ANALYSIS OF LAND USE/LAND COVER DYNAMICS, DRIVERS AND SOCIOECONOMIC IMPACTS IN AND AROUND JIMMA TOWN, SOUTH WEST ETHIOPIA

MSc. THESIS

BY

MELKAMU MAMUYE

JUNE 2015

JIMMA, ETHIOPIA

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BY

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APPROVAL SHEET OF THESIS

Jimma University College of Agriculture and Veterinary Medicine

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I have completed my thesis research work as per the approved proposal and it has been evaluated and accepted by my advisors. Hence, I hereby kindly request the department to allow me to present the findings of my work and submit the thesis.

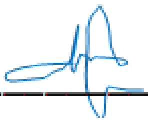
Melkamu Mamuye Kebede ________________________ **11/06/2015**

Name of student Signature of student Date

We, the thesis advisers have evaluated the contents of this thesis and found to be satisfactory, executed according to the approved proposal, written according to the standards and format of the University and ready to be submitted. Hence, we recommend the thesis to be submitted.

Zerihun Kibebew(Associate Professor) _______________ ___________________

Major Advisor; Signature Date



Gudina Legese (PhD) ________________ **JUNE / /2015**

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Decision/suggestion of Department Graduate Council (DGC)

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Chairperson, CGS Signature Date

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DEDICATION

This thesis manuscript is dedicated to my beloved mother Ethalemahu Amare for all the sacrifices, wishes and praise worthy to my success in all my endeavors and to my late father Mamuye Kebede who passed away at a very early age without seeing any of my success.

STATEMENT OF THE AUTHOR

I, the undersigned, declare that this thesis entitled "analyses of land use/land cover dynamics, drivers and socioeconomic impacts in and around Jimma town, south west Ethiopia" is my work and is not submitted to any institution elsewhere for the award of any academic degree, diploma or certificate. This thesis has been submitted in partial fulfillment of the requirements for MSc. degree at Jimma University, college of agriculture and veterinary medicine and is deposited at the university library to be made available to borrowers under the rules of the library.

Name: Melkamu Mamuye
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BIOGRAPHICAL SKETCH

The author Melkamu Mamuye Kebede was born at Alge-Sachi district, Ilu Aba Bora zone of Oromia region on December 1983. He attended his elementary School at Sachi Primary school, his junior secondary school at Chora junior school and his high school at Metu comprehensive secondary school. He took ESLCE in 1999, and joined the then Debub University, Wondo Genet College of forestry (now Hawasa University, Wondo Genet college of Forestry and Natural Resource) and granted diploma in Forestry in 2001. He was employed under Oromia region agriculture bureau, and has been served in Ilu Aba Bora zone office of agriculture as district level natural resource management expert since 2002 up to 2008.

In the same time, he joined Jimma University College of agriculture and veterinary medicine in 2005 and granted BSc in natural resource management in 2008. Since then he has been served at Boset district of east Showa zone until he joined the school of graduate studies of Jimma University on September 2013 to pursue his studies for Master of Science in Natural Resource Management (watershed management). This Peace of work is his MSc. thesis submitted as partial fulfilment for MSc. degree to be awarded by Jimma university in 2015.

LIST OF ABBREVIATIONS

AOI	Area of Interest
CSA	Central Statistical Agency
DEM	Digital Elevation Model
EDC	EROS Data Center
ERDAS	Earth Resources Data Analysis System
EROS	Earth Resources Observation and Science
ESLCE	Ethiopian School Leaving Certificate Examination
ETM+	Enhanced Thematic Mapper Plus
FAO	Food and Agricultural Organization
GIS	Geographic Information System
HH	House Hold
IFS	International Fund for Research
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
LU/LC	Land Use/ Land Cover
LULCC	Land Use/Land Cove Change
MOA	Ministry of Agriculture
MSS	Multi Spectral Scanner
SNNPR	Southern Nation Nationality and Peoples Region
Tiff	Tagged Image File Format
TM	Thematic Mapper
UN	United Nations
USGS	United States Geological Survey
UTM	Universal Traverse Mercator
WGS	World Geodetic Survey

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ABSTRACT

Land use/land cover change is a common phenomenon in many parts of Ethiopia. Understanding the dynamics of land use/land cover change, its driving factors and impact helps the policy makers to understand the situation and put forward sustainable land uses. The objective of this study was to analyze LU/LC changes, its drivers and socioeconomic impacts in and around Jimma town, Ethiopia. A combination of GIS, remote sensing, and household survey methods were employed to carry out the study. Satellite images of different dates (1985, 1995, 2005 and 2013) were used to quantify land cover changes using maximum likelihood algorithm of supervised classification. A total number of 140 households and focus group were used for socioeconomic data. The results of the study showed that built up area shows increasing trend between; 1985 to 2013. In 1985, the built up area was account for 2.19%; nevertheless, it was 3.09 % in 1995, 6.24% in 2005 and 7.09 % in 2013. In general built up area was increased at the expense of grasslands and water bodies. Water bodies showed continuous declining from 0.06% in 1985, 0.04% in 1995, 0.037% in 2005 and 0.033% in 2013. Moreover, grassland continuously decreased from 10.37% in 1985, 7.62% in 1995, 4.823% in 2005 and 3.64% in 2013. Whereas, forestland shows decreasing trend between 1985 to 2005 (48.19% in 1985, 42.11% in 1995, 32.16% 2005) and then increased to 36.36% between 2005 to 2013. Settlement expansion due to population growth and immigration was identified as the most drivers of change. These changes resulted in change in household income sources, livestock asset, availability of forest product and fragmentation and loss of cultivated land. Based on these, it was concluded that there were significant land use land cover changes due to various socioeconomic factors that induced various socioeconomic impacts and it needs sustainable land use plan to set management options.

Key words: Change detection, Land cover, GIS and Remote sensing, Socioeconomic, south west Ethiopia

1. INTRODUCTION

1.1. Background and Justification

Land cover refers to the physical and biological cover over the surface of land. It includes forest, water types, bare soil, impervious surfaces, crop cover and others. Land use shows how people use the landscape; whether for development, conservation, or mixed uses (Wei, 2007). Land cover change is the complete replacement of one cover type to another (Bhatacharya, 2002; Deng *et al*., 2009). The land use and land cover pattern of a region is an outcome of natural and socio-economic factors like population growth, urbanization, agricultural activity, infrastructure expansion and natural hazards (Abate Shiferaw, 2011). Currently, land use/land cover change (LU/LCC) is now recognized as a fundamental concern of global environmental change (Agarwal *et al*., 2002; FAO, 2006). Over recent decades, developing countries are characterized by rapid land use/land cover change. In general a decreasing trend in rural area and an increasing trend in urban area with the cost of various land cover classes (Dewan and Yamaguchi, 2009; Yin *et al*., 2011). The change has a marked effect on ecosystem structure, function and dynamics (Deng *et al*., 2009). Exponential growth of population, increased demand for food, fuel wood, shelter and various infrastructures coupled with urbanization and other diverse interactions between society and the environment were drivers for the changes (Antrop, 2005; Haregewoin Bekele, 2005; Codjoe, 2007; Peter *et al*., 2010; Gupta and Sen, 2008).

According to the United Nations report (2012), the current 7 billion of world population is expected to be between 8.3 billion to 10.9 billion by 2050. The urban areas of the world are expected to absorb all the population growth expected over the next four decades. Furthermore, in the cities and towns of less developed regions the expected population growth is more concentrated than the developed regions (Desa, 2012). Associated with the rapid expansion of urbanization, a lot of land has been converted from rural to urban. From the land use and land cover change point of view, expansion of urban areas is of greater importance because of its strong effect on other land cover types, such as agricultural lands, non-built areas, forests and others(Woldeamlak Belay, 2002).

Ethiopia, with a total population of more 80 million is the second largest population in Africa. It has a 2.3% of annual growth rate and having 4.6% an average annual urban growth rate (Haregeweyn *et al*., 2012). In spite of its low urbanization rate compared to other African countries, the impact of land use and land cover changes become a big challenge that aggravated environmental changes (Turner *et al*., 2001). Currently, only 19% of Ethiopian populations live in urban centers. Furthermore, the country's urban population is expected to grow on average by 3.98% and by 2050, about 38% of the total population is expected to be inhabited in urban centers (CSA, 2013; UN, 2014).

Due to this, there will be high rate of conversion of natural landscapes to other anthropogenic land uses resulting in associated ecosystem disturbances (Leulsegged Kasa *et al*., 2011). Hence, land use/land cover change is an important driver of environmental change on all spatial and temporal scales (Turner *et al*., 2001; Leulsegged Kasa *et al*., 2011). Olson *et al*., (2004) and Badege Bishawu, (2005) have also shown rapid land use/land cover change in Ethiopia. High annual deforestation rate with increase in plantation forests and clearing of natural vegetation for agriculture, fire wood, and grazing are the immediate causes of land use/cover changes in Ethiopia (FAO, 2010; Mesay Mulugeta, 2011;). Hence, as noted by Belay Tessema (2002) and Mausel *et al*. (2003), well-timed and accurate change detection of the natural resources such as; vegetation cover, water and soil is essential for an accurate investigation of the status, causes, processes and rate of land use/land cover changes.

There are studies of land-use/cover changes at regional or local levels in Ethiopia, that often deal exclusively with quantifying land-use/cover changes using remote sensing tools (Badege Bishaw, 2005; Leulsegged Kasa *et al*., 2011). Mapping spatial changes using remote sensing tools gives quantitative descriptions but does not explain or provide understanding of the relationship between the patterns of change and their driving forces (Olson *et al*., 2004; Mesay Mulugeta, 2011). Some recent advances in remote sensing play a major role in linking social models with the spatial dynamics of land-use changes (Serneels and Lambin, 2001; Mottet *et al*., 2006; Serra *et al*., 2008). However, such studies linking land cover changes with drivers are rare for southwestern parts of Ethiopia.

Jimma town is out of the fastest expanding towns in Ethiopia resulting in large land use/ cover changes by diverse driving forces that have profound effect on the natural ecosystem of inside urban and rural-urban boundary of the town (Melaku Tegegn, 2008). Recognizing the current socioeconomic activities, changes in natural land escape and competitions for natural resources around Jimma town; Melaku Tegegn (2008) suggested land use land cover change analysis for Jimma area. On other hand, land cover change study for two different times (1984-2007) showed significant changes in land cover categories in response to complex interactions between several biophysical and socio-economic conditions in Jimma town (Chalachew Abreha, 2013). However, the study lacks analysis on trends of land use/land cover change dynamics over time intervals, relation between patterns of change, driving forces and impacts of the change and

Hence, this study also aimed to analyze land use/cover dynamics, identifying main drivers which brought most important transformations (i.e., conversions) among the land use/cover classes and socio economic impacts in and around Jimma town within nine kilometers radius by integrating remote sensing, geographical information system and socioeconomic survey.

1.2. Objective

1.2.1. General objective

The general objective of the study was to quantify the land use/ land cover dynamics, relation between patterns of change, driving forces and its socio economic impacts in and around Jimma town over the period of the past three decades (1985-2013).

1.2.2. Specific objectives

- To examine land use/land cover change dynamics occurring in and around Jimma town in the past three decades (1985-2013).
- To identify major drivers of land use/land cover change in the area.
- To examine the socioeconomic impacts of land use/land cover change.

1.2.3. Research questions

i. How was land-use/cover change around Jimma town in the past three decades (1985-2013) and in what magnitude?

ii. What are the major driving forces of land use/land cover change?

iii. What are the major socio economic consequences of these land use/ cover changes?

2. LITERATURE REVIEW

The earth's surface has been changed considerably over the past decades by human activities like urbanization, deforestation, agriculture etc. Even though the rate of conversion of land to agriculture, rate of deforestation and other land use changes vary across the world, the number of people residing in cities and urban-rural interactions has been increasing continuously. In this section, related studies are discussed in order to strengthen this specific study.

2.1. The Concept of Land Use/Land Cover Change

Land use refers to the ways in which and the purpose for which, human beings employ land and its resources (Briassoulis, 2000). Land use can be broadly defined as the level of spatial accumulation of activities such as production, transaction, administration and residence with highly dynamic relationships between them (Kaiya *et al*., 2013). Land use reflects the nature of social and economic activities in an area, as well as interactions with other areas. It results from the complicated interactions between the land system and the social economic systems (Jianquan, 2003). Land uses include settlement, cultivation, pasture, rangeland, recreation, and so on. Land use change at any location may involve either a shift to a different use or an intensification of the existing one (Kaiya *et al*., 2013).

Land cover denotes the physical state of the land. It embraces, for example, the quantity and type of surface vegetation, water, and other earth materials. A land use change is likely to cause some land cover change, but land cover may change even if the land use remains unaltered like a forest will steadily shrink if a constant rate of timber extraction or shifting cultivation exceeding growth is maintained (Liang *et al*., 2002). The realms of LULC are interconnected by the proximate sources of change: those human actions that directly alter the physical environment. It is through the proximate sources that the human goals of land use translated into changed physical states of land cover (Eric *et al*., 2003). Example of proximate sources represents the point of intersection between the core concerns of the natural and the social sciences, between physical processes and human behavior. On one side, these proximate sources produce land cover changes, or alterations of the properties of the land surface (Liang *et al*., 2002). They may take the form of either conversion or modification, and they may lead as well to secondary environmental impacts: like trace gas emissions, biodiversity loss, soil erosion and degradation, albedo alteration and microclimatic change, water flow and water quality changes. On the human side of the chain, the proximate sources reflect human goals mirrored in land uses (Seto and Kaufmann, 2003). Land cover classification has recently been a hot research topic for a variety of applications and a great deal of researches has been conducted throughout the world in an attempt to understand major shifts in land use and land cover and to relate them to changing environmental conditions(Liang *et al*., 2002).

According to Baulies and Szejwach (1998), during the next decades, land-use dynamics will play a major role in driving the changes of the global environment. Therefore, LULCC research needs to deal with the identification, qualitative description and parameterization of factors that drive changes in land use and land cover, as well as the integration of their consequences and feedbacks (Cohen, 2006). However, one of the major challenges in LULCC analysis is to link behavior of people to biophysical information in the appropriate spatial and temporal scales (Codjoe, 2007). However, it is argued that land use and land cover change trends can be easily assessed and linked to population data, if the unit of analysis is the national, regional, district or municipal level.

Land use and land cover changes result from various natural and human factors within social, economic and political contexts. Hence, the local human activities expressing the drivers can be determined by measuring the rates and types of changes and analyzing other relevant sources of data like demographic profiles, household characteristics and policies related to land resources administration. To achieve this, it is crucially important to consider multiple sources of information and to acquire temporal, spatial and other non-spatial forms of data. This is because land use attributes are complex and the boundaries between different types of data are quite diffuse (Eric *et al*., 2003).

2.2. Why to Study Land use/land cover Change?

The impacts of human activities on ecosystems have been major issues of ecological interest. The impact of LULC change raises concerns about the processes and functions of ecosystems (Roy *et al*., 2008). The need for optimal use of the land resources and balance of land cover capability with anthropogenic stress is one of the issues of man-kind. The way people uses the land has become a concern for the future of the world. The inability of many countries to balance environmental and production needs as well as land cover capability and anthropogenic stress emphasize these issues. Therefore, rational planning of land use/land cover development and optimal use of the land resources is evident(Milanova *et al*., 2007).

Land use data are also needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels. One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time (Anderson *et al*., 2000). Information on land use/land cover in the form of maps and statistical data is very vital for spatial planning, management and utilization of land for agriculture, forestry, pasture ,urban-industrial development, environmental studies, economic production, etc. Today, with the growing population pressure, low man-land ratio and increasing land degradation, the need for optimum utilization of land assumes much greater relevance (Roy *et al*., 2008). LCC plays a vital role in regional, social and economic development and global environmental changes. It contributes significantly to earth-atmosphere interactions. Hence, scientists, researchers and planners have paid much attention to the issues of land cover change over the past decade (Shaikh *et al*., 2005).

Documentation of the land use and land cover change provides information for the better understanding of historical land use practices, current land use patterns and future LU trajectory. Analysis of LULCC contributes significantly to earth atmosphere interactions, forest fragmentation, and biodiversity loss study. It has become one of the major issues for environmental change monitoring and natural resource management. Identifying, delineating and mapping of the types of land use and land cover are important activities in support of sustainable natural resource management (Zhang *et al*, 2004).

Generally, determining the effects of LU/LCC on the earth system depends on an understanding of past land use practices, current LU/LC patterns, and projections of future land use and cover, as affected by human institutions, population size and distribution, economic development, technology and other factors. That needs assessment of LULC change as an important step in planning sustainable land use (Kiros Meles, 2008).

2.3. Drivers of Land Use/Cover Change

Land use change is always caused by multiple interacting factors originating from different levels of organization of the coupled human environment systems (Pedro, 2009). The mix of driving forces of land use change varies in time and space, according to specific human-environment conditions. Driving forces can be slow variables, with long turnover times, which determine the boundaries of sustainability and collectively govern the land use trajectory (Javaid, 2013).

Biophysical and other socioeconomic factors drive land-use changes (Ahimed *et al*., 2013). Available case studies highlight that, land-use changes mostly result from individual and social responses to changing economic conditions, which are mediated by institutional factors. Opportunities and constraints for new land uses are created by markets and policies and are increasingly influenced by global factors (Hussen *et al*., 2010). Economic factors and policies define a range of variables that have a direct impact on the decision making by land managers, e.g., input and output prices, taxes, subsidies, production and transportation costs, capital flows and investments, credit access, trade, and technology (Jieying *et al*., 2006). Internal consumption affects land less than external demand, so subsistence croplands and naturally forested areas consequently decrease while land under crops for markets and other land use types increases with a parallel increase in agricultural intensity (Ahimed *et al*., 2013).

The unequal distribution of wealth between households, countries, and regions determines geographic differences in economic opportunities and constraints. It affects, for example, who is able to develop, use, and profit from new technologies that increase efficiency in land management rather than conversion of land cover (Lambin and Geist, 2007). Improving agricultural technology; as much as providing secure land tenure and giving farmers had better access to credit and markets can potentially encourage more deforestation rather than relieving pressure on the forests (Hussen *et al*., 2010). Demographic factors at longer timescales, both increases and decreases of a given population also have a large impact on land use. Demographic change does not only imply the shift from high to low rates of fertility and mortality but it is associated with the development of households and features of their life cycle (Masek *et al*., 2000). The family or life cycle features relate mainly to labor availability at the level of households, which is linked to migration, urbanization, and the breakdown of extended families into several nuclear families that profound effect on land cover change (Ahmed *et al*., 2013).

To explain land-use land cover changes, it is also important to understand institutions (political, legal, economic, and traditional) and their interactions with individual decision-making (Rajagopeal *et al*., 2012). Local and national policies and institutions (Masek *et al*., 2000) structure access to land, labor, capital, technology and information. Land managers have varying capabilities. Relevant non-market institutions include property-rights regimes, environmental policies to participate in and to define these institutions. Decision making systems on resource management, information systems related to environmental indicators as they determine perception of changes in ecosystems, social networks representing specific interests related to resource management, conflict resolution systems concerning access to resources and institutions that govern the distribution of resources and thus control economic differentiation (Zhang *et al*, 2004).

2.3.1. Urbanization

Urbanization refers to the increasing amount of people that live in urban areas. It predominantly results in the physical growth of urban areas, be it horizontal or vertical and from broader point of view urbanization is one of the ways in which human activities altering global land cover. Urbanization is closely linked to modernization, industrialization and sociological process of rationalization. Urbanization can describe a specific condition at a set of time, i.e. the proportion of total population or area in cities or towns, or the term can describe the increase of this proportion over time (Potts, 2011). Therefore, the term urbanization can represent the level of urban development relative to overall population, or it can represent the rate at which the urban proportion is increasing. Urbanization is not merely a modern phenomenon, but a rapid and historic transformation of human social roots on a global scale, whereby predominantly rural culture is being rapidly replaced by predominantly urban culture (Seto and Kaufaman, 2003).

Higher population density and vast human features in comparison to the rural areas surrounding it characterize an urban area. Urban areas are created and further developed by the process of urbanization. Measuring the extent of an urban area helps in analyzing population density and urban sprawl, in determining urban and rural populations and associated ecological impacts (UN, 2001). Urban expansion in developing countries is predicted to increase at an average rate of 2.3% per year between 2000-2030 following migration of rural people to cities for better opportunities (United Nations, 2010; Angel *et al*., 2011) and problems associated to the conversion of agricultural land into built-up area are also more severe than developed countries (Deng *et al*., 2008).

When we consider the rate of urban expansion in Ethiopia, some scholars has describe it as it is a kind of unplanned horizontal expansion with impacts such as loss of agricultural lands (Fransen, 2008; Haregeweyn *et al*., 2012; Agegnehu, 2014). Farmers near urban areas, where land values are rapidly rising, face displacement from the conversion of agricultural land to building land (Toulmin, 2008). United Nations (2012) predicted that in developing countries because of doubling population in the next thirty years from 2 billion in 2000 to almost 4 billion in 2030; the built up areas of cities of developing country in 2000 estimated to be 200,000 km^2 by 2030, will increase to more than 600,000 km^2. In other words , by 2030 these cities can be expected to triple their land area, with every new resident converting on average , some 160 m^2 of non-urban land to urban land during the coming years (UN, 2012). Urban areas in Ethiopia are also currently expanding at higher rates exhibiting high land tenure transformation from agricultural to urban land use types. This expansion is expected to quadruple even more in the future and should have to consider encyclopedic spatial planning strategies valuing the property rights of the subsistence peri-urban farmers. (Agegnehu, 2014).

Aspects of the economy that can affect the urban expansion include the level of economic development, differences in household income, exposure to globalization, the level of foreign direct investment, the degree of employment, decentralization, the level and effectiveness of property taxation and the presence of high inflation and acute shortage of housing (Angel and shlomo, 2005). The expansion of urban to the periphery largely depend difference in house hold incomes. These two conspicuous factors are urban development and urban population increase. The demand for land by various firms who inhabit the city can intensify economic development projects, which could be one cause for urban expansion to the periphery (Javaid, 2013). Space is needed for various economic and social infrastructures, cultural, and other purposes. Redevelopment and organization of inner cities again cause displacement of citizens. This in turn requires space, which invites extension of urban settlements to the rural territories (Wu, 2000).

2.3.2. Population growth

Most theoretical perspectives on environmental change argue that at any given level of affluence and technology, population is the key determinant of natural resource consumption (Hunter, 2001). A number of different dimensions of population change may influence land use in general, and changes over time in the fraction of land. The connections that bind human and natural systems are innumerable, but arguably, one of the most discussed through human history has been the ever-increasing size of the human population and its relation with the natural resources up on which it depends. Modern theories on the association between population growth and the environment date to 1798, with Thomas Malthus's statement that, "The power of population is indefinitely greater than the power in the earth to produce subsistence for man" (Bremner *et al*., 2010).

Population growth is a frequently cited as a reason of environmental change. Population growth is generally recognized as an important contributing factor to land cover change. Some have declared population growth and poverty to be the primary causes of global deforestation (Mather and Needle, 2000), while others recognize population growth and poverty as underlying factors (Geist and Lambin, 2002; Lambin *et al*., 2001). However, the relationship between population growth and environmental change is rarely a directly proportional relationship, since it is influenced by population dynamics and consumption patterns mediated by institutions.

Understanding the system of present and future human population distribution is critical to understanding the impacts that population growth could have on the rest of the earth's system in the future (Cincotta *et al*., 2000). More than 40% of the world's surface is under agriculture (Sanderson *et al*., 2002), 99.7% of human food comes from the terrestrial environment (World Bank, 2004) and forest clearing for agricultural expansion in the tropics is currently the most significant land conversion happening on earth associated with increasing human population (Sanderson *et al*., 2002; Geist and Lambin, 2002; Davis, 2006).

Current population growth is being accompanied by a significant change in human habitat. As an increasing number and fraction of the global population live in urban areas, the physical environment inhabited by humans is rapidly changing. This change is likely to influence both human populations and the ecosystems where the populations are concentrated. According to some forecasts population growth will continue until at least the year 2100 (O'Neill and Balk, 2001) at the same time, resulting in widespread urbanization. Near-term (50 yr) population growth is expected to occur primarily in moderate-sized urban areas of developing countries maintaining high birth rates (UN, 2001). This represents a relatively recent change of physical habitat for humans as well as a change in the nature of human impact on specific ecosystems. Dispersed agrarian populations influence different ecosystems in ways that are different from how dense urban populations influence them. Cities and their surrounding communities exert influences (i.e., physical, political, socioeconomic) disproportionate to their relatively small areas (Seto *et al.*, 2003; Javaid, 2013). Natural population growth is a major element in urban growth for all countries, but rural urban migration contributes more in many developing countries. Migration contributes to fast growth of urban population due to the relative economic development that attracts people to urban nuclei for commerce, employment, and education (Angel and Shlomo, 2005).

2.4. Impact of Land Use/cover Change

Land use practices generally develop over a long period under different environmental, political, demographic, and socio-economic conditions. These conditions often vary and have a direct impact on land use and land cover (Lambin *et al.*, 2000).The interaction of nature and society and their implications on land use and land cover is a very complex phenomenon that encompasses a wide range of social and natural processes and impacts (Muttitanon and Tripathi, 2005; Codjoe, 2007).

According to MoA (2003), Ethiopia's heterogeneous topography is one of the major factors for the existence of a variety of environmental features existence of 15 land use patterns. Especially Ethiopia's towns contribute significantly to economic growth, to perform crucial service and production functions (Merkebu, 2010). Despite the economic benefits, the rapid rates of urbanization and unplanned expansion of towns have resulted in several negative consequences (Pedro, 2009). Urban growth affects the ecology of cities in a number of ways, such as eliminating and fragmenting native habitats, modifying local climate conditions and generating anthropogenic pollutants because there are interactions between natural resources and human systems (Janine *et al*, .2007).

Land is one of three major factors of production along with labor and capital. It is an essential input for housing and food production and land use change is necessary and essential for economic development and social progress. However, Land use change does not come without costs (Wu, 2014). Conversion of farmland and forests to urban development reduces the amount of lands available for food and timber production. Soil erosion, salinization, desertification, and other soil degradations associated with intensive agriculture and deforestation reduce the quality of land resources and future agricultural productivity (Lubowski *et al*., 2006). Thus, land use is the backbone of agricultural economies and it provides substantial economic and social benefits.

Land use change around urban area presents many challenges for farmers on the urban fringe. Conflicts with nonfarm neighbors and damage, such as destruction of crops and damage to farm equipment, are major concerns of farmers at the urban. Neighboring farmers often cooperate in production activities, including equipment sharing, land renting, custom work, and irrigation system development. These benefits will disappear when neighboring farms are converted to development. Farmers may no longer be able to benefit from information sharing and formal and informal business relationships among neighboring farms. Land use change due to urban expansion may also cause a lack of confidence in the stability and long-run profitability of farming, leading to a reduction in investment in new technology or machinery, or idling of farmland. Competition for labor from non-agricultural sectors may raise farmers' labor costs. When the total amount of farmland falls below a critical mass, the local agricultural economy may collapse as all agricultural supporting sectors disappear (Muttitanon and Tripathi, 2005). With increasing conversion of agricultural lands to urban land uses in some rural areas, urban sprawl has encroached to such an extent that the community itself has been lost. In other areas, the lack of opportunities has turned once–viable communities into towns. Urban sprawl intensifies income segregation and economic disparities between urban and suburban communities (Wu, 2006).

Since, some urban growth has resulted in the conversion of land for urban uses without any systematic development plan, urban land expansion has resulted in the conversion of land for urban uses (Gupta and Sen, 2008). Urbanization, industrialization, economic growth population growths are closely related, and these affect directly and indirectly the rural countryside and natural landscape over increasingly vast areas. Natural and traditional rural landscapes are profoundly modified and disappeared, while new highly dynamic ones are created (Antrop, 2005).

Urban land expansion has caused many impacts on natural resources associated with the reduction and conversion of green space, productive agricultural land, forests, surface water bodies and ground water prospects are being irretrievably lost (Javaid, 2013). The current land use and land cover changes in developing countries taken as one of the most important variables of environmental threat and changes that has a direct and indirect impact on better living condition achievement, economic growth, production and improved infrastructures (Haroon and Mohd, 2012).

2.5. Land Use Land Cover Changes Studies in Ethiopia

Researches on land use and land cover change in Ethiopia involved in different regions and disciplines depending on the availability of data and tools to perform analysis (Emily and Mekamu Kedir, 2009). However, most of the studies have focused on deforestation for the expansion of cultivated land and its effect on land degradation, river catchments and watershed, natural ecosystems and forests as well as the associated consequences. Among these; Tekle and Hedlund (2000); Zeleke and Hurni (2001); Amsalu Abera *et al.* (2007); Bewket Wondimu and Abebe Solomon (2013); Yeshaneh *et al.*, (2013). Additionally some studies related to urban land use/land cover change were also reported by; Zeleke and Hurni (2001); Amsalu Abera *et al.* (2007); Bekalo (2009); Dorosh and Schmidt (2010); Haregeweyn Bekele *et al*. (2012) in different parts of the country.

Zeleke Getachew and Hurni (2001) reported an expansion of cultivated land at the expense of natural forest cover between 1957 and 1982 in northwestern Ethiopia with a series trend of land degradation resulted due to the expansion of cultivated land on steep slopes at the expense of natural forests. Amsalu Abera, *et al*., (2007) showed a significant decline in natural vegetation cover, however, there was an increase of plantation in Beressa watershed, in the central highlands of Ethiopia between 1957 and 2000. Yeshaneh Endale, *et al*. (2013) also showed a significant decrease of natural woody vegetation of the Koga catchment since 1950 due to deforestation in spite of an increasing trend in eucalyptus tree plantations after the 1980's. Bewket Wondimu and Abebe Solomon (2013) reported a reduction of natural vegetation cover, but an expansion of open grassland, cultivated areas and settlements in Gish Abay watershed, northwestern Ethiopia.

Tegene Belay (2002) reported a significant conversion of natural vegetation cover to cultivated land between 1957 and 1986 in Derekolli catchment Amhara Region. Kindu Misganawu *et al* (2013) investigated a significantly reduction of natural forest cover and grasslands, but an increase of croplands between 1973 and 2012 in Munessa Shashemene landscape of the Ethiopian highlands. A similar study by Tekle Kidane and Hedlund (2000) has shown an increase of open areas and settlements as the expense of forests and shrub land between 1958 and 1986 in Kalu District, Amahara region, Ethiopia.

The impacts of land use and land cover changes on the hydrological flow regime of the watershed have been also reported in many studies (Muluneh and Arnalds, 2011; Geremew, 2013). Land use and land cover changes in response to urban growth also reported by some studies that, an expansion of urban areas annually from 1957 to 2009 has been identified by Haregeweyn Bekele *et al.*, (2012) in the urban fringe of Bahir Dar area as a consequence of increasing population. Bekalo (2009) identified a significantly increase of urban areas from 34% in 1986 to 51% in 2000 in Addis Ababa, Ethiopia by the expense of agricultural land and vegetated areas driven by population growth. Dorosh and Schmidt (2010) also reported a significant urban growth for the last 3 decades because of increase in population of Ethiopian highlands. Muluneh Abera and Arnalds (2011) stated that unsustainable growth of population contributed to environmental degradation especially in most populated areas such as in Ethiopian highlands.

From most of these studies it is evident that population pressure is one of the major drivers of land use and land cover changes through destruction of forest and vegetation cover for the purpose of agricultural and urban expansion as discussed by Zeleke and Hurni (2001) and Amsalu *et al.* (2007). Population growth coupled with migration from rural to cities leads to further expansion of urban areas at the expense of vegetation cover that is commonly practiced in western highlands of Ethiopia according to Zeleke and Hurni (2001) study.

2.6. Application of Remote Sensing for LULCC Analysis

Accurate and timely monitoring of LULC change is essential for understanding the various impacts of human activity on the overall ecological condition of the environment (Zhang *et al.*, 2004). Remote sensing and GIS are providing new tools for advanced ecosystem management and it is the best tool for analysis of land use/cover change at various temporal and spatial scales (Ernani and Gabriels, 2006). There is significant variation between various remote sensor instruments' capability and wealth of information captured and the applicability depends on the objective of the intended study. There is also clear variation in the spatial and spectral properties of satellite images acquired by different versions of a particular sensor instrument. Landsat instruments can be taken as a good example of showing continuous improvement in radiometric and spectral property of images enabling better understanding of land resources (Mather, 2004).

Since, 1972, the Landsat satellites have provided repetitive, synoptic, global coverage of high-resolution multispectral imagery. Their long history and reliability have made them a popular source for documenting changes in land use and land cover over time (Turner *et al*., 2001) and their evolution is further marked by the launch of Land sat 7 by the US government in 1999. Multispectral Scanner (MSS) data from the U.S. Geological Survey's (USGS) EROS Data Center (EDC) has provided a historical record of the earth's land surface from the early 1970s to the early 1990s (Mather, 2004).

The collection of remotely sensed data facilitates the synoptic analyses of earth-system function, patterning, and change at local, regional, and global scales over time. Such data also provide a vital link between intensive, localized ecological research and the regional, national, and international conservation and management of biological diversity (Ernani and Gabriels, 2006); remotely sensed data have powerful helps in understanding and managing earth resources and have been proven to be a very useful data for LULC change detection (Lillesand and Kiefer, 2004).

Change detection and monitoring involve the use of several multi-date images to evaluate the differences in LULC due to various environmental conditions and human actions between the acquisition dates of images (Ernani and Gabriels, 2006). Successful use of satellite remote sensing for LULC change detection depends upon an adequate understanding of landscape features, imaging systems and methodology employed in relation to the aim of the analysis (Yang and Lo, 2002). With the availability of historical remote sensing data, the reduction in data cost and increased resolution from satellite platforms, remote sensing technology appears balanced to make an even greater impact on monitoring land-cover and land-use change (Rogan and Chen, 2004).

In general, analysis of LULC dynamics involves the interpretation and analysis of multi-temporal and multi-source satellite images to identify temporal phenomenon or changes through a certain period. Remote sensing data are the primary source for change detection in recent decades and it have made a greater impact for different planning agencies and land management initiatives (Yang and Lo, 2002).

Satellite images provide valuable datasets that can be used to analyze, evaluate, and monitor changes in ecosystems through change detection. Several studies have investigated the ability of satellite imagery, including Land sat MSS, TM and ETM+, to perform change analysis (Mather, 2004). Therefore, the use of remote sensing data and analysis techniques provide accurate, timely and detailed information for detecting and monitoring changes in land cover and land use.

2.6.1. Image Classification

In order to examine environmental and socioeconomic applications such as: land cover changes as a result of natural and socioeconomic variables, image classification results with better accuracy are mandatory. Image classification refers to the extraction of differentiated classes or themes, usually land cover and land use categories, from raw remotely sensed digital satellite data (Weng, 2012). Image classification using remote sensing techniques has attracted the attention of research community because; classifications are the backbone of environmental, social and economic applications (Lu and Weng, 2007).

Image classification is generated using a remotely sensed data; the characteristics of a study area, availability of high resolution remotely sensed data, ancillary and ground reference data, suitable classification algorithms and the analyst's experience are among factors that cause difficulty to achieve a more accurate result. These factors highly determine the type of classification algorithms and approaches to be used for image classification (Lu and Weng, 2007; Weng, 2012).

2.6.2. Land use/cover change detection analysis

Change detection is defined as the process of identifying differences in the state of object or phenomena by observing them at different times by using remote sensing techniques (Ramachandra and Uttam, 2004). Essentially, it also involves the ability to quantify temporal effects using multi-temporal data sets. Because of repetitive spatial coverage at short time intervals and consistent image quality, change detection is considered as one of the major applications of remotely sensed data obtained from satellites (Zhang Shaoqing and Xu, 2008).

Change detection has a wide range of applications in different disciplines such as land use change analysis, forest management, vegetation phenology, seasonal changes in pasture production, risk assessment and other environmental changes (Singh, 1989). The main objective of change detection is to compare spatial representation of two points in time frame by controlling all the variances due to differences in non target variables and to quantify the changes due to differences in the variables of interest (Lu *et al*., 2004).

A change detection research provides vital information: area change and rate of changes, spatial distribution of changed types, change trajectories of land-cover types and accuracy assessment of change detection results. Quantifying land use and land cover changes and applying suitable change detection methods highly depend on the type of changes(Categorical and continuous) that happened in landscapes and how those changes are noticeable in images. In which change detection in categorical land cover change focuses on identifying new land cover class and changes between land-cover classes through time, whereas change detection in continuous land cover changes focus on measuring the degree of changes in amount or concentrations through time. Among various change detection techniques like image regression, image ratio method, image differencing and post classification methods; image differencing is one of the most extensively applied change detection method. In which images of the same area from different times are subtracted pixel wise to show spatial extent of land cover changes in the two images (Xu *et al*., 2009).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. Location

The study was conducted in and around Jimma town, southwestern Ethiopia. Geographically it is located at $7^{0}40'44.11''$N and $36^{0}50'17.90''$E. The area covers Jimma town and the surrounding 16 rural kebeles (within 9 km radius of the town). In relative terms, the study area is found at a distance of about 346 km from the capital city of Ethiopia, Addis Ababa. It is bordered with Kersa district in the east; Manna district in the north, Manna & Seka Chekorsa in the west and Dedo in the south direction (Figure 1).

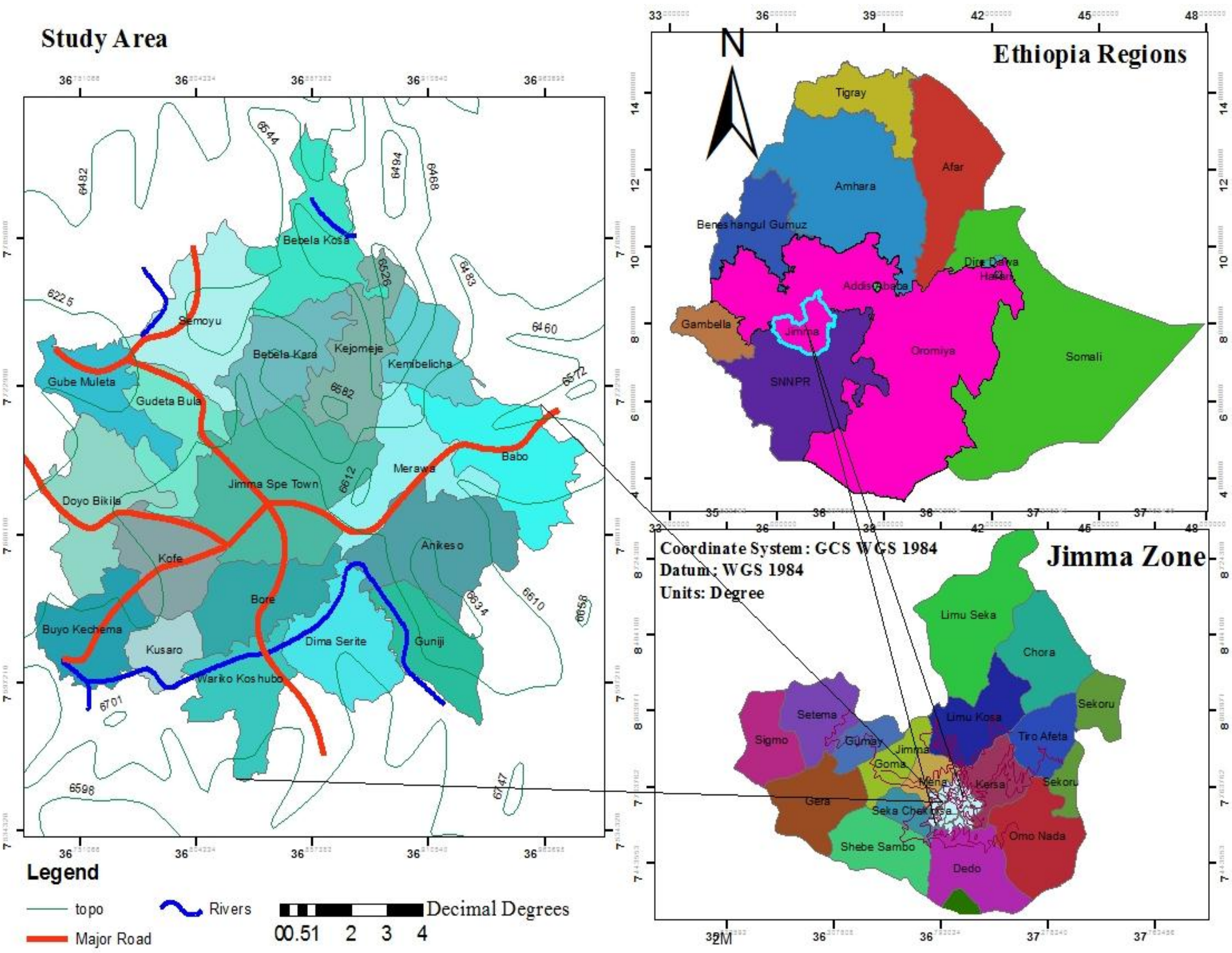


Figure 1 Map of the study Area

3.1.2. Population

Jimma zone has a total area of about 18,412.54 km^2, of which Jimma town and the surrounding rural kebeles covers an area of 45,955 hectares (459.55 km^2). The population of the zone is around 2 million, of which about 245,975 people live in the study area. The town is by far the largest urban center in the zone and southwestern part of the country. The population density of the study area is 535 persons per km^2 (CSA, 2008).

3.1.3. Climate

The study area grouped under humid tropical zone and characterized by warm climate with a mean annual maximum temperature of 30°C and a mean annual minimum temperature of 14°C. The total annual rainfall in the study area and its surrounding is 1450-1800 mm. There is a significant seasonal variation for rainfall in different years (NMA, 2007). Maximum precipitation occurs during the three months period, June to August, with minimum rainfall in December and January. From a climatic point of view, abundant rainfall makes this region one of the best watered of Ethiopian highland areas, conducive for agricultural production and known in coffee production (Abebe Alemu *et al*., 2011).

3.1.4. Physiographic nature of the study area

The study area stretches over a predominantly flat land with noticeable slope change. The elevation variation in study area ranges from 1663 m.a.s.l (around kitto, airfield of Jimma town) to the highest 2582 m.a.s.l. found in Kejo-muja kebele to northeast direction of Jimma town (Figure 2). The general slope orientation of the area is towards Gibe River and there is no well- defined course of surface water direction, but the direction of drainage is dominantly towards Gibe River.

Topographically it exhibits features of the upper part of the Gibe-Omo River basin, made up of gentle slopping hills. The area is dominated by reddish brown residual tropical coffee soil & alluvial soil of brownish gray and grayish white clay soils. The reddish brown soil (2-5m thick) occupies area that is drained while the alluvial soil forms the river flood plains (Hailu Degefa *et al*., 2011).

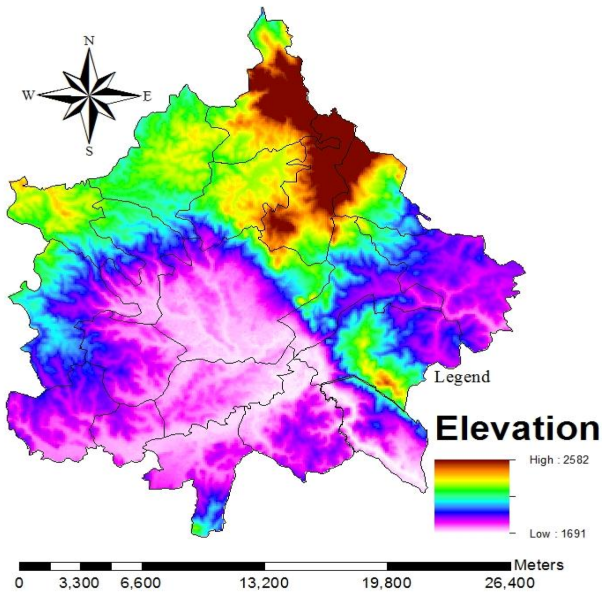


Figure 2 Map showing elevation of the study area

3.1.5. Hydrology

The study area is located in the main upper part of the Gibe-Omo river basin, which is tributary of the Gibe River that in turn drains to Lake Turkana. The local drainage of the study area is from the north and northeast and drains to the south through the two most important perennial rivers Aweytu and Kitto that form Boye. There are number of streams that cross the area in the north-south direction within the built-up and expansion areas including; Furdisa, Abey, Faki, Mole and Denge Dawi. All these streams have very small discharge and shallow depths and some of them will not have water during dry season. Kitto & Aweytu Rivers constitute the major natural drainage system of the study area. The collected storm water from the built up and undeveloped mountain areas drain to the south direction. Aweytu River, particularly, bisects the built up parts of the area from north to south direction.

3.2. Methodology

In present study, different methods of data collection and analysis were employed. This section shows the general methods used, applied techniques and the data inputs used throughout this study.

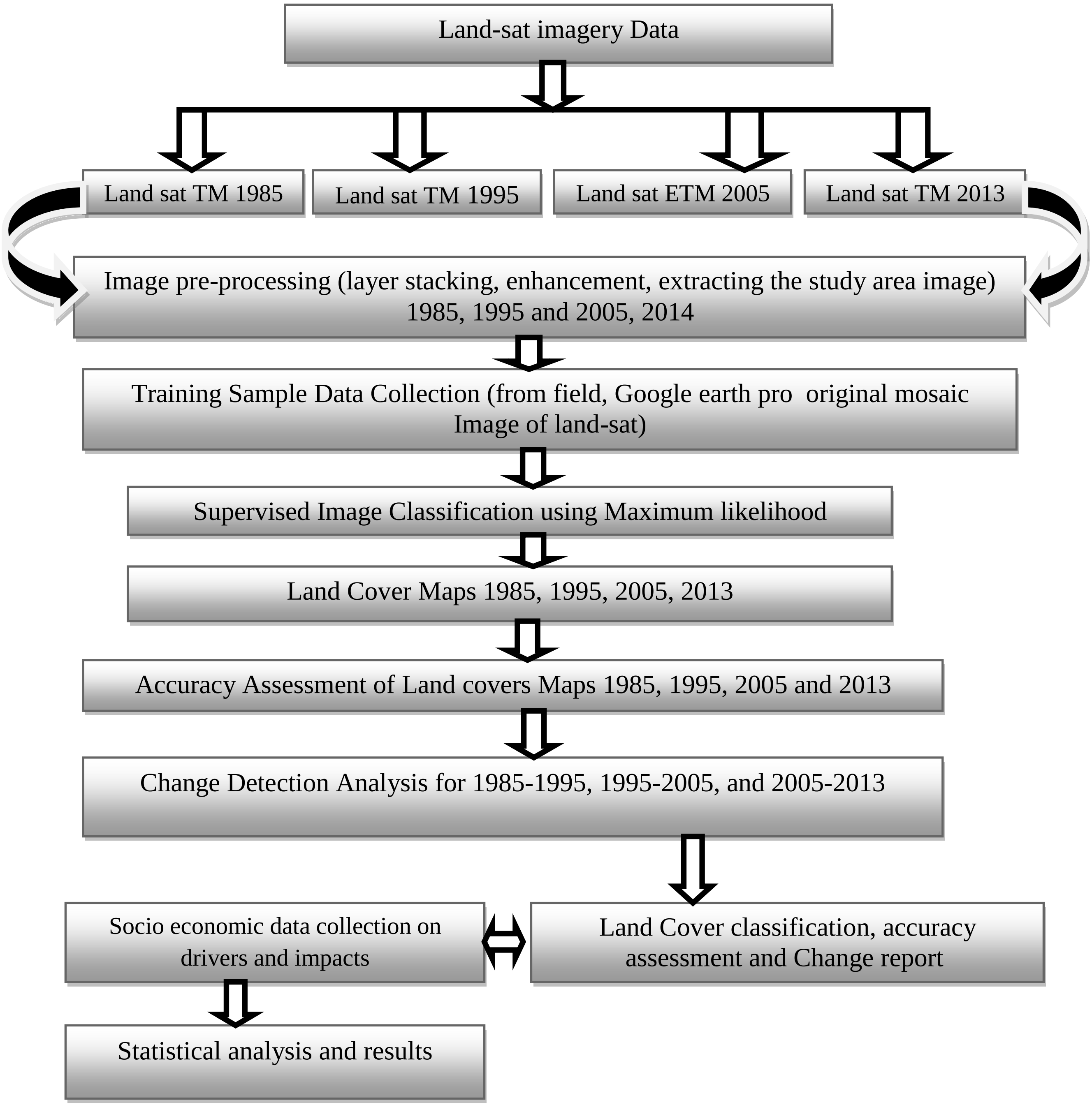


Figure 3 Flow chart showing general methodological approach

As shown in the figure 3, the first section of the methodology involved on preprocessing of data, remote sensing image classification, change detection analysis and socioeconomic data collection and analysis. After having classified land cover images, the next step employed were analysis of classification report, socioeconomic and other secondary data.

3.2.1. Satellite data and processing

Landsat images of TM (1985, 1995 and 2013) and ETM+ (2005) having the same level of resolution(30m x 30m) were employed. The images were obtained from the GLCF website (http://www.glcf.umd.edu/) and USGS glovis (www. http://glovis.usgs.gov/) which was spatially referenced in the UTM with a datum of WGS 1984 UTM zone 37N . The images were extracted to Tiff formats for further processing and analysis. The details of image properties were summarized in Table 1. Those satellite images have composed of different bands and combinations of those bands were used in order to identify surface features in the study area (Appendix 6).

Table 1 Landsat image types used in the study

Sensor	Acquisition time	Spatial resolution	Path/row	Projection
Landsat TM	09/01/1985	30x30m	169/55	WGS 1984 UTM Zone 37 North
Landsat TM	21/01/1995	30x30m	169/55	WGS 1984 UTM Zone 37 North
LandsatETM +	24/02/2005	30x30m	169/55	WGS 1984 UTM Zone 37 North
Landsat TM	30/01/2013	30x30m	169/55	WGS 1984 UTM Zone 37 North

3.2.1.1. Layer Stacking

During layer stacking, all seven bands of landsat data, excluding the thermal band were considered.

3.2.1.2. Image Enhancement

To increase interpretability of the image by removing cloud cover on some portion of the image of land sat TM 1984 haze reduction technique were employed. This is to reduce overall haze in an input image based on the tasseled cap transformation that removes haze and transform the image back into RGB space.

3.2.1.3. Extraction of the study area

The study area that overs Jimma town and surrounding rural kebeles within 9 km radius having a total area of 459.55 km^2 was extracted from original mosaic images using a vector format administrative boundary of Jimma town and rural kebeles boundary map obtained from EMA with the help of ArcGIS 10 and ERDAS Imagine 9.2 software.

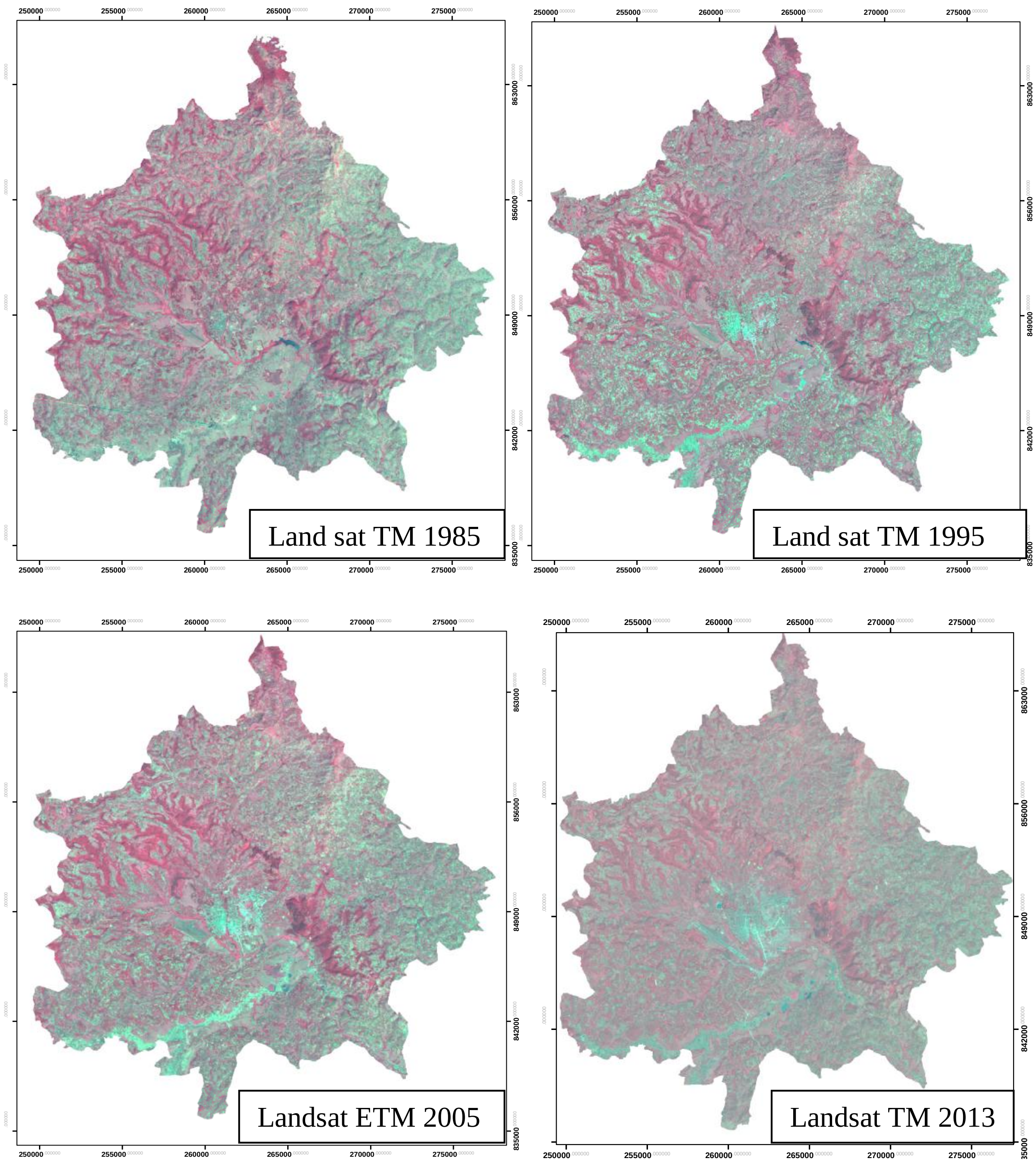


Figure 4 False color (4,3,2) composite of land sat 1985, 1995, 2005 and 2013 images of the study area

3.2.2. Nomenclatures of Land cover Classes

Before collecting training samples, the land cover classes should be known so as to make the classification easier (Bekalo, 2009). The classification nomenclature derived from Anderson *et al.*, (2000) and FAO, (1998) land cover classifications for remote sensing were used and is modified based on detailed physiographical knowledge of the researcher about the study area.

Table 2 Land cover categories and its description used for classification

Code	LULC Classes	Descriptions
01	Built up area	Residential, commercial services, utilities, public and private infrastructures; buildings, roads, concrete and asphalt surfaces market places institution such as school, clinic and rural clustered homestead buildings.
02	Cultivated land	Areas of land prepared for growing agricultural crops. The category includes areas currently under crop, and land under preparation. For rain fed and irrigated cultivation, including fallow plots, cultivated land mixed with some bushes like scattered chat plantations in the farmland, trees and rural homesteads but dominated by farmland.
03	Wetlands	Include all kind of wetlands situated on the shallow margins and rivers and other water body (including an area covered by watercourses, rivers, artificial ponds).
04	Grass lands	All areas covered with natural grass and small shrubs dominated by grass including grazing lands.
05	Forest	It refers to the ground cover provided by plants and any other specific botanical or geographic characteristics of forest and semi-forest coffee ecosystem, which is characterized by significant disturbance of the original natural stand by commercial utilization and other human activities. Including a rage of plantation forest types with one common feature and dominated by, *Eucalyptus spp*, *Gravilia robusta*, *Cupressus lusitanica*, etc plantations.

3.2.3. Training Data collection

Training data used for classification and classification accuracy assessments were collected randomly. Number of training data(GPS points) collected were decided based on Congalton and Green (1999) that suggest to collected 50 testing samples for each LULC-category by considering variations in size and variability within land cover classess. Based on these sample point data were collected from the study site representing land cover classes(Table 3). Samples were collected based on the researcher's personal experience and physiographical knowledge of the study area.

Table 3 Number of training data collected

S/n	Number of sample point data		Year	Source of data
	For classification	For accuracy assessment		
1	75	116	1985	Original mosaic image of land sat TM
2	85	132	1995	Google earth pro
3	100	127	2005	Google earth pro
4	80	256	2013	Field survey

3.2.4. Image Classification

Image classification refers to the task of extracting information of classes from a multi-band raster image. The resulting raster data from image classification was used to create land cover maps. During classification each pixel was assigned to only one class, from ground truth data and the images areas of interest (AOI) were created and converted to parametric files, that represent the spectral signatures of the selected points (ERDAS, 2010). Signatures separability test using distance measure of Jefferies-Matusita (which ranges between 0 and 1414) was done and signatures that are nearest to upper bound was selected to determine statistical distance between signatures. These signature files were used to do an automatic pixel based supervised classification of land cover based maximum likelihood classification algorithm. Based on the statistical parameters of the specified classes from the training data, this method calculates the likelihood, with which every pixel in the image belongs to these classes. Every pixel was then assigned into the class with the highest likelihood (Albertz, 2009, Richards and Jia, 2006). Google earth pro was used as a reference images during image classification through detail visualization and interpretation of different band combinations to identify land cover classes. As stated by Jensen (2009), “no pattern classification method is inherently superior to any other”. It is the responsibility of the researcher, using his or her knowledge of the problem set, the study area, the data sources, and the intended use of the results, to determine the most appropriate, efficient, time and cost-effective approach.

Historical information, knowledge of the area acquired from fieldwork and knowledge about color representation of important features in different band combinations were employed to associate those formed classes with their corresponding meanings with the ground features. Satellite bands were composed in different ways in order to identify surface features in the study area. True color composite usually known by RGB (3,2,1) combination and false color composite which uses an RGB combination of 4,3,2 to get better visualization in identifying objects were used.

Finally, a number of both classification and reclassification procedures were employed in order to improve the classification accuracy and neglect misclassified cells.

3.2.5. Accuracy Assessment

Accuracy assessment was done for comparing the accuracy of a classification result with geographical data that were assumed to be true. It is performed by comparing a map created by using remote sensing analysis to a reference data obatined from field survey, google earth pro and original mosaic images. An interpretation is then made of how close the newly produced map matches the reference data. Evaluation of the accuracy of a classified image was done using an error matrix which shows correctly allocated cases in a percentage to calculate and analyze user accuracy, producer accuracy, overall accuracy and kappa coefficient (Addis Getnet, 2009; Foody, 2002).

In this study, a total test samples of 116 for image 1985, 132 for image 1995, 127 for image 2005 and 256 for image 2013 were randomly selected from original land sat TM image of 1985 and Google earth pro for the images 1995, 2005 and from field survey for 2013 (Table

3). The test sample points was examined and assigned a class value and accuracy assessments were conducted for each classification result. Thus, agreement and disagreement of the analysis was evaluated by using an error matrix and simple descriptive statistics.

3.2.6. Change analysis

The change analysis part provides a rapid quantitative assessment of changes, allowing the researcher to generate evaluations. In this study, land use and land cover maps of the study area obtained from image classification for the periods of 1985, 1995, 2005 and 2010 were used for the analysis. Based on the principle of land change analysis, area change and change rate, change trajectories of land cover types were produced and analyzed. The selection of an appropriate technique for change analysis depends on characteristic features of the study area (Elnazir *et al*., 2004), and accurate registration of the satellite input data.

3.2.7. Socioeconomic data collection and analysis

Analysis of the drivers and impacts of land-cover and land-use change requires use of multiple methods and critical interpretation of the data to characterize the drivers and impacts of change through a hierarchy of temporal and spatial scales (Campbell et *al*., 2005). Socio economic data used in this study were from primary and secondary data sources in which both designed in order to answer research questions related to drivers and socioeconomic impacts of LULCC for the periods of 1985-2013.

The secondary data including population data of different times, land use data of both urban and rural areas were obtained from Jimma town municipality, and central statistical agency Jimma office and Jimma zone land administration office. A simple random sampling techniques were used in selecting a total of 140 sample household heads from 5 rural peasant associations and 2 urban Kebeles for primary data collection and kebeles were selected purposively based on distance from urban center and observation socioeconomic activities; where sample size was determined by Cochran (1977) formula;

$$no = \frac{(P)(q) * Z^2}{d^2} \qquad n1 = \frac{no}{(1+\frac{no}{N})}$$

Where, no= the desired sample size when the population is greater than 10,000,

n = the desired sample size when the population is less than 10,000,

Z = 95% confidence limit i.e. 1.96

P = 0.1 (population proportion to be included in the sample i.e. 10%)

q = 1-0.1 i.e. 0.9

N = total number of population 13327

d = margin of error or degree of accuracy (i.e. 0.05).

A questionnaire covering a wide range of topics (Annex 2) relevant to the central issue of drivers and impacts of land cover change were collected covering a time horizon matched to the period for which satellite images were available starting from 1985 and the data were analyzed using SPSS and Microsoft Excel software. Discussion were made with 18 members of different group from which 2 municipal leaders and 1 urban planners from Jimma town and 5 kebele administrators, 5 development agents and 5 elders from rural peasant associations around Jimma town, to capture major drivers, historical issues and current trends and visible impacts related to land use/cover change in the area.

4. RESULTS AND DISCUSSIONS

4.1. Land cover classification results

The land cover maps generated after running a maximum likelihood supervised classification as well as a post classification algorithm are presented in Figures 5,6,7,8 below. The result showed that, there has been a consistent increase of built up areas with respective values 2.19% of the study area in 1985 to 3.09 % in 1995, 6.24 % in 2005 and 7.09 % in 2013. Cultivated lands have also shown consistent increase between the study periods of 1985-2005 from 39.2% to 56.75% and showed decreasing trend to 52.9% in 2013. However, there have been a decrease of forestland, wetlands and grasslands starting from 1985-2013 except forest land which start rising again in the year 2013. In 1985, forestland was the most dominant land cover but shown a continuous decrease from 48.19% by 1985 to 32.16% in 2005 again rise to 36.36% in 2013. It is also visible that wetlands have decreased from 0.06% in 1985 to 0.04 % in 1995 and from 0.037% 2005 to 0.033% in 2013. Grasslands also have shown a continuous decrease in the study period from 10.37% in 1985 to 3.64% of the study area in 2013.

Table 4 Area statistics of the land use and land cover units from 1985-2013

Classes	**Year 1985**		**Year 1995**		**Year 2005**		**Year 2013**	
	Area		**Area**		Area		Area	
	Km^2	**%**	Km^2	%	Km^2	%	Km^2	%
Forest	221.45	48.19	193.58	42.11	147.8	32.16	167.12	36.36
Built up area	10.06	2.19	14.18	3.09	28.66	6.24	32.6	7.09
Cultivated land	180.13	39.2	216.64	47.14	260.80	56.75	243	52.9
Wetlands	0.30	0.06	0.20	0.04	0.17	0.037	0.17	0.033
Grass land	47.66	10.37	35.0	7.62	22.17	4.823	16.71	3.64
Total	**459.60**		**459.60**		**459.60**		**459.60**	

Source; own analysis of satellite images

In a classification result for 1985, forest was the dominant class covering 221.45(48.19%) followed by cultivated land with 180.13km^2(39.2%) while grass land, built up and wetlands exhibits 47.66 km^2(10.37%), 10.06 km^2(2.19%) and 0.30 km^2(0.06%), respectively (Figure 5).

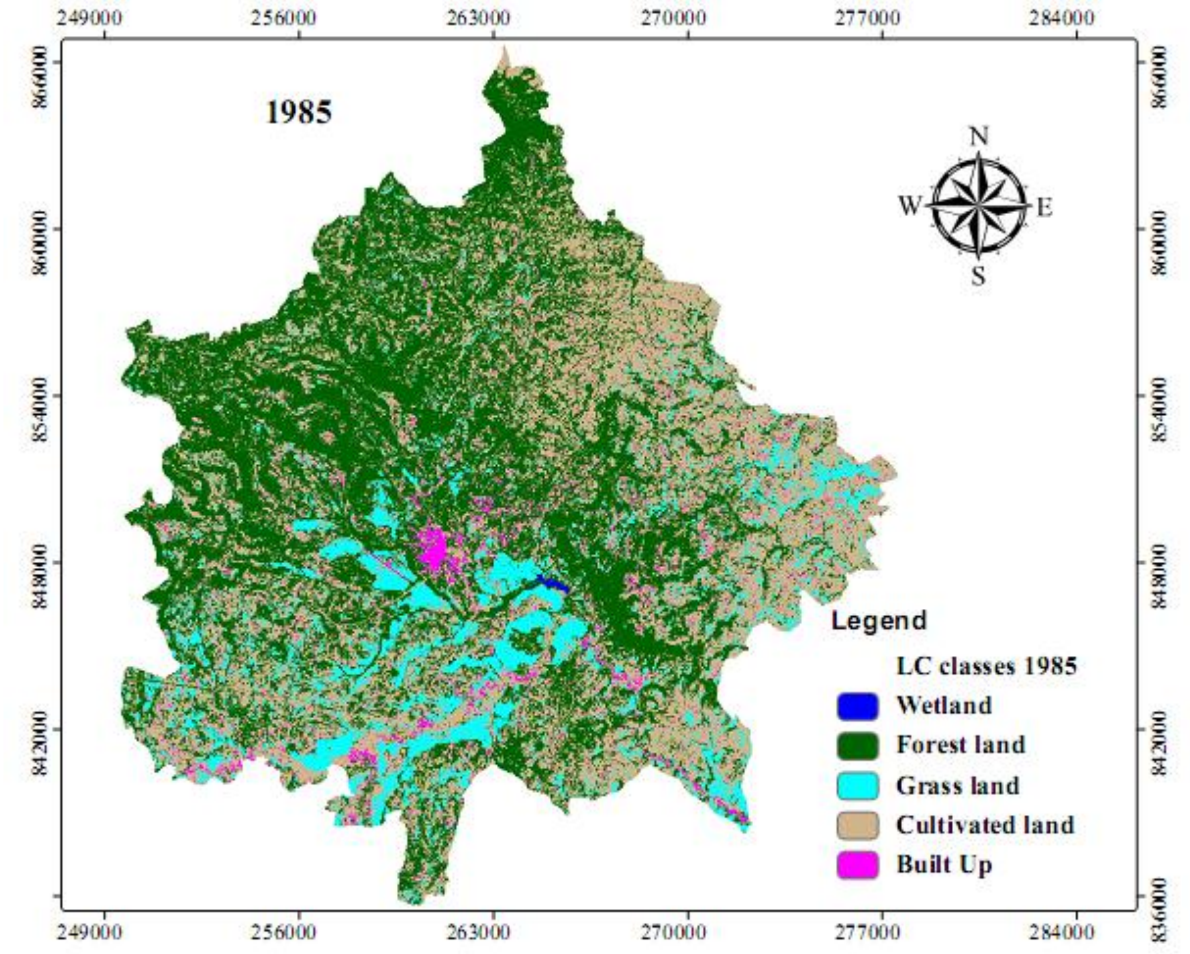


Figure 5 Land cover map of 1985

In 1995, Cultivated land was the dominant class covering 216.64km^2 (47.14%) followed by forest land with 193.58km^2(42.11%) while grass land, built up and wetlands exhibits 35.0 km^2(7.62%), 14.18km^2(3.09%) and 0.20 km^2(0.04%), respectively (Figure 6).

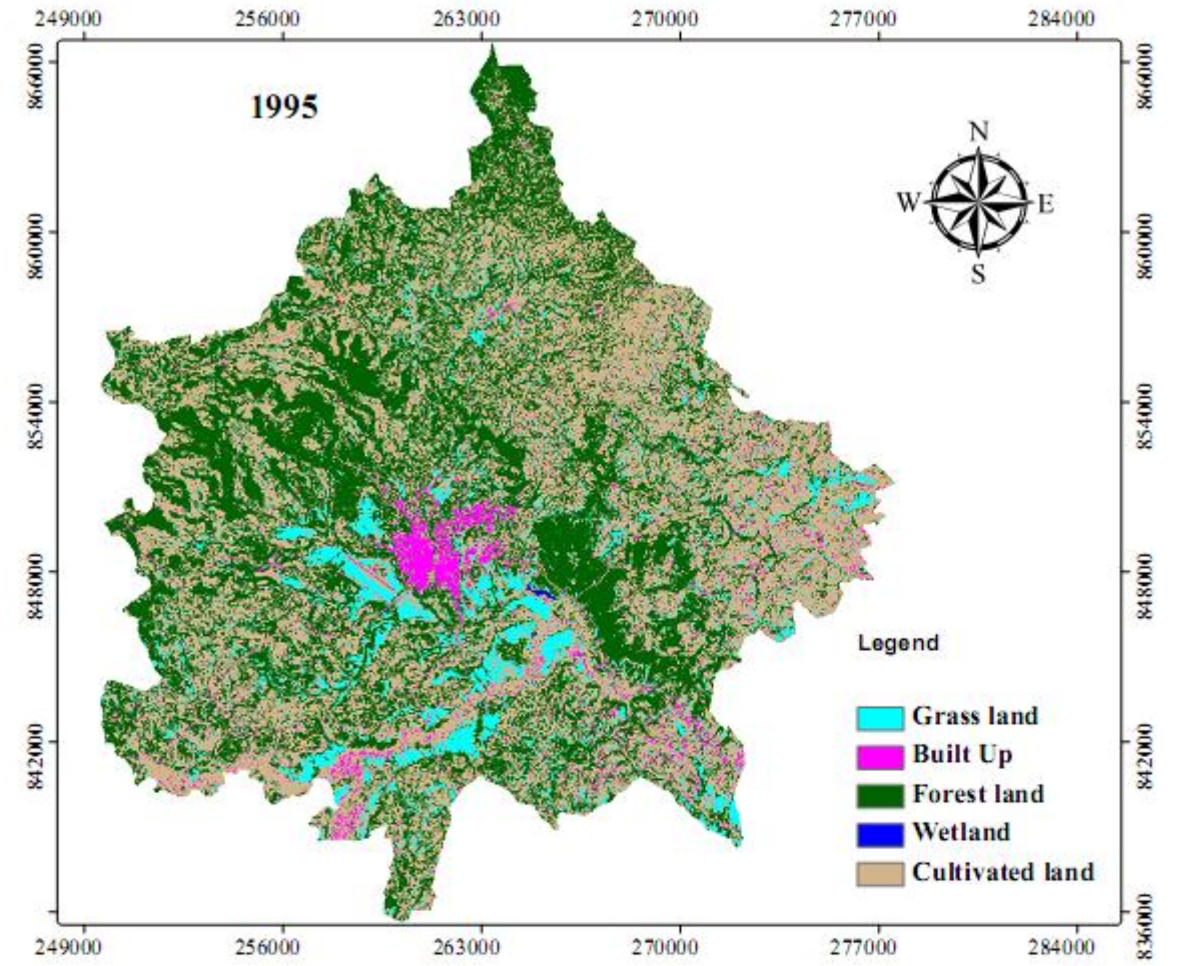


Figure 6 Land cover map of 1995

Cultivated land constituting the highest share in 2005 with 56.75% which is 260.80 km^2 , followed by forest land and built up with 147.8km^2(32.16%) and 28.66 km^2 (6.24%) respectively. Grass land covered 22.17km^2(4.82%) of the area while wetlands took the minimum area coverage with 0.17 km^2 (0.037%) as shown in Table 4 and Figure 7.

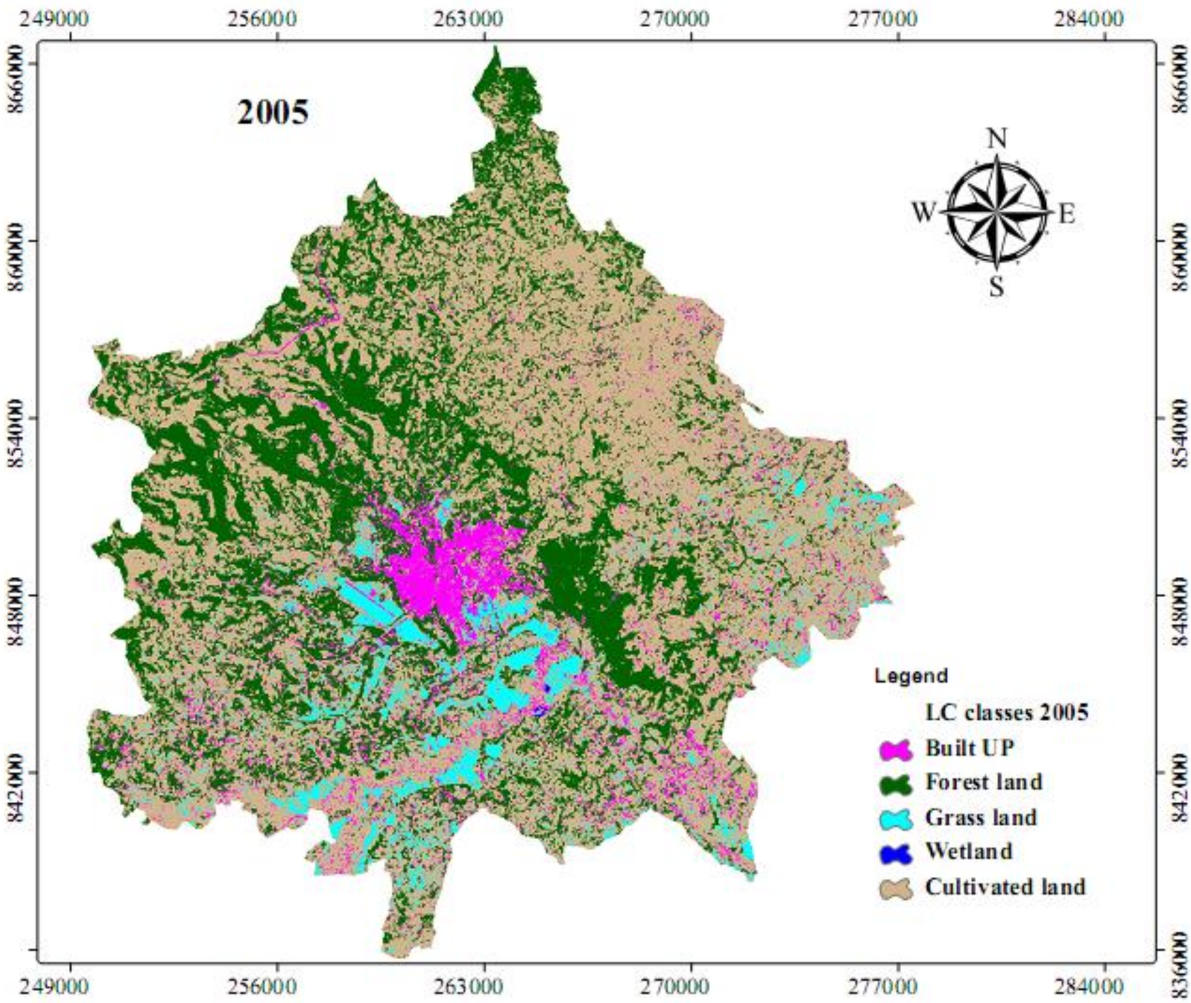


Figure 7 Land cover map of 2005

Similarly, for 2013 classification result cultivated land was still identified as dominant land cover with a value of 243 km^2 (52.9%), followed by forestland with 167.18 km^2 (36.36%). Built up, grassland and wetland comes next in order with values of 32.6 km^2 (7.09%), 16.71(km^2 (3.64%) and 0.17km^2(0.033%) respectively (Figure 8, Figure 9).

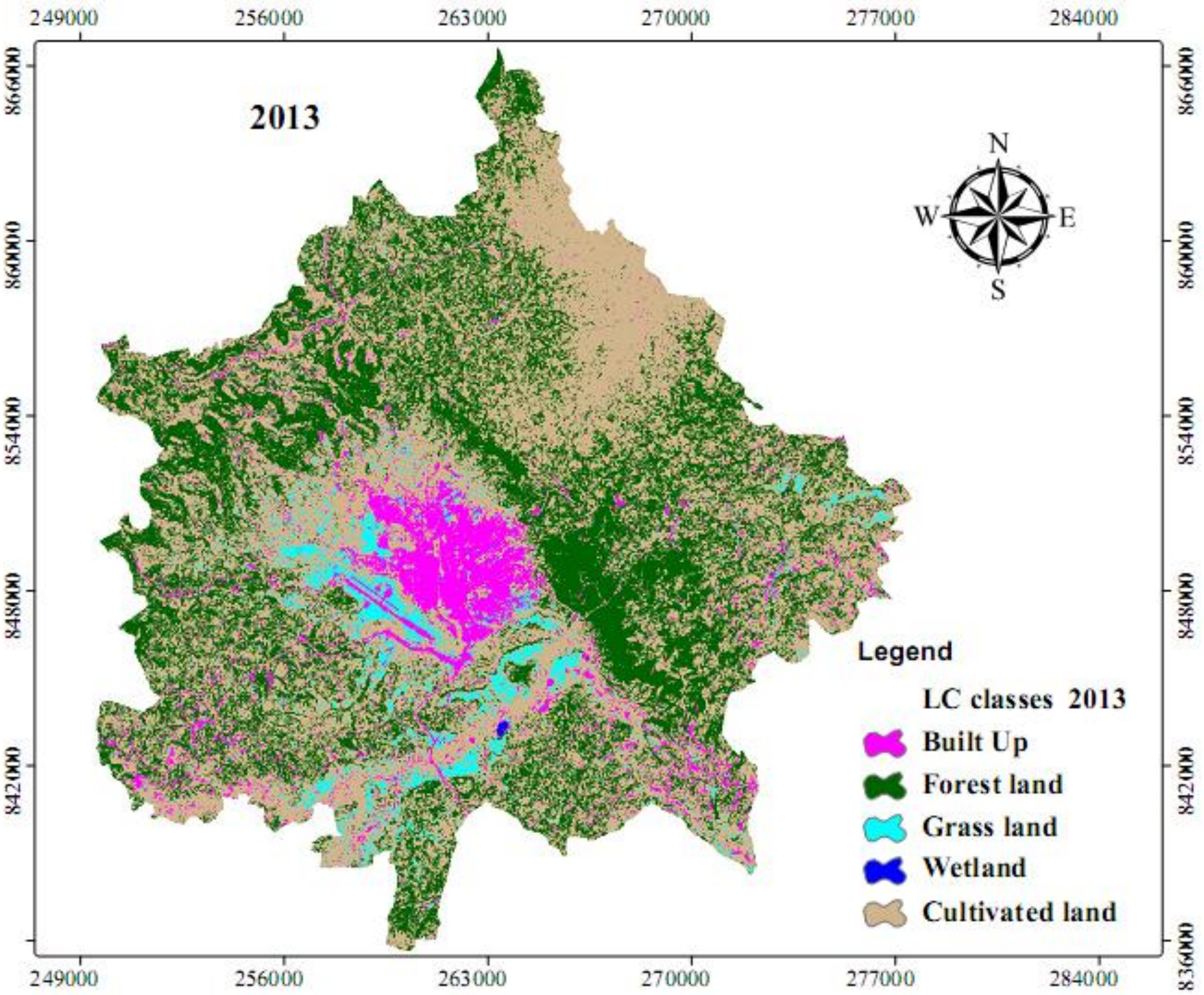


Figure 8 Land cover map of 2013

4.2. Accuracy Assessment of the Classification

Because classified land cover maps from remotely sensed images contain various types of errors, it is the necessary to find out those errors so as to make the produced land cover maps become reliable and easily interpretable by users. To do so, the accuracy of a classified map has to be assessed and compared with a referenced data using an error matrix as explained in section 3.2.5. The accuracy assessment in this study was made using data obtained from original mosaic image for 1985 and Google earth images for the study periods of 1995, 2005 and field survey for 2013.

4.2.1. User's Accuracy

Users accuracy (type I error i.e. error of omission) refers to the number of correctly classified pixels in each class (category) divided by the total number of pixels that were classified in that category of the classified image (row total). It represents the probability that a pixel classified into a given category actually represents that category on the ground.

Results of user's accuracy in this study showed that in 1985 water bodies where correctly classified and the minimum was forest land with an accuracy of 87.18% as presented in Table 8 below. In 1995, the class accuracies range from 87.50% to 100% where as in the period 2005 and 2013, it ranges from 95.45% to 100% and 84.00% to 100% as indicated in tables 9 and 10 respectively. The lowest values of class accuracies were misclassified due to spectral property similarities among other land cover classes like built up and agricultural lands. As shown from Tables 5, 6 , 7 and 8, the user's accuracy was lowest for forest land, grassland and agricultural land as some of the agricultural areas were largely misclassified as built up, forest and masking of forest canopies over built up areas and similarity of water bodies specially wetlands with green grass vegetation covering the wetlands. According to Vaclavik and Rogan (2009), the category of agriculture was the most problematic because it represented a mixture of various crops in different phonological stages as well as bare soil (plowed fields). In addition to this, the spatial resolution of Landsat data could have an influence on the image classification. According to Zhou *et al*. (2009) for detailed urban land cover mapping at very fine scales, high spatial resolution imagery from satellite sensors such as IKONOS and Quick Bird become more accurate.

4.2.2. Producer's Accuracy

Producer's accuracy (Type 2 Error i.e. Error of Commission) refers to the number of correctly classified pixels in each class (category) divided by the total number of pixels in the reference data to be of that category (column total). This value represents how well reference pixels of the ground cover type are classified. As showed in table 5,6,7, when compared to other land cover classes grass land areas were largely misclassified as 87.5%, 87.5% and 60% respectively and in Table 8, cultivated lands and forest lands became a low accuracy of 82.35% and 83.67% compared to others. The lowest values for these accuracy results were due to misclassification of the similar spectral properties of different land cover classes such as built up areas and agricultural areas, grasslands and grass dominated water bodies.

Table 5: Confusion matrix for land cover map of 1985

Reference Map

Classified Map

Land cover classes	Built up area	Forest	Water body	Grass land	Cultivated	Grand total	No. of corrected	Users Accuracy (%)
Built up area	13	-	-	-	-	13	13	100.00
Forest	1	34	2		2	39	34	87.18
Wetland	-	-	7	-	-	7	7	100.00
Grassland	-	1	-	7		8	7	87.50
Cultivated land		1		1	47	49	47	95.92
Total observation	14	36	9	8	49	116	108	
Producer's Accuracy (%)	92.86	94.44	77.77	87.5	95.92			
Overall Accuracy (%)		93.1						
Overall kappa statistics		0.9007						

Table 6: Confusion matrix for land cover map of 1995

Reference Map

Classified Map

Land cover Classes	Built up area	Forest	Water body	Grass land	Cultivated	Grand total	No. of corrected	Users Accuracy (%)
Built up area	29	1	-	-	-	30	29	96.67
Forest	1	42	-	3	-	46	42	91.30
Wetland	-	-	3	-	-	3	3	100
Grassland	-	-	-	7	1	8	7	87.50
Cultivated land	-	-	-	1	43	44	43	97.73
Grand total	30	43	3	8	44	131	124	
Producer's Accuracy (%)	96.67	97.67	100	87.5	91.49			
Overall Accuracy (%)		94.66						
Overall kappa statistics		0.9245						

Table 7: Confusion matrix for land cover map of 2005

	Reference Map							
Land cover classes	Built up area	Forest	Water body	Grass land	Cultivated	Grand total	No. of corrected	Users Accuracy (%)
Built up area	40	4	0	0	0	44	40	90.91
Forest	0	31	0	0	1	32	31	96.88
Wetland	0	0	2	0	0	2	2	100
Grassland	0	0	0	3	0	3	3	100
Cultivated land	0	0	0	2	42	44	42	95.45
Grand total	40	35	2	5	43	125	118	
Producer's Accuracy (%)	100	88.57	100	60	97.67			
Overall Accuracy (%)		94.4						
Overall kappa statistics		0.92						

Classified Map

Table 8: Confusion matrix for land cover map of 2013

	Reference Map							
Land cover Classes	Built up area	Forest	Water body	Grass land	Cultivated	Grand total	No. of corrected	Users Accuracy (%)
Built up area	80	0	0	1	8	89	80	89.89
Forest	1	42	0	7	0	50	42	84.00
Wetland	0	0	3	1	0	3	3	100.00
Grassland	0	0	0	8	1	9	8	88.89
Cultivated land	6	9	0	0	82	97	82	84.54
Grand total	87	51	3	16	141	248	215	
Producer's Accuracy	91.95%	82.35 %	100.00%	88.89 %	83.67%			
Overall Accuracy%		86.69(215 ÷248)						
Overall kappa statistics		0.8033						

Classified Map

4.2.3. Overall Accuracy

It is computed by dividing the total number of correctly classified pixels (i.e., the sum of the elements along the major diagonal) by the total number of reference pixels. It shows an overall result of the tabular error matrix. The overall accuracies performed in this study period 1985 was 93.1% (Table 5), in 1995 was 94.66% (Table 7) and during 2005 and 2013 it was 94.4% (Table 7) and 86.69% (table 8) respectively. As mentioned by Anderson *et* *al*. (1976) for a reliable land cover classification, the minimum overall accuracy value computed from an error matrix should be 85%. However, Foody (2002) showed that this baseline makes no sense to be a universal standard for accuracy under practical applications. This is because a universal standard is not exactly related to any specific study area. Foody (2002) also noted that Anderson *et al*. (1976) do not explain in detail about the criteria of map evaluation for universal applications. Moreover, Lu *et al*. (2004) noted that the accuracies of change detection results highly depend on many factors, such as: availability and quality of ground truth data, the complexity of landscape of the study area, the change detection methods or algorithms used as well as classification and change detection schemes. Therefore, the overall accuracies for all maps were above 85% based on Anderson's criteria.

4.2.4. The Kappa Analysis

Kappa analysis is a discrete multivariate technique used in accuracy assessment to statistically determine whether one error matrix is significantly different from another (Congalton, 2004). This measure of agreement was done based on the difference between the actual agreement in the error matrix (i.e., the agreement between the remotely sensed classification and the reference data as indicated by the major diagonal) and the chance agreement that is indicated by the row and column totals. The kappa value for this study showed strong agreement that; 0.9007 for 1985 map, 0.9245 for 1995 map 0.92 for 2005 map and 0.8033 for 2013 classified map (Table 5,6,7,8). In which all lies in the range recommended by Conglaton (2004); which is characterized a value greater than 0.80 (80%) as strong agreement.

4.3. Change Detection

For this particular study land cover change analysis were made for area change and change rate, relative changes and change trajectories of land-cover type (Table 9 & 10). As Blaschke (2004) stated there are a number of detection techniques but the most common approach is the simple technique of post classification comparison. For the present study, post-classification comparison was applied by differentiating the corresponding classified maps data to generate change rates based on suggestion of Fan *et al*. (2007).

Change detection statistics calculated from the processed image of year 1985, 1995, 2005 and 2013, which covers a period of 28 years, reveals that built up area increased from 2.19% in 1985 to 7.09 percent in 2013, which is almost 4 times during the period (Table 9). The change in land use has largely been between built-up, agricultural land, forestland and grasslands. It is more evident from the fact that area under cultivated land was about 39.2 percent in 1985, which increased to 56.75% in 2005 and then declined to 52.9 percent in 2013, which shows a general declining trend of agricultural land. Cultivated lands have shown consistent increase between the study periods of 1985-2005 from 39.2% to 56.75% with the cost of grasslands, water body and forestlands, but later shows decreasing trend to 52.9% because of expansion of forestland and built up areas. The highest positive change (9.61% increase) observed for cultivated land was during 1995-2005 and highest negative change was observed during 2005-2013 which was a decrease in 3.87%.

Built up areas are dynamically increasing in the study area from 2.19% by 1985 to 7.09% in 2013. The highest increase in built up was observed between the 1995-2005 showing the highest positive increase of 3.15% due to the conversion of wetlands, grasslands and agricultural land to residential and commercial activities in the low-density areas in the town. Urban built-up area shifting from the inner core/older part of the city to the peripherally zone over the land cover reflect the natural population growth and in migration from the surrounding areas, high demand for land and urban supplies and change in housing type in the area. Wetlands have shown a continuous negative change between the years 1985-1995, 1995-2005. Tali *et al.* (2013) also stated that with growing population and increasing urbanization rate in all countries built up areas are increasing with the cost of other ecologically valuable land cover classes. The decreased in water bodies was because of the subsequent use of this land for built up and over extraction of wetland products like brick making, sediment load from agricultural watersheds, conversion to agricultural land and *Eucalyptus* plantation and over grazing. Haregeweyn Bekele *et al*. (2006) also reported a similar study in other parts of Ethiopia due to poor management and unplanned use, which threatened the life of different water bodies.

Grasslands also showed successive decrease during study period in which highest decrease was observed during 1995-1985 and 1985-1995 with values of negative 2.79% and 2.75% respectively. This is because of the highest pressure on grasslands for agriculture, built up and plantation forest expansion. On the other hand, forestlands show continuous decrease for 1985-1995, 1995-2005 and later increased by 4.2% during 2005-2013. The increasing trend of forest cover during 2005-2013 was observed because of expansion of plantation forest and agroforestry practices during the period. Lu *et al.* (2004) indicate that a good change detection research should provide information on area change, change rate and change trajectories of land-cover types.

Table 9 Total Change and Rate of conversion of Land Use/Cover (1985-2013)

Land Use/Cover Type	Area change in km^2			Percent points change		
	1985-1995	1995-2005	2005-2013	1985-1995	1995-2005	2005-2013
Forest	-27.87	-45.78	+19.32	-6.06	-9.96	+4.20
Built up area	+4.12	+14.48	+3.94	+0.89	+3.15	+0.86
Cultivated land	+36.51	+44.16	-17.8	+7.94	+9.61	-3.87
Wetlands	-0.1	-0.03	0.0	-0.023	-0.01	0
Grass land	-12.66	-12.83	-5.46	-2.75	-2.79	-1.19

Overall change analysis for 1985-2013 shown that a relative decline of forest cover, water body and grasslands with a value of 11.82%, 0.03% and 6.73% respectively, whereas, built up and cultivated land increased with 4.9% and 13.68% (Table 10).

Table 10 showing relative changes of land cover between 1985-2013

	1985		2013		Relative change	
	Km^2	%	Km^2	%	Km^2	%
Forest	221.45	48.19	167.12	36.34	-54.33	-11.82
Built up area	10.06	2.19	32.6	7.09	22.54	4.90
Cultivated land	180.13	39.2	243	52.9	62.87	13.68
Wetlands	0.3	0.06	0.17	0.033	-0.13	-0.03
Grass land	47.66	10.37	16.71	3.64	-30.95	-6.73
	459.6		459.6			

Note; - &+ shows decreasing and increasing trend respectively

4.4. Result from socio-economic survey

A socio-economic survey was conducted from March 2014 to April 2014. It involved interview of selected households, discussion with focus group and key informants to generate information on drivers of land use/land cover change and socioeconomic impacts because of change in land cover.

4.4.1. Socioeconomic profile of the respondents

The result from the data revealed that sample households include 11.5 % female-headed families and the average age of household head is 43. The average household is composed of six family members. 53% sample household heads were not educated; where only 25.7% primary school (1-4), 15.5% junior school and 5.8% are high school complete. Households generate mainly their main income from crop production 39.3% (permanent and perennial crops mainly coffee, Teff, Maize and other fruit and vegetables), from both crop and livestock 16.2% and from forestry related activities 3% and various non-farm activities like business trade, hired, etc 41.5%. The total average annual household income from all household activities ranges between 1,000.00 birr among poor households and 24,000.00 birr among reach households with average annual income of 7038.45 Birr. Farm income constituted 58.5% of the total household income, and 41.5 % of this was derived from other sources(trade, livestock, salaried, forest based and wage).

4.4.2. Drivers of land use/cover change

The responses obtained from the survey was shown that land-cover changes in Jimma area are the result of a variety of processes of interlinked socioeconomic driving forces acting not in isolation but in intricate webs of place and time relationships. As Belay Tesema (2002) and (Roger and Darrell *et al*. (2012) indicated that LULC changes are the result of a number of interacting variables and processes. From a range of biophysical, demographic, economic, and infrastructural factors, eight drivers was perceived by the informants as being important to land-use/cover changes in the study area (Fig. 9). According to the informant's population growth and immigration, urban expansion, agriculture and rural settlement, fuel wood and timber demand, weak land planning, land degradation, different livelihood strategies to increase household income, land tenure took place as drivers of change. Because of various push factors, particularly in the past three decades; were resulting in a dynamic change of land cover types.

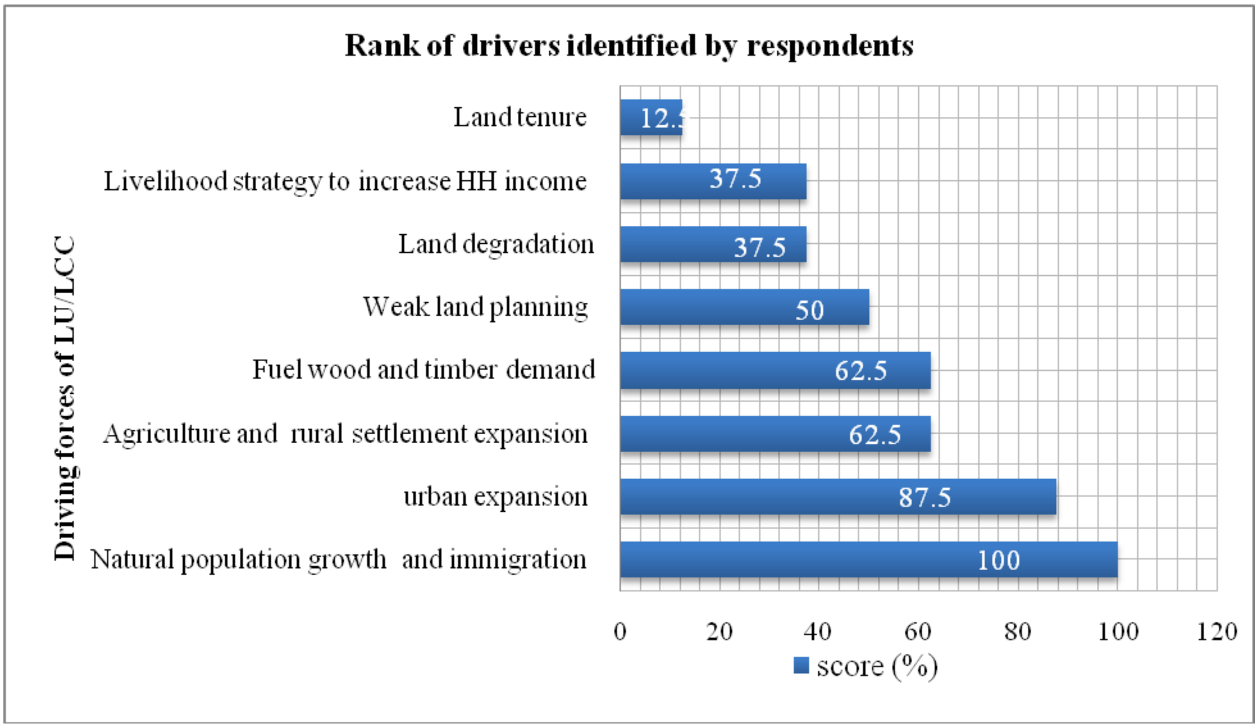


Figure 9 Key driving forces of land-use/cover change perceived by respondents.

The findings of this study show that underlying drivers of land use/cover are specific to a location as it was revealed by other similar studies (Geist and Lambin, 2002; Leper *et al.*, 2004; Rudel *et al.*, 2005). The driving forces of land cover include both biophysical and socioeconomic factors (Geist and Lambin, 2001; Keys and McConnell, 2005) as described in the next sections. Wood *et al*. (2003) also reported various categories of drivers that include intensive agriculture, climate, infrastructures, population pressure, development projects, commodity production, forestry practices, land tenure and others in Senegal.

4.4.2.1. Population growth

The growing population is one of the most critical drivers of the observed land cover dynamics because the livelihood of the population of the study area is dependent on a mixed farming system of crop production and livestock and forest based activities and other land resources. Additionally, increasing need of land for residential and other social and economic activities of urban dweller also grew with increasing population. At the same time, the growing demand for cultivated land and settlement and trees for fuel and construction purposes in both urban and rural areas aggravates the change. Data obtained from CSA Jimma office depict that the population of Jimma town and surrounding rural kebeles increase with more than double with 30 years period (Figure 10). Population growth coupled with increasing need of farmland in rural areas for new household and increased demand of land for built up in urban areas; ultimately, leads to expansion of built up area, and plantation forests with the cost of wetlands, grazing lands, agricultural. The existing high rate of population growth, because of the high natural increase and in-migration to urban centers, also exerts immense pressure on land resources in Jimma town and its surrounding. Agrarian population and urban population in Ethiopia(CSA, 2008), in general, Jimma town and its surrounding rural area in particular, is experiencing high annual growth rate, exceeding 5.53 percent and 3.78% respectively. Ndabula C. *et al*. (2011) in their study on Kaduna City of Nigeria growth in population have been identified as one factor that contributed greatly to land use land cover change and spatial expansion of urban areas.

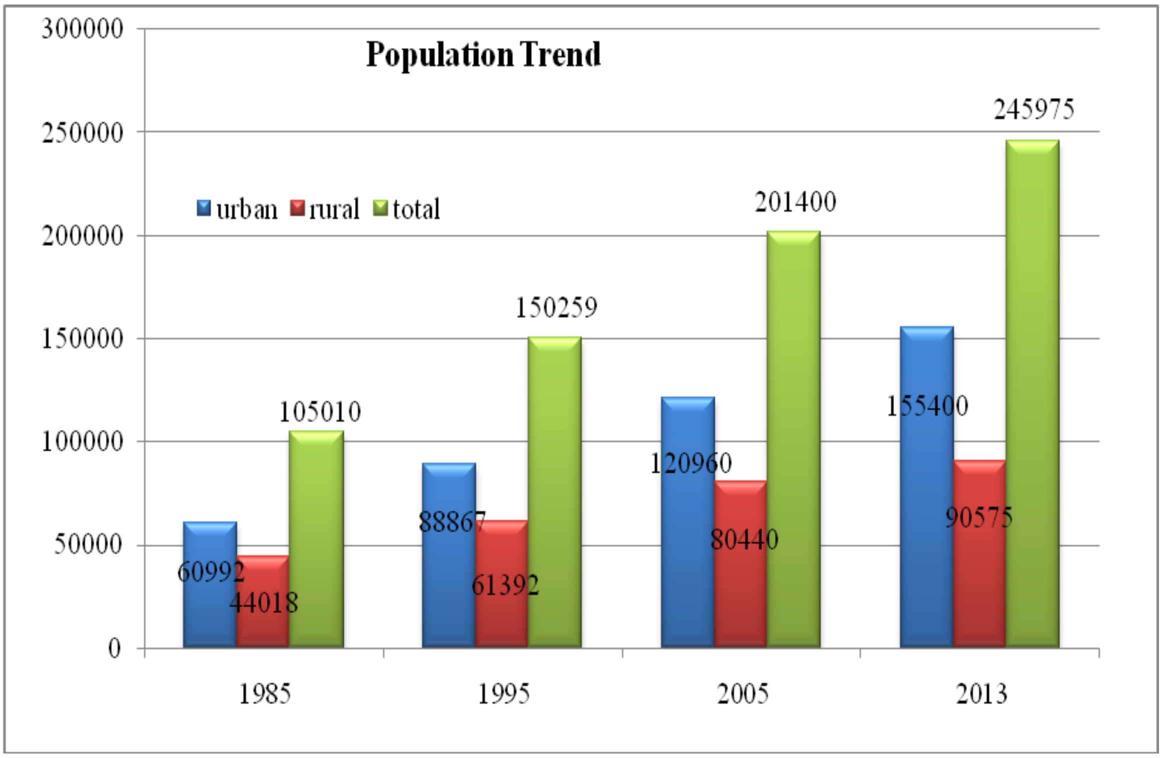


Figure 10 Graph showing trend of population growth in the study area

4.4.2.2. Urbanization

Urbanization greatly contributed to the loss of agricultural land, wetland and coffee forests in the area and it is generally seen as one of the most important driver of land use change without considering the natural condition of the land. According to socio economic survey with individual households and discussion with focus group living in the area expansion of urban and other infrastructures were listed as the drivers of land cover change in Jimma town and the surrounding rural areas especially between the years 2005-2013 as indicated on Figure 11(a) and 11(b).

The main infrastructural expansions associated with in the past and recent years include Jimma airport, privately owned housing units and educational institutions covering large area, rural infrastructures expansion, and construction of condominium buildings on open space of the town. The relationship between the spatial urban expansion and urban population growth was also examined in this study. The average annual spatial expansion of Jimma town was 7.8% and whereas the average annual population increase rate of Jimma town is 5.53%. There is high rate of spatial urban expansion and increase of population; which facilitate rate of land cover change. Studies by Njungbwen (2011) and Tran (2008) also stated the impact of urbanization as a major driver of land use/cover change in urban environments.

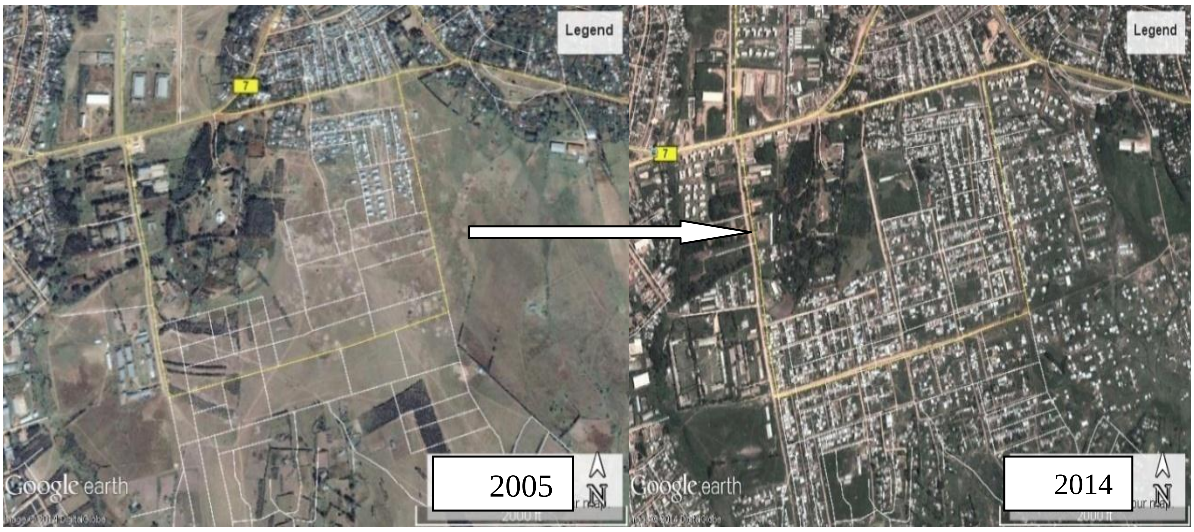
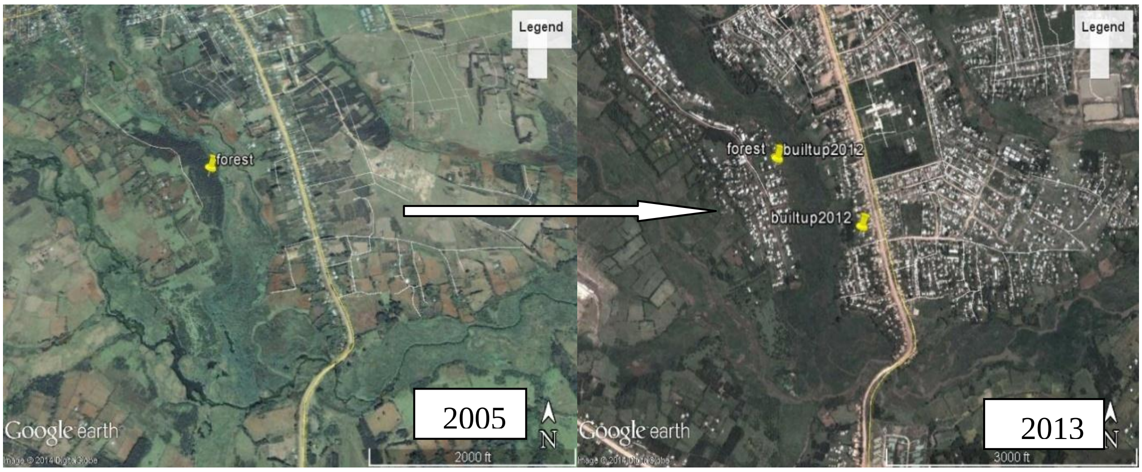


Figure 11(a) Sample pictures of LU/LC change because of expansion of housing units on some parts of the study area with the cost of agricultural land, forestland and wetlands.



Source; Google Earth Pro

Figure 11(b) Sample pictures of LU/LC change because of expansion of housing units on some parts of the study area with the cost of agricultural land, forestland and wetlands.

The survey indicated that in past decades the number of rural to urban flow of households for seeking urban life style is increasing and economically better off households from rural areas construct home in urban rural boundaries, because of these recently agricultural lands at urban boundary, seasonal wetlands and other open spaces are converted to residential areas. Additionally, in rural areas around Jimma town small clustered village centers with relatively modern buildings (namely; recently more developed clustered rural centers include; Merewa, Mazoriya, Gunju were increased compared to the past years) were expanded as a result of growing need of urban life style.

4.4.2.3. Growing demand for forest products

Associated with population increase and conversion of natural forests to coffee plantations in rural areas and urban rural boundary of Jimma town there is great expansion of eucalyptus plantation in contrary to past decades. Out of the total respondents in rural area around Jimma town and rural urban boundary 69.28 % of them have 0.1 to 1.5ha of *Eucalyptus spp.* plantation to meet their wood demand shortage, construction material and as income source. The owners responded that the eucalyptus plantations were expanded by conversion of grazing lands, farm plots and wetlands. The main reason for increasing attention of eucalyptus plantation in this area is the decreasing trend of land quality, increasing cost of agricultural inputs (fertilizer and improved seeds), low labor and material requirement of growing *Eucalyptu*s plantation; high market demand in urban centers for fuel wood and construction.

Zerihun kibebew (2010) on his study in Jimma area also reported that the intention of growing Eucalyptus under community and farm forestry program before three decades to solve wood demand shortage in response to loss of natural forest has been changed to market oriented growing practices over period of time because of its significant economic benefit to the land user. (Tariku Mekonnen and Abebayehu Aticho, 2011) also depict that eucalyptus spp. plantation at the bank of the wetland around Jimma town as a main driver of wetland degradation and land use change.

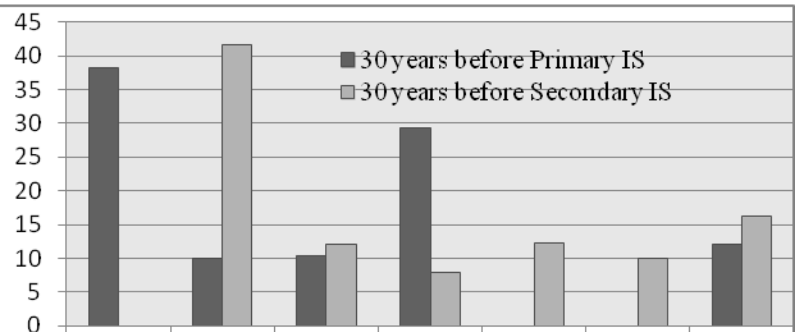
4.4.2.4. Livelihood strategies

The major livelihood strategy-induced driving forces towards the existing rapid LU/LC changes in Jimma area are the expansion of agricultural land, *Catha edulis* (khat) plantation, fruit tree plantation, charcoal production and firewood collection. The farmers are currently converting the grazing lands into plots of farmlands mixed with scattered chat plantation, in order to increase their income. Meanwhile, some rural households are increasingly engaged in plantation of fruit trees (*Persea americana*, *Mangifera indica*, etc) mixed with Coffee and khat plantation around homestead as a strategy to increase household income. Particularly, those economically unfortunate households are highly dependent on charcoal, firewood sale, brick making and lumber processing to fulfill the livelihood requirements of their family. The combined effects of these factors certainly result in rapid conversion and/or modification of the land cover. Walker *et al.* (2001) wrote that in many countries, local peoples combine subsistence and income-generating activities that may leads to affect land cover category.

4.4.3. Impacts of Land use/cover change

4.4.3.1. Changes associated with household income source

Out of the total households interviewed in rural areas 100 % of them respond that the contribution natural forest products, cattle production, wetland products and farm lands to household income is dramatically decrease because of conversion of natural forests completely to disturbed coffee forest and farm lands, wetlands and grazing lands to other land use type compared to past three decades. Respondents in rural area depict that compared to last 30 years the main source of household income that were previously generated from natural forest and wetland was lost. Out of the total interviewed respondents, 38.3% depend on crop production, 10% livestock rearing and 10.4% involve both livestock and crop production, 29.3 % engaged in trade activity, and 12% of them are hired/salaried as the household main income source before 30 years (figure 12).



	crop production	livestock	Mixed	Business (trade)	sell of forest products	other income source	hired salaried
30 years before Primary IS	38.3	10	10.4	29.3	0	0	12
30 years before Secondary IS	0	41.7	12	7.9	12.2	10	16.2

Figure 12 Perceived Household income sources before thirteen years

Whereas, currently this was changed to diversification of income sources associated with shortage of land, conversion of natural areas to disturbed anthropogenic land uses. As it is depicted on Figure 13; currently 29.5% of the respondents depend on annual and perennial crop production, 5% of them on livestock production 15.1% of them on mixed agriculture, 28.1% of them use trade as main income source, 5% forest based income and 12.3% was hired/salaried as main income source.

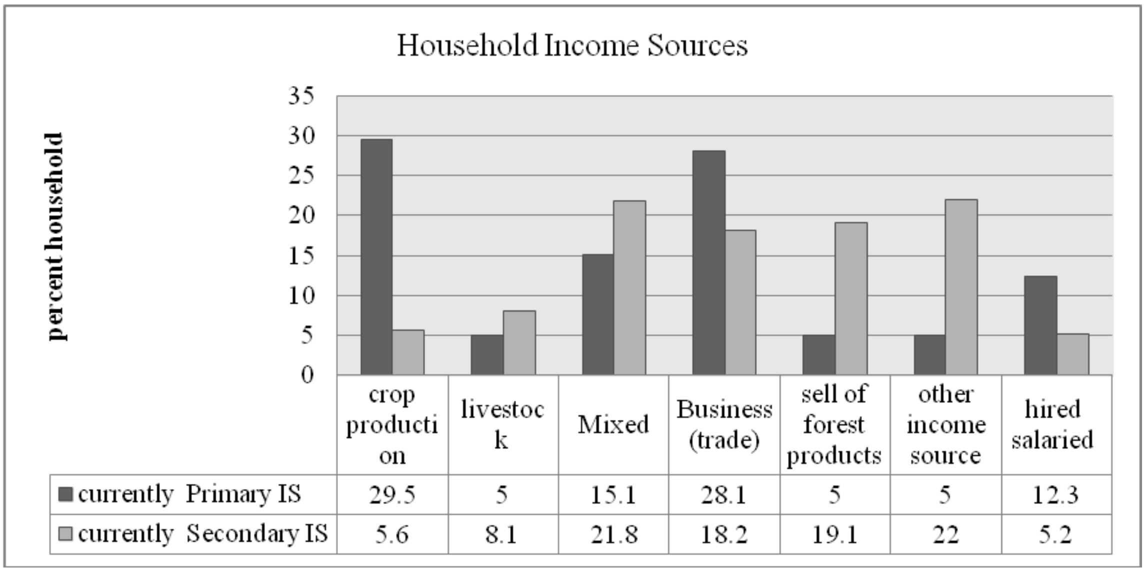


Figure 13 Current household income sources

This shows because of changes of land cover categories to other land use systems most of the inhabitants of the study area were obliged to diversify their income source rather than relying on individual activities. In addition 27.14% household respond that currently compared to past 30 years total household income from natural landscapes like forest, wetlands shows complete decreasing trend.. Whereas, 72.86% respond that their income shown increasing trend by diversifying other income sources and using new agricultural technologies to increase production. This finding is similar with Hun Rasmey *et al*. (2010) which shows; associated with land cover changes natural resource dependent and other economically unfortunate communities will obliged to search for other income sources. Mary K., *et al.* (2009) also finds that because of land use/cover change inhabitants obliged to diversify their income source to cope up the impacts.

4.4.3.2. Changes associated with livestock asset

In the study area, according to interview with respondents the source of livestock feed were private land, common land and both the private and common land and other factory by-products. The general trend of livestock population shows declining; as impacted by land holding size of the household. This is because of the interplay of increasing population, loss of soil fertility and land fragmentation resulted in loss of grazing lands for food production, rural settlement expansion, plantation expansion and urbanization. As such households change from traditional methods of animal husbandry such as large number of cattle on communal grazing land to small number of cattle in tethered, zero grazing feeding and on own plots of grazing land.

Allocation of previously communal grazing lands for land less people, conversion and fragmentation of most of private grazing lands to crop land and eucalyptus plantation was create obstacles to increase livestock number and reduce benefits generated from livestock production. Because of shortage of grazing lands most households owing cattle in urban centers, peri-urban and rural areas of Jimma town use wetlands as feed source for their cattle through continuous grazing. 71.2% of the respondent households shown that the decline in livestock number and benefits from livestock; because of loss of grazing land, 28.1% of them depict the increasing trend in number of livestock using modern ways of animal production (zero grazing and tethering) and 0.7% shows no change as result of using large own grazing land. Generally, there was a decline in the number of cattle that were kept by most of the households in the area as shown below Figure 14 below.

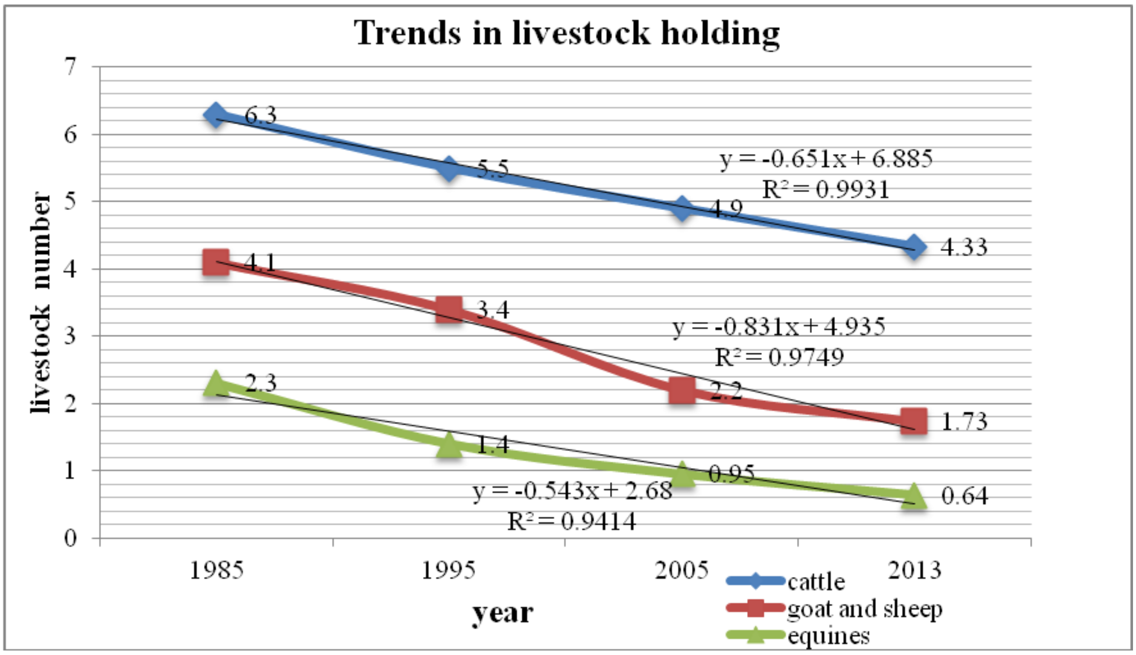


Figure 14 Trends of livestock Asset

The reasons for the declining of livestock number are many and most of the respondents recognized that grazing area had declined, due to the conversion to cultivated land, decrease productivity of grazing land, conversion of bush land to cultivated land and expansion of settlements.

Amanuel Abate, 2014 also find that the declining trend of livestock holding in Asandabo watershed of Gilgel gibe catchment because of conversion of grazing lands to other land use types. Hoekstra *et al*. (1999) also reported that the decline in fodder resources is due to the ever-increasing human population which resulted in an increase in crop land at the expense of traditional grazing areas such as bush land, natural pasture and forest, which has recently been aggravated.

4.4.3.3. Changes associated with crop production

Major crops grown in the study area include maize, sorghum and teff. Maize was the dominant crop. According to the focus group participants and 96% of the sampled households respondents the current land productivity is low as compared to thirteen years ago. There was an increasing trend of crop productivity for some years compared to the past that could be due to high fertility of the soil from expansion to new land best for agricultural production and new agricultural technology adoption. Meaning, there was agricultural land expansion into previously uncultivated areas, which usually takes place at an extensive and constant technological level; and agricultural intensification on already cultivated land.

According to the interviewed household and data on crop yield average production varies among different landscapes and between crops. , the main reasons for the changing in crop production mentioned was directly associated mainly with land use change. High population pressure in the area contributed to reduction of land for agricultural production. Similarly, the results of remote sensing data on land use change also show a decreasing trend of agricultural land for the last one decade. The decline in the average land holding, together with the disproportion between population growth and agricultural land further aggravated soil erosion later decline in soil fertility and impact on agricultural productivity.

Starting from village establishment (Mender Misreta) was made around 1987 during the Derg regime when farmers start using fertilizers through established cooperatives. People around rural areas and urban boundary of Jimma town became dependent on the use of fertilizers for crop production. According to 54% of respondents, currently the amount of crop yield harvested from a hectare of land is increased with increasing cost of input material (chemical fertilizers, improved seeds, herbicides etc) and labor input (improved agronomic practice) when compared to 30 years before and mainly it is for subsistence. Whereas; according to the rest 46% farmers, associated with continuous farming and expansion of eucalyptus plantation the amount of crop yield is decreasing. The dependency on fertilizer and other industrial inputs is affecting those poor farmers with low annual income and small land holding size because of lack of capital to afford those inputs. Joseph, *et al*. (2010) also find that land use change coupled with continuous cropping, erosion, leaching and removal of vegetation impacts soil productivity that will affect crop productivity.

4.4.3.4. Changes in availability of forest products

There were variations between urban and rural households in terms of forest product consumption. Rural households completely depend on forest products both for fuel wood and construction, whereas, urban households have other alternatives such as modern fuels and electric powers. The rapid population growth in the study area has led to an increased demand of forest products in particular fuel wood, construction material. Firewood and other products collected and used for home consumption are traditionally regarded by rural households as free commodities is now valued in money terms. According to respondents in rural area in the past decades they collect fuel wood mostly from nearby communal areas, own coffee forests and boundaries of their farmlands. Out of which 10.7% from own farm boundary, 2.1% from own woodlot, 33.3% from own coffee forest and 53.9% from open access areas and purchase in average distance of 1.1km (min.0.3km and max.2km). But currently 1.4% of households obtain firewood and other forest products from their own farm, 25% of them from own woodlot, 25% from own coffee forest, 49.3% purchase within average of 2.6km (minimum 1km, max. 4km). They spend a large percentage of their time searching for fuel wood instead of performing productive work in agriculture and they obliged to use crop residue (maize and sorghum straw).

Kiflu *et al.* (2009) in their study in and around Jimma town stated that the shortage of fuel wood because of high population growth rate that increased demand for agricultural land was the cause for conversion of forestland to other land use types. Other findings on fuel wood, deforestation and land degradation; also shown that imbalances between wood and other forest product consumption and supply affect time of household that used for productive work by searching fire wood and other products, increase use of crop residue and animal dung as fuel and affecting agricultural output (Bensel, 2008) .

4.4.3.5. Loss of agricultural land and land fragmentation

Respondent in rural area pointed out that an area that was owned by one individual in the time before three decades is now divided between several households. The average size of land holdings has shown a decline from 2.3 to 1.5ha per households (minimum holding 0.5ha and maximum holding 5ha (Table 14) over 30 years.

Land fragmentation to different small parcels is common in the area; in average, each household has about four parcels (minimum 1parcel and maximum of 9 parcels) of land fragmented to different place from homestead. Among the various factors identified and directly or indirectly contributed to land fragmentation are inheritance from parents to sons (which divide a family's land among all the remaining sons) sharing of resources including land when divorcing, transferring of land with permanent crop like coffee and chat to other household in form of sell and other economical factors play significant roles. According to respondents these land fragmentation to different parcels affects working time of farmers and needs high labor cost in production process. Additionally it makes supervision and protection of the land difficult; it entails long distances, the problem of transporting agricultural implements and products; and results in smallholdings. There were increasing demand of urban land in the area in between 1985 and 2013 with the cost of cultivated area in the fringes of Jimma town that converted to built-up, additionally agricultural land in rural area were converted to eucalyptus, chat and coffee plantations with loss of land for annual crop production. Totally, average cultivated land holding for annual crops were decreased from 1.12 hectares to 0.78 hectares. The decrease of cultivated land is resulted from the city's rapid expansion towards the farmland in urban fringe and conversion of other land use type in rural area. In the urban fringe, the local population has fear of their land taken by the city administration for expansion of housing and this further forced the farmers around the periphery of the town to transfer part or their farmland to other land seeker.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Present study demonstrate the combined methodology of multi-temporal remote sensing image interpretation and GIS spatial analysis to quantitatively describe the dynamics of land use/land cover change , drivers and impacts in and around Jimma town during the 1985-2013. Land use and land cover changes have wide range of consequences at all spatial and temporal scales. Because of these effects and influences it has become one of the major problems for environmental change as well as natural resource management. Identifying the complex interaction between changes and its drivers over space and time is important to predict future developments, set decision-making mechanisms and construct alternative scenarios.

This study has been conducted by integrating GIS, remote sensing tools and socioeconomic survey. In order to detect and analyze changes in land cover classes, these techniques were implemented. In the first section, satellite data for the study periods of 1984, 1994, 2004 and 2014 and remote sensing techniques were applied to generate land cover maps through a maximum likelihood supervised image classification algorithm. The accuracy assessment and change detection processes has also been done. The overall accuracy of land use and land cover maps generated in this study had got an acceptable value of above the minimum threshold. In the last section, socioeconomic survey was conducted to identify major drivers and impacts of change.

From the remote sensing part of image classification result, the study showed that the proportion of built up areas were increased. There was a rapidly changing of built up areas from 2.19% in 1984 to 3.09% in 1994 and 6.24% in 2004 and 7.09% in 2013. Agricultural areas and wetlands were played a major role for this much conversion to built up areas. Agricultural land showed a continuous increasing from 39.2% in 1985 to 56.75% in 2005 and finally had a decreasing value of 52.9% in 2013 as a result of pressure on agricultural lands by converting to built up areas and other land use types. The conversion of agricultural land, wetlands and grasslands to built-up areas could be related to increment of population and large socioeconomic activities in Jimma area. Accuracy assessments of classified images show better results with an overall accuracy of 93.1% in 1985, 94.66% in 1995, 94.4% in 2005 and 86.69% in 2013.

Socio economic survey also indicated in line with GIS analysis in the last three decades, trend of land use/cover in the study area indicates; forestland, grass land, and water body has shown a decreasing fashion. On the other hand there was a continuous increase in built-up area with cost of other land use types, whereas agriculture land shows increasing trend in the first two decades and then decreasing trend. These dynamics of land use/cover change were resulted from various socioeconomic driving forces like population growth, urban expansion, agriculture and rural settlement expansion, increasing demand for forest products, weak land planning and management land degradation, land tenure and different livelihood strategies to increase household income. As a result, there were various impacts on the environment and inhabitants. Among the impacts perceived by respondents: reduction in livestock asset, change in income sources of the households, loss of agricultural land, land fragmentation, changes in crop production and changes in availability of forest product are the major ones.

5.2. Recommendations

The results of this specific study have shown that remote sensing and GIS are important tools in land use and land cover change studies and integrated the results with socioeconomic data to identify drivers and impacts of the change have important indicators to set recommendations for land users and planners. Therefore, based on the findings of this study, the following points were recommended as future research directions:

- The use of high resolution imageries such as IKONOS and Quick Bird are important in generating good quality of land cover maps. Because urban areas have complex and heterogonous features, a high resolution imagery provide better information by mapping these areas. Moreover, the use of ancillary data as ground truth helps for better accuracy of an image classification.
- Use of land use change models are recommended for the area to obtain future spatio-temporal information of land use and land cover changes especially on urban areas to provide the possibility to understand the influence of urban dynamics supported by a set of drivers, hence; to improve efficient utilization of land.

- ❖ Land users, urban planners and other policy makers have to consider the status of declining water bodies around Jimma town and it is better to carry out urban expansion considering the natural condition of the land escape to reduce threats to wetlands and other land use types.
- ❖ Growing Eucalyptus plantation around Jimma town needs attention to reduce impacts on agricultural lands, grasslands and water bodies.

Finally, among other factors the land use/cover change in the study area were affecting natural resources and induces various impacts on livelihood of the local community. Therefore, the current trends in land use must be improved, towards the resources management and conserving of the existing natural resources in the study area through, planned use of urban land considering the natural condition of land escape using sustainable land resources management plan so that the negative impacts of land use/land cover change will reverted.

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APPENDIX

Appendix 1 Questioner

PART I- General Background Information

1. Name of interviewee (household) ___________________________________ House hold code______ Age__________ Sex_______ PA __________ Educational Level; _____

(Choose in year for level of education, 0=1, 1-4=2, 5-8=3, 9-10=4, 11-12=5, above 12=6)

2. Number of family members and their level of education

No,	Class	Male	Female	Total	Remark
1	0				
2	1-4				
3	5-8				
4	9-10				
5	11-12				
6	Above 12				
	Total				

3. For how long do you live in this area(years)_________________________________
4. Household's economic status category (rich, poor, medium) _____________
5. Household occupation in 1985__________ now_________ reason for change_________ (1= crop production only, 2= Off-farm activities 3= mixed agriculture (crop and livestock, 4=salaried, 5= trade (business), 6=others
6. Total land owned (rural area); in 1985 ______________ (facaasa)._______ (ha) urban land(M^2)________ Now ______________ (facaasa)._______ (ha) urban land (M^2) ________reason for decrease or decrease_____________________________________
7. What was number of Livestock over the last 30 years (Increasing, Decreasing, unchanged, why)

S/N	Item	Amount owned (in number)				Underlying reason
		Now 2013	10 years ago (2005)	20 years ago (1995)	30 years ago (1985)	
1	Sheep					
2	Cow					
3	Goat					
4	Donkey					
5	Oxen					
6	Horse					
7	Mule					
8	other					

Underlying reason (Lack of fodder = 1, Shortage of grazing land =2, Disease prevalence=3, Lack of veterinary services =4, Shortage of water =5, others (specify) =6

PART II. Land Use Change

8. What major shift in land use occurred in your locality (including communal lands) in the last 30 years?

(Provide qualitative description; +, - & No change)

Type of land use	Approximate size of each land use type								
	Last 10 years (2004-2014)			Last 20 years (1994-2004)			30 years ago (1984-1994)		
	Area	Quality	Underlying reason	Area	Quality	Underlying reason	Area	Quality	Underlying reason
Agricultural land									
Grazing/grass land									
Forest(Plantation									
Natural forest									
wetlands									
Urban land									
Water body									
Rural Settlements									

Key underlying reason= Fertility, market, climate, pest, policy..)

PART III. Land Use Type

1. How many parcel of land do you own? In 1985______ in 2013_____ reason for change___
2. Describe house hold land use type for each plots of land

No,	House hold Parcel of land (#) number or name of parcel	Area	Current land use (use code)	Objective of the land use	Past decades					
					10 yrs ago	Objective of the land use(code)	20 yrs ago	Objective of the land use (code)	30 yrs ago	Objective of the land use (code)
1										
2										
3										
4										
5										
6										

i. Key current use= (Grain crops (cereals) Teff, maize, sorghum) =1 coffee=2, Fruit Crops=4, chat= 5 Root Crops=6, Vegetables=7, Enset=8

ii. Key Objective of the land use (cash=1, food=2, other specify=3_____)

iii. Definition; a parcel of land is a piece of land with single operator or owner separated from other parcel by natural or manmade borders. A parcel/field can hold a single plot or more according to operator use.

3. Trends in Crop productivity per hectare of cropland by crop types (trends)

(Increasing=1, decreasing=2, no change=3)

No,	Type	Trends compared to **current productivity**					
		30 years before	Underlying Reasons	20 yrs	Underlying Reasons	10 year ago	Underlying Reasons
1	Annual crops (cereals) Teff, maize, sorghum etc						
2	Trends in input Use						

Key underlying reason; improved Awareness, new variety, increased fertilizer use,
Reasons related to forest destruction, ____

____

Key (degradation of farm land=1, change in land use type=2, expansion of urban area=3 infrastructures like road=4, other specify=5)

PART IV. Driving Forces

1. What are major drivers of land use change in your locality you think of?

(1= fertility decline, 2=Crop price, 3=climate, 4= government enforcement, 5= infrastructures like road, 6=increasing family sizes, 7=urban expansion, 8= increasing demand for forest products, others (specify))

______, _________, _______, _________, ________, _________, _________,

____

2. Describe new practices & regulations that influence land use in your locality at different points in time and their impact (land use policy, market, infrastructure expansion …)

____

____

3. Other specify (Agriculture and Rural Settlement Expansion=1, Demand for fuel wood and construction materials =2, sprawl of urban centers=3, exploitation for construction materials=4)

____

____

4. What is (are) your opinion(s) on the major causes of damage to forests in the area?

(Over-cultivation=1, need of cropland=2, Illegal cutting of wood=3, Over-grazing=4, Government weak Forest law enforcement=5, other= 6 specify)

______, ______, ________, ___________, _____________, ___________, _________,_____

____

PART VI. Socio Economic Impacts

1. How do you describe livelihood impact of Land use/cover change of the area? (the community is better off,=1, worsened=2)____ If better off, how? ____

   Describe____

   If worsened describe

   ____

2. What are the major social and economic impacts of changes in land cover(forest, wetlands, etc) on the surrounding community Effects________________________________

   (1= Scarcity of firewood and construction materials, 2= Animal feed shortage, 3= soil erosion, 4=food security, 5= other specify) _____, ______, ______, ___________,

   How? ____

(1= Decrease in livestock quantity and quality include, 2= Decline of household income from the sale of live animals, 3= Loss of draught animals, 4=Scarcity of milk and milk products, and 5= Lack of animal manure to replenish the soil fertility, 6= Implications of soil erosion like low productivity,)

3. Comments of the interviewed person regarding the information provided/ Special remarks of the interviewer regarding land use/cover change and its impacts:

____

Appendix Table 2 Land holding size of respondents

	Average land owned in hectare	Number of parcels	Annual crops ha	Coffee farm	Chat and other permanent crop	Woodlot	Grazing land
Mean	1.9662	4.2786	0.7762	0.4335	.3253	.2654	0.1445
Minimum	0.50	1.00	0.00	0.00	0.00	0.00	0.00
Maximum	5.50	9.00	3.25	1.75	1.00	1.50	1.75

Appendix Table 3 land holding size by land use types

Land size category	total land holding	Annual crop land	Coffee	other permanent crops	woodlot	Grazing land
0ha	0	7.86	9.29	1.43	30.71	51.43
<=0.5	7.14	28.57	67.14	90.71	57.14	43.57
0.5-1ha	20	48.57	21.43	7.86	10	4.29
1-1.5ha	15	12.14	1.43	0	2.14	0
1.5-2ha	22.14	1.43	0.71	0	0	0.71
2-3ha	26.43	0.71	0	0	0	0
>3ha	9.29	0.71	0	0	0	0

Appendix Tbale 4 Landsat TM and ETM+ satelite image properties

Property	Thematic Mapper (TM)	Enhanced thematic Mapper plus (ETM+)
Spectral Resolution (μm)	1. 0.45-0.52 (B) 2. 0.52-0.60 (G) 3. 0.63-0.69 (R) 4. 0.76-0.90 (NIR) 5. 1.55-1.75 (MIR) 6. 2.08-2.35 (MIR) 7. 10.4-12.5 (TIR)	1. 0.45-0.52 2. 0.53-0.61 3. 0.63-0.69 4. 0.78-0.90 5. 1.55-1.75 6. 2.09-2.35 7. 10.4-12.5 8. 0.52-0.90 (Pan)
Spatial Resolution (meter)	30 x 30 120 x 120 (TIR)	15 x 15 (Pan) 30 x 30 60 x 60 (TIR)
Temporal Resolution (revisit in days)	16	16
Spatial coverage (km)	185 x 185	183 x 170
Altitude (km)	705	705