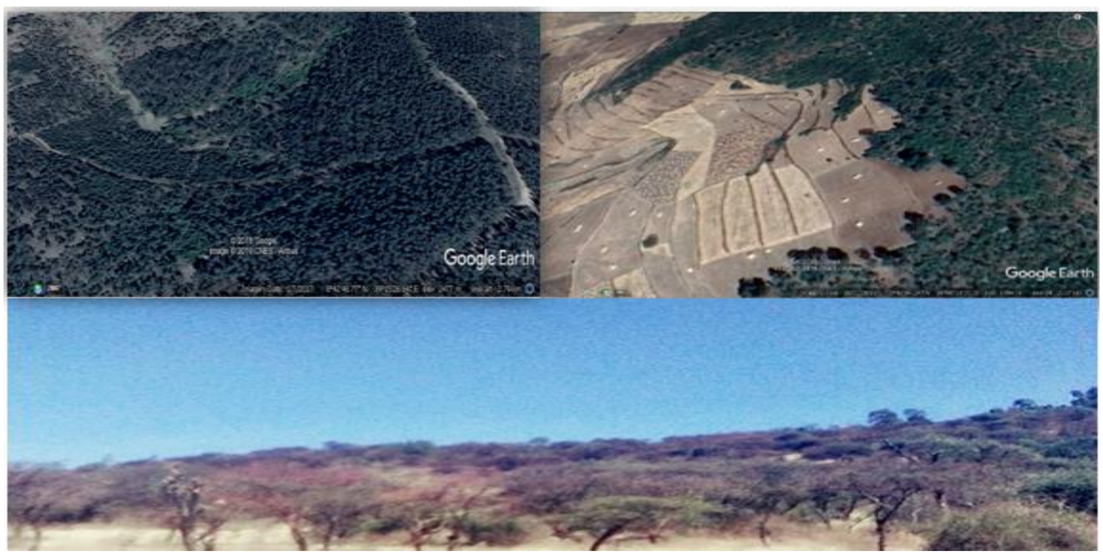
FOREST COVER CHANGE AND IT'S DRIVING FORCES IN LUME DISTRICT, CENTRAL ETHIOPIA



M .Sc THESIS

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HAWASSA UNIVERSITY WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCE

MAY, 2019

WONDO GENET, ETHIOPIA

FOREST COVER CHANGE AND IT'S DRIVING FORCES IN LUME DISTRICT, CENRAL ETHIOPIA

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THESIS SUBMITTED TO

HAWASSA UNIVERSITY

DEPARTMENT OF GENERAL FORESTRY

COLLEGE OF WONDO GENET,

SCHOOL OF GRADUATE STUDIES,

HAWASSA UNIVERSITY,

WONDO GENET, ETHIOPIA

IN PARTILAL FULFILLMENT OF THE

REQUIREMENTS FOR THE

DEGREE OF

MASTER OF SCIENCE IN FOREST RESOURCE ASSESSMENT AND MONITORING

MAY, 2019

WONDO GENET, ETHIOPIA

Declaration

I, the undersigned declared that this thesis is my original work, has not presented at any other university for a degree and all sources of material used for the thesis have been orderly acknowledged.

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This thesis have been submitted for evaluation for my university advisor

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APPROVA1 SHEET I

This to certify that the thesis entitled "Forest Cover Change and Its Driving Forces in Lume District, Central Ethiopia" submitted in partial fulfilment of the requirement for the degree of master's with specialization in Forest Resource Assessment and Monitoring, the graduate program of school of General Forestry and has been carried out by Hailu Wondu Jufare .Id.No MSc/FRAM/011/10, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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Name of advisor	Signature	Date
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Name of Graduate coordinator	Signature	Date

APPROVAL SHEET II

We the undersigned members of the board of examiners of the final open defence by Hailu Wondu have read and evaluated his thesis entitled "Forest Cover Change and Its Driving Forces in Lume District, Central Ethiopia" and examined the candidate. Accordingly, this is to certify that the thesis has been accepted in partial fulfilment of the requirement for the degree of Masters of Science.

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SGS approval	Signature	Date

Acknowledgment

First of all my interminable thanks consent for the Omnipotent God for his never-ending love and kindness.

This thesis has been possible by guidance of many people. My gratitude thanks go to my Major advisor Dr. Mersha Gebrehiwot for her indispensable support in all stages of my thesis. I heartedly thanks her for devoting her valuable time in reading, commenting and correcting my thesis.

I am also thankful for Lume woreda agricultural office for their cooperation in through provision of secondary data and organizational support for data collection. My special thanks also go to Development Agents of the study kebeles for their intensively helping me during data collection.

I thank my beloved friends Sangi Olani, Tadesse Leta, Daniel Belay for their endless support, encourage, and suggestion for my research work.

At last but not the least, I thank all my family for their moral support, endurance and finance that enabled me to complete my education and this thesis work comfortably. Finally, MRV project, for providing me financial support for academics and this research work.

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Acronyms

AOI	Area Of Interest
CSA	Central Statistical Agency
DAs	Development Agents
DN	Digital Numbers
EMA	Ethiopian Map Agency
ENVI	Environment visualizing Image
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGDs	Focus Group discussions
GDP	Gross Domestic Production
GFRA	Global Forest Resource Assessment
GIS	Geographic Information Science
GLS	Global Land Survey
GPS	Global Positioning System
HHS	House Hold Survey
IHDP/IGBP	International Human Dimension Programme/ International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
KIIS	Key Informant Interviews
L1TP	The Standard Terrain Correction Landsat Level 1 Product
LULC	Land Use/Land Cover
MOFED	Ministry Of Finance and Economic Development
MSS	Multi-Spectral Scanner
NASA	National Aeronautics and Space Administration
OFWE	Oromia Forest and Wildlife Enterprise
OLI	Operational Land Imager
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal

QGIS	Quantum Geographic Information Science
ROI	Region Of Interest
RS	Remote Sensing
SCP	Semi-automatic Classification Plugin
TIRS	Thermal Infrared Scanner
TM	Thematic Mapper
U.N	United Nation
USGS	United State Global Survey
WAO	Woreda Agricultural Office
WFEDO	Woreda Finance and Economic Development

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Abstracts

Forest cover change and forest degradation is a serious global problem that affects the socio-economic and ecological function of forest landscapes in the Globe. Lume district in Ethiopia is one of the forested area that has important socio economic and ecological function. Currently, despite their contribution to both economic and ecological service forests of Lume district are under serious streak both from anthropogenic and natural calamities. Hence, the fundamental aim of this study is to investigate the magnitude and rate of forest cover change, identifying the respective driving forces for the last 33 years (1985-2018). Quantitative data was collected using Landsat5 TM and Landsat8 OLI_TIRS satellite image; these data were used to define the spatial and temporal change-using quantum GIS (QGIS). Qualitative data were collected using key informant interviews, household surveys and focus group discussion for determining the driving forces of the change. SCP, QGIS 2.18.2, MOLUSCE, EXCEL and R software were used for processing and analysing data obtained from RS and social survey respectively. The finding of the study revealed that, during 33 years period agriculture land and urban buildings/settlements increased by 7828ha (10.82%) and 15471.92ha (21.39%) respectively with equivalent area of 3887.85ha (5.37%) and 17502.55ha (24.2%) decline in forests and shrub land. Throughout the study periods, steady net increasing rate of expansions observed for urban buildings/settlements and agriculture land by 468.8ha and 237.27ha per annual. In contrary, a net decline rate noted for shrub lands and forests by 530.38ha and 117.8ha per year. The main findings of this study disclosed that, a resume increase in agriculture land and urban buildings and settlements at the expense of forests and shrub lands throughout investigated periods (1985-2018). The major proximate and underlying drivers of forest cover change identified through HHS and FGDS are agricultural land expansion, fuelwood extraction, charcoal production, urban expansion, expansion of rural settlements, extended dry period, infrastructural development, high rate of population growth, landlessness, low institutional enforcement and others. Hence, in order to revoke the problem of forest cover change and its impact, proper measures had been forwarded which can be implemented both in the long and short-term commitment of concerned stakeholders in the district and national level.

***Key words**: Accuracy, Land use/Land cover change, Magnitude, Rate, Trends*

1. INTRODUCTION

1.1 Background

Forests make up one of the world's most important precious natural resource and play a crucial role in global ecological balance (Torahi, 2013). The forests of the world cover about 4 billion hectares (FAO, 2010). They are vital for the conservation of ecosystem, maintenance of water quality, prevention and reduction of natural hazards such as floods, erosion, landslides, avalanches, and drought and hence in regulating the climate on the regional level (Rashid and Iqbal, 2018). Forests provide support for one billion people that live in far beyond the norm poverty around the world, and provide emolumentive employment to more than one hundred million as Violini (2013) cited in (FAO,2011).

In Africa forests are very crucial for protecting water catchments and for enhancing conservation; for regulating rainfall; for preventing landslides and are an in important of biodiversity pool (FAO, 2011). The most important use of forest resources from the viewpoint of the population in Africa is as an energy source. Wood fuel is used by over 60 percent of the population for cooking and generates 29 times as many jobs as the forestry/wood products sector (Rametsteiner and Whiteman, 2014). Employment numbers and the importance of the informal forest economy of both the Sub- Saharan Africa region and the North Africa put up to 0.1% to the overall career. The highest contribution in any region to share of GDP is found in sub-Saharan Africa, which accounts for 1.8 % (Agrawal *et al.*, 2013).

According to Global Forest Resources Assessment (GFRA) Ethiopia's forest cover is 12.4 million hectares (11.5 percent) (FAO, 2015). The importance of natural forest ecosystems to human Well-being cannot be exaggerate (Bamlak Ayenew and Yemiru Tesfaye, 2015). Forest-based ecosystem services are directly available as products derived from and within forests and those that indirectly support other production landscapes. Forest fragments in southwest Ethiopia have higher ecosystem service richness where 85% of all forest-based ecosystem services described by local people were found in the landscape (Getachew Tadesse *et al.*, 2014). According to (Sisay Nune Hailemariam *et al.*, 2012) cited in MOFED (1995–2005) the forestry sector contributed on average 5.7% of the total GDP in Ethiopia over the years 1995–2005.

1.2. Statement of the problem

Despite their significant pertaining to both economic and ecological services, forests are currently under serious threats both from anthropogenic and natural destructives (Worku Zewdie and Csaplovies, 2017). For several centuries the world‘s forests have been under streak due to alarmingly increase human population. These activities have resulted in loss of biodiversity, degradation of water catchments and increase in greenhouse gases, which have far-reaching effects(Wachiye *et al.,* 2013). Total area of 4128 million ha has covered by forests in the 1990 and by the end of 2015; this has reduced and recorded to 3999 million ha. There is a globally decline in forest cover from 31.6% to 30.6% (Rashid and Iqbal, 2018).

Deforestation is most noticeable in tropical regions such as Africa. Africa accounted for a net loss of 4.0 million hectares per year (Kero Alemu *et al.,* 2018). Deforestation is very serious issue in developing countries. It has been occurring at rapid rates, primarily to clear land for agriculture and for production of fuel wood for domestic use. Highly concentrated agriculture and immoderate tree felling for the use of energy lead to a serious deforestation problem among the most of African countries (Yasar Arfat, 2010). FAO (2009) indicates that Africa’s forests cover is about 21.4% of the total land area. In East Africa, forests and woodlands thus making these resources quite limited and threatened cover around 13% of the land mass.

Ethiopia is part of the dynamic land cover change where more than 90% of the country’s highlands once forested, and currently the percentage of forest cover is less than 12% (FAO, 2015). In Ethiopia, several studies had carried out to estimate forest cover change. The country has suffered drastic historical deforestation, primarily due to agricultural expansion coupled with population growth (Bongers and Tennigkeit, 2010). Due to massive exploitation, the forest resource of the country has marginalized itself to small remnants on the highlands particularly, almost all located at unreachable areas. However in relation to the available information of forest cover in the country, there is still no adequate documented information on the location, extent of the remaining forest cover of the country and the rate at which this resource is expended.

In the study area, Lume district, there is high forest cover change due to agricultural expansion, energy production (fuel wood and charcoal), settlement, the establishment of infrastructure such as road; industries and urbanization also contribute for forest cover change. Furthermore, like in many other parts of the country, the problem of forest cover change is a very serious environmental problem such as deficit precipitation, extreme temperature, flooding and unseasonal rainfall. In the study area, forests and far-reaching areas of forest cover including shrub lands have been deforested.

However, the rate and an actual extent of the forest cover change has not well studied to date. Thus, for a sustainable forest resource management and reduce deforestation it is necessary to estimate forest cover change on large spatial and temporal scales. In addition, it is crucial to assess and monitor the trends of forest cover change and the drivers of the change in the district to acquaint consistent and sustainable forest conservation strategies.

1.3. Objectives:-

1.3.1. General objective

- ✓ To investigate the long-term spatiotemporal forest cover change and its driving forces in Lume district, Central Ethiopia (1985-2018)

1.3.2. Specific Objectives

- ✓ To investigate the magnitude and rate of forest cover change within each periods
- ✓ To examine forest cover trends and management system in the district
- ✓ To Identify the driving forces of forest cover change in the district

1.4. Research Questions

1. How much forest area gain and/or lose coincidence in the study area?
2. What is the rate, extent and magnitude of forest cover change within specified period in the district?
3. What type of patterns and management system experienced in the study area?
4. What are the major driving forces of forest cover change in the district?

1.5. Significance of the study

The study will be stress how forest cover change mapping and explicitly identification of drivers is indispensable for decision-making and for forest resource management. In developing countries, deforestation is very serious issue. It has been occurring at rapid rates, primarily to clear land for agriculture and production of fuel wood for domestic use and interaction of proximate and underlying drivers that accelerate the dynamics of land use/land cover change.

Therefore, the study will be initiate to overcome these problems and to bring a hint for the forestry sectors and planners about forestland cover data that are important for sustainable natural resource management and standards to maintain the current and future land use/land cover managements. On the other hand, information on forestland cover change and other land use in the form of maps and statistical data is very crucial for special planning, management and utilization of land for agriculture, forestry, pasture, urban-industrial, environmental studies etc. The study further contributes to scientific knowledge related to extracting information from remotely sensed data and stipulates perspective analysis techniques to fully exploit these data for better forest resource monitoring. It is expected that the results of this study will be of ultimately crucial for policy makers and natural resource managers in the district.

2. LITRATURE RIVIEW

2.1. Forest cover change in Ethiopia

Forest cover changes is actively moving, pervasive and accelerating process, mainly passionate by natural phenomena and anthropogenic activities, which in turn drives changes that would strongly influence natural ecosystem (Melaku Melese, 2016). In recent year, conservation of biodiversity and management of tropical forest have become a major issue in developing countries. According to data provided by the U.N. Food and Agricultural Organization, approximately 4,168 million hectares of the earth's terrestrial surface was covered by woodlands and forest cover in the 1990s (Deb and Mishra, 2016)

However, continued access to forest resources is increasingly become challenged through deforestation and forest degradation (Wachiye *et. al.*, 2013). Despite their crucial importance in livelihood and climate regulation, forest resources all over the globe are subject to enormous pressure resulting in deforestation and degradation because of the increase in human and cattle population and extensive rural poverty (Negasi Solomon *et. al.*, 2018).

According to FAO (2015) Ethiopia's forest, cover (FAO definition) is 12.4 million ha (11.5%), clearly underestimated compared to the IPCC definition of 17.2 million ha (MEFCC, 2017). Forest cover indicate a decline from 15.11million ha in 1990 to 12.4 million ha in 2015, during which 2.65% of the forest cover was removed (Moges *et.al,* 2010). FAO's appraises and the findings of the individual studies, predict the forest and woodland cover change in Ethiopia indicate that the average annual rate of deforestation is greater than 0.25% (Hansen, *et. al.*, 2010).

2.2. Change Detection of forest area

Change detection is the process of identifying departure in the state of an object or phenomenon by observing it at different times. Remote sensing based change detection pertain comparison of a set of temporal images covering period of interest using specific change detection algorithms (Abiyot Yismaw *et al*., 2014). According to the IHDP/IGBP report, digital change detection studies make an effort to assess the information about the processes of forest cover change, their tessellation and human interactions to forest cover change (Deb and Mishra, 2016).

Digital change detection fundamentally consist of the quantification of temporal phenomena from multidate imagery that most commonly secured by satellite-based multispectral sensors (Running and Bauer, 1996). Change detection analysis stipulate a thematic view to understand the natural and artificial behaviour of changes in land (Sommer *et al*., 2011). Information on land and land cover change in the form of maps and statistical data is very vital for special planning, management and utilization of land for agriculture, forestry, pasture, urban-industrial, environmental studies, economic production (Abineh Tilahun and Bogale Teferie, 2015).

2.3. Accuracy Assessment

The accuracy assessment is a comparison of a classification with ROI or ground-truth data to evaluate how well the classification represents the real world (Lillesand, 2004). Accuracy assessment has vital role in remote sensing studies dealing with image processing and change detection processes. It is very important for the analysis of results as well as decision-making

The accuracy assessment has done by a confusion matrix that delivers the relationship between the samples taken as reference data and the corresponding samples on classified image. The accuracy assessment consists of overall accuracy, producer's accuracy, user's accuracy and kappa coefficients (Fichera *et al.*, 2012).

The overall accuracy is the ratio of total number of correctly classified samples and total number of samples. The ratio of total correct samples in a class and the total number of reference samples in that class is name as producer's accuracy, which shows the way reference samples of the ground are classified. Whereas, the user's accuracy is define as the ratio of number of correctly classified sample to the total number of sample classified in that class. User's accuracy signifies the probability of a pixel to be classify in a particular category representing on ground (Russell and Plourde, 2001). One more accuracy assessment parameter is kappa coefficient that is the basis for statistical significance of a confusion matrix in any classification (Munoz and Bangdiwala, 1997).

2.3. Drivers of forest cover change

A broad range of factors such as agricultural expansion, insecure land tenure, international markets, colonization, infrastructure and road building, urbanization, mining, grazing, uncontrolled fire, political unrest, fuelwood extraction, and timber logging influences deforestation (Ferretti-Gallon and Busch, 2014). Deforestation is the major source of forest cover change in the tropics including Ethiopia and this is due to several factors (Rahman and Sumantyo, 2010).

The main causes of deforestation in Ethiopia are the rapid population growth, underslung agricultural productivity, the impoverished economic performance of the country, shifting agriculture, livestock production and fuel in drier areas (Tigabu Dinkayoh, 2016). Two types of drivers: proximate (direct drivers) and underlying drivers.

Proximate (direct drivers): of deforestation and forest degradation are human activities and actions that straightly affect forest cover and result in ruin of carbon stocks. Agriculture is account to be the proximate driver for around 80% of deforestation worldwide (Kissinger *et al.*, 2012). Direct deforestation drivers in Ethiopia are expansion of smallholder traditional agriculture following population growth in forest areas, expansion of enormous-scale development activities, population growth, wood extraction and other forest products collection and forest fires (Melaku Melese *et al*., 2015).

Underlying (indirect drivers): Underlying drivers include range of political, cultural and socio-economic factors, including unsound policies, weak governance and lack of law enforcement, landlessness and unclear allocation of rights, rural poverty, lack of investment and financial resources, population growth and migration, and civil conflict (Arevalo, 2016). According to Ashebir Mengistu (2018) cited in (Lambent et al., 2003; Lambin and Geist, 2003) in Ethiopia, the underlying drivers are characterized by a complex social, political, economic, demographic, technological, cultural and biophysical variables that are considered to be vital forces underpinning the proximate causes function at a much broader scale.

As Mersha Gebrehiwot (2013) cited in (Labin and Geist, 2006a; Geist and Labinb, 2002) in Ethiopia, both proximate and underlying drivers of change often comprise more fold factors and drivers. Those are deed jointly rather than single-factor causation, as most of the world's tropical deforestation has influenced by an interaction of economic, institutional, technological, cultural and demographic variables where economic factors are prominent.

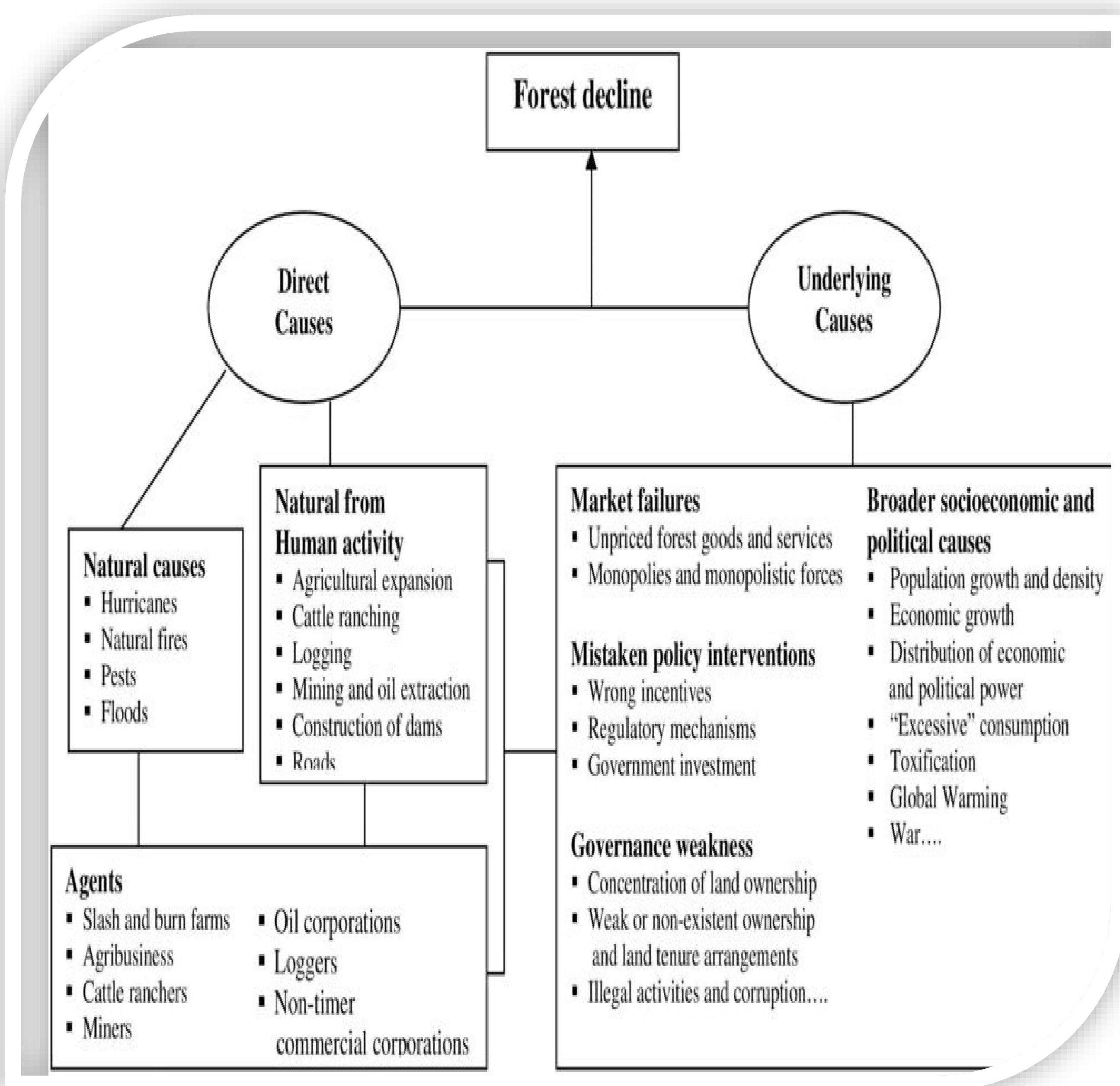


Figure 1: This diagram shows the direct and underlying causes of forest decline.

Adapted from Contreras-Hermosilla (2000), Underlying causes, CIFOR, p. 5

2.4. Application of GIS and RS in Ethiopia

Remote sensing refers to acquiring information about objects or areas by using electromagnetic radiation (light) without being in direct contact with the object or area (De Jong, 2004). According to Awange and Kiema (2013) cited in (Trigal, 2015) a GIS is a set of tools made up of hardware, software, data and users, which allows us to capture, store, manage and analyse digital information, as well as make graphs and maps, and represent alpha numeric data.

For the past few decades the application of remote sensing (RS) not only completely changed the way data has been collected but also notably enhanced the quality and accessibility of important spatial information for natural resources management and conservation. The quick approval of the use of remote sensing for conservation and nature protection corresponds with the frequent reporting of wide spread adaptation of natural systems and destruction of wildlife habitats during the past three to four decades (Bedru Muzein, 2006). The parallel advance in the trustworthy of Geographic Information System (GIS) has allowed the processing of the large quantity of data produced through remote sensing (Lunetta, 1999). In Ethiopia, recent GIS applications have included site preference for village schools, oil and gas discovery in the Ogaden desert, agriculture and forestry development, research activities in poverty reduction, drought management and irrigation suitability studies (Kebede Ganole, 2010).

Recent advances in geographic information system (GIS) and remote sensing (RS) instruments and techniques allow researchers to essentially model urban growth. Satellite Remote Sensing images provide excellent data sources from which thorough information about land use and land cover can be efficiently extracted, analysed and predicted (Afera Halefom *et al*., 2018). Take into account the importance of remote sensing and geographic information system (GIS) in evaluating the changes in landscape cover, this technique is use for the present study. Remote sensing provides a relevant means of detecting and analysing temporal changes. Since early 1970s, satellite data have been ordinarily use for detecting these changes over large landscapes (Mary Tahir *et al*., 2013).

According to Mary Tahir *et al.* (2013), cited in (Mohan, 2005 and Jaiswal *et al.*, 1999) the development of spatial data infrastructure is a vital to sustainable land development. Whereas Information on existing LULC, its spatial distribution and change are important prerequisite for planning. Remote Sensing and GIS technologies now stipulated the potential for mapping and monitoring the spatial extent of the built environment and the related urban land use changes in Ethiopia.

3. RESEARCH METHODOLOGY

3.1. Description of the study area

3.1.1. Location

Lume is one of the district in the Oromia Region of Ethiopia. Part of the East Shoa Zone located in the Great Rift Valley. Lume is border on the south by the Koka Reservoir, on the west by Ada'a Chukala, on the northwest by Gimbichu, on the north by the Minjar District, and on the east by Adama. Mojo is the capital of the district; which is located 70 kms Southeast of Addis Ababa., other towns include Ejere, Ejersa and Koka. Due to the geographical proximity of Mojo to Addis Ababa, it has a great advantage for market access for both agricultural and industrial products (Kassahun Melese *et al*., 2014). The district is found between the coordinate of the following figure (2) with an altitude ranged from 1500 to 2300 meters above sea level (Tesfaye Moreda, 2016)

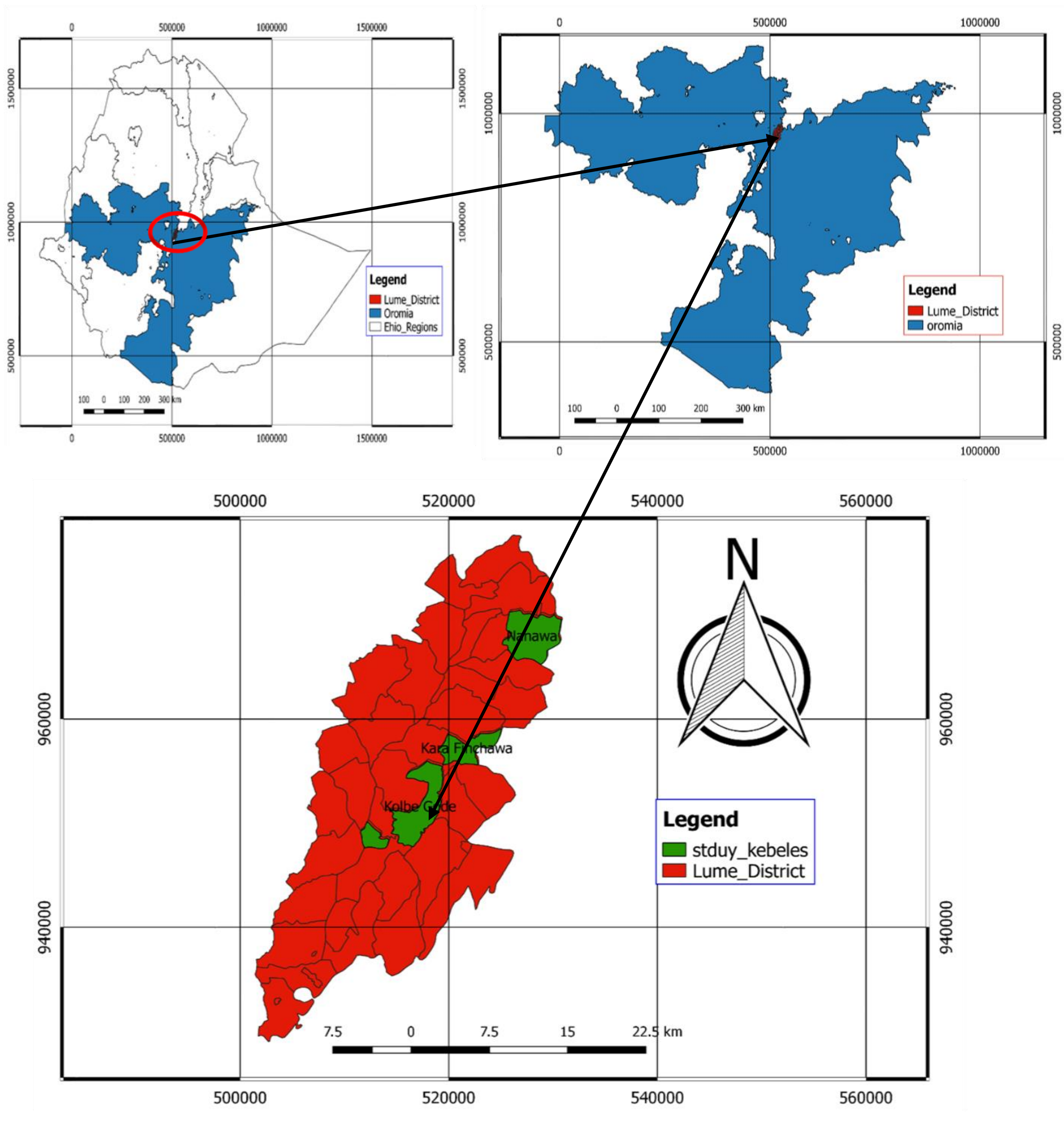


Figure 2: Map of Lume district

3.1.2. Climate

Agro- ecologically, the study district is classified as Moist Woina Dega (30%), Woina Dega (45%) and Kola (25 %). Annual temperature and rainfall varies between12^{0}C to 28^{0}C and 500mm to 1200mm, respectively (Lume district agricultural office report, 2015/16). Soil is defined as a natural body consisting of layers or horizons of mineral and/or organic constituents of variable thickness, which differ from the parent material in their morphological, physical, and chemical properties and their biological characteristics (Davidson, 1980). According to FAO soil classification, the soils of Lume District were grouped into seven soil types which is mainly dominated by Eutric Vertisol (44.84%), Mollic Andosols (21.69%) and Luvic Phaeozems (14.76%) (Ahmed Kamil and Bekele Ayalew, 2017).

3.1.3. Demographic Characteristics

According to Lume district Finance and Economic Development Office 2015/16 report, the district cover 75,220.32 ha of land, the total cultivated land of the district is 43,713 ha, for livestock grazing 361.08 ha, for irrigation 6,497 ha, for forest 2,462.38 ha and unproductive land was 22,186.86 ha. The district total population 142,288 of which 72,973 (51%) male and 69,315 (49%) female and urban human population was 72,105 of which 31,570 male and 40,535 female respectively (CSA, 2013).

3.1.4. Agricultural Practice

Livestock is considered as an important component of the prevailing crop-livestock mixed farming systems of the study district. Smallholder farmers of the study area owned various livestock species such as; cattle, sheep, goat, chicken and equines. According to report of Agricultural office of Lume district (2015), the study district is reported to have a total population of 33,797 for cattle, which (33, 148 local and 649 exotic cattle), 10,953 for sheep and goat, 12,699 for equine, 31, 984 for chicken, which (26,852 local and 5132 cross and exotic breed chicken). Vegetables are an important cash crop. Koka Lake is the major lake, which gives economic importance in the district. It is mainly use during the dry season for the production of horticultural crops, mainly vegetables (WFEDO, 2015/16). The main crops cultivated in the Lume district are tef, wheat, chickpea, barley, faba beans, lentil, pea, maize and bean.

3.1.4. Vegetation cover

Major types of natural vegetation and manmade found in the district are forest, shrubs & bushes. Natural vegetation combines Acacia woodland and savannah. Across the district, grain crop and livestock farming are dominant, whereas in areas adjacent to the Rift Valley Lake (Koka) and river (Mojo river), irrigated vegetable farming and horticulture are practiced. Within the grain–livestock areas, the combination of crop and trees shows some variation: teff–wheat with Faidherbia albida to maize–beans–sorghum with Acacia tortilis across the north south transect. Moreover, teff–wheat with F. albida to teff–maize–sorghum and with A. tortilis across the west– east transect. Mountainous parts of the district mostly covered with shrub species and acacia species. The highland part of the district more commonly covered with Eucalyptus plantation forest. The shrubs, bushes, woodlot (around settlements and towns), natural forest and plantation forest together cover 25.7% of the total land use of the district.

3.2.1. Material and Method

I. Method for GIS and Remote Sensing

3.2.1. Satellite Data Acquisition

Land use/land cover change analysis for the last 33 years were done with the help of Landsat multi-spectral data (i.e. years 1985, 1999, 2013 and 2018). The images have had downloaded from

NASA Landsat series distributed by United States Geological Survey (USGS) with the required specifications: satellite type, acquisition date, path/row, spatial resolution, cloud/scene cover and others. To ensure complete coverage of the study area and obtain precise forest cover change, four-(4) cloud and scene free Landsat L1TP image were acquired for 1985, 1999, 2013 and 2018 periods.

Table1: Type and Characteristics of Satellite images

Sensors	**Resolution**	**Path**	**Row**	**Acquisition date**	**Source**	**Periods**			
						1985	**1999**	**2013**	**2018**
Landsat5 TM	30m*30m	168	054	1985/01/02	USGS	✓			
Landsat5 TM	30m*30m	168	054	1999/01/25	USGS		✓		
Landsat8 OLI_TIRS	30m*30m	168	054	2013/12/01	USGS			✓	
Landsat8 OLI_TIRS	30m*30m	168	054	2018/02/01	USGS				✓

Source: Researcher

Standard Terrain Correction (L1TP) is Landsat Level-1 data products, which is radio metrically, calibrated and orthorectified using ground control points and digital elevation model (DEM) data to correct for relief displacement. These are the highest quality level-1 products suitable for pixel level, time series analysis. Dry period had selected for the acquisition of satellite image to obtain cloud free image and to distinguish the spectral reflectance between forest and seasonal agricultural crops.

Landsat5 TM and Landsat8 OLI_TIRS multispectral satellite data were used for change detection of two consecutive periods. Landat7 ETM+ was not used for satellite data since it was full of strip and blurred to distinguish spectral value of different landscapes. The time interval between the first two periods is 14 years and 5 years for the last period since there is no Landsat5 and Landsat8 image from 2000-2010. Change detection was starts from 1985 and ends in 2018 to compare the forest coverage between the dergue regime and the current government at institutional level and policy.

Table2: Quantitative data collection

No.	Data Type	Data Source
1	**Primary data**	
	Training and validation points	Ground control points using GPS
	Differentiate homogenous sample of landscapes	Field observation
2	**Secondary data**	
	Satellite images	USGS
	Shape files	Internet, CSA
	Aerial photo	Google Earth
	Base map	Google Satellite

Source: Researcher

3.2.2. Image Pre-processing and Classification

The image pre-processing tasks were performed in Semi-Automatic Classification plugin for the area of interest (AOI) using Landsat satellite images. Image processing involves manipulation and interpretation of digital images. The spatial resolution of images were enhanced using resolution merge technique that integrates images of different spatial resolution or pixels. Radiometric enhancement, however, improve the area of image classification by addressing stripping and banding errors that occur when the detector goes out of adjustment. Each image was assigned to be classified into 7-9 land classes based on specific Digital Number (DN) values or spectral reflectance of different landscape elements.

Maximum likelihood algorithm employed for supervised classification of images. The spectral signature of each class was obtained from the raster images. This has done through selection of

ROI for each of the LULC category. The ROI helps in producing the map by defining an area in the map based on the colour assign to that category and the spectral homogeneity of the pixels of chosen area. This classification had yield a good result after subjecting the classified maps to a confusion matrix. The change analysis was carried out by using MOLUSCE software in QGIS.

Table3: Description of land use/land cover types

Id	Land Use type	Description
1	Forest land	Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent.
2	Shrub land	A shrub land is a specific type of ecosystem and Land with shrubs/bushes canopy cover ≤ 10%
3	Lake	A lake is a body of water that is surrounded by land/and or A lake is a very slow flowing body of open water which occupies a land depression
4	Settlement area	Refers to the physical spaces and environments in which households are sheltered, and how one shelter relates to others.
5	Woodlot	Is any track of land, regardless of shape or size that supports naturally occurring or planted trees
6	Bare land	Areas with little or no “green” vegetation present due to erosion, overgrazing and crop cultivation.
7	Agricultural land	Land allotted for crop cultivation both annual and perennial crops

Sources: (Danilo *et al.,* 2014), (Mittermeier *et al.,* 2018) and (Hannon and Cotterill, 1998)

2.4. Forest cover change detection

3.2.3. Change detection analysis

In this process, images of every year had been classified and labelled separately. After classification, ground verification were done in order to check the precision of the classified LU/LC (forest cover) map. Based on the ground verification necessary correction and adjustments was made. Following classification and verification reclassification was proceed to classify land cover categories into forest and non-forestland cover. The reclassified images were then compare to determine the change that has taken place between the two images using a change matrix. This enable the changed areas to be extracted and by how much through the computation of change maps and change matrix statistics. With this information, it was easy to quantify and explain the change LULC as well as in the forest and non-forestland cover.

The map from t_1 (e.g., 1985) was compared with the map produced at time t_2 (1999) as well as the map at t_2 was compared with the map produced at t_3 (2013), whereas the map at t_3 was compared with the map t_4 (2018) and a complete matrix of categorical change was obtained.

3.2.4. Determination of magnitude of change

The magnitude of change is a degree of expansion or reduction in the LULC size. A negative value showed a decrease in LULC size while a positive value indicated an increase in the size of LULC class (Mahmud and Achide, 2012).

- The magnitude of change (K) is calculated by the simple equation:

$$K = Q2 - Q1 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (equation 1)$$

- The percentage of change (A) is calculated by the formula:

$$A = \frac{Q2-Q1}{Q1} \times 100\% \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (equation 2)$$

- The rate of change (r) is estimated by:

$$\text{r} = \frac{Q2-Q1}{t} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(Equation3)}$$

Where, r= Rate of Change

Q2= Recent year forest cover in ha

Q1= Initial Year forest cover in ha and

t= Interval year between Initial year and Recent year

K = magnitude of change

A = percentage of change

3.2. 5. Accuracy Assessment

For accuracy assessment, maximum number of validation point were randomly distributed on both supervised classification image and high-resolution image such as Google Earth, which show the ground truth of each land classes clearly. In addition, 372-ground control points were collected 153 from agriculture, 121 from urban and settlements, 27 from woodlot, 38 from bare land, 22 from shrubland and 16 from forestland were collected based on proportional area of each LU/LC using GPS for validation. (Lillesand *et al.*, 2004). Then, each points were coded and assigned for the land uses on supervised classification and inter into accuracy software to produce confusion matrix.

The accuracy assessment has done by a confusion matrix that delivers the relationship between the samples taken as reference data and the corresponding samples on classified image. A minimum of 85 percent accurate classification at the 95 percent confidence level was recommended for research (Stan Aronoff, 1982). In this study, all the accuracy assessment parameters (i.e. overall accuracy, producer's accuracy and user's accuracy) have determined for the classification images of year 1985, 1999, 2013 and 2018 respectively. More complete measure of the classification accuracy is Kappa coefficient, also known as Kappa hat or K-hat. Minimum value of kappa hat between 0.61and 0.80 was recommended which is substantial agreement (Tymków, 2009) According to (Neiser *et al.*, 2013) accuracies were calculated as:

- User's accuracy=$\frac{Cii}{Nri}$ where, (Nri) = $\sum_{j=1}^{m} Cij$……………………………..1

- Producer's accuracy=$\frac{Cii}{Nci}$ where, (Ncj) =$\sum_{i=1}^{m} Cij$…………………………2

- Overall accuracy = $\frac{1}{N}\sum_{i=1}^{m} Cii$ where, N=$\sum Cii$………………………………..3

- Kappa coefficient (K-hat) = $\frac{N\sum_{i=1}^{m} Cii - \sum_{i=1}^{m} Nri.Nci}{N2 - \sum_{i=1}^{m} Nri.Nci}$ …………………4

Where, N- total number of pixels in the classification image (N)

i- The sum of any row of the confusion matrix gives the total number of pixels

j- The sum of any column of the confusion matrix gives the total number of pixels

Cii/Nri- is the %age of correct classification of class i, based ground truth

Cii/Nci- is the %age of correct classification of class j, based on ground truth

Cii- The major diagonal elements or correctly classified pixels

K- Kappa coefficient

II. Method for Social Survey

3.2.6. Sampling design and data collection techniques

Both purposive and random sampling techniques were employed. Three (3) representatives kebeles in the study area were selected depend on their potential of forest coverage, proximity, accessibility and agro ecological conditions (Dega, woinadega and kola) in relatives to others kebeles in the district. Hence, Kara Fincawa, Nanawa and Kolba Gode were selected purposefully. Here proportionality was not a concern since the target is to capture areas with specific criterion. In other ways three (3) data collection techniques were employed namely key informants (KIS), Focus Group Discussions (FDGs) and household survey (HHS).

Key informants (elders, and government bodies (kebele leaders)) were selected purposefully, since it was expected that they have knowledge, experience, profession and background in management system, drivers of forest cover change, forest cover trends and current situation of the forest relatively. Eighty (18) key informants were selected purposefully, six (6) individuals from each kebeles.

For household survey, open ended and close-ended questions had been asked to avoid, restricting the participants and give respondents control over what they wish to say and how they wish to say it. The interviews involve sex, age, socioeconomic, major forest cover change driving force, management, status and trends of the forest cover. In total, 384 households were randomly selected using Participatory Rural Appraisal (PRA) tools, where, Participatory rural appraisal (PRA) is a set of participatory and largely visual techniques for assessing group and community resources, identifying and prioritizing problems and appraising strategies for solving them. Random sample, imply that all members of the community have equal chance of being involved to avoid bias in favour of specific groups. Additional members (people reserved in contingency) were interviewed when the initial sampled members were not available.

In addition to household survey and key informants, the researcher made six (6) group discussions with PFM cooperatives, households and development agents and kebele leaders. This focus group were selected purposefully based on their experience and knowledge of the existing LUCL types, the major driving forces of forest cover change and identifying mostly increasing/decreasing land use/land cover type. According to many authors such as (Pripathy and Pripathy, 2017; Robinson, 1999 and Jakasekara, 2012) based on the variability of sample population and interest of the researcher the size of participants in FGD ranges 8 to 12. Hence, each group was comprises of 8 to 12 individuals and the topics for the discussion were related to their perception of forest cover change and drivers of forest cover change.

3.2.7. Sample size determination

The study were conducted in three (3) kebeles, which had selected purposefully. In order to collect the data (qualitative & quantitative) close ended and open-ended interviews were administered to the sample population and the number of households sampled from each kebeles were determined. The following assumptions had made to determine the minimum sample size for the study.

-Estimation of population percentages or proportions were 50%, as this was result in the maximization of variance and produce the maximum sample size.

-A marginal error of 5% (SE) will take assuring a 95% level of confidence (Z). Accordingly, the following formula given by (Taherdoost, 2017) was used to determine the sample size.

- The sample (n) = $(p(1-p))/[(SE/Z)]^2$ where, P=0.5, Z=1.96 & SE= 0.05
  n= $(05(1-0.5))/ [(0.05/1.96)]^2$
  n= 0.25/0.00065

  n=384

  Ten percent (10%) contingency: 0.1*384=38.4 then,

  Total (N) = 422

- Population size for Kara fincawa=1235, for Nanawa=1532 and for Kolba Gode=1654
- **Total(N) = 4421**

Therefore: Sample size for Kara Fincawa kebele (n) = $\frac{384*1235}{4421}$= **107**

Sample size for Nanawa kebele (n) = $\frac{384*1532}{4421}$= **133**

Sample size for Kolba Gode kebele (n) = $\frac{384*1654}{4421}$= **144**

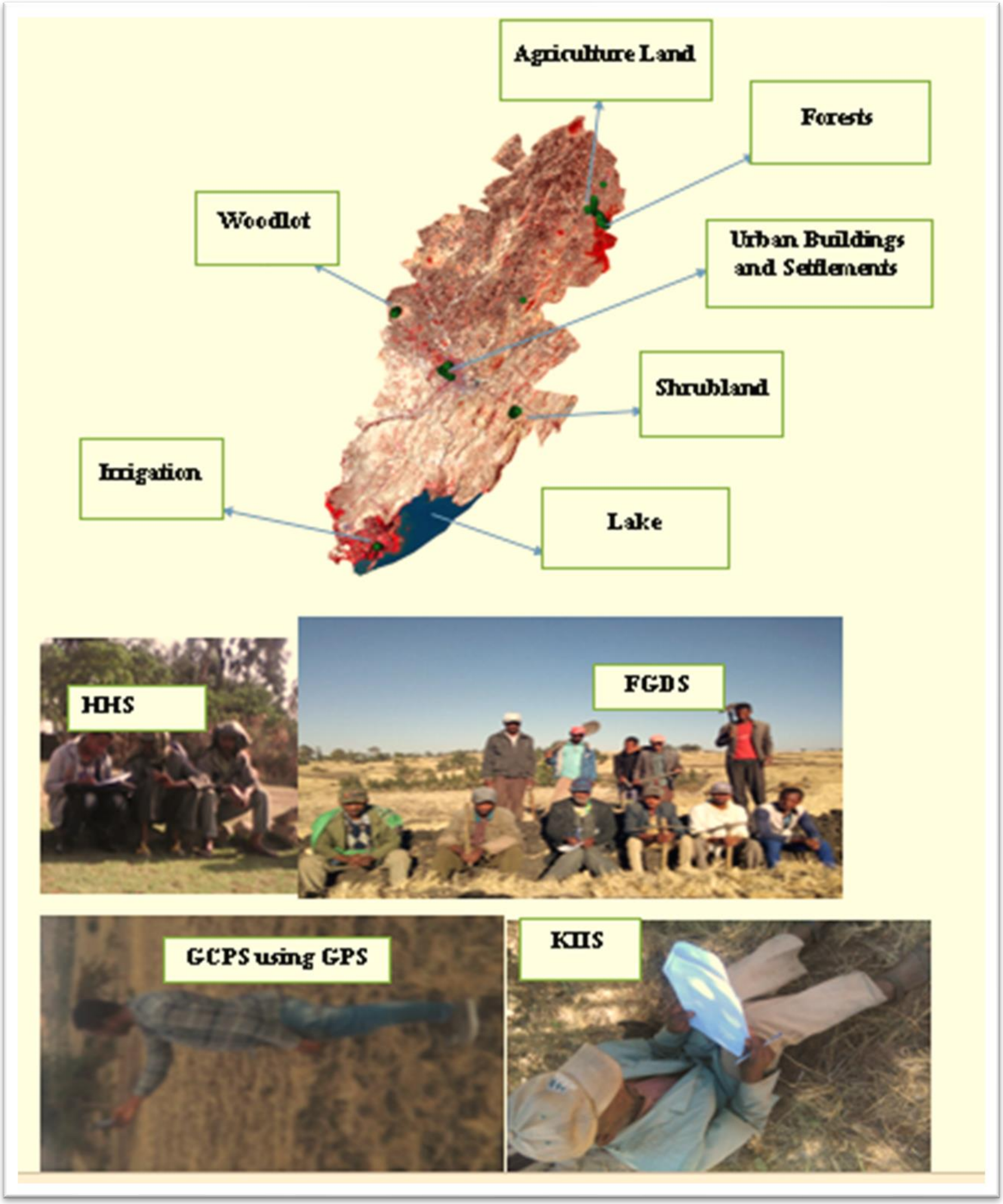


Plate 1: Field Works. (By Hailu Wondu, February 2019).

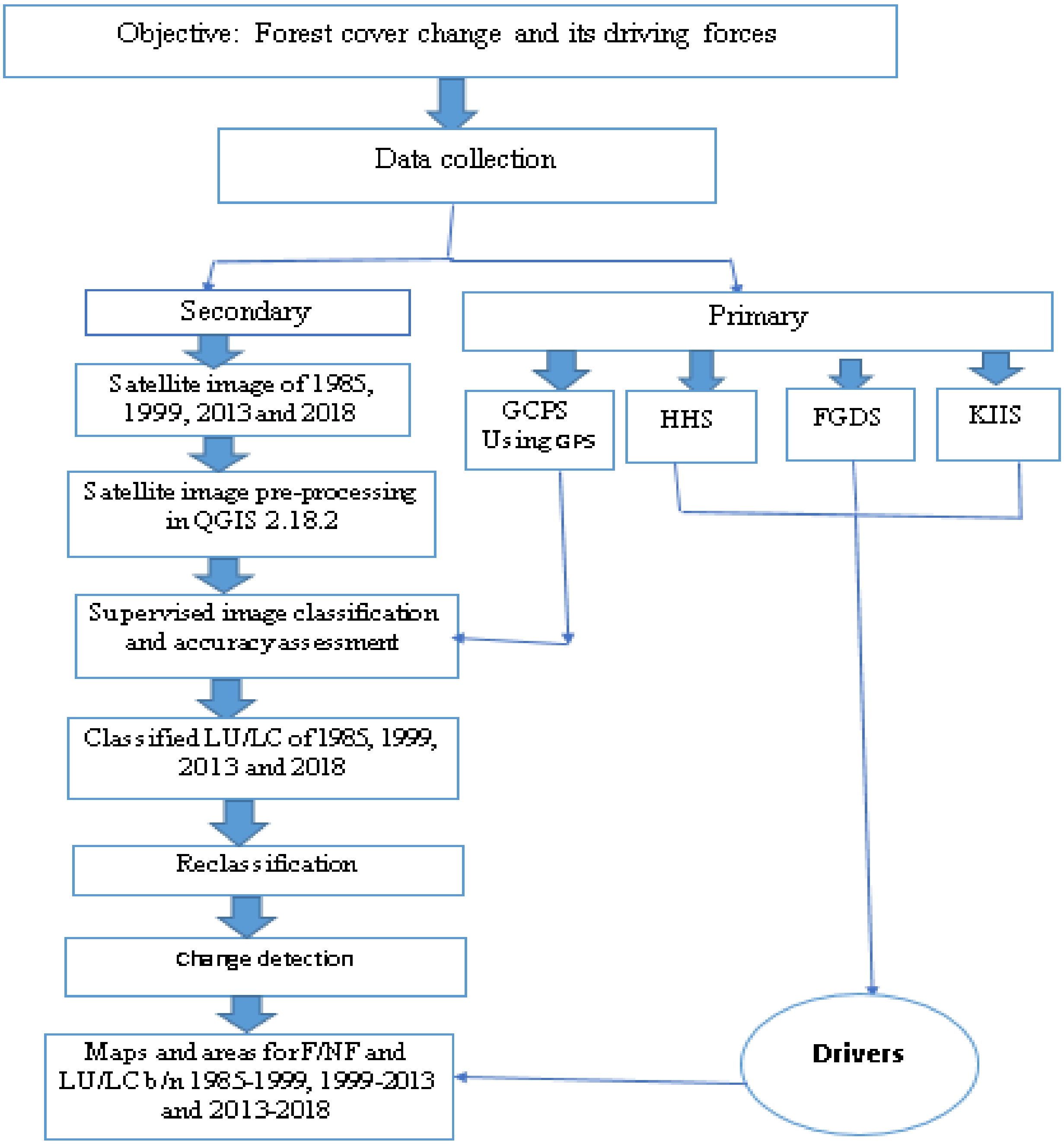


Figure 3: Flow-chart for the general methodology. Adopted from Huang *et al.*, (2010) and Esayas (2015) with some modification.

Table 4: Qualitative data collection

Study kebeles	Data type	Data source	Sampling technique	Total Sample	Sample size per site
1.Nanawa	Primary	KIIS	Purposefully	18	6 from each kebeles
2.Kara Finchawa		HHS	Randomly	384	107, 133 and 144 from the three kebeles
3.Kolba Gode		FGDS	Purposefully	6	2 from each kebeles
	Secondary	Socioeconomic data	Formal requesting	Full profile of the	1 document

Source: Researcher

3.2.8. Data Analysis

3.2.8.1. Data analysis for GIS and Remote Sensing

To improve the interpretability of the images, appropriate pre-processing procedures including radiometric correction were applied by using Semi-automatic Classification Plugin of QGIS. Classification of land use land cover has performed in Semi-Automatic classification plugin algorithm of QGIS and Using training samples, maximum likelihood supervised classification was performed. Then reclassification of the image was proceeded to produce forest and non-forest land classes. For accuracy assessment, the validation point from ground truth distributed on the maps randomly and coded as 1-7 for LULC in the attribute table. Then this coded data were feeds to accuracy software in QGIS to produce error matrix of producer's accuracy, user's accuracy, overall accuracy and kappa coefficient.

Using MOLUSCE software from QGIS, a real change and changed map were obtained for two consecutive period maps. Areas that were converted from one class to any of the other classes was computed and the change directions were determined. The values has been computed in terms of hectares and percentages. Finally, the result has been summarized and presented by tables, graphs, maps and charts.

3.2.8.2. Data analysis for social survey

Following data collection, validation and coding of data collected through the interviews were carried out for their easier capturing and analyzing. Two computer programs namely Microsoft Excel and R-software were used in performing the analysis of differences in perceptions among respondents in different kebeles concerning the forest cover change and drivers of forest cover change. A descriptive statistical method such as frequency and percentage were also employed to analyze the data collected. Table, pi-chart, histogram and graph were used for presentation and summarize the data analyzed by frequency and preferred soft wares.

4. RESULTS AND DISCUSSION

4.1. Investigating the magnitude and rate of forest cover change (1985-2018)

LULC categories and change in the study area during the past 33 years is condensed in Table 5 and 6. The result showed that, rapid increments of urban buildings and settlements as well as agricultural land in the area for 33 years investigated (Table 5 and 6, Figure, 4, 5, 6 and 7). In the reverse, shrub land and forestland have highly declined. In between 1999 to 2013 and 2013 to 2018 Agricultural lands has shown increment in 8.33% and 2.76% respectively. In contrary forestland has shown decline to -0.37% and -0.3% respectively it might be due to conversion into cultivation land, which has lead agricultural land expansion at its expense. This reported in Daniel Jaleta *et al.*, (2016), as bush land has reduced by 11.8% during the study period. This is due to expansion of cultivated land and in Biniyam Alemu *et al.*, (2015) suggested that, the land use and land cover changes that were detected in all study areas revealed, in general, the greater areas of wood land, shrub land and grazing land were transformed into agricultural land, bare land and settlement.

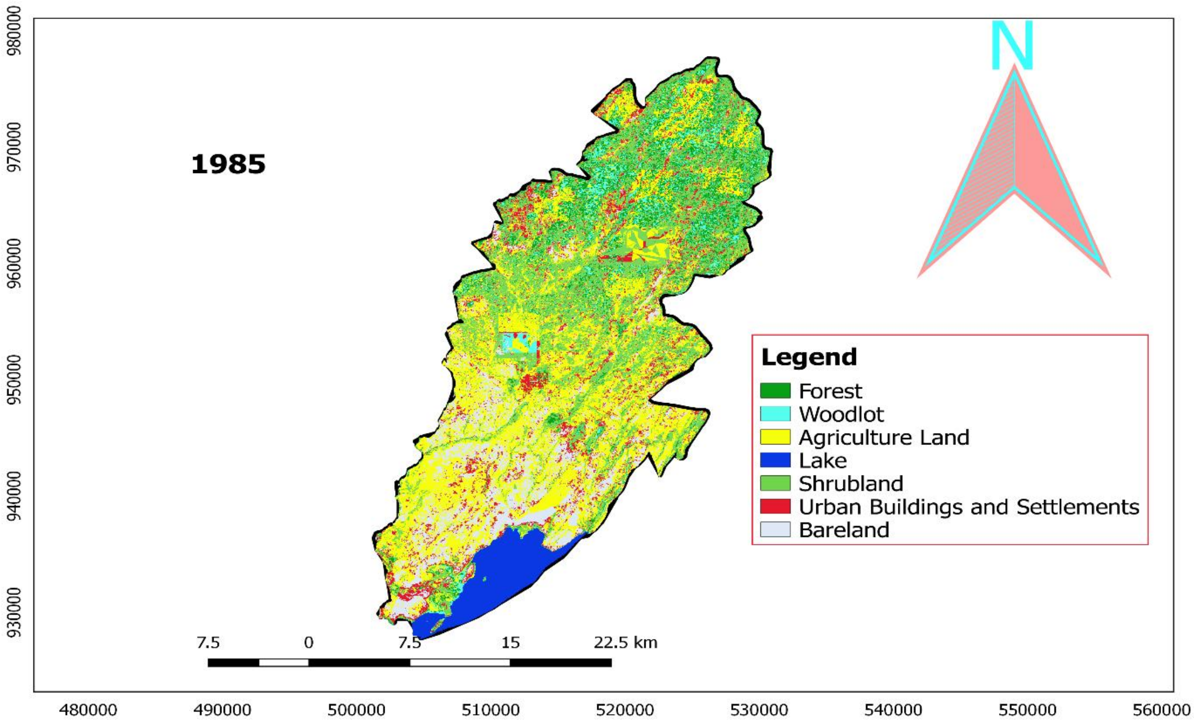
In the years between 1985-1999 and 2013- 2018 there was significant shrub land area reduction -12275.74 and -5519.21ha respectively, which has directly converted to agricultural land and settlements and/or urban buildings. This result is similar with, (Mikias Biazen, 2015) which revealed that, over the entire study period, the annual rate of the cropland area increased. While the rate of the woodland and shrub/bush land, area declined and showed a fluctuating trend between the study years. Throughout the study periods (1985, 1999, 2013 and 2018) urban buildings indicate an increasing tendency of 13.38%, 22.92%, 24.21% and 30.06% respectively that might be due to settlement area expansion for the sake of high rate of population growth and infrastructural development due to urbanization. Agricultural land reduces only in the period between 1985 and 1999 by -0.27% that could be converted to settlement area due to resettlement program of the dergue policy following 1984/5 famine.

As the result depicted, (table 6 and figure 8) from the period 1985 to 2018 there has been a net gain for woodlot, Agriculture land and urban buildings and settlements by 1369.11ha, 7828.73ha and 15471.92ha respectively, in contrary, there has been a net loss for forestland, shrub land, lake and Bare land by-3887.85ha, -17502.55ha, -2690.69ha and -2690.69ha respectively. This might be due to the increasing demand for land in expansion of agricultural land and space for settlements and buildings including bare land/open space with relevant rapid rate of population growth. This confirmed in, Biniyam Alemu *et al.*, (2015). The net gain from woodlot might be due to the increasing demand of tree planting around home for fuelwood consumption with respective expansion of settlement area.

Table 5: Categories and patterns of Land Use/Land Cover in the study area

Land Cover classes	1985		1999		2013		2018	
	area(ha)	%	area(ha)	%	area(ha)	%	area(ha)	%
Forest	6779.3	9.37	3377.59	4.67	3107.24	4.29	2891.45	3.99
Woodlot	3663.69	5.06	8306.5	11.48	3223.55	4.45	5032.8	6.96
Agriculture Land	20588.36	28.46	20392.91	28.19	26418.07	36.52	28417.09	39.28
Lake	3876.69	5.36	4110.76	5.68	4227.43	5.84	3288.01	4.54
Shrub land	21477	29.69	9201.27	12.72	9493.67	13.12	3974.46	5.49
Urban Buildings and Settlements	6275.79	13.38	16580.77	22.92	17511.45	24.21	21747.71	30.06
Bare land	9678.4	13.38	10369.44	14.33	8357.81	11.55	6987.71	9.66

Source: Researcher



Source: Researcher

Figure 4: LULC map of Lume district in 1985

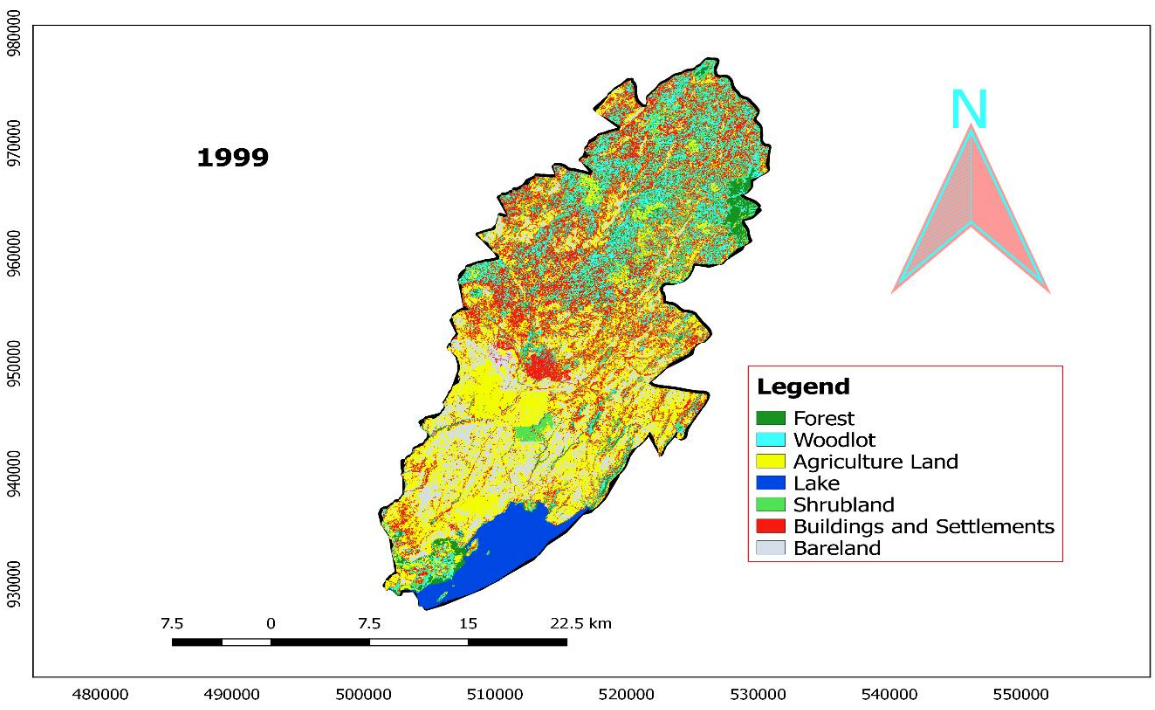
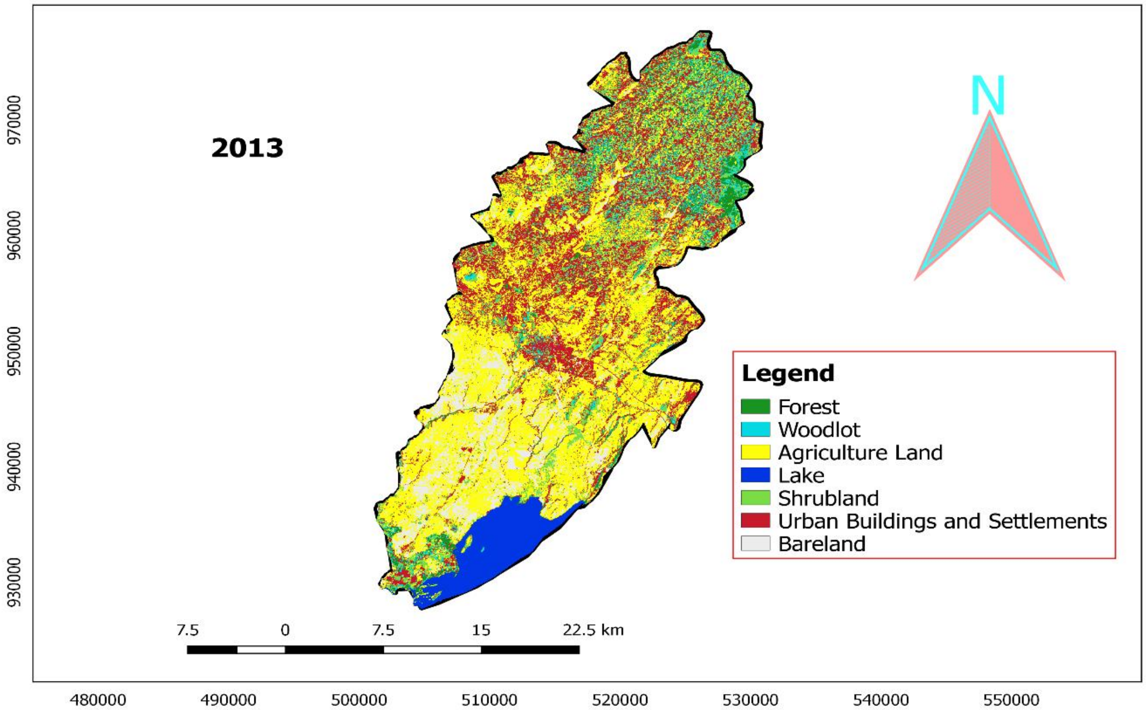
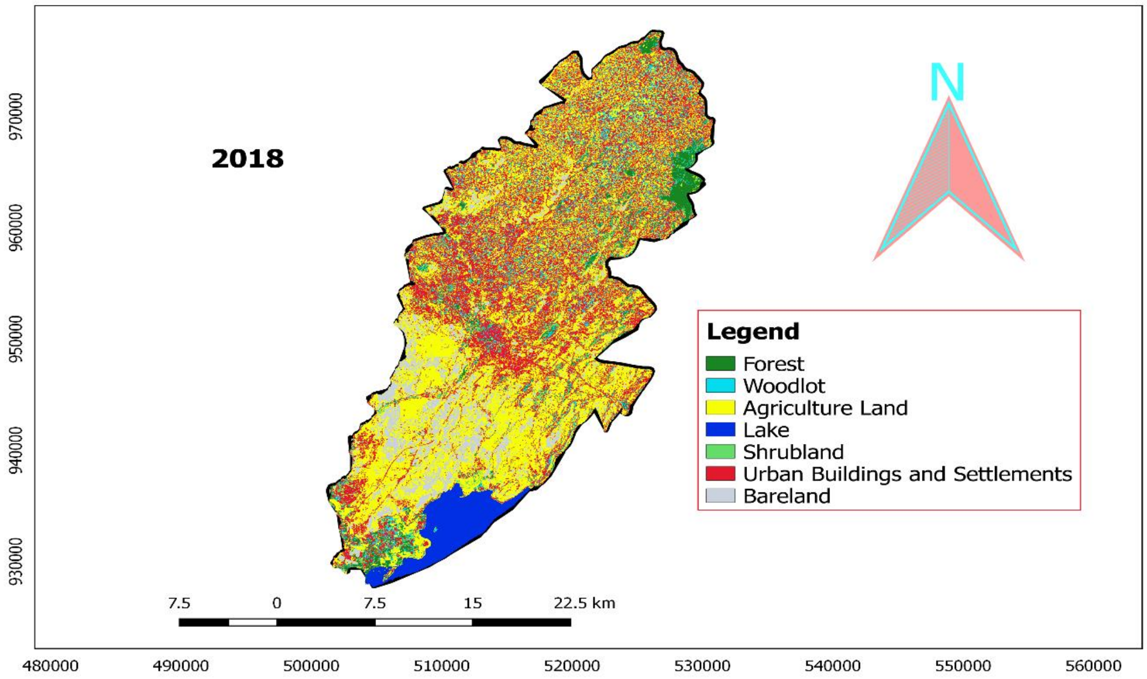


Figure 5: LUCL map of Lume district in 1999



Source: Researcher

Figure 6: LUCL map of Lume district in 2013



Source: Researcher

Figure 7: LULC map of Lume district in 2018

Table 6: Magnitude of Land Use /Land Cover change

	1985-1999		1999-2013		2013-2018		1985-2018	
Land cover classes	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Net Δ Area(ha)	Net Δ %
Forests	-3401.71	-4.7	-270.35	-0.37	-215.79	-0.3	-3887.85	-5.37
Woodlot	4642.81	6.42	-5082.95	-7.03	1809.25	2.5	1369.11	1.89
Agriculture Land	-195.45	-0.27	6025.16	8.33	1999.02	2.76	7828.73	10.82
Lake	234.07	0.32	116.67	0.16	-939.42	-1.3	588.68	-0.82
Shu bland	-12275.74	-16.97	292.4	0.4	-5519.21	-7.63	-17502.55	-24.2
Urban Buildings and Settlements	10304.98	14.24	930.69	1.29	4236.25	5.86	15471.92	21.39
Bare land	691.04	0.95	-2011.63	-2.78	-1370.1	-1.89	-2690.69	-3.72

Source: Researcher

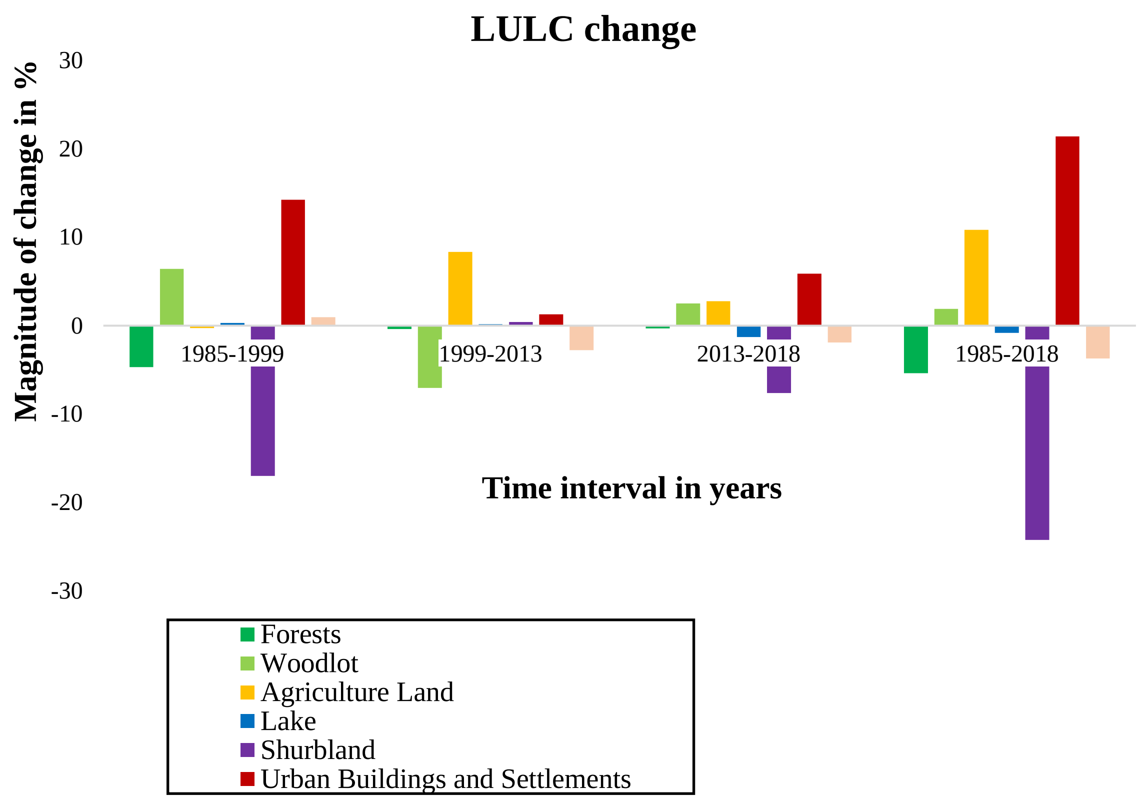


Figure 8: LULC change of Lume district (1985-2018)

Source: Researcher

The amount of changes varied among the LULC types. For instance, out of 6779.3ha forests in 1985, only 924.13ha (13.63%) was unchanged during the study period, wich implies about 86% of forestlands were converted to others LULC. From 86% converted forestland, 3.4% converted to agricultural land, 37.6% converted to woodlot and 20.24% were converted to settlement area. Similarly in this period, out of 21477ha only 4986.3ha (23.22%) remained unchanged shrubland and the remaining 77% of shrubland were converted to others LULC. From 77% shrubland converted, 13.8% converted to agriculture, 15.5% converted to woodlot and 40.72% converted to settlement area (Table 5 and 7). This might be due to increasing expansion of settlement area with the respective high rate of population growth and highly increasing demand for food crops and fuelwood production. Similarly, recent researches have revealed that the expansion of agricultural land has been at the expense of lands with natural vegetation cover (Belay Woldeamlak, 2002).

Major gained trends of LULC changes were observed from the conversion matrix for agriculture land and urban buildings/settlement area. Agriculture land replaced about 7828.73ha the land that used to be covered by other LULC types. The main conversion were from bare land (2643.4ha), shrubland (843.3ha), woodlot (756.94ha) and forestland (165.74ha). Therefore, agricultural land gained an increase of 138% throughout the study period. In addition, there was a conversion to urban buildings and settlement area from other LULC types. However, the conversion from agriculture land and shrubland were the highest, which were about 5542.89ha and 2540.6ha respectively.

Moreover, forest, woodlot and bare land were also contributed to gained conversion of urban buildings and/or settlement area by 454.18ha, 520.66ha and 215.74ha consecutively. As a result, urban buildings and/or settlement area indicated an increment by 346.5% of its areal coverage at initial study period in 1985 (Table 8 and 9, Figure 13, 14 and 15). This might be due to the increasing demand space for residential and urban infrastructures and technological transformation in the scene of urbanization and fulfilling social and economic needs of urban and rural communities. Similar reports in Abineh Tilahun *et al.*, (2015) when population pressure increases there is a demand for settlements. This has a two-way effect on the environment. On one hand there is a need for settlement area through burning of bush lands, on the other hand, there is a need for housing construction material particularly wood, and hence farmers cut trees. Similar suggestion in (Mahendra and Karen, 2019), noted that, unmanaged urban expansion increases the costs of service provision, deepens spatial inequities, and imposes heavy economic and environmental burdens.

Table 7: LULC conversion matrix of 1985-1999

LULC	Forest	Woodlot	Agriculture	Lake	Shrub	Urban Buildings and Settlements	Bareland
Forest	924.13	2549.98	230.87	46.9	1631.4	1372.37	25.76
Woodlot	841.2	1373.2	84.7	91	648	419.6	7.8
Agriculture	501.7	739	14368.2	49.45	1064.4	231.8	3624.4
Lake	11.8	4	1.7	3855.4	4	1.35	0.63
Shrub	962.5	3335.4	2956.8	65.3	4986.3	8745.4	408.5
Urban Buildings and Settlements	107.65	222.8	2795.3	5	609.93	5082.2	1154.9
Bareland	29.64	82.6	3648.5	0	254	517.3	5150

Source: Researcher

Table 8: LULC conversion matrix of 1999-2013

LULC	Forest	Woodlot	Agriculture	Lake	Shrubland	Urban Buildings and Settlements	Bareland
Forest	1134.46	618.13	279.78	168.81	495.35	675.15	6.94
Woodlot	804.77	1187.8	955.1	32.6	2067.7	3236.8	22.34
Agriculture	171.15	138.72	16288.14	20.26	1303.5	302	3162.3
Lake	61.16	7.8	49.2	3979.73	5.6	9.6	0
Shrub	470.85	736.8	2462.63	16.84	2540.6	3915.3	55.13
Urban Buildings and Settlements	454.183	520.66	5542.89	10.8	2754.64	10064.36	215.74
Bareland	12.25	14.32	4830.3	0.9	324.65	289.87	4899.8

Source: Researcher

Table 9: LULC conversion matrix of 2013-2018

LULC	Forest	Woodlot	Agriculture	Lake	Shrubland	Urban Buildings and Settlements	Bareland
Forest	727.3	550.66	979.89	20.9	46.75	762.9	7.66
Woodlot	604	850.6	745	0	129.7	888.64	5.58
Agriculture	165.74	756.94	24,016.04	23.96	843.3	152.4	2646.4
Lake	112.15	92.87	568.5	3244.95	73.14	129.98	8.3
Shrubland	837.4	1252.56	2300.55	0	1697.3	3434.2	201.3
Urban Buildings and Settlements	173.4	1507.4	4773.7	0	1196.53	15,932.17	164.4
Bareland	12.25	11.08	3461.77	0.18	31.8	269.25	3143.52

Source: Researcher

In the year between 1985 and 1999, forestland declined by -3401.71ha (-4.7%) and shrubland reduced by -12275.74ha (-16.97%) whereas woodlot and settlement area increased by 6.42% and 14.24% respectively. This insists that forestland and shrubland decreased at the rate of 243ha and 876ha per year respectively, while woodlot and settlement area increased by rate of 331.63ha and 736ha per annum consecutively (table 6 and 7, Figure 8 and13). According to discussion with FDGS, there was high rate of deforestation during this period since it was transition period (1990-1991) for the downfall of dergue regime, political unrest and the coming of current government. Hence, there was no responsible institutional and legal framework for conservation of forests and other natural resources. Similarly this reported in, Amogne Asfaw (2014) which proposed that, the majority of these 'community forests' were destroyed during the conflict and transition after the downfall of the Dergue (1991) because they were undertaken without the consent of the locals with the exception of the few cases.

In the second and third period also the declined of forest and shrubland cover continued by rate of 19.31ha, 43.2ha and 20.88ha, 1103.84ha per annum consecutively, whereas agriculture land and urban buildings and settlements keep on increasing in the remaining periods (1999-2013 and 2013-2018) by the rate 430.4ha, 399.8ha and 66.5ha, 847.25ha per year respectively (Table 7). It might be due to high demand for food crop production and space for buildings and settlements with corresponding high rate of population growth. Similarly reported in, (Ebrahim Esa Hassen and Mohamed Assen, 2017) which disclosed that, the area devoted to farmland and settlement showed a steady expansion by about 33.44% (370.3 ha/year) in this third period of analysis.

Table 10: Rate of Land Use/ Land Cover Change (1985-2018)

	1985-1999		**1999-2013**		**2013-2018**		**1985-2018**	
Land Cover classes	%age of (A)	rate of Δ /yr.	%age of (A)	rate of /yr.	%age of (A)	rate of /yr.	%age of (A)	rate of /yr.
Forests	-0.5	-243	-0.08	-19.31	-0.07	-43.2	-0.57	-117.8
Woodlot	1.3	331.63	-0.61	-25.93	0.56	361.85	0.37	41.48
Agriculture Land	-0.009	-13.96	0.3	430.4	0.75	399.8	0.38	237.23
Lake	0.06	16.72	0.03	8.33	-0.22	-187.88	-0.15	-17.84
Shurbland	-0.57	-876.84	0.03	20.88	-0.58	1103.84	-0.81	-530.38
Urban Buildings and Settlements	1.64	736	0.05	66.5	0.24	847.25	2.46	468.8
Bare land	0.07	49.36	-0.19	-143.69	-0.16	-538	-0.28	-81.5

Source: Researcher

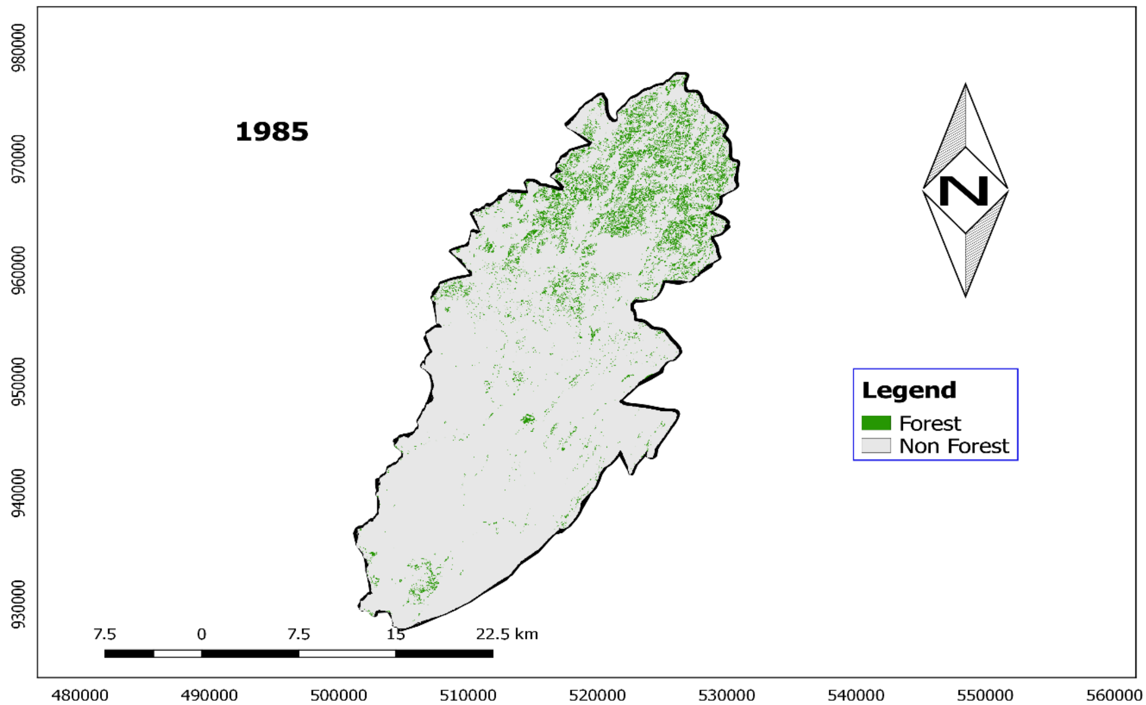
The result indicated (table 11) the extent of areal share of forest lands from the total land cover of the district which implies maximum share in 1985 of which 6779.3ha (9.37%) and minimum share in 2018 of which 2891.45ha (4%) . Furthermore, it showed the amount of forest cover converted to non-forest land (other land uses) in the specified period. In between 1985 and 1999 high amount of forestland 3401.71ha (4.7%) was converted to non-forestlands and in between 2013 and 2018 relatively low amount forest area 215.79ha (0.3%) was converted to non-forestland (Table 9, Figure 13, 14, 15 and 16). This might be due to enhancing forest management by Ethiopian government commitment through establishing various institutions such as Ministry of Environment Forest and Climate Change in 2012, Regional forest enterprises: Oromia Forest and Wildlife Enterprise in July 2009 and Amhara Forest Enterprise in November 2009. This involves Participatory Forest Management and which increase ownership and responsibility of the local community for forest conservation. The result confirmed the finding in Mulugeta Lemenih *et al.*, (2015) which noted that, today PFM is formally recognised in forest proclamations of Ethiopia's Federal Government and several regional states. The approach has expanded significantly.

For example, according to information from OFWE (2018) branch in Lume district, 1500.5ha of plantation forest is managed by Enterprise in the study district. It could be also due to the elaborated increment of awareness creation by Development Agents throughout the country recently. However, a net loss of 3887.85 ha (5.37%) forest area was recorded throughout of study periods 1985-2018 (Table 9, Figure, 9, 10, 11 and 12).

Table 11: Patterns of Forest and Non Forest cover in the district (1985-2018)

Land Cover type	1985 area(ha)	1985 %	1999 area(ha)	1999 %	2013 area(ha)	2013 %	2018 area(ha)	2018 %
Forest	6779.3	9.37	3377.59	4.67	3107.24	4.3	2891.45	4
Non Forest	65559.93	90.63	68961.64	95.33	69231.99	95.7	69447.78	96

Source: Researcher



Source: Researcher

Figure 9: Forest and Non Forest cover map of Lume district in 1985

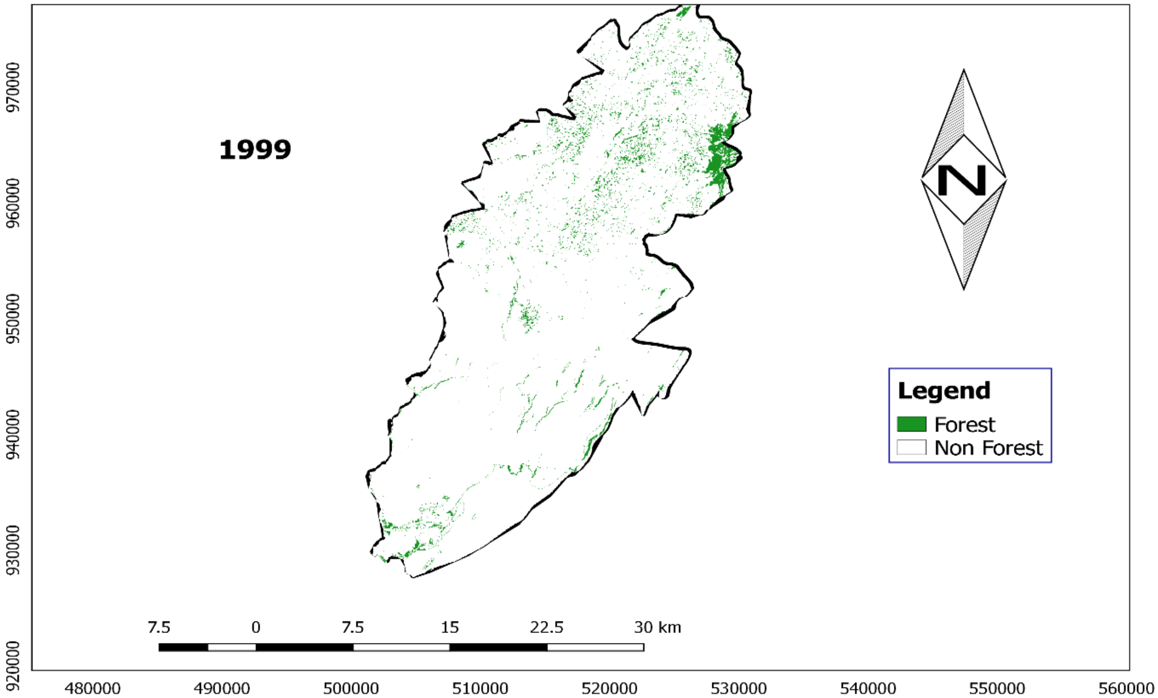
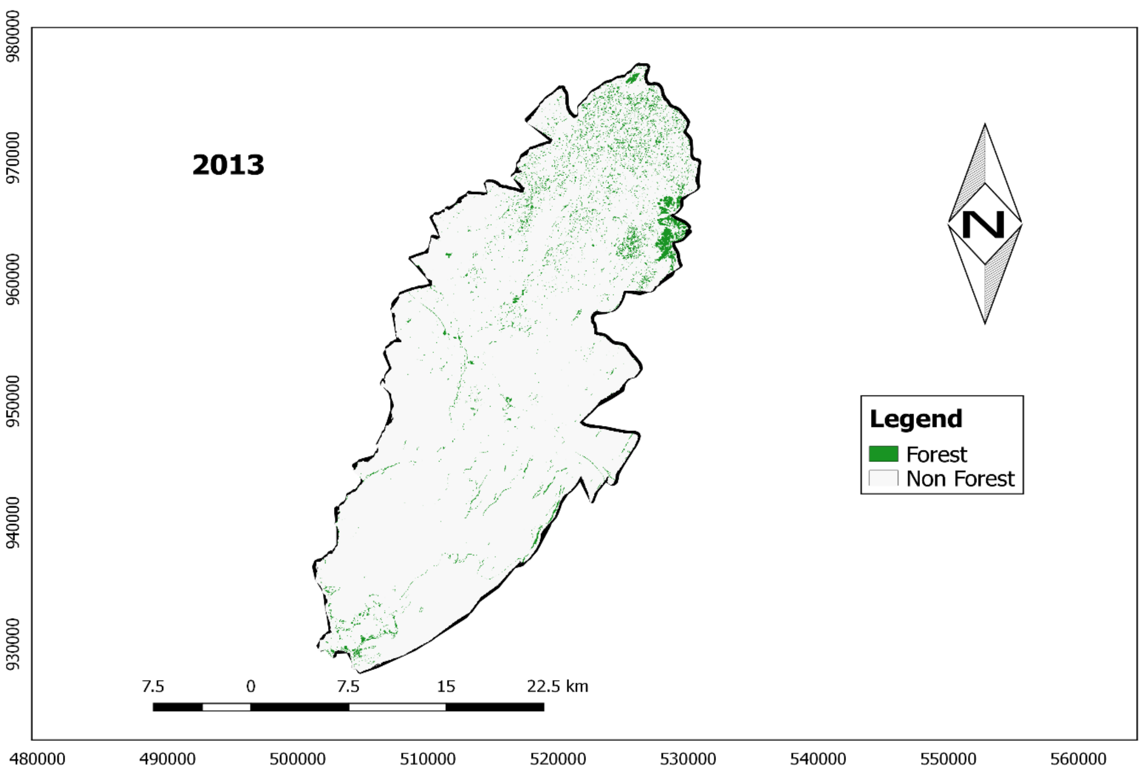
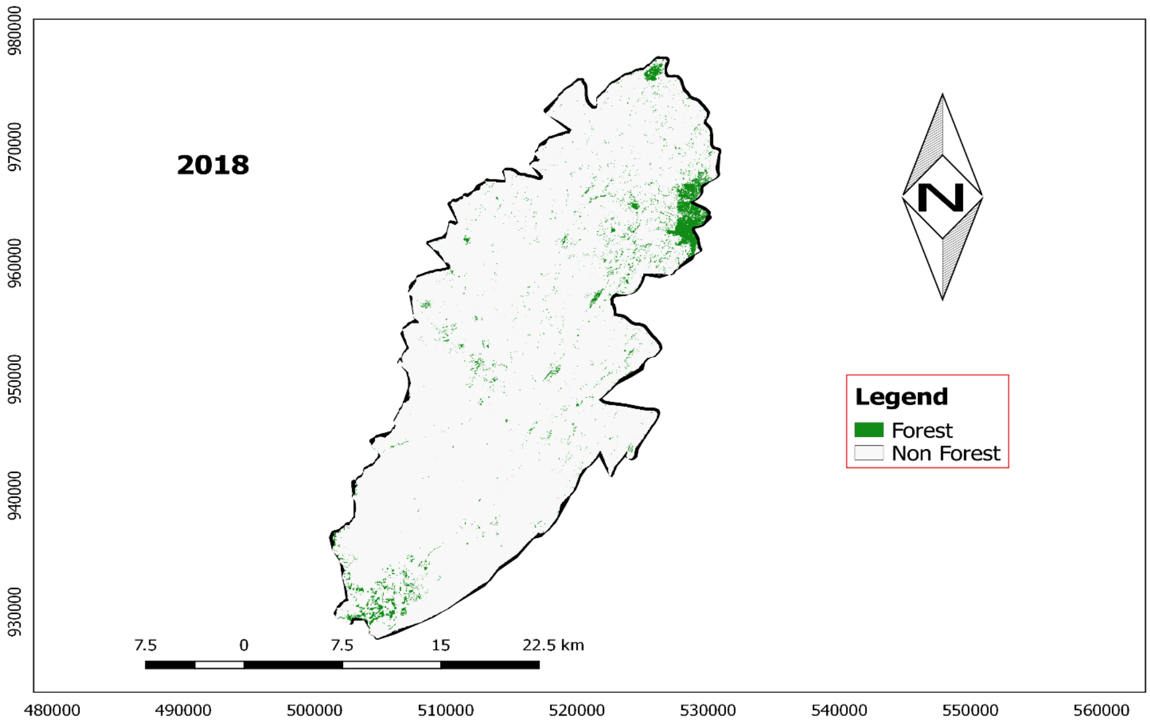


Figure 10: forest and Non-forest cover map of Lume district in 1999



Source: Researcher

Figure 11: Forest and Non Forest cover of Lume district in 2013



Source: Researcher

Figure 12: forest and Non-forest cover of Lume district in 2018

Table 12: Magnitude of Forest and Non Forest cover change (1985-2018)

	1985-1999		**1999-2013**		**2013-2018**		**Net change**	
Land Cover type	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Δ Area(ha)	Δ %	Net Δ Area(ha)	Net Δ %
Forest	-3401.71	-4.7	-270.35	-0.37	-215.79	-0.3	-3887.85	-5.37
Non Forest	3401.71	4.7	270.35	0.37	215.79	0.3	3887.85	5.37

Source: Researcher

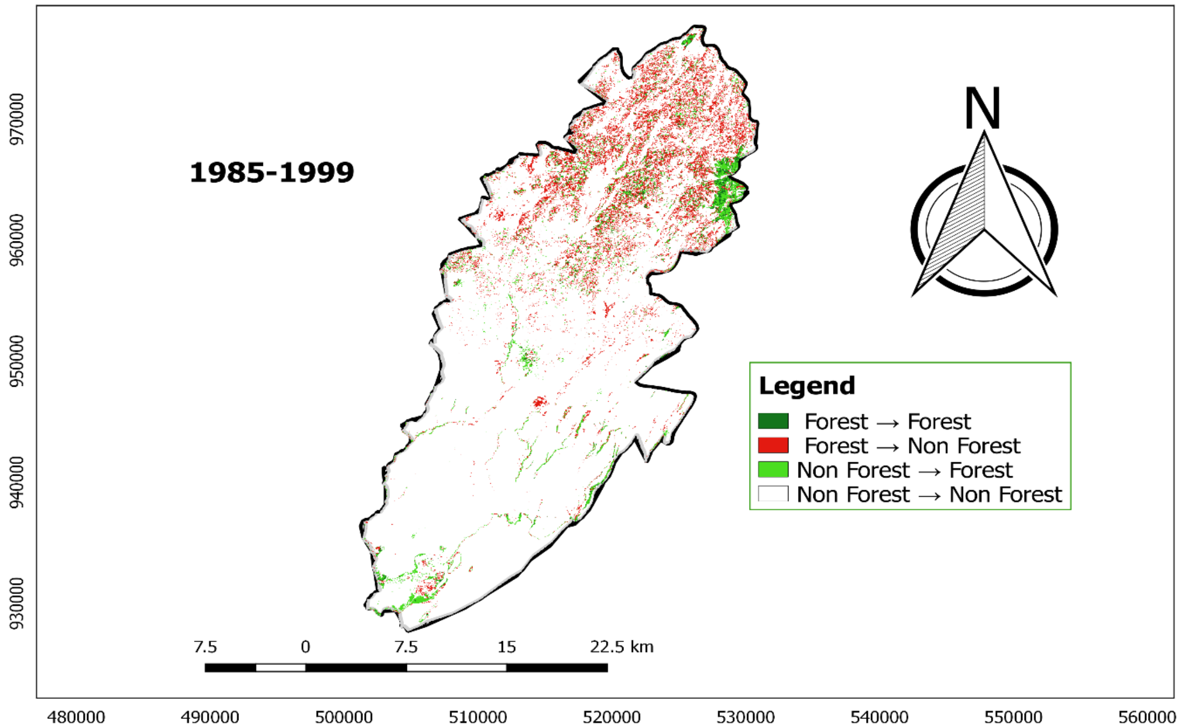
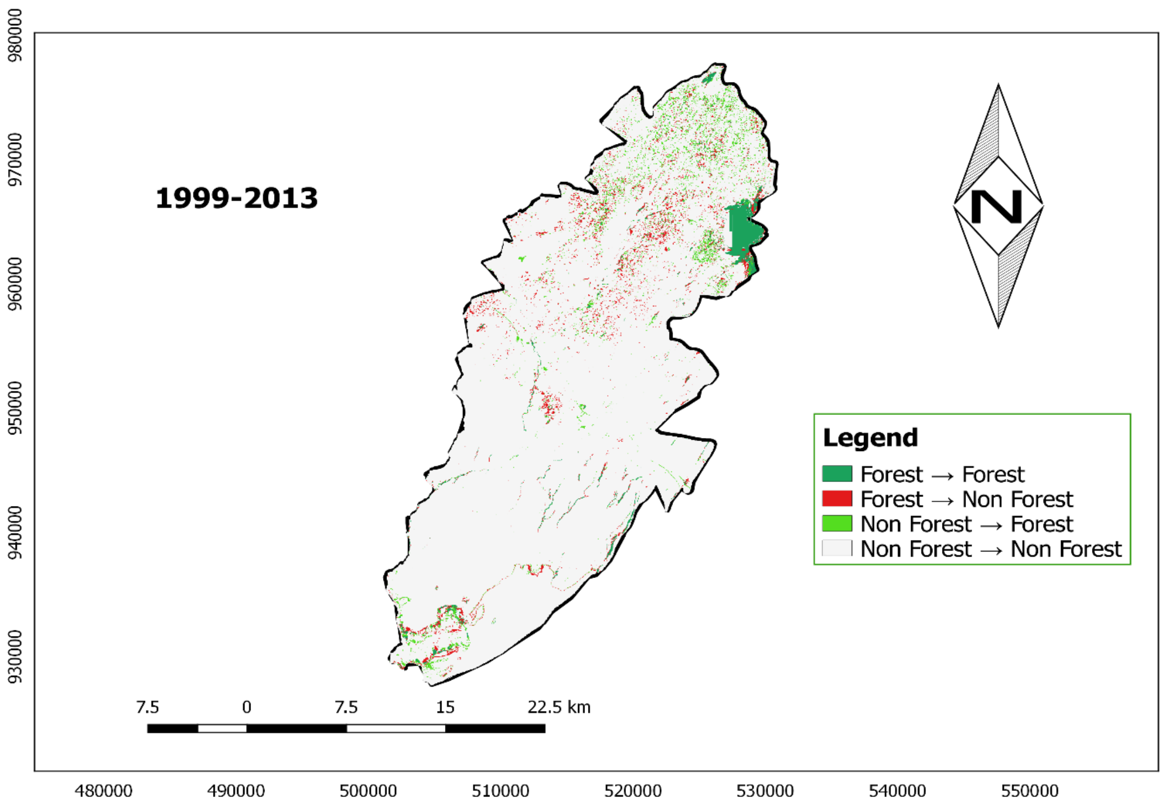
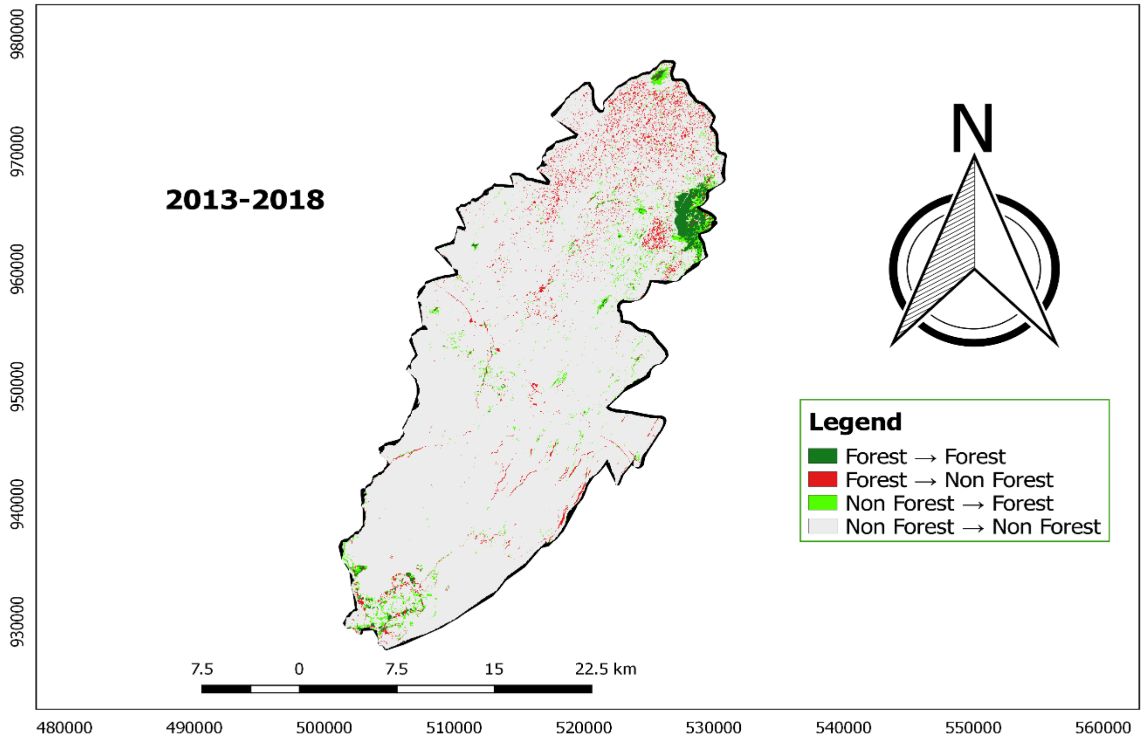


Figure 13: Changed map of Lume district between 1985 and 1999



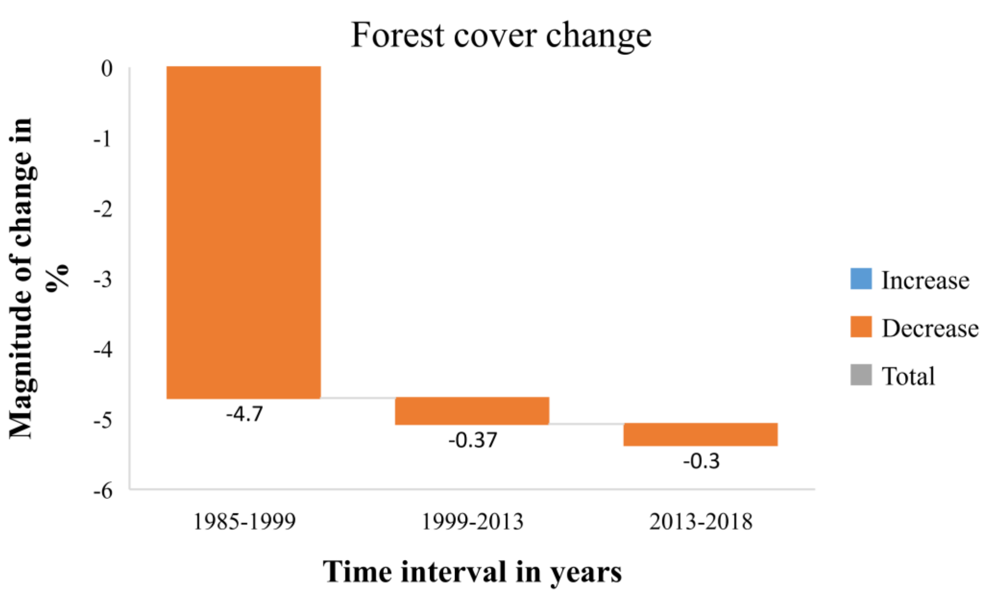
Source: Researcher

Figure 14: Changed map of Lume district between 1999 and 2013



Source: Researcher

Figure 15: Changed map of Lume district between 2013 and 2018



Source: Researcher

Figure 16: Magnitude of Forest cover change in Lume district (1985-2018).

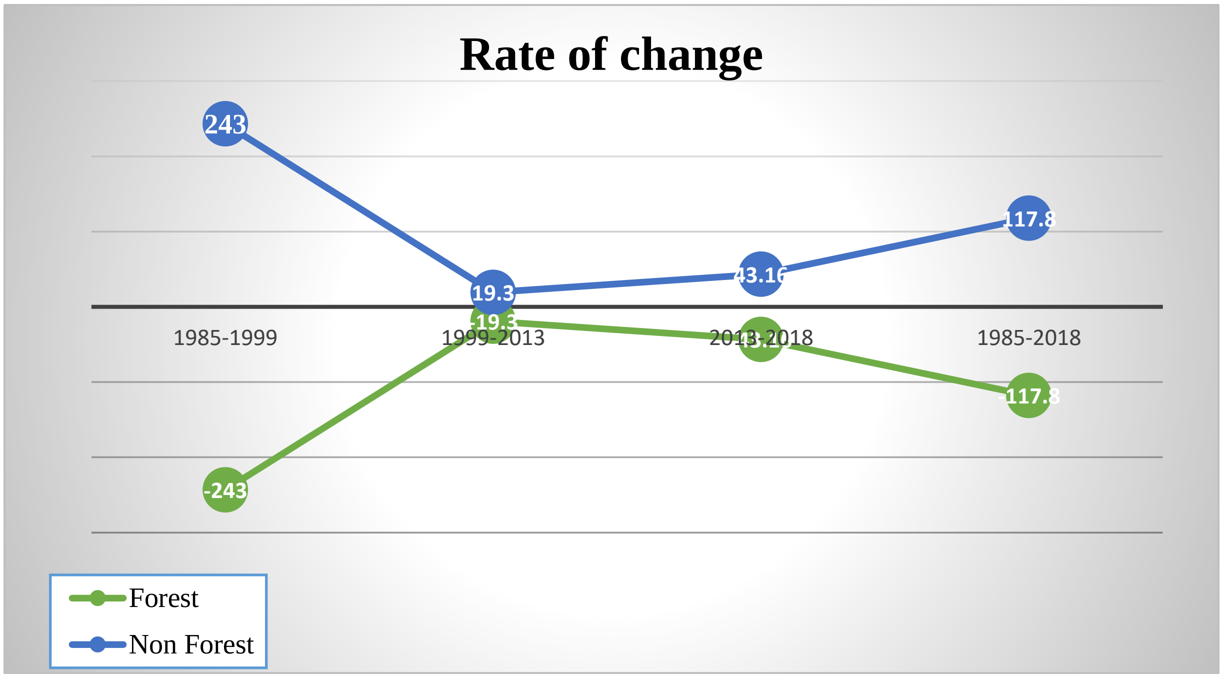
The computed result (table 13 and Figure 17) showed that the average rate of forest cover change in between 1985 and 1999 was declined by 243ha per year, between 1999 and 2013 it was decreased by 19.3ha per annum and between 2013 and 2018 reduced by 43.16ha per annum. This result supported, the findings of Abiyot Yismaw *et al.*, (2014) which noted, rate of forest cover change from year 1973 to 1986 is -245.2 ha per year (6044.4ha –2855.9ha/13 years) and from year 1986 to 2003, it was -24 ha annually (2855.9-2446.9ha/ 17years). The annual rate of forest cover change throughout the assessment period was -117.8ha. This could be due to alarming rate of population growth in needs for high food security and space for settlements combined with low-income source forced farmers to deforestation.

Table 13: Rate of change for Forest and Non Forest (1985-2018)

Source: Researcher

Land Cover type	**1985-1999**		**1999-2013**		**2013-2018**		**1985-2018**	
	%age of (A)	rate of /yr.	%age of (A)	rate of /yr.	%age of (A)	rate of /yr.	%age of (A)	rate of /yr.
Forest	-50.18%	-243	-8	-19.3	-6.94	-43.16	-57.3	-117.8
Non Forest	5.18	243	0.39	19.3	0.31	43.16	57.3	117.8

Source: Researcher



Source: Researcher

Figure 17: Rate of Forest cover change in Lume district (1985-2018)

<u>**Note:**</u>**-**The rate of forest cover change and LULC was computed using Equation (3)

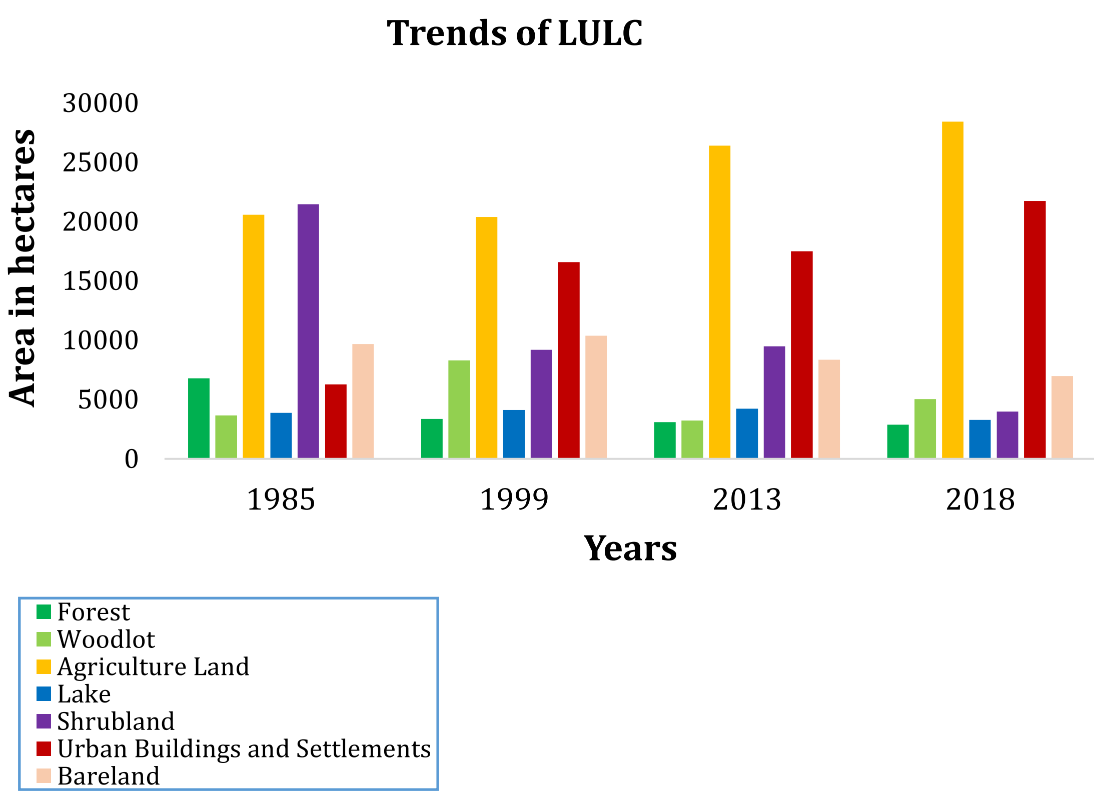
Percentage of forest cover and LULC change was computed using Equation (2)

4.2. Examining forest Cover trends and management system in the district (1985-2108)

The trend analysis of forest cover and other land use/land cover disclose that a change in area of each LULC through the investigation of 33 years period (Table 5, Figure 18 and 19). The change happened in the district were reduce in forest and shrubland due to deforestation, Agricultural land expansion, expansion of settlements and urban buildings were the major changes encountered in this period. Urban buildings and settlements undergoes the most increment change during the study period. This confirmed the finding in (Pratik and Ashok, 2017); in which settlement experienced a most positive change during the 21-year study period. This might be, as result of ongoing population growth, socio economic activities for livelihood, urbanization and technological transformation. This support the finding in Asirat Tolosa (2018) suggested that, the increase of aerial coverage for cropland and grassland was due to an increase of population pressure, demand for cultivated land in the highland and intervention of soil conservation practice by different NGOs and Governmental Organization.

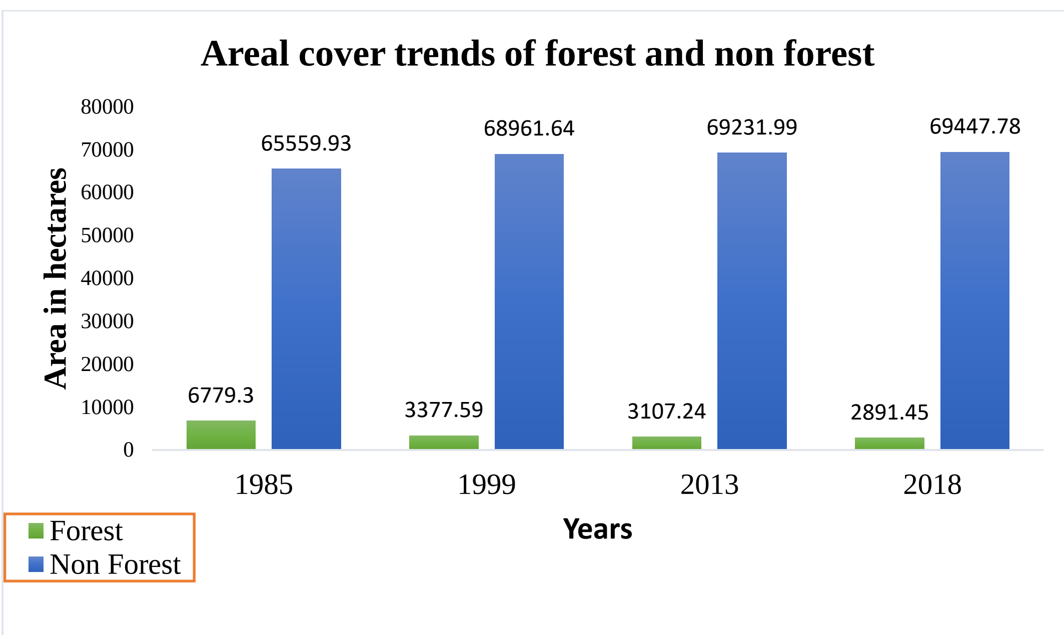
Hence the area coverage of urban buildings and settlements 6275.79ha (13.38%) in 1985 increased to 21747.71ha (30.06%) in 2018, which was a dramatic change from LULC existed in the district and followed by agricultural land which covers 20588.36ha (28.46%) in 1985 and 28417.09ha (39.28%) in 2018. For more emphasize, the net gain in percent for settlement area is 21.39% and 10.82% for agricultural land area (Table 6 and 9). Forestland cover indicate a negative change over the 33 years of study period. In 1985, 9779.3ha (9.37%) and declined to 2891.45ha (3.99%) in 2018 (Table 8, Figure 18 and 19). This might be due to expansion of agricultural land, urban growth and expansion of settlements, rapid rate of shrubland reduction that can developed to forest gradually and due to improper management system.

The transition matrices displayed that, forests and shrub lands are the most exposed to the future LULC change. Currently, bare land has the highest probability (0.43%) of being converted to agricultural land, while forest has a probability of 0.29% to convert into agricultural land and shrub land has a probability of 0.36% to convert into urban buildings and settlements (Table 8). Similar findings reported in (Pratik and Ashok, 2017).



Source: Researcher

Figure 18: LULC trends in Lume district (1985-2018)



Source: Researcher

Figure 19: Forest and Non Forest cover trends in Lume district (1985-2018)

According to information from key informants, every year there is a plantation program which mobilize and involving massive participation of local communities starting from the mid of July to the beginning of August. However, the survival rate is low due to water deficiency in long dry period (November to April) since it is a period when seedlings needs excessive amount of water and low participation and responsibilities of local communities for post plantation activities. Similarly, in the district water and soil conservation practices are performed yearly from the mid of January to beginning of March through mobilization of local communities and concerned stakeholders including DAs, woreda experts and cadre from administration office.

During this period, various soil and water conservation structures were established in agricultural land and forest area. Furthermore, awareness creation nourished to local communities by different experts at the end of daily physical work to increase their knowledge concerning forest conservation, their security and other natural resources management.

Series interview held with KIIS depicted that, forest plantation, soil and water conservation and awareness creation and PFM are most commonly practiced forest management system in the district (Table11). Currently Nanawa and Kara Finchawa plantation forest are managing under OFWE through PFM, but the benefit sharing between each stakeholder is still not fair, since it was 40% for local community, 10% for administrative kebeles and 50% for government. This confirmed findings in Amogne Asfaw (2014), So as long as the intervention is to enhance the productivity of nature and to improve the livelihood of local community, locals have to actively participate right from the outset to the completion of the program; and they have to be the number one beneficiaries.

Table 14: Investigated Forest Management System in the District

Major Forest Management System in area	Respondents	Proportion	Rank
Forest Plantation	4	22%	3
Area Closure	1	6%	5
Soil and Water conservation	5	28%	1
Participatory Forest Management	3	17%	4
Awareness Creation	5	28%	1
Total	18	100%	

Source: Researcher

4.3. Accuracy assessment for classified images of 1985-2018

Accuracy assessment is an important step in the process of analysing remote sensing data. Remote sensing products can used as the basis for political as well as economical decisions. Potential users have to know about the reliability of the data when face up with maps derived from remote sensing data. In order to increase the result of overall accuracy, images of different land use/land cover divided into more parts. For instance, in this study agricultural land divided into five different parts to increase homogeneity of pixels and finally categorize as agricultural land. Thus, 86.16%, 84.7%, 85.8% and 85% overall accuracy were achieved for 1985, 1999, 2013 and 2018 respectively, which is satisfactory level for GIS and RS research. Furthermore, 0.756, 0.807, 0.787 and 0.779 kappa coefficient were attained for 1985, 1999, 2013 and 2018 consecutively, which is substantial agreement, that produced by accuracy assessment of error matrix/confusion matrix (Table 15, 16, 17 and 18). The Kappa coefficient lies typically on a scale between zero and one, where the latter indicates perfect agreement.

The overall map accuracy is not always representative of the accuracy of individual classes. High overall map accuracy does not guarantee high accuracy for forest and others land cover losses. Therefore, both producer's and user's accuracy for all single classes need to be considered. For instance a higher user's accuracy (85.4%) and low producer accuracy (81.1%) implies that more forest loss in the map was also loss in the reference data (Table 15). In contrast to the overall accuracy, the Kappa coefficient considers also non-diagonal elements. It measures the proportion of agreement after chance agreements have been removed from considerations. Therefore, always the value of kappa coefficient is less than overall accuracy. The result in (Table 15, 16, 17 and 18) also confirmed the fact of this statement. This also reported in (FAO, 2016).

Table 15: Confusion matrix for LULC of 1985

	References Data								
Classification Data	Forest	Woodlot	Agriculture Land	Shrubland	Lake	Urban Buildings and Settlements	Bare land	Total	User's accuracy
Forest	258	32	47	1	61	0	3	302	85.4%
Woodlot	65	107	39	3	12	0	0	176	60.8%
Agriculture Land	45	24	1460	3	168	36	105	1541	94.7%
Lake	0	0	0	253	0	0	0	253	100%
Shrubland	41	16	226	6	769	24	9	897	85.7%
Urban Buildings and Settlements	6	3	85	5	26	157	37	249	63.1%
Bare land	3	2	121	0	10	37	459	531	86.4%
Total	318	134	1684	296	849	184	503	4019	
Producer's accuracy	81.1%	79.8%	86.7%	85.50%	90.6%	85.32%	91.2%		

Source: Researcher

Overall accuracy=86.16% **Kappa coefficient** =75.6%

Table 16: Confusion matrix for LULC of 1999

Classification Data	Forest	Woodlot	Agriculture Land	Lake	Shrub land	Urban buildings and Settlements	Bare land	Total	User's accuracy
	Reference Data								
Forest	53	3	8	4	15	10	0	69	76.8%
Woodlot	21	257	35	4	45	39	0	311	82.6%
Agriculture Land	7	15	1294	3	17	188	145	1383	92.8%
Lake	0	0	0	276	0	0	0	276	100%
Shrubland	0	47	38	0	296	92	5	393	75.4%
Urban buildings and Settlements	7	54	226	0	97	713	25	943	75.6%
Bareland	0	0	136	0	3	20	515	574	89.7%
Total	64	286	1437	312	383	872	590	4019	
Producer's accuracy	82.8%	89.7%	90%	%	77.3 %	81.8%	87.3		

Source: Researcher

Overall accuracy=84.7% **Kappa Coefficient**=80.7

Table 17: Confusion matrix for LULC of 2013

Classification Data	Forest	Woodlot	Agriculture Land	Lake	Shrubland	Urban buildings and Settlements	Bare land	Total	User's accuracy
	Reference Data								
Forest	46	0	44	0	2	26	0	106	43.4%
Woodlot	3	54	20	0	7	7	0	59	91.5%
Agriculture Land	9	10	1746	9	80	136	141	1841	94.84%
Lake	0	0	0	278	0	0	0	278	100%
Shrubland	8	15	110	0	353	70	1	387	91.2%
Urban buildings and Settlements	1	19	343	0	135	672	4	967	69.5%
Bare land	0	0	90	0	0	27	299	316	94.6%
Total	55	66	2057	312	407	729	345	4019	
Producer's accuracy	83.6%	81.8%	84.88%	89.1%	86.7%	92.2%	86.7%		

Source: Researcher

Overall accuracy= 85.8% **Kappa Coefficient**=79.7%

Table 18: Confusion matrix for LULC of 2018

	Reference Data								
Classification data	Forest	Woodlot	Agriculture land	Lake	Shrub land	Urban Buildings and Settlements	Bare land	Total	User's accuracy
Forest	73	14	5	15	10	4	0	84	87%
Woodlot	3	213	67	4	19	52	0	227	93.8%
Agriculture land	6	72	1524	8	94	259	136	1608	94.7%
Lake	0	0	0	231	0	0	0	231	100%
Shrubland	14	28	67	15	247	62	2	259	95%
Urban buildings and Settlements	18	126	494	10	104	782	11	1223	64%
Bare land	0	3	115	0	3	18	297	329	90.3%
Total	77	325	1772	283	301	850	338	3961	
Producer's accuracy	94.8%	65.5%	86%	81.6 %	82%	92%	87.7%		

Source: Researcher

Overall accuracy= 85% **Kappa Coefficient**= 78.7

4.4. Major Driving Forces of Forest cover change in the study district

4.4.1. Socio-economic characteristics of study population

In the study area, 90% of the participant were male headed and only 10% were female headed. Mostly it is expected that women are involved in fuel wood collection and other forest products from the forest, hence the effect is less. This is in line with, Sunderland *et al.,* (2014) which noted that, in many places, particularly in Africa; it is women and girls who are the main collectors of fuelwood. Respecting age of participants 65% of sampled population were in between 35 and 50 years, which were enough matured to easily understand the use of forest and participate in forest management activities rather than deforestation. 62% of the respondents were owned 0.5 to 1.5 ha of land and only 4% of sampled population has land 3 to 6ha. This insist that, 62% of the farmers forced to secure others income source to change and support their life properly (Table 19).So they might be involved in deforestation to expand their farmland or cut trees for sale of fuelwood and charcoal production.

Regarding income, 48% of the participants were generating 15000 to 25000 birr per year, which is not satisfactory in the current life situation. Hence, these farmers also forced to search for others income source alternatives including forest products and expanding of agricultural land through deforestation of forests and shrub lands. This in line with, (Jane and Charles, 2008) which suggested that, a decomposition of income shares by source and wealth groups show that the lowest income group derive higher income from forest crop farming . From below socio-economic data, displayed (Table 19) land holding size and income has a negative impact on expansion of forests and shrub lands.

Table 19: Socio-Economic Characteristics of Sampled Population

No.	Variables	Categories	Frequency	Percentage (%)
1.	Sex	Male	347	90
		Female	37	10
2		25-35	93	24
	Age	35-50	246	65
		50-65	45	12
3.	Education	Illiterate	120	31
		Literate	264	69
4.	Family Size	1-3	66	17
		3-6	229	60
		>6	89	23
5.	Land Holding(ha)	0.5-1.5	238	62
		1.5-3	130	34
		3-6	16	4
6	Income Per Year	5-15	35	9.
	(Birr in 1000)	15-25	184	48
		25-35	149	39
		>35	16	4

Source: Researcher

4.4.2. Proximate Drivers

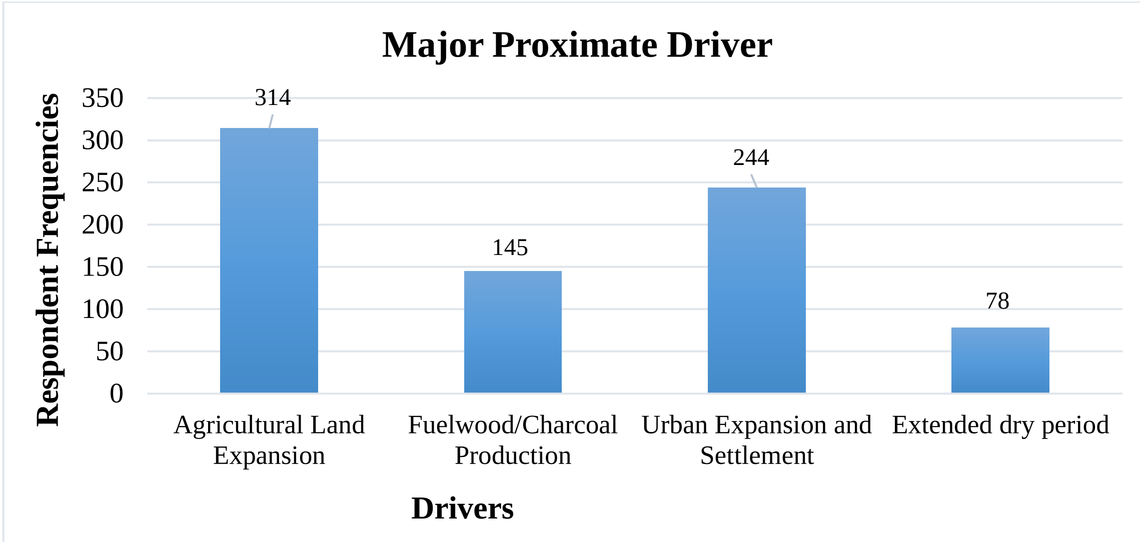
The consecutive interview and discussion held with HHS and FGDs in the study sites depicted that four major proximate drivers of forest cover change existed in the districtwide.1) Agricultural land expansion 2) Fuelwood/charcoal production 3) Urban Expansion and Settlements and 4) Extended dry period. The perception from HHS indicate that, agriculture is the main life supporting practices in the district since the agro ecology of the district is more suitable for diversity of crop production and livestock rearing. So, most of rural farmers are dependent on agriculture for their livelihood and income generation. Nevertheless, the population size of the study site increase from time to time, which needs more additional food crops from agriculture. Thus, highly demand for food security combined with expensive living condition leads to farmers to expand their lands by destructing forests and shrub lands for the use of agriculture. Therefore, agricultural land expansion (314) is the major driving force in the district (Figure 20). This also reported in Kissinger *et al.,* (2012), as most of the smallholder farming resettlement schemes are established on forestlands and therefore environmentally unfriendly.

According to the interview with HHS and discussion with FGDS, fuelwood and charcoal were the primary energy sources (145) in the rural area (Figure 20). To fulfil the needs of energy, many rural farmers planting trees around home and settlements. However, the demand for energy increase with respective high rate of population growth and this forced forest surrounding community to exploit additional fuelwood and charcoal production from forest trees. Similar reports in Tigabu Dinkayoh (2016) which suggested that, trees or derived charcoal can be sold as a commodity and used by humans, while cleared land is used as pasture, plantations of commodities and human settlements. The result also confirmed the finding in (Negasi Solomon *et al.*, 2018) which noted that, elders pointed out that they are dependent on the selling of fuelwood as an immediate source of income during decline or failure of crop production because of drought years.

The discussion with FGDS revealed that, the increasing tendency of urban expansion and settlement area (244) were very high due to high rate of population growth, immigration and strategic location of the district for technological transformation and investment (Figure 20 and Plate 2). Recently, the district became a station for Ethiopian dry port (Mojo dry port), Addis

Ababa to Adama high way which is passed through the district, Hawassa to Mojo high way, Addis Ababa to Djibouti rail way and others urban buildings and infrastructures combined with highly increasing demand of space for residence and settlements increase the encroachment of agricultural land and shrub lands. This result also supported finding in Mary Tahir *et al.,* (2013), which proposed that, the magnitude of land cover change reflected in the city was basically due to an increase in the human population density coupled with an increase in residential, industrial and institutional building at the expense of bare lands and agriculture lands This portrayed that, farmers need to search another new land through deforestation of forests and shrub lands to replace land lost by urbanization and settlements. The result is in line with, Eshowe *et al.,* (2019) which suggested that, both settlement expansion and road transport were found to be more frequently occurred specific factors that caused land cover changes.

The perception from farmers (78) insists, in the district large amount of seedlings were planted annually, but the survival rate of seedlings were very low due to the recent climate change and long term dry period (November to April) usually observed in the district. They also said, the drought happened in 2016/17 had damage high amount of planted seedlings and regeneration of natural seedlings.



Source: Researcher

Figure 20: Major proximate drivers in Lume district

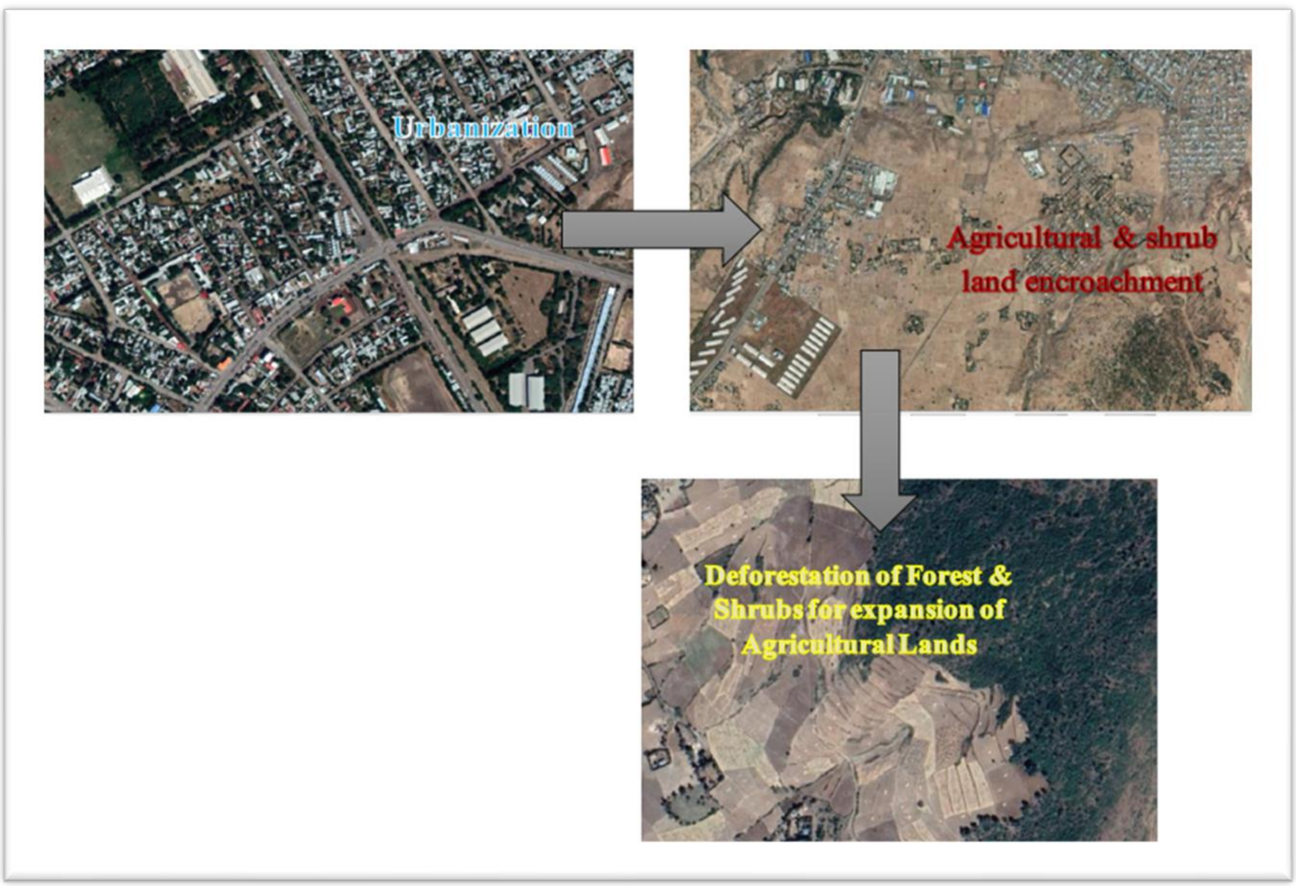


Plate 2: The spatial relation of urban, agriculture land, shrubland and Forests in Lume district. Screen shot from google satellite (by Hailu Wondu, April 2019).

The arrow indicate how urbanization leads to encroachment of agricultural and shrub lands and the expansion of agricultural land result in deforestation of both forests and shrub lands.

4.4.3. Underlying Drivers

The above-discussed proximate drivers were passionate by various types of underlying causes such as lack of awareness, weak law enforcement, landlessness, high rate of population growth, poverty, technological transformation and policies that were identified by HHS and FGDS (Figure 22). According to the responses from FGDS and HHS (39%), the population of the district raises steadily from time to time (Figure 21) due to immigrants from different parts of the country, since the district is potential for various industries and factories that can provide job opportunity for many people.

In addition, population size increases due to early marriage that leads high fertility rate without considering family planning. The demand of space for residence and settlements, high supply of food crops, energy (fuelwood and charcoal), infrastructures (school, health centre and roads) and construction materials increases with the respective growth of population size. Hence this result in encroachment of forests and shrubland for increase agricultural land, expand settlement area and secure the required energy and construction material as well. The result confirmed the finding in Hosonuma *et al.*, (2012) which noted that, as the increased population has also meant more demand for food items and hence more pressure to clear forestland to provide for the demanded food. The finding also supported the result in Meshasha *et al.*, (2016), which noted that, rapidly growing of population brought shortage of land, removal of forest cover and soil erosion and land degradation

The discussion with HHS and FGDS (25%) depicted that, in the district landlessness became increasing recently, due to large amount of land were gave for investment, technological transformation (flower company, tanary, meat processing industries and others), infrastructures and urban expansion. This situation affect youth (15-25 years) of the community part, mostly that failed from different educational level and remained jobless (Figure 22). This in turn, triggered those people to encroach forestlands and other communal lands such as shrub lands and bare lands to generate income through crop production, charcoal production and fuelwood collection.

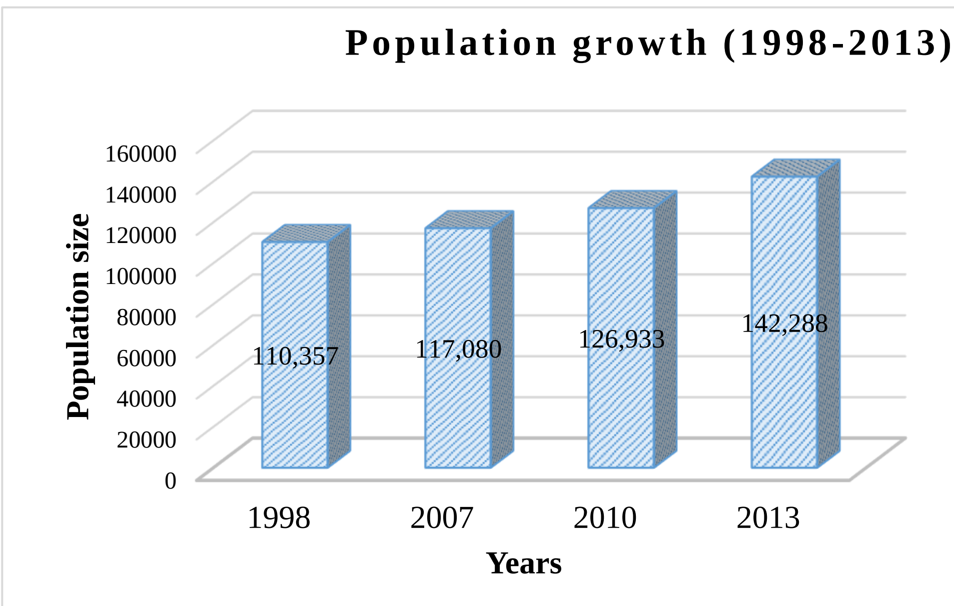
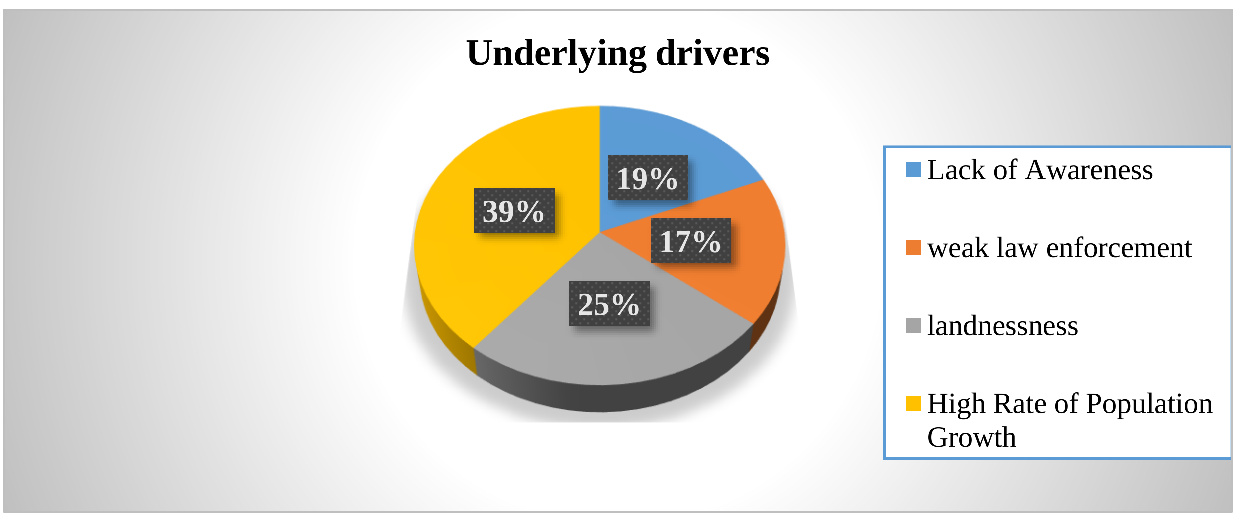


Figure 21: Population growth trends of Lume district 1998-2013

Source: (CSA, 1998; 2007 and 2013) and (WFEDO, 2010)

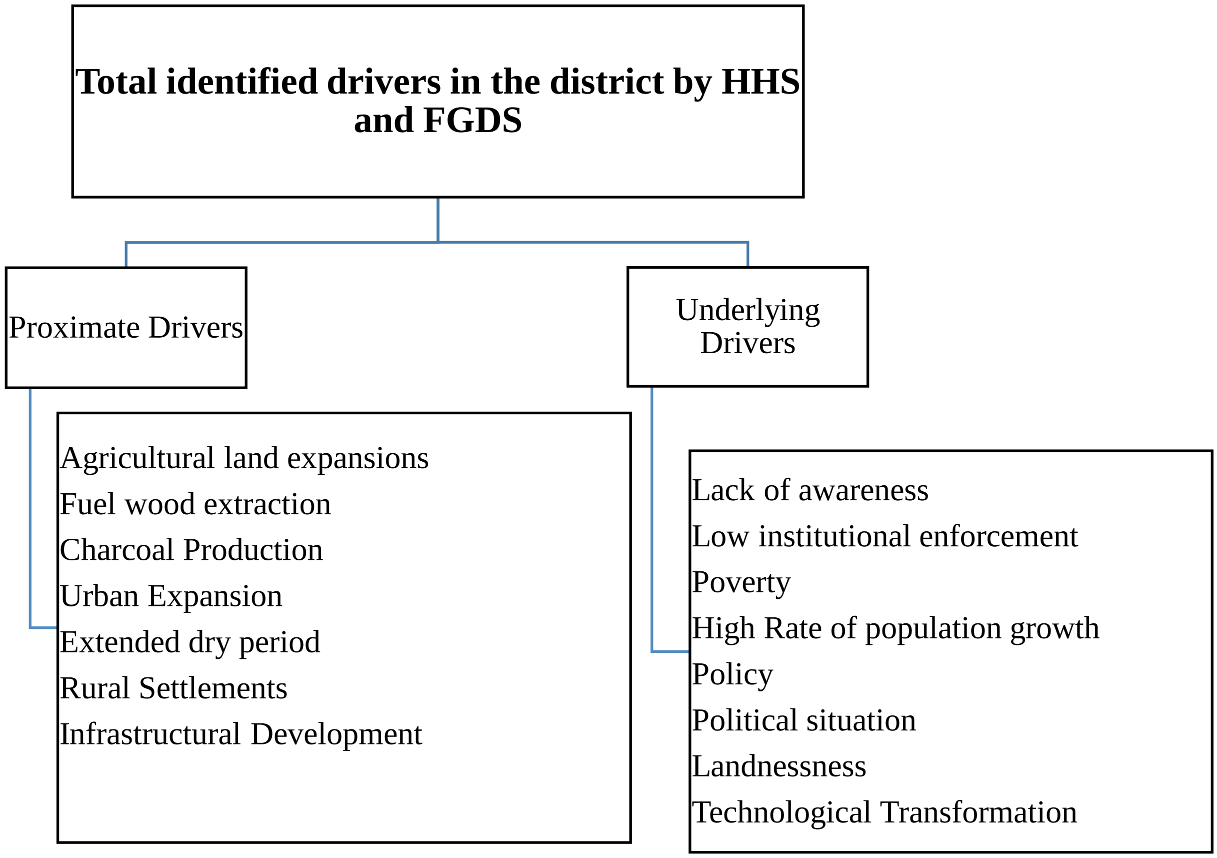
The information from HHS and key informants (19%) insisted that, the implementation of laws for forest protection and management was low (Figure 22). Until now, some people cutting trees illegally and they were not punished tantamount of their damage and this result in frequent illegal forest destruction continued in the district. For example, As stated in forest development, conservation and utilization proclamation No. 542/2007 (FDRE, 2007), in order to properly conserve, develop and utilize the forest resources of the country, major forestlands should be designated as state forests, their boundaries should be demarcated with the participation of the local community and they should be registered as protected and productive forests (article 8:1); forests shall be protected from forest fire, unauthorized settlement, deforestation, undertaking of mining activities and other similar dangers (article 9:7).

However, deforestation of both forest and shrubland, free grazing of protected area and illegal settlement in and around forests continued in the study district and many parts of country to date. According to information from key informants (19%), in the district DAs and other concerning bodies were nourished training for farmers regarding the use and management of forests, but can't address all stakeholders (women, youth and elders) at equal level, mostly the training focused on adults. Thus, the attitude of some community members still not changed worrisome of environmental benefit and sustainable use of the forest.



Source: Researcher

Figure 22: Major indirect drivers of LULC in Lume district



Source: Researcher

Figure 23: Summary of proximate and underlying drivers

5. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

Forest cover change in the form of deforestation is the major environmental problem demonstrated in Lume district. The main findings of this study disclosed that, a resume increase in agriculture land and urban buildings and settlements at the expense of forests and shrub lands throughout investigated periods (1985-2018). From the analysed results, the extent of land use/land cover in general and forest cover change in particular was fundamentally changed between 1985 and 2018. Specifically dramatic expansion of urban buildings/settlements and awesome decline of shrub lands as well as forests were monitored in the district.

The study demonstrated that, areal coverage of forests and shrub land were declined from time to time. The finding revealed that, maximum areal share of forestlands and shrub land at starting of study period and minimum share was recorded at the end of study time due to conversion into agricultural lands and urban buildings and/or settlement area. Throughout the study periods, steady net increasing rate of expansions observed for urban buildings/settlements and agriculture land annually with the respective high rate of population growth and urbanization. In contrary, a net decline rate noted for shrub lands and forestlands per year due to deforestation for the use of agriculture and settlement area. The assessment of KIIS revealed that, awareness creation, soil and water conservation, forest plantation and PFM were the major forest management system existed in the district.

Forest cover change in Lume district is an outcome of various interactions between direct and indirect drivers. The major proximate drivers of forest cover change identified through HHS and FGDS are agricultural land expansion, fuelwood extraction, charcoal production, urban expansion, and expansion of rural settlements, extended dry period and infrastructural development. In addition, lack of awareness, low institutional enforcement, and poverty, high rate of population growth, policy, political situation, landlessness and technological transformation are the main underlying drivers recognized in the district. In conclusion, high rate of population growth is the most triggered factors, which resulted in expansion of agricultural land, demand for fuelwood and charcoal production, urban expansion, infrastructural development for public service, expansion of settlement area and others socio-economic needs. Hence, this situation leads for more depletion of forest resources and shrub lands at the expense of fulfilling demand for growing population.

5.2. RECOMMENDATION

Eventually, from general study it had been understood that forest cover of Lume district has been conjugated. Hence, to protect the forest resources and shrub land from extra expenditure and to utilize these irreplaceable natural resources in sustainable basis, the following feasible suggestion are forecasted based on the findings and conclusion drawn.

1. Improved urban planning and design should be prepared and implemented by urban planners. The plan should be based on emphasize urban greening, reducing costs of service provision, integrating existing informal or regularized settlements within the town's formal authority. Moreover, it should be based on improving and maintaining residents' social and economic networks while reducing the need for more urban land and promoting upward growth to reduce pressure from agriculture land and shrub land is crucial.
2. Alleviation of food crops demand from agricultural land is important by increasing the productivity of land through using agroforestry technologies such as planting suitable

horticultural crops with trees and livestock around homestead, growing of nitrogen fixing trees in farmlands, expanding integrated agriculture to all farmers and using of new agricultural inputs that facilitated by agricultural and irrigation sectors.

3. Fuelwood energy and charcoal burning is as one problem of forest cover change. Hence, Planting of trees around homestead and periphery of agriculture land is important for household fuelwood supply and introduction and distribution of improved stoves for fuel is indispensable for the reduction of pressure from forests for the use of fuel energy.
4. Diversified job opportunity and income generation through the district macro and micro enterprise sector for youth and landlessness farmers minimize strongly dependency on agricultural and forest products. To address the increasing population pressure, awareness as well as service provision of family planning to all local communities via integrated extension service is exhaustedly crucial.
5. Further studies is required on suitable tree species production that can tolerate the long-term dry period, specifically planting indigenous species that could adopt the environment should be considered as a strategy to increase productivity of multipurpose trees and expand spatial coverage forests and shrub lands.
6. To reduce further depletion of forest and to understand the impact of deforestation working on the knowledge of farmers through awareness creation and training of the concerned stakeholders, on community forest production and sustainable forest management is crucial.
7. To improve the efficiency of existing local PFM projects, to promote creation of additional project members and to reduce complain of stakeholders concerning benefit sharing, it is strongly suggested that, project planners should revise the existing management plan and design, which will benefit local community as number beneficiary and increase ownership

as well as responsibility of local communities towards forest conservation is extremely important.

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APPENDICES

Annex 1: Questionaries' on drivers of forest cover change and local community's perception about forest cover change

Interview number/code: ___________

Name of the Interviewer______________ Signature_____________________

Location: Region______________Zone__________Woreda_________Kebele___________

Altitude____________ Latitude____________ Longitude_____________

Date of Interview: Day ________ Month ________Year____________

A. **Personal information and questions for House Holds**

1.1. Name of household head: ______________________

1.2. Respondent's name (if different from the head): ____________________________

1.3. Gender of head (1) M = ____ (2) F = _____

1.4. Age of respondent____________

1.5. Educational status (year of schooling) _________________ If illiterate record zero; if literate record one

1.6. House hold family size: __________________________

1.7. Land holding size: ______________

1.8. Mean household income in birr: ____________________

2. What are the major uses of forests in your area? A. Used for construction B. Fuelwood/energy C. Soil and water conservation D. Timber production E. Others specify______________

3. Do you think that deforestation is the major problem in your locality? A. Yes B. No

4. How is today's coverage of the forest when compared to the conditions before 1985? A. Declined B. Increased C. No change

5. Do you think, severe and rapid forest cover change observed today? A. yes B. No

6. If the answer to question number '5' is yes, what were/are the major causes of deforestation? And how?

____

A. Agricultural land expansion B. Fuelwood/ Charcoal production C. Settlement area D. Extended dry period

7. What is your major source of income? A. Sale of cash crops B. Sale of wood and charcoal C. Sale of livestock and livestock products D. Others specify__________

8. What do you think about the possible solution to alleviate the current problem of deforestation and to use forest resources in a sustainable manner? A. Participatory Forest Management B. Use of improved stove. C. Sustainable timber production D. Others specify____

9. What are the existing efforts to reduce deforestation and forest degradation in the study district?

A. Afforestation/ Reforestation B. Increase the distribution of improved stove C. Integrated agricultural practice D. Other specify____________

10. What are the challenges in implementing the efforts to reduce deforestation and forest degradation in the area? A. Lack of awareness B. low institutional enforcement C. Poverty D. High rate of population growth

B. Checklists for Key Informants

1. Have you noted any change in the land use/land cover in your area over the past 33 years?

A. Yes B. No

2. If your answer to question number 2 is yes, what changes did you observed?

Increase/decrease in: A. Agricultural land B. Forest cover C. Woodland D. Scrub land E. Settlement and infrastructure

3. What are the causes behind their increase/decrease? I. Direct causes II. Indirect (root) causes Specify and discuss____

4. Participation of the local communities, government and non-government organizations

in resource conservation and management activities and how they are participating?

____

4. Do you think national policies and institution implemented starting from 1985 until today have responsibility for land use/land cover change? A. Yes B. No,

   If Yes how? ____

6. What major natural calamities occurred in your area in the last 33 years?

____

C. Checklist for Focus Group Discussion (FGDS)

1. What are currently existing land use/land cover types in your locality?

List them.____

2. Which land use/land cover type is increasing and which is decreasing starting from 1985? Why? ____

3. What are the direct/proximate drivers of land use/land cover change over the last 33 years, between 1985 & 1999, 2013 & 2018? And how?

A. Infrastructure development and urban expansion

B. forest encroachment for illegal and legal settlement,

C. Agricultural expansion,

D. Unsustainable harvest of forest products (like firewood, charcoal, logging)

4. What are the underlining causes along each proximate driver? How?

A. Complex social characteristics

B. Political Situation

C. Economic factors

D. Demographic characteristics

E Technological transformation

F. Cultural and biophysical variables

H. Others specify__________________