambridge University Press.

Meyer WB and Turner BL. 1992 .Human population growth and global land-use/cover change. Annual review of ecology and systematics 23:p39-61

Meyfroidt, P., & Lambin, E. F. 2008. The Causes of the Reforestation in Vietnam. 25: Land Use Policy.

Mikias Biazen Molla .2014.Land Use / land cover dynamics in the Central Rift Valley Region of Ethiopia :The Case of Arsi Negele District.Academia Journal of Environmental Sciences.74–88p. doi: 10.15413/ajes.2014.0105.

Milenov, P. 2008.Standardization of the land cover classes using FAO Land CoverClassification System (LCCS).17–18p.

MoFED.2010. Ministry of Finance and Economic Development Growth and Transformation

Plan 2010/11-2014/15, Federal Democratic Republic of Ethiopia .Volume I: Main Text Draft, Addis Ababa, Ethiopia, 2010.

Negasi Solomon, Hadgu Hishe, Ted Annang,OpokuPabi, Isaac K Asante,and Emiru Birhane.2018. Forest Cover Change, Key Drivers and Community Perception in Wujig MahgoWaren Forest of Northern Ethiopia.7-32p.

Othow, O. owar, Sintayehu, L. G. and Gemeda, D. O. 2017.Analyzing the Rate of Land Use and Land Cover Change and Determining the Causes of Forest Cover Change in Gog District, Gambella Regional State, Ethiopia, Journal of Remote Sensing & GIS, 6(4):p.1–13. doi: 10.4172/2469-4134.1000218.

Polisgowdar, B. S., Ayyanagowdar, M. S. and Dandekar, A. T. 2018.Accuracy Assessment of Supervised and Unsupervised Classification using Landsat-8 Imagery of D-7 Shahapur Branch Canal of UKP Command Area Karnataka ,India.7(07):p.205–216.

Pontius, R. G., & Suedmeyer, B. 2004. Components of Agreement between Categorical Maps at Multiple Resolutions.

Prestele, Reinhard Arneth, Almut Bondeau, Alberte De Noblet-Ducoudré, Nathalie Pugh,Thomas A.M.Sitch, StephenStehfest, ElkeVerburg, Peter H.2017.Current challenges of implementing anthropogenic land-use and land-cover change in models contributing to climate change assessments', Earth System Dynamics, 8(2):p.369–386. doi: 10.5194/esd-8-369-2017.

Ramachandra, T. and Kumar, U.2004.Geographic Resources Decision Support System for Land Use, Land Cover Dynamics Analysis', Proceedings of the FOSS/GRASS.p:12–14. doi: 10.1073/pnas.0907765106.

Reddy, M. A. 2008. Remote Sensing and Geographical Information Systems, Components. doi: 10.1017/S0376892900039278.regression. (Vol. 30): Applied Geography

Rita, A. and Sevivas, D. M. 2018. Analysis land use and land cover changes and the driving forces: A case study in Kaysone Phomvihan District, Laos M 2018.

Rocha, P. 2007.Integration of Cellular Automata and Gis for Simulating Land Use Changes', 5th International Symposium Spatial Data Quality - ISPRS.

Roy, P. S. and Roy, A. 2010.Land use and land cover change in India: A remote sensing & GIS prespective', Journal of the Indian Institute of Science.90(4):p.489–502.

SEDAC, S. D. a. A. C. (2018). Global UN-Adjust Population Density, 2000, 2005, 2010, 2015. NASA, SEDAC.

Serneels, S., & Lambin, E. F. 2001. Proximate causes of land-use change in Narok District, Kenya: a spatial statistical model. (Vol. 85): Agriculture, Ecosystems & Environment

Serra, P., & Pons, S., D. 2008. Land-cover and land-use change in a Mediterranean landscape: a spatial analysis of driving forces integrating biophysical and human factors. Applied Geography, 28(3), (Vol. 28): Applied Geography.

Seto, K. C., & Kaufmann, R. K. 2003. Modeling the drivers of urban land use change in the Pearl River elta, China: integrating remote sensing with socioeconomic data. (Vol. 76): Land Economics, 79(1), 106-121.

Singh, A. K. 2003. Modelling Land Use Land Cover Changes Using Cellular Automata in a Geo-Spatial Environment.

Singh, Sudhir Kumar,Mustak, Sk,Srivastava, Prashant K. Szabó, Szilárd

Islam,Tanvir.2015.Predicting Spatial and Decadal LULC Changes Through Cellular Automata Markov Chain Models Using Earth Observation Datasets and Geo-information', Environmental Processes.2(1):p.61–78. doi: 10.1007/s40710-015-0062.

Story, M. and Congalton, R. G. 1986.Accuracy assessment: a user's perspective.', in Photogrammetric Engineering & Remote Sensing.397–399p.doi:10.1111/j.1530-9290.2010.00257.x.

Swart, R. 2016. Monitoring 40 years of Land Use Change in The Mau Forest Complex. Centre for Geo-Information Science and Remote Sensing, Wagningen University

Taherdoost, H. 2017. Determining Sample Size ; How to Calculate Survey Sample Size Survey Sample Size, International Journal of Ecnomics and Management Systems. 237–239p.

Temesgen Gashaw, Taffa Tulu, Mekuria Argaw and Abeyou W. Worqlul.2017.Evaluation and prediction of land use/land cover changes in the Andassa watershed, Blue Nile Basin, Ethiopia', Environmental Systems Research. Springer Berlin Heidelberg.6(1):p.17. doi: 10.1186/s40068-017-0094-5.

Turner II, B. L., Skole, D. L., Sanderson, S., Fischer, G., Fresco, L. O., & Leemans, R.1995. Stockholm and Geneva: IGBP Report No. 35 and HDP Report No.7: Science/Research Plan.

Turner, B. L., Meyer, W. B. and Skole, D. L. 1994.Global land-use land-cover change - towards an integrated study,Ambio. 23(1):p.91–95. doi: 10.2307/4314168.

Verburg, P. H., Van Eck, J. R., De Nijs, T. C., Dijst, M. J., Schot, P.,. 2004. Determinants of landuse change patterns in the Netherlands. Environment and Planning B, 31(1), 125-150

(Vol. 31): Environment and Planning B.

Verfasser and Arsanjani, J. J. 2011.Dynamic Land Use /Cover Change Modelling :Geosimulation and Agent-Based Modelling.

Verne, J. 2016. Image Pre-Processing, Semantic scholar.35–74p. doi: 10.1007/978-3-319-33762-3_2.

Wakjira Takala, Tamene Adugna and Dawud Tamam.2016.Land use land cover change Analysis using Multi Temporal Landsat data in Gilgel Gibe , Omo Gibe Basin , Ethiopia.5(7):pp.309–323.

Walda amlak Bewket and Sterk, G.2005. Dynamics in land cover and its effect on stream flow in the Chemoga watershed, Blue Nile basin, Ethiopia.

Were, K., Dick, Ø. B., & Singh, B. R. (2014). Exploring the geophysical and socio-economic determinants of land cover changes in Eastern Mau forest reserve and Lake Nakuru drainage basin, Kenya (Vol. 79): Geo Journal.

http://earthexplorer.usgs.gov

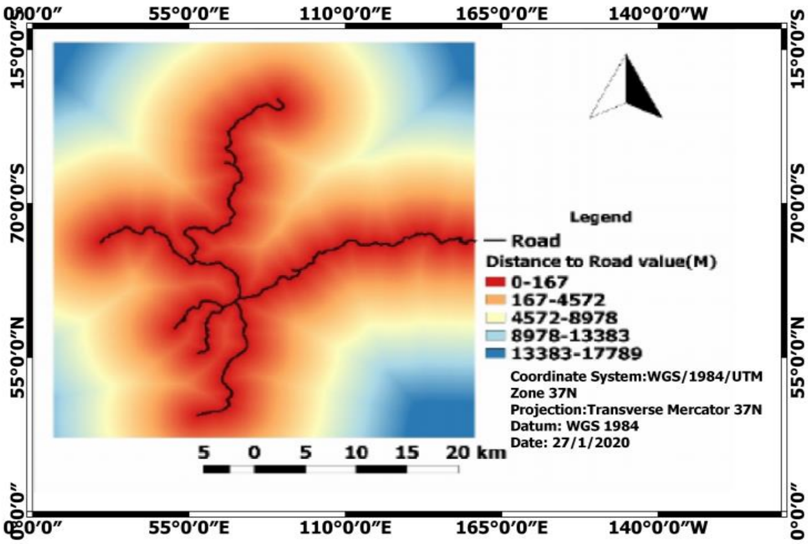
https://en.wikipedia.org/wiki/Google Earth

https://en.wikipedia.org/wiki/Setema

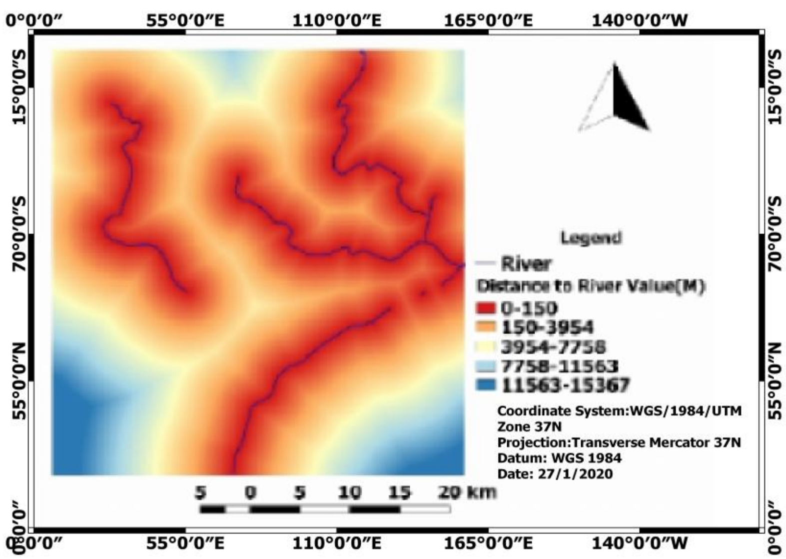
Appendices

Appendix A

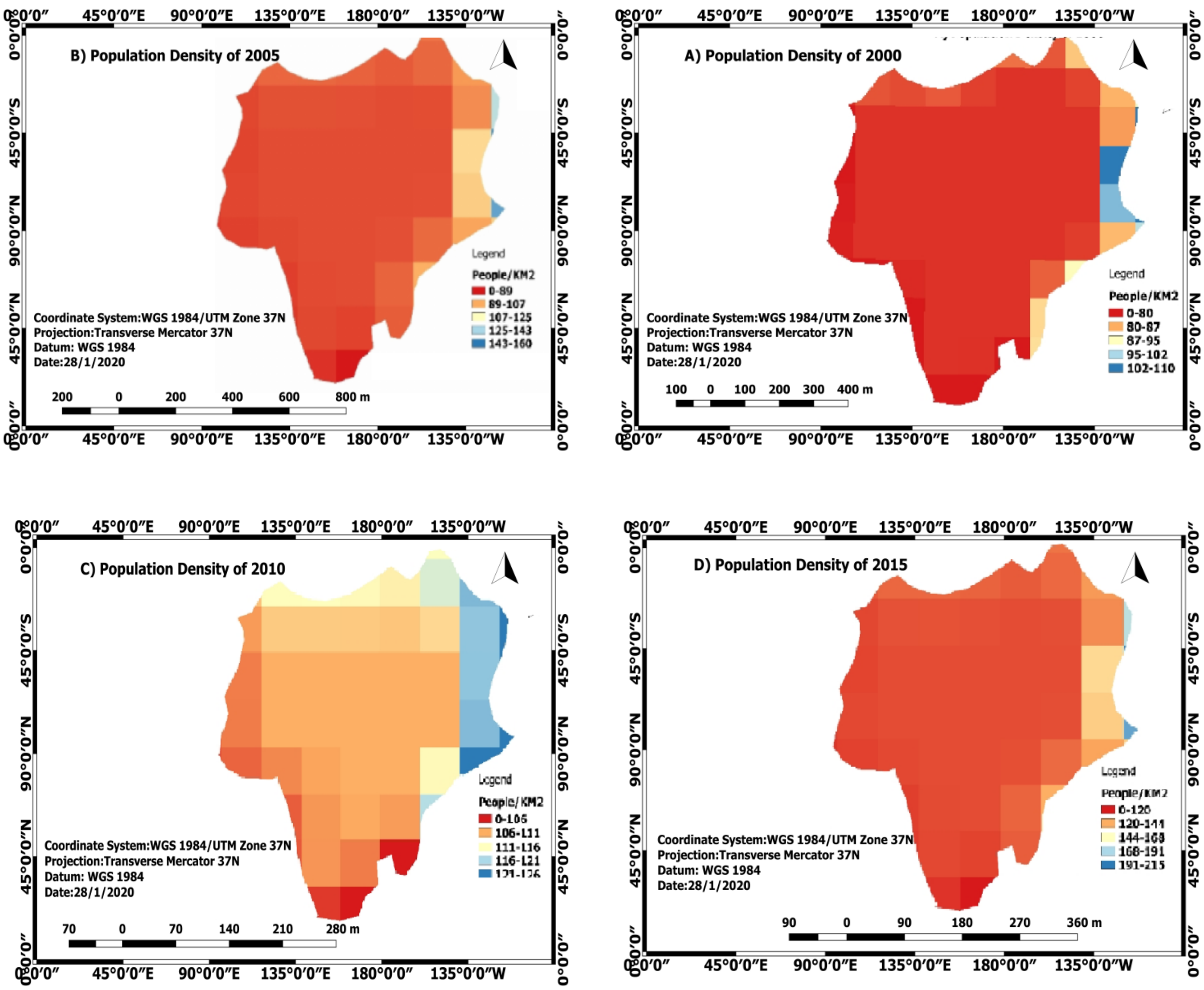
Appendix A.Figure.1: Distance to road map.



Appendix A.Figure.2: Distance to river map



Appendix A.Figure..3: Population density map of 2000, 2005,2010 and 2015



Appendix B

Appendix B. Table .1. LULC Classes of study area

land cover classes	Description of LULCC
Forest land	Areas that are covered with dense growth of trees with closed canopies.It, was made to include human made plantation forest, riverine forests, dry ever green forest and moist mountain forest.
Grass land	Areas dominated by permanent grass cover mixed with scattered trees along ridges steep slopes and plain areas used for grazing; usually individual as well as communal
Agricultural land	Areas used for crop cultivation (both annual and perennials), scattered rural settlements, some pastures and plantations around settlements. Sparsely located settlements were included here as it was difficult to separate them from agricultural lands.
Settlement Area	Areas occupied by urban and rural residential houses and other buildings
Seasonal Swampy area	Areas that are very flat and swampy in the rainy season and relatively dry during the dry season. It is used as supplementary grassland, which is source of grass for dry area.
Bush/shrub land	Land covered by an open stand of trees/or-scattered shrubs 2 to 5m tall and canopy cover of more than 20% as well as short shrubs and thorny bushes with little useful woods found along rugged micro level
Bare land	Areas that have little or no vegetation cover, mainly with gullies and ex posed rocks. (Barren eroded lands mostly on top of mountains, open areas near homesteads).

Source:Addis Getinat, (2009), GirmayKassa ,(2003), and Wakjira *et al*, (2016).

Appendix B. Table .2. Confusion matrix for LULC of 1988

LULC Classes		Ground truth reference							Total	UA
		FL	GL	AL	BL	BUL	WL	SL		(%)
Classified image	FL	**107**	3	2	0	8	0	0	120	89.2
	GL	0	**113**	4	0	0	0	3	120	94.2
	AL	0	8	**105**	0	0	0	7	120	87.5
	BL	0	0	10	**65**	0	0	5	80	81.3
	BUL	7	3	2	0	**75**	0	0	85	88.2
	WL	0	3	2	0	0	**55**	0	60	92
	SL	0	7	35	11	4	0	**63**	120	52.5
Total		114	137	158	76	87	55	78	705	
PA (%)		93.8	82.4	66.4	85.5	86.	100	80.7		
OA (%)		82.6 %								
Kˆ (%)		79.60%								

Appendix B. Table .3.Confusion matrix for LULC of 1998

LULC Classes		Ground truth reference							Total	UA
		FL	GL	AL	BL	BUL	WL	SL		(%)
	FL	105	2	1	0	9	0	3	120	87.5
	GL	2	**114**	0	0	0	1	3	120	95.0
	AL	0	7	**104**	3	1	2	3	120	86.6
	BL	0	0	7	**68**	0	0	5	80	85.0
	BUL	6	3	2	0	**74**	0	0	85	87.0
	WL	3	0	0	0	6	**51**	0	60	85.0
	SL	0	3	17	13	0	0	**87**	120	72.5
Total		116	129	131	84	90	54	101	705	
PA		90.5	88.3	79.3	76.9	82.2	94.4	86.1		
OA		85.5 %								
Kˆ		82.9%								

Appendix B Table. 4. Confusion matrix for LULC of 2008

LULC Classes		Ground truth reference							Total	UA (%))
		FL	GL	AL	BL	BUL	WL	SL		
Classified image	FL	**97**	6	3	0	9	0	5	120	80.8
	GL	2	**104**	4	0	0	3	7	120	86.6
	AL	0	2	**108**	4	0	0	6	120	90.0
	BL	0	2	6	**69**	0	0	3	80	86.2
	BUL	5	1	3	0	**76**	0	0	85	89.4
	WL	2	0	0	0	1	**57**	0	60	95.0
	SL	0	3	4	5	1	0	**107**	120	89.1
Total		104	120	128	78	87	60	128	705	
PA (%)		93.2	86.6	84.3	88.4	87.3	95.0	83.5		
OA (%)	87.65%									
Kˆ (%)	85.47%									

Appendix B Table.5. Confusion matrix for LULC of 2018

LULC Classes		Ground truth reference							Total	UA (%)
		FL	GL	AL	BL	BUL	WL	SL		
Classified image	FL	**112**	2	2	1	3	0	0	120	93.3
	GL	0	**115**	0	0	2	3	0	120	95.8
	AL	0	2	**105**	3	3	0	7	120	87.5
	BL	0	2	3	**71**	0	0	4	80	88.7
	BUL	4	1	0	3	**77**	0	0	85	90.5
	WL	2	5	0	0	0	**53**	0	60	88.3
	SL	0	3	3	5	0	0	**109**	120	90.8
Total		118	130	113	83	85	56	120	705	
PA (%)		94.9	88.4	92.9	85.5	90.5	94.6	90.8		
OA (%)	91.06%									
Kˆ (%)	89.4%									

PA=producer accuracy, A=over all accuracy, Kˆ =Kappa coefficient, A=User accuracy, FL= Forest land, GL=Grass land, AL=Agricultural Land, BL=Bare Land, BUL=, Bushland, WL=Wetland, SL=Settlement land

Appendix B Table.6: LULC conversion matrix of LULCC 1988-1998

LULCC	FL	GL	AL	BL	BUL	WL	SE
FL	**0.765251**	0.015057	0.197164	0.000020	0.003110	0.002311	0.017086
GL	0.018138	**0.506129**	0.422078	0.000181	0.010366	0.008454	0.024654
AL	0.011697	0.024874	**0.894119**	0.000004	0.010619	0.004593	0.054095
BL	0.030806	0.049763	0.009479	**0.736967**	0.144550	0.002370	0.000000
BUL	0.029858	0.023103	0.271593	0.005489	**0.603560**	0.002033	0.064363
WL	0.035896	0.075713	0.060772	0.000000	0.017182	**0.801098**	0.009338
SE	0.000998	0.014925	0.003479	0.000000	0.003239	0.009981	**0.967378**

Appendix B Table.7: LULC conversion matrix of LULCC between 1998 – 2008

LULCC	FL	GL	AL	BL	BUL	WL	SE
FL	**0.783881**	0.043938	0.140351	0.000053	0.004362	0.003093	0.024322
GL	0.070977	**0.651270**	0.238809	0.000239	0.007128	0.009797	0.021737
AL	0.009122	0.002561	**0.922487**	0.000075	0.006092	0.003699	0.055844
BL	0.004608	0.057419	0.006912	**0.857327**	0.069124	0.004608	0.000000
BUL	0.043037	0.025336	0.055180	0.003163	**0.851039**	0.004605	0.017640
WL	0.018676	0.065468	0.099633	0.000000	0.009650	**0.790077**	0.016458
SE	0.000963	0.013162	0.007260	0.000183	0.006458	0.004236	**0.967555**

Appendix B. Table.8: LULC conversion matrix of 2008-2018

LULCC	FL	GL	AL	BL	BUL	WL	SE
FL	**0.807021**	0.024951	0.139465	0.000006	0.005817	0.003811	0.018928
GL	0.016663	**0.321147**	0.593869	0.000102	0.003379	0.003089	0.061751
AL	0.001167	0.057544	**0.918464**	0.000009	0.002252	0.003336	0.017228
BL	0.018136	0.069915	0.014407	**0.863220**	0.023136	0.004831	0.006356
BUL	0.054793	0.086898	0.106266	0.006949	**0.705638**	0.005634	0.033822
WL	0.001087	0.057071	0.209636	0.003865	0.009041	**0.694554**	0.004559
SE	0.004866	0.015332	0.006557	0.000030	0.003464	0.007597	**0.982154**

Note: FL= Forest land, GL=Grass land, AL=Agricultural Land, BL=Bare Land, BUL=, Bushland, WL=Wetland, SL=Settlement land

Appendix C: 1.Ground control point (GCP) data sheets

Setema District LU/LC Ground survey

Date___________________________

Zone Name________________________

Woreda Name_______________________

Kebale Name_________________________

Collector Name____________________________

Code	Sampling point/GCP coordination For Classification			Type of LULC
	Latitude	Longitude	Altitude (M)	

Code, Forest land =1, Agricultural land =5, Grazing land=7, Shrub land r=3, other specify=9,

Appendix: 2Questioner Check list for House Holds (HHs)

Questionnaire Number/code: ________________

Name of the interviewer ____________________Name of Interviewed_________________

Survey Area: District: ____________ Kebele: __________ Village: _________

Date of interview: Day: ________ Month _________ Year: ___________

Land hold size you have____________________

1. For how long did you live here? __________

2. According to your knowledge, Is there LULCC in your area? A) Yes____ B) NO_____

3. If yes Which LULC is change rapidly from 1988-2018? Rank it

A. Forest land cover ___________
B. Agricultural land cover__________
C. Grazing land_____________
D. Shrub/Bush land cover_______________
E. Water body land cover/Wet land______________
F. Bare land______________________
G. Settlement land___________________

4. If there is change which land LULC are decrease/ increase starting from 1988 until now (2018)? Rank it.   Decrease=1   Increase =2   No change =0

LULC type	Years			
	In 1988	In 1998	2008	In 2018
Forest land cover				
Agricultural land cover				
Grazing land				
Shrub/Bush land cove				
Water body land cove/Wet land				
Bare land				
Settlement land				

5. If there is a LULCC (decrease/increase) what is your opinion for the drivers (proximate and Underlying) of LULCC in Your area? Rank it

A. Illegal Settlement____________
B. Agricultural Expansion_________

C. Property issue for land__________
D. Infrastructure development______________
E. Population density_______________
F. Unsustainable wood extraction for firewood, charcoal constructional materials, and logging____
G. Corruption___________
H. Others______________________

6. What are the existing land use management systems in your area?

7. What kind of LULCC do you expect in the future?

Why? ____

Appendix: 3.Questioner Check list Focus Group Discussion (FDG)

Region: ________, Zone: _______, Wereda: __________

Name of Rural Kebele ____________Village Name _________ No. of participants__________ Date_____________

1. What does LULC looks like in your area?

2. Is there decreasing/increasing of LULC in your area?

3. Which LULC increase/Decrease Rapidly? List/rank

4. At which period the period LULC change rapidly?

A/1988, B/1999, C/2010, D/2018

5. What is the drivers/ direct and indirect/ for LULCC?

6. What is the solution for the drivers of LULCC?

7. What changes will occur within the next 10 years on the existing LULCCs/future?

Why? _______________________________________

Appendix: 4.Questioner Checklist for Key Informant Interview (KII)

Questionnaire Number/code: _______________

Name of the interviewer _______________

Name of interviewed_________________

Survey Area: District: ___________ Kebele: _________ Village: ________

Date of interview: Day: _______ Month ________ Year: __________

1. What are the existing land use management systems in your area?

2. Have you know any change in the LULC in your area over the past 30 years? A) Yes B) No

3. Which LULC you observed and change rapidly? Please rank

4. What is your opinion for the drivers (proximate and Underlying) of LULCC in your area?

5. In your opinion what do you think the solution for Cause/drivers of the LULCC?

6. Is there none government organization those participate on conservation of the resource (Natural Forest….)?

7. Is there naturalcalamities occurred in your area in the last 30 years?

If yes what kind of calamities?

8. How do you participate community to conserve the resource?

9. What changes will occur within the next 10 years on the existing LULCCs/future? Why?

Why? ____________________________________