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COLLEGE OF SOCIAL SCIENCE AND HUMANITIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

ASSESSMENT OF LAND USE LAND COVERCHANGE USING GIS AND REMOTE SENSING TECHNOLOGIES; A CASE STUDY OF WANTHOA WOREDA, GAMBELLA REGIONAL STATES, WESTERN ETHIOPIA

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TABLE OF CONTENTS

ACCRONYMS

CSA: Central Statistical Agency

DEM: Digital Elevation Model

FAO: Food and Agriculture Organization

GIS: Geographic Information System

ITCZ: Inter Tropical Converged Zone

LULCC: Land Use Land Cover Change

MoA: Minister of Agriculture

MoARD: Minister of Agriculture and Rural Development

RS: Remote Sensing

UNEP: United Nation Education Programs

WB: World Bank

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The study described the land use and land cover resources variability in WanthoaWoreda from 2005 to 2019 using Geographical Information System (GIS) and remote sensing. Satellite remote sensing and GIS acts as an effective approach for analyzing the direction, rate and spatial pattern of land use dynamics. Land sat TM for the period 2005, 2010 and 2019 was used to prepare the land use/land cover (LULC) map for different periods. The methodology that was employed consisted of an object-oriented classification approach for LULC mapping and a post-classification change-detection technique for quantifying the changes for seven major land use and land cover types which included Settlements land, Agricultural land, Grass land, Forest land, water occupied land, Shrub land, Woodland in the area. And the result was analyzed using this classification.

Accordingly the study founded that change was detected in different land use class between 2005 and 2019 which indicated that grass land, wood land shrub land and forest land cover class lost much of their land in the expend of agriculture land and settlement land. this showed that these land cover for the sack of others land use decrease by -1522,-728,-426 and -1030 hectare of land respectively between 2005 and 2019. In other hand these two land use types which include agriculture land and settlement land receive much of their gains from the above mentioned land use types by +3184 and +4434 hectare of land respectively within the same time frame that's 2005-2019. Within this study, the researcher found that, the entire classes of the study have gone some change in which most of the land cover received negative transformation to other land use. Therefore, within the entire 15yrs of study, agriculture and settlement receive a positive change which is 6000 and 5500 hectare of land that's is (9.20 %) and 11.89% of land respectively while others land cover which include grassland, woodland, forest land, water and shrub land received a negative change that's -2.44%,-12.92%,-70.31%,-26.66% and -35.78% respectively.

Keywords**:** *GIS, Remote Sensing and Land use land cover resources variability.*

CHAPTER ONE

1. Introduction

1.1 Background of the Study

Land-use/land-cover changes refer to quantitative changes in the aerial extent (increases or decreases) of a given type of land use or land cover, respectively. However, land-cover changes may result either from land conversion (a change from one cover type to another), or land modification (alterations of structure or function without a wholesale change from one type to another), or even maintenance of land in its current condition against agents of change. Global research on biodiversity has noted an increase in the magnitude and spatial changes in land cover resources variability on global biophysical resources due to increasing demands from humans (Meyer & Turner 1994).

Continuous pressure and unsustainable utilization of biophysical resources to acquire life-sustaining needs has resulted in increasing and considerable impact on the Earth's ecosystem functions (Lamb in et al., 2001). However, drivers of LULCC vary across the local, regional and global scale (Ramankutty& Foley 1999), but the ultimate implication for these rapid LULCC changes has significant impact across all three scales. For example the consequences of land cover resources variability includes global climate change (World Bank, 2008), natural resources depletion, species loss, habitat encroachment around protected areas buffer zones (Kintz et al., 2006).The rapid acceptance of the use of remote sensing for conservation and nature protection coincides with frequent reporting of wide spread modification of natural systems and destruction of land cover resources during the past three to four decades. Concerns about the increase in adverse environmental conditions prompted the remote sensing experts and users to quickly catch up with the evolving technology. The parallel advance in the reliability of Geographic Information System (GIS) has allowed the processing of the large quantity of data generated through remote sensing (Muezzi,2006).

According to Salem, (2003) geographic information system (GIS) is an important tool for monitoring biodiversity which accommodates large varieties of spatial and a spatial (attribute) data. The information embedded in a GIS is used to target surveys and monitoring schemes. Data on land cover resources distribution from different sources allow monitoring of the location and the extent of change. Conservation is considered“maintaining of nature as it is, or might have been before the intervention of either human beings or natural forces (Sigh, 2015).” Natural resources including land cover resources and their environment are getting depleted and environmental problems are increasing. It is, thus, necessary to conserve and protect our environment, therefore, applications of geospatial technology today is inevitable as a more comprehensive tool for assessing, managing, protecting and measuring land cover resources variability.

Like many other developing countries, Ethiopia has been experiencing environmental degradation problems including LULC conversion, soil erosion, loss of forest and other vegetation covers and water resource degradation (MoA and WB 2007). National level detailed investigation regarding the magnitude of land cover resources variability and its environmental implication is inadequate, however, micro-watershed level land use change studies using remotely sensed images were carried out in different parts of Ethiopia (Solomon 1994; Gete and Hurni 2001; Kebrom and Hedlund 2000; Woldeamlak 2002; Aklilu et al. 2007; Bezuayehu and Sterk 2008; Mohammed and Tassew 2009). Almost all of these studies found that land cover change conversion process is very intense in the highlands of Ethiopia. For example, one of the land cover components, forest has declined from 40% about a century ago to an estimated less than 15% currently with an approximate deforestation rate of 160,000 to 200,000 ha yr.

Nonetheless, the estimated figure lacks consistency from literature to literature. The expansion of cultivated, grazing and both urban and rural settlement were the typical reasons for this (Shiberu and Kifle 1998; Badege 2001; MoARD and SLM Secretariat 2008). Besides, too much reliance on woody biomass for fuel, the expansion of agricultural activities at the expense of vegetation cover and demand for wood for construction materials contributed to uncontrolled land cover change and deforestation in Ethiopia (Alemu and Damte 2011). Theorists in the field of social and earth system sciences hypothesized that LULC dynamics are triggered by the interaction of anthropogenic and biophysical driving forces. These drivers are a complex mixture of political, social, economic and biophysical factors that add force to environmental changes (Geist *et al.*, 2006) and intensified through high population growth rates (UNEP 2000). The expansion of diversified agricultural activities, wood extraction and infrastructure extension are clusters of proximate (direct) causes of LULC changes. As opposed to proximate causes, complexes of technological, economic, demographic, political, institutional and socio-cultural factors are grouped under underlying (root) causes of LULC changes. Thirdly, biophysical triggers such as topography, landslides, droughts, and natural fires are referred to as biophysical factors that underpin LULC changes (Ojima*et al.,* 1994, Lambin*et al.,* 2003, 2006, Geist *et al.*,2006).

Therefore in Gambella Region which is one among the least developed region in the country, resettlement program, demographic growth, large land investment in some part of the region and others factors like natural phenomena has cause social and environmental impact as forest and others land cover resources are being clear which lead to land resources variability in region in general and also in Wanthoaworeda in particular. Therefore as this variability of land cover resources was witness in the region, Wanthoaworeda is one among these area which has suffer a lot with this change of land use land cover Variability (CSA, 2007)

1.2 Statement of the Problem

Land use or land cover resources variability pattern of a region is an outcome of both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense anthropogenic pressures, e.g., agricultural expansion, forest logging, commercial plantation, mining, industry, urbanization, road hydropower, etc. All of these are responsible for damaging the land cover (Geist, 2002). It has already been widely accepted that the LULC play a very important role at local to global scales on ecosystem functioning, ecosystem services, and biophysical and human variables such as climate and government policies. Hence, land-cover classification and change detection analysis have become one of the most important and typical applications of remote sensing data. These natural and human factors were also seen in wanthoaworeda in which most of the area becomes sparsely covered than before (woreda report 2008). Therefore the increase of these natural and human factors had not only depopulate the land cover resources but also it leaded to a serious land degradation which had also affect the livelihood of the rural community who inhabited the woreda. Change in land use and land cover had result in land degradation that manifests itself in many ways depending on the magnitude of changes. All of these manifestations have potentially severe impacts on land users and people who rely for their living on the products from a healthy Landscape. This alteration of LULC type coupled with poor land management practice in the region resulted in exposing of land for erosion hazard, which was later turned to accelerated land degradation. All the factors of deforestation such as the prevalence of various types of agricultural activities, fire wood and charcoal production, cutting trees to fulfill the demand of constructional materials, settlement expansion and income generation are directly or indirectly related to population growth and new settlements. Therefore, it had been the work of this study to analyze the importance factors, which has highly influence the rapids of this land use land cover resources variability in the Wanthoaworeda.

1.3 Objectives of the Study

1.3.1 General of Objective

- The overall general objective of this study was to assess Land use land cover change in WanthoaWoreda using GIS and Remote Sensing Techniques.

1.3.2 Specific Objective

In association of general objective, the subsequent of the specific objectives were delineated in the following.

- To assess recent land use land cover change in WanthoaWoreda for last 15yrs
- To determine the factors that facilitates the land use land cover change in the area.
- To detect the magnitude of land use land cover change in community of WanthoaWoreda.

1.4 Research Questions

This research had attempted to synthesize the land covers resources variability in the area of study and its intensive effect on socio-economic and environmental frame. Therefore, the following Research Questions were carried out;

- Is there any land use land cover change in WanthoaWoreda?
- What were the causes of land use land cover change in the area?
- What magnitude of land cover change had been seen in the area?

1.5 Significant of the Study

Land use land cover resources variability is one of the current problems facing many areas today. It's difficult to prevent but can be managed in order to reduce its social and economic impacts. Therefore in this study, the people of the study area had understand the areas that are more susceptible to the change on land cover resources and help them to calls for proper planning process in managing land cover resources change in the land and provides details on sources of factors which increase variability in the area. This helped andpermitted the peoples to understand about physical parameter methods for land cover resources Variability. Risk intensity on social, economic and ecologies systems as well as the influences of both Natural and Human activities on Land use land cover Resources Variability. The Consequences, the exposure and the adverse impact of the Environmental cover change on human health, environment, cultural heritage and economic activity had been understood.

1.6 Organization of the Paper

The paper had been organized into five chapters;- Chapter One; deals on introduction/the background of the study, Statement of the problem, Objectives (general and specific objectives of the study) ,Research Questions ,Significance of the study , scope and limitation of the study and organizations of the paper. Chapter Two; deals with review the Literature that linked with Land cover Resources Variability assessment. Chapter three; deals on Research methodology, description of the study area, Sources and Types of Research data, Sample sizes and Sampling techniques, Method of data analysis and Presentation, and Ethical considerations. Chapter four although deals with how the data were presented and how they were analyzed and finally Chapter five focused on the conclusion seen the resulted data and how the researcher recommended the community to take measure on current ongoing problem in the area

1.7 Limitation of the study

Despite the fact that the research finished on time, many obstacles were also there. These included lack of soil data in the area, inappropriate response from the respondents and lack of free transport to the area due to recent instability in the region.

CHAPTER TWO

2. Literature review

2.1 The concept of land use land cover variability

Land use land cover resources variability has the global concern of the twenty-first century, with the dramatic implication for human survival. Land cover change is the change in the physical as well as biological characteristics of land which is attributable to management including conversion of grazing and forest land into farming land, pollution and land degradation, removal of vegetation, and conversion to nonagricultural uses (Quentin et al. 2006; Prakasam 2010; Shiferaw 2011). Recently research on land use and land cover change detection has drawn attention of many researchers (Liang et al. 2002; Ayele et al. 2016). It affects biodiversity, hydrological cycle, land productivity and the sustainability of natural environment (Lupo et al. 2001). Continuous from the previous and in the coming years land cover resources variability has been playing a wide role of driving force in alteration of the global environment (Baulies and Szejwach 1998). The increasing change is alarming, and can have a huge implication on local, regional, national and global environment and consequently affect the food availability (Minale 2013).

According to Reid et al. (2000), land cover resources variability is continuously changing the surface of the earth. In the past few decades the conversion of forest and wood land, grass and pasture land into agricultural and pasture land has dramatically increasing in the tropics (Turner 1990). Land cover change is accelerated by human activities and natural processes. Similarly, the change due to the complex interaction of various social, economic and biophysical situations following agricultural diversification, advancement in technology coupled with alarming rate of population pressure. Shiferaw (2011), pointed out that associated population pressure found to be negative result on land use change. Soil erosion, land degradation, destruction of habitat and biodiversity; loss of endemic species due to our migration are resulted from land use dynamics (Meyer and Turner 1992). Even though many controversies on the factors of land cover dynamics, few research studies concluded that demographic factor is intensively accelerate to land use cover change (Mather and Needle 2000). Alarming rate of population dynamics, insecure land use right, lack of credit facilities and lack of market availability are some of socio-economic factors which facilitates for the change of land cover resources. For the poor those are living under subsistence farming has no other option other than natural resource. There was mismanagement of natural resource such as overgrazing, de-vegetation and expansion of agriculture into the marginal land as well as steep slope for the survival of their livelihoods (Grepperud 1996; Minale and Rao 2012a, b; Amare 2013; Asres et al. 2016). Despite the expansion of cultivation from sloping into steeper slope with inappropriate soil and water conservation measure, crop production is still lagging behind by 2.67 % annual population growth rate (Asres et al. 2016). Intense pressure on agricultural land, forest land and the availability of fuel wood in the sounding area in Ethiopia is the result of spatial and demographic changes; it exerts massive pressure on land use, agricultural productivity, and the use of ecosystem (Minale and Rao 2011). In most parts of the world, particularly in developing countries agriculture is the livelihoods of the population in turn primarily the most driver of land use change.

However, limited studies have been done on long term trend of land cover change (Goldewijk and Ramankutty 2004). For instance, in east Africa in the last 50 years, as the expense of other land use, there has been intensive expansion of agriculture into marginal land (Yitaferu 2007). Semiarid and sub humid areas were dominated by pasture land with widely scattered settlement and agricultural activity before 1950, but then after there has been a massive change of grazing land into mixed crop- livestock agriculture. Interaction between various socio-economic conditions of the society, population pressure, physiographic feature, and land use type has resulted in land cover change, Therefore, land use classification used to analyses the interaction between socio-economic and land cover variability, which is contributed for the dynamics of land use and land cover change resulted from diversified and intensives agriculture and livestock population (Mendoza et al. 2002). The interaction between various anthropogenic and natural factors cause for land cover change (Fasona and Omojola 2005) and the utilization of this resource by human population in time and space (Cleavers et al. 2004), analyzing land use and land cover change at watershed and sub-watershed level using Land sat imagery and clearly identifying the rate and extent of land cover change is critically important input for the prioritization of natural resource management. To monitor land cover resources variability, geospatial techniques has important role, therefore, geographic information system tools are used to grasp information about extent, rate and magnitude of land use cover change and disseminate accurate information (Carlson and Sanchez-Azofeifa 1999; Guerschman et al. 2003; Dezso et al. 2005). As FAO (1986) cited in Asres et al. (2016), in the mid1980s, around 27 Mha highland part of Ethiopia was significantly eroded as the same time around 14 Mha was seriously eroded. It concluded that more than 2 Mha of agricultural lands has reached at the point of zero return. Critically analyzing the driving force for land cover dynamics of the past trend is important to understand the recent changes and predict for future alteration. A study of land cover resources change and its driving force in time and space provides favorable foundation for the sustainability of natural resource systems, because it used to reflect the state of watershed. Therefore, land cover change and its driving forces are important for designing policies and strategies for the sustainable natural resource management and use. Even though different studies have under taken about the extent and status of clearing of forest, land cover change and soil erosion in many parts of Ethiopia, poorly documented about land use land cover resources change and its driving force.

2.2 Trend of Land use land covers variability

Several decades of research have revealed that land-use/cover change (LUCC) is one of the most essential interacting components of global change affecting the Earth's system (Foley et al. 2005). The importance of monitoring LUCC has been recognized by scientists and practitioners, and the capacity to monitor this has been greatly facilitated by the number of and improvement in remote-sensing sensors over the past two decades (Gut man et al. 2004). Burgeoning research programs and projects on utilizing datasets derived from Earth observation have generated diverse publications, including, but not limited to, monitoring LUCC (Townshend and Justice 2002), simulating its change (Parker et al. 2003), linking social with physical processes (Walsh and Crews-Meyer 2002) and investigating the consequences of LUCC (DeFries et al. 2002). Keeping track of the latest scientific advances of this subject is, however, challenging because the increasing volume of the literature and the interdisciplinary nature of LUCC studies could easily obscure the patterns, trends and relationships in research publications. A visualization approach that can reveal the pattern and structure of the established LUCC research is therefore desirable.

2.3 Factors of land use land cover variability

2.3.1 Physical factors of land cover variability

Biophysical and societal factors at the micro and the macro levels are intricately interrelated and interdependent. Local weather conditions are affected by and affect the regional land cover change. Local soil and ecosystem types are determined by and determine regional soil and ecosystem types which play a great role in land cover resources variability(Kaihura and Stocking, 2003).. The decisions of individual land managers are influenced, sometimes strongly, by decisions of persons or organizations at higher levels so that, in essence, local land-use change is often the result of higher level decisions as Blake and Brookfield have demonstrated. Land-use and land-cover changes produce environmental and socio-economic impacts that frequently feedback and modify the biophysical and societal factors causing them. Thus, new rounds of change come up as the ensuing discussion will demonstrate .The establishment of unambiguous causal relationships among the particular biophysical and societal factors that act as driving and mitigating forces of land-use and land-cover change is not straightforward because their relative influence and importance as well as their interactions depend on the spatial and temporal level of analysis and the geographical and historical context of study, their intricate spatial and temporal interplay, their changes over time and the difficulties to observe and describe many of them as well as the processes through which they influence land-use change.

2.3.2 Anthropogenic Causes of Land cover Variability

Expansion of cultivation in many parts of the world has changed land cover to more agro ecosystems and less cover of natural vegetation (Lyaruu, 2002; Tiffen, 2003). These changes are fuelled by a growing demand for agricultural products that are important for improving food security and generate income, not only for the rural poor but also for the large-scale investors in commercial farming sector. Historically, humans have increased agricultural outputs mainly by bringing more land into production (Lamb in et al., 2003). Natural vegetation cover has given way not only to cropland but also to native or planted pasture (Lambing et al., 2003). During the last few decades, the area under cultivation has more than doubled in East Africa (Olson et al., 2004). Land scarcity in the highlands of East Africa caused farmers to intensify their land use because there was little land available for extension of their farms (Olson et al., 2004). Globally, concerns about the changes in land cover resources emerged due to realization that land surface processes influence climate and that change in these processes impact on ecosystem goods and services (Lambing et al., 2003). The impacts that have been of primary concern, are the negative effects of land use change on biological diversity, soil degradation and the ability of biological systems to support human needs. Crop yields have declined, forcing people to cultivate more land to meet their needs. Grazing areas have become less productive resulting from over stocking of livestock.

Anthropogenic alterations of the natural landscape through urbanization, agriculture and forestry have been continuous and increasing process for the past millennium (Vanacker, 2002). This has caused significant and adverse effects on physical and ecological process (Bailey, 1994), on soil and water (Munishi et al., 2006) on local and global climate and on biodiversity (Turner et al., 1994). A study by Meyer and Turner (1996) showed that land use both deliberately and in adversely alters land cover such as vegetation by changing it into different state like building materials, medicinal, wood and fuel, hence deforestation. Recently, efforts have been made to quantify the nature and extent of land use/land cover changes including vegetation at global scale (e.g. Zhou et al., 2008; Dewan and Yamaguchi, 2009). Richards (1990) estimated that, over the last 300 years, the total global area of forest and woodland diminished by 19%, while grasslands increased by 46.6%. Despite the recognition on the magnitude and impact of global changes in land cover resources variability; there have been relatively few comprehensive studies on land use changes and their impacts (Strategic Plan for the climatic change Science program 2003)

2.3.2.1 Agricultural expansion

Agricultural expansion}defined as higher levels of inputs and increased output (in quantity or value) of cultivated or reared products per unit area and time} permitted the doubling of the world’s food production from 1961 to 1996 with only a 10% increase in arable land globally (Tillman, 1999). Such achievements are viewed skeptically by observers contemplating the future of non-irrigated agriculture in the tropical world where intensification may be considered as environmentally untenable, owing to special biophysical constraints and socio-economic conditions that inhibit farmers’ (especially smallholders’) access to input factors. Rapidly developing land scarcity may trigger increase in cropping frequency unmatched by appropriate changes in inputs or management, resulting in a ‘‘stressed’’ system with stagnating or declining output (English, 1998Turner and Ali, 1996), abandoned ‘‘land’’ capital such as terraces, irrigation (Stone, 1998; Ramakrishna, 1992), and land degradation. Although such negative trajectories of change are well documented, the more common response to land scarcity may be adaptation of the agricultural system to increase yield (Bray, 1986; Netting, 1993; Turner et al., 1993; Dasgupta et al., 2000). Such adjustments usually include both intensification within the subsistence sector and increasing commercial output (Guyer, 1997), as well as new strategies by households, including circulation, migration and on-farm employment. Various combinations of diversification sustain agricultural systems even under high population densities and climatic risk (Mortimer and Adams, 1999; Mortimer and Tien, 1994).

2.3.2.2 Rangeland modifications

Rangelands are defined by the presence of grass and trees used by grazers or browsers, and encompass vegetation types ranging from complete grass cover, through woodlands with as much as 80% canopy cover, to pastures within dense forests. Despite advances in rangeland ecology, some management specialists hold to the misconception that rangelands are natural entities which, in the absence of human impact, would persist unchanging within climate epochs. Some rangelands are indeed largely edaphically or climatically determined (arid/xeric; coastal zone, alpine and wetland ecosystems). More generally, large areas of rangelands are maintained in their current state by the interaction of human and biophysical drivers (Solbrig, 1993; Sneath, 1998). Thus, human activities are commonly a functional part of these ‘‘semi-natural’’ ecosystems, and reducing or eliminating human use will trigger significant changes. Temperate and tropical rangelands are both highly dynamic and also resilient, moving through multiple vegetation states, either as succession sequences or by shifting chaotically in response to random interplay of human and biophysical drivers (Walker, 1993).

2.3.2.3 Settlement expansion

At least two broad urbanization pathways lead to deferent impacts on rural landscapes. In the developed world, large-scale urban agglomerations and extended peri-urban settlements fragment the landscapes of such large areas that various ecosystem processes are threatened. Ecosystem fragmentation, however, in peri-urban areas may be onset by urban-led demands for conservation and recreational land uses. In a deferent vein, economically and politically powerful urban consumers tend to be disconnected from the realities of resource production and largely inattentive to the impacts of their consumption on distant locales (Sack, 1992). Urbanization in the less-developed world outbids all other uses for land adjacent to the city, including prime croplands. Cities attract a significant proportion of the rural population by way of permanent and circulatory migration, and the wages earned in the city are often remitted by migrants to rural homelands, in some cases transforming the use of croplands and creating ‘‘remittance landscapes’’. Perhaps most importantly, this urbanization changes ways of life ultimately associated with demographic transitions, increasing expectations about consumption, and potentially a weakened understanding of production–consumption relationships noted for the well-developed world and this event lead to land cover resources variability.

2.4 Impact of Land cover Variability

2.4.1 Impact of land cover variability on community’s livelihood

Land degradation which appeared in the area particularly in agriculture is a result of rapid LULC changes. Land use/ land cover change and conversion can lead to deterioration in the properties of soils and degradation of land that affect the cultivated land. Since land use/ land cover patterns are interrelated with the types and properties of soils. The rate and severity of soil erosion and land degradation partly depend on land use pattern. The problem of soil erosion starts with the removal of land cover for various purpose (Solomon 2015) .The land use affects the soils. The land use/ land cover is by far most important determinants of erosion in the highlands of Ethiopia (Bewket W, et a l 1950). Among others the one factor that affect the productivity of the land are land use type. Vegetation cover and dead plant biomass are also used to reduce soil erosion by intercepting and dissipating raindrops and wind energy. However, once forestland is converted to agriculture, erosion rates increase because of vegetation removal, over-grazing, and continuous cultivation. Land degradation comprises the temporary or permanent decline in the productive capacity of land. Degradation adversely affects the productive, physiological, cultural and ecological functions of land resources, such as soil, water, plants and animals (UNEP 1992). Scherer et al. reveal that by 2020 land degradation may pose a serious threat to food production and rural livelihood, particularly in poor and densely populated areas of the developing countries (Scherer SJ, et al). Land degradation occurs in a number of forms, including depletion of soil nutrients, salinization, agrochemical pollution, soil erosion, vegetative degradation as a result of over grazing, and deforestation to increase farmland. All these types of degradation cause a decline in the productive capacity of the land, and thus reduce potential yields.

2.4.2 Impact of land cover variability on Forest Resources

The growing population and increasing socio-economic necessities creates a pressure on LULC. This pressure results in unplanned and uncontrolled changes in LULC. The LULC alterations are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods etc (Seto et al, 2002). LULC is increasingly recognized as an important driver of environmental change on all spatial and temporal scales (Turner et al, 1994). LULC contributes significantly to earth atmosphere interactions, forest fragmentation, and biodiversity loss. It has become one of the major issues for environmental change monitoring and natural resource management. LULC and its impacts on terrestrial ecosystems including forestry, agriculture, and biodiversity have been identified as high priority issues in global, national, and regional levels (Zhang et al, 2009). According Boakye et al (2008), LULC leads to degradation of forest or woodland and these have impact on forest cover changes, it is remarkable to note the difference between the past and the present forest cover in Ethiopia. FAO currently presented Ethiopian forest cover information that 11.2% or about 12,296,000 ha are forested. Of this 4.2% (511,000 ha) is classified as primary forest.

Ethiopia had 511,000 ha of planted forest. Ethiopia lost an average of 140,900 ha or 0.93% per year between 1990 and 2010. In total, between 1990 and 2010, Ethiopia lost 18.6% of its forest cover or around 2,818,000 ha. LANDSAT/TM satellite images from 1986 to 1990 show that Ethiopia's forest cover had since then been reduced to 3.93%, or 45,055 sqkm (Ministry of Water Resources, 1997). The figures refer to an annual deforestation rate of 163.600 ha. This means that up to 1999, the size of Ethiopia's natural high forests has been reduced to 2.36%, respectively 27,059 sqkm. Today, larger forest areas can only be found in very remote and inaccessible areas of South and Southwest part of Ethiopia. A detailed analysis of the density classes shows that between 1973 and 1990, the area coverage of closed forest stands had been reduced from 30,243 sqkm (2.64% of the country's area) to 2,346 sqkm (0.2% of the country's area). The ongoing exploitation could be documented by the fact that within the same time span, the share of severely degraded high forest increased from 0.87% to 3.08%. The following figure shows the extent and the area dynamics of the forest degradation by human impact in Ethiopia between 1973 and 1990 (Reusing, 2000). As mentioned earlier, different studies made using remotely sensed data of different years, for some parts of Ethiopia indicate that croplands have expanded at the expense of natural vegetation including forests and shrub lands (Selamyihun, 2004; Girmay, 2003; Belay, 2002; Gete and Hurni 2001; Solomon, 1994). While Kebrom and Hedlund (2000) reported that there is an increase in the size of open areas and settlements at the expense of shrub lands and forests. Open areas increased by about 333% while urban and rural settlements increased by about 192 and 57%, respectively in twenty eight years (between 1958 and 1986), in Kalu area of Wello. So one way or another, forest cover of different parts of Ethiopia is under serious threat and this could result a country with very small, sparse and fragmented forests

2.4.3 Impact of land cover variability on surface water

The main reason for land use change pattern is the fast development in socio-economic, which include change of cropland to urbanization, as well as changes within classes such as a change in crops or crop rotations. Particularly in regions where limited water is available, land use changes might result in an increment of water scarcity and thus contribute to a decline in living standards. This is mostly true in the case of the fast developing city like Pun in India. The major land use changes that were recognized were an increase in urbanization from 5.1 % to 10.1 % and agriculture from 9.7 % to 13.5 % of the catchment area during the 20 years. Urban growth was largely experienced in the eastern part and change to cropland in the mid-northern part of the catchment. Urbanization leads to rise of water yield by 7.6 %, and a related reduction of evapo-transpiration, whereas the increase of agricultural area resulted in an increase of evapo-transpiration by up to 5.9 %. (K. Schneider et al 2015).

CHAPTER THREE

3. Description of the Study area and Methodology

3.1 Description of the Study Area

3.1.1 Location of Study area

Wanthoa is one of the woredas in the Gambella Region of Ethiopia. Part of the Nuer Zone, the geographic Coordination System of the WanthoaWoreda is between 8°30’N-8°20’N latitudes and 33°10’E-33°30’E of longitudes. As seen in Figure 1, Akobo borders Wanthoa on the south on the west and north by South Sudan, on the east by Jikawo, and on the southeast by Anuak Zone; the Akobo River to the west and the Baro River on the north define Wanthoa's boundaries with South Sudan. The main towns in this woreda include Matar

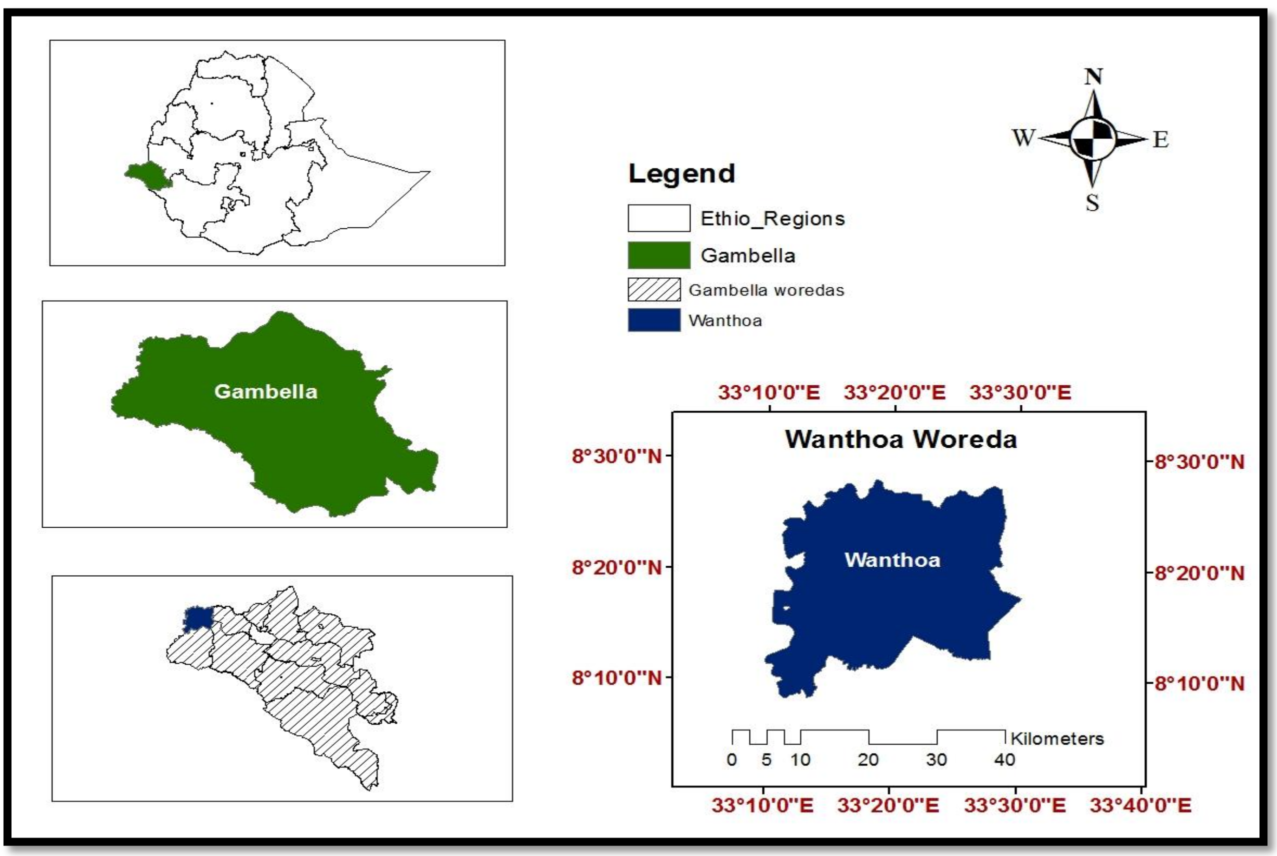


Figure 1: Location Map of Study area (Ethio-GIS, 2019)

3.1.2 Demographic of the area

According to (CSA), 2007 Census this woreda has a total population of 20,970, of whom 10,991 are men and 9,979 women; with an area of 887.74 square kilometers, Wanthoa has a population density of 23.62, which is less than the Zone average of 23.79 persons per square kilometer. While 2,851 or 13.60% are urban inhabitants, a further 59 individuals are pastoralists. A total of 3,996 households were counted in this woreda, which results in an average of 5.2 persons to a household, and 3,846 housing units. The majority of the inhabitants said they were Protestant, with 92.82% of the population reporting they observed this belief, while 3.22% practiced traditional religions, 1.89% are Catholic, and 1.58% of the population practiced Ethiopian Orthodox Christianity.

3.1.3 Economic Activities

The economy of the areas is mixed farming (crop production complemented by livestock rearing).Crop production are rainfall feeding. The main crops grown for home consumption are maize, and sorghum. Maize and sorghum are long cycle. The livestock reared are cattle, sheep, goats, donkeys and chickens. Livestock are replaced through purchase and from within the herd. Men and women share the responsibility of looking after animals. Livestock's are the primary source of income in Woreda. In the Rural and Town people are mostly depends on agriculture, livestock, fishing, trade and administrative services (CSA, 2007).

3.1.4 Topographic and Climatic Condition

The woreda extends hot lowland zones with extreme ranges of temperature and rainfall variation. There are two seasons in the Wanthoaworeda based on the movement of Inter-Tropical Convergence Zone (ITCZ), the amount of rainfall and the rainfall timing. The two seasons are Kiremt (summer), which is the main rainy season (June-October), Bega (spring), which is the dry season (November-May). The mean annual rainfall varies from 800 mm in the elevated areas to 1,200 mm in some area of the woreda. In the same way, the mean annual temperature of WanthoaWoread ranges from 30.8°C in the upper part to 39°C in the lower part. The terrain in WanthoaWoreda consists of marshes and grasslands area; the elevations range from 390m to 410 m. a. s. l. Ethiopia is an important regional center for biological diversity due to its wide ranges of altitude, its great geographical diversity with high and rugged mountains, flat–topped plateaus and deep gorges, incised river valleys and rolling plains. These helped the emergence of wide ranges of habitats that are suitable for the evolution and survival of various plant and animal species. The topography of Wanthoa district is located within altitudinal range between 401 and 411 m above sea level. Mostly, it's an area located on a nearly flat plain penetrated by Makuey River the tributary of the Baro, Gilo and other small rivers. It falls within the watersheds of the Baro and Gilo rivers–the tributaries of the Nile (Figure 4).

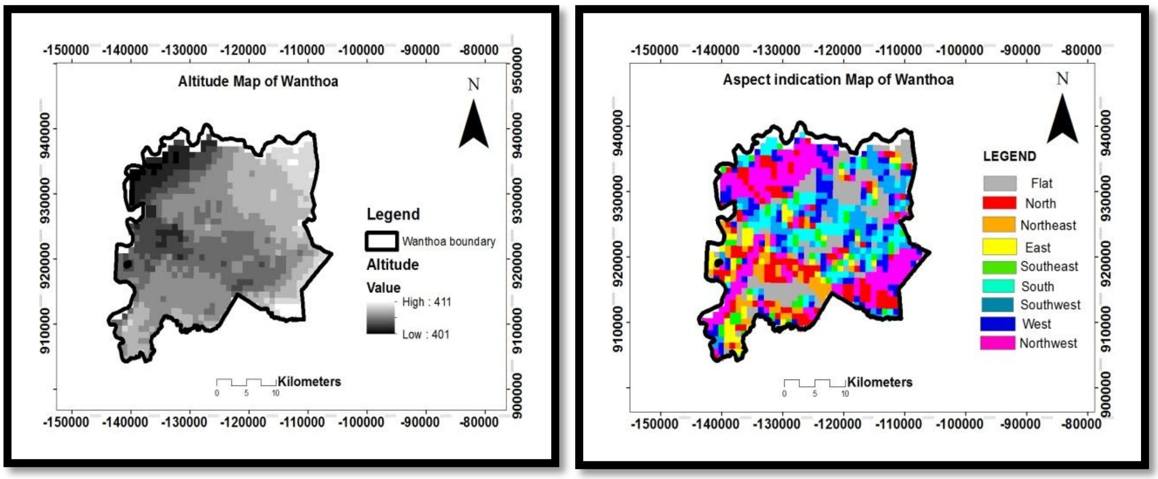


Figure 2:(A) Altitude Variation map of wanthoa; **(B)** Aspect map of wanthoa;

3.1.5 Land use, Land cover and soil

Area lies in moist every green forest and grass endowed with a vast marginal land which is suitable for Agriculture and other economic activities. The existing land cover (vegetation) types of the Woreda are identified as cultivated land, forest, woodland, bush land, grassland, wet (marsh land).The most common soil types in the study area are Cambisols and Vertisols. The Vertisols are dominated by the clay mineral. This clay mineral expands when there is a wet condition and shrinks when there is a dry condition, causing cracks at the surface in the dry season (FAO. 2014)

3.1.6 Vegetation

The woreda has a vast collection of savannahs, flood plains, riverine forests, lazily flowing rivers and grasslands. The general landscape is flat but it has area of little raised ground that supports deciduous woodlands and grasslands. Extensive areas covered by grasslands are inundated by water forming valuable seasonal wetlands in the rainy season. There are however extensive areas of permanently inundated wetlands especially near rivers. Grasses have lush growth and there are species, which can reach 2-3 meters in height (Tesfayeawas*et al.,* 2001)

3.2 Research Methods

Land use land cover change involves a complex set of factors, interacting in space and time leading to a decrease in land productivity and others problems. It is closely related to many environmental factors such as climate, soil, vegetation cover, and morphology where their characteristics, and their intensity, contribute to the evolution and characterization of different degradation levels. Land cover change is also strongly linked to socio-economic factors, since human's behavior and his social and economic actions can greatly influence the evolution of numerous environmental characteristics. There was much information for land cover change assessment, but to assess this phenomenon in an effective way, it needed to select and use some simple and available key indicators and indices to tackle this complex process. And the land cover classes were the following.

Table 1: Description of land use/ land cover class study

Land use land cover types		**Description of land cover types**
1	Agriculture land	Land used for crops cultivation both annual and perennial crops
2	Settlement land	Scattered rural settlement, urban settlement that include trees around homestead
3	Grass land	Land surface with small grass, tall grass mostly of natural vegetations
4	Wood land	Land area dominated by large tree scatter and associated with small grass.
5	Water land	Land area having surface water which include pond, stream, river lake and marsh land
6	Forest land	Area of covered with dense natural forest
7	Shrub land	Land covered with scattered grass, shrub and trees

Source: primary

3.2.1 Data sources and Data Analysis

The source for land uses and land cover dynamics was freely downloaded Land sat imagery from http://earthexplore.usgs.gov. The detail of satellite data area presented in Land sat 4, land sat 5, and land sat 8 path/row of 172/54 with 30 m spatial resolution was acquired on 15/12/2005, 19/01/2010, and 25/1/2019. The imagery was processed using ArcGIS10.3 and ERDAS IMAGE14 software. Initially images were converted into Universal Transfer Mercator and geo-referenced to a datum in which Ethiopia has selected by WGS-84. To improve the image quality, it was enhanced using histogram equalizations. Then land use and land cover change detection of the study area was analyzed for the last 15 years. To classify Land sat image supervised classification was used. Before actual identifying the land cover change detection, Thematic Mapper was geo-referenced, transformed and enhanced. To reduce the resolution difference of Thematic Mapper images, using nearest neighbor -resampling techniques the image was re-sampled into the same size. The topography of the study area was defined by DEM which is generated from the country elevation model map, used to describe the elevation of points for the given area at a specific spatial resolution. In addition, parameters including slope, slope, aspect, and altitude were obtained from the digital elevation models (DEM). The various steps developed and used to analyzed, quantify and interpret the map are presented in Table 2.

Table 2: Material and data sources of study

S/No	Image	Resolution(m)	Sensor	Path/Row	Date of acquisition
1	Land sat 4	30 x30	TM	172/054	15/12/2005
2	Land sat 5	30 x 30	TM	172/054	19/01/210
3	Land sat 8	30 x 30	TM	172/054	25/01/2019

Source: primary

3.2.2 Data type and data Sources

3.2.1.1 Data types

In this study, the qualitative and Quantitative data had beenused. The Quantitative data were used to measure the physical and human factors responsible for the changes of land use land cover resources variability in the area. (By using GIS and Remote Sensing as tools) to understand the magnitudes, intensity and degree of land cover Resources Variability. Qualitative approach was used for described the explanations of paragraph express earlier in quantitative manner.

3.2.1.2 Data Sources

The possible data sources were composed from both primary and secondary sources. Primary source of data were collected from sampled respondents or households in study sited, which were obtained by questionnaires, focuses group discussion and field observation. The secondary source of data were collected from the related documents, internet and others related research. The secondary data sources include the following: Socio-Economic data (Population density, Population growth rate and Illiteracy rate), Climate data (Mean annual rainfall, Mean annual temperature and the Amount of Sunshine of the area),Digital Elevation Model (DEM, Altitud and Aspect or direction), Soil data (soil organic content, soil ph bulk density, soil texture and soil depth), Satellite Image of the area (area vegetation cover) and Land use types (settlement land, Agriculture land, Forestland, Grassland, Wood land, Shrub land and water occupied or wetland) were find from geological data, climate data and soil data of the country.

3.3 Data processing Technique

Satellite image pre-processing

During pre-processing, the primary goal was to eliminate or reduce the errors of satellite images. These steps are always essential. In the aim of the further analysis, other pre-processing steps and procedures were used. These were used to emphasize the images' important information. The latter include, for example, image enhancement that means applying different processes to ease the visual interpretation of images, the recognition and differentiation of objects. It is important to know that the pre-processing methods can change the original information of the satellite images. Radiometric correction is the name of those procedures, which are used to approximate the differences in pixel values to their original reflectance values. These differences arise from sensor failures or mis-calibration, as well as from the effects of the atmosphere in electromagnetic radiation (atmospheric distortion). Applying this procedure, the pixel values are changed. The goal of geometric correction is to remove or decrease the geometric distortions appearing on the original satellite images, and to fit the image into a valid map projection.

Finally, the image was classified to detect the change in the land uses of the area. In addition, others data processing was showed by the following flow-chart.

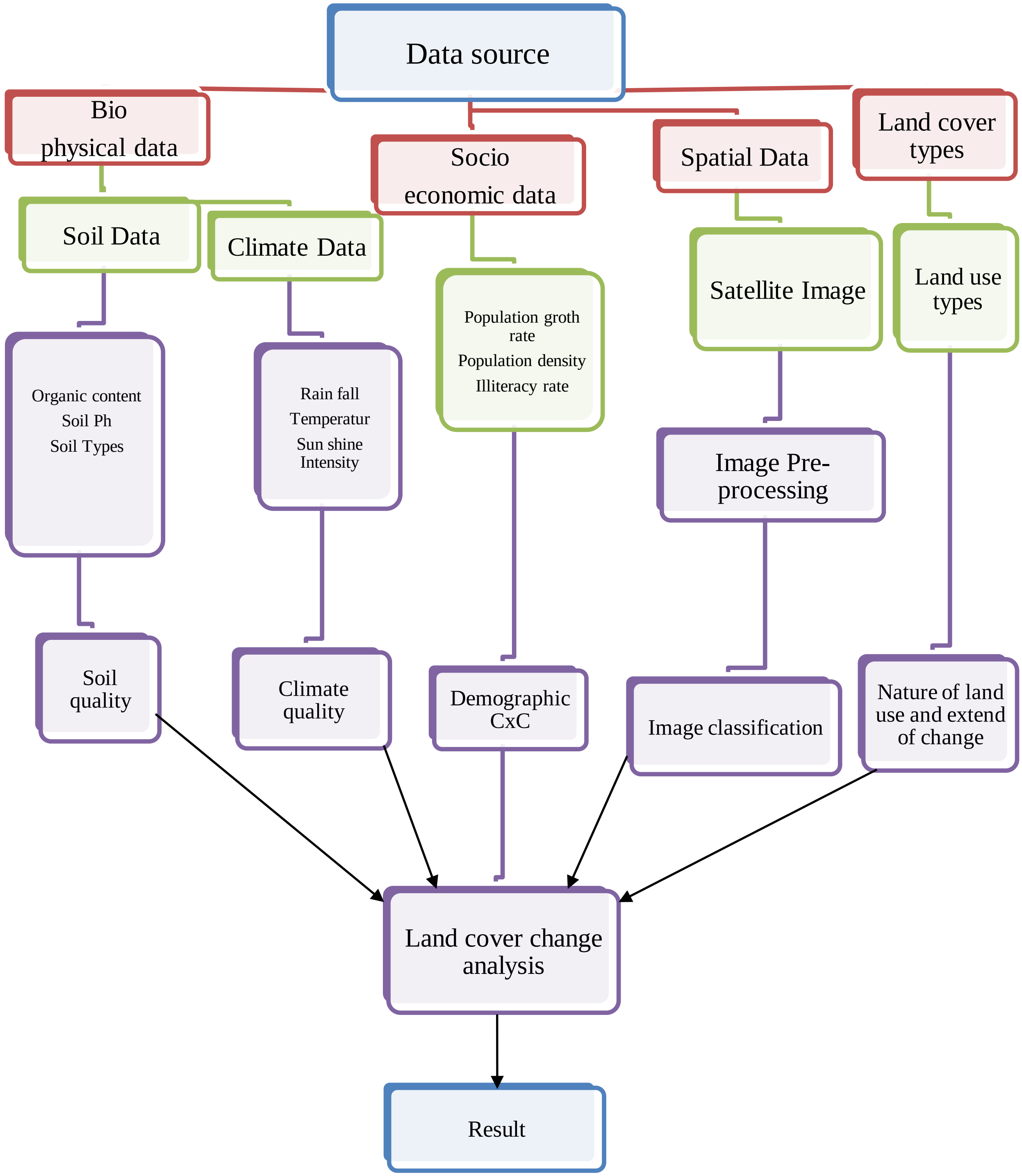


Figure 3: Work flow chart (Souce: primary)

3.3.1 Sampling Size and Sampling Technique Determination

3.3.1.1 Sample Size Determination

The Following Sample Size was determined to find the representative sample units (or subset) from total population in order to identify the truth information of the Land cover Resources Variability. Therefore, out of 20,970 with total house hold of (450hh) the researcher had taken half of population which is 10,485 which comprise 225hh. Here the researcher had taken only 2% of the sample population and the study population sampling size was 111 people using the following mathematical formula Kothari (2004).

$$\mathbf{n} = \frac{\boldsymbol{N}}{\mathbf{1} + \boldsymbol{N}(\boldsymbol{e})^{\mathbf{2}}}$$

Where;n = number of sample size; N = total number of Population; e = specifies the desired level of precision, where e = 1 - precision (0.05 limit of tolerable error) level of precision = 9% (0.09) and 1 = a theoretical or statistical constant

= 2% x 10,485/100 = 209

Therefore n =20970/ (1+209 (0.95)2) = 20970/(210(0.90))

210 x (0.90) = 189

20,970/ 189 = **<u>111</u> people (sample size)**

3.3.1.2 Sampling Technique Determination

The two broad categories of sampling techniques (Probability sampling techniques and Non probability sampling techniques) were used.To obtain the relevant information of the cause of Land use land cover Resources Variability, the Researcher had written the Questionnaires in English and translated in to local language administered to help the respondents for clearly understanding the questions.

3.4 Method of Data Collection

The Interview, field Observation and Questionnaires (surveying with closed-ended questions) were used to collect depth information about a particular human activities, which has impact on land cover resources change in the area. In addition, this was done by using questioners, whichhad been distributed to the area dweller who have high knowledge about the area. These people were farmers, pastoralist, educated (those who know how to read and write and those who have qualification) and woreda land administration office, Agricultural bureau and related document which include book, articles and related research were considered. In addition, how the land is being used was asked to consider its impact on this change. On physical aspect side, soil properties, which include soil texture, soil ph, soil organic contents, bulk density and parent material, were analyzed from Ethiosoil map. Satellite image like that of Land sat (TM) was used to show a real land cover resources variability on different years. Climatic data like area rainfall mean annual temperature, sunshine intensity of the area was included, and Areal altitude, Slope was generated from the country's digital elevation model Map (DEM) .lastly the researcher analyzed all these information, whichmake up the final finding on land cover resources variability of the area.

3.5 Data Analysis and Interpretation

Before, prepare and facilitate on the final land use Land covers Resources Variability map, the researcher first performed the evaluation of all distributed materials to respondents (achieving sequences from the questionnaire survey, Key Informants Interview, and field observations) to ensure clean data set, editing, coding and cleaning of the collected data. Then the data were analyzed using Arc GIS 10.3/5(Software package for mapping factors), ERDAS imagine 2015 (For Image processing activities on satellite image or computed change detection analysis of LU/LC), Ms Excel 2010 was included for analyzing the data.

3.6 Ethnic Consideration

To administering the questionnaire, the ethical concern was taken into consideration. The careful approach of not harming people by disregarding their privacy, not respecting them as individuals or subjecting them to unnecessary research was considered. Collected data from community members waskept confidential by not identifying them when giving a report. Consequently, the attitude or the full willingness of the respondents was understood before any actions. The gender quality thought and Environmental consideration of the respondents were extremely kept.

CHAPTER FOUR

4. Data analysis and Discussion

4.1 Demographic Characteristic of the respondent

Based on key demographic and socioeconomic characteristics of the surveyed households, a large percentage of household heads (54%) were males whereas females constituted the remaining proportion (46%). Large proportions (67 %) of respondents were between the ages of 31 and 64 years, while 22.5% and 10% of them were between 21 and 30 years, and 65 or older, respectively. Twenty-Eight percent of the respondents were illiterate. Relatively a greater proportion (33.3%) of the respondents ranged from grade 1th to grade 8th. In addition, another portion with large respondent of the household heads (38.7%) had attended grade 9th and above level of formal education. Based on their experience a large number of households (59.5%) were aware of land cover variability in the area and its effect particularly soil erosion, soil nutrient depletion and others related problems of land cover change as showed Table 1.

Table 3: Demographic characteristic of respondents (Source: primary)

Name	Demographic types	Respondents	(%)	Total (%)
Gender	Male	60	54	**100**
	Female	51	46	
Age	21-30	25	22.5	
	31-40	55	49.5	**100**
	41-64	20	18	
	65+	11	10	
Education	Illiterate	31	28	**100**
	Primary (1-8)	37	33.3	
	High school and 43Above		38.7	
Farming experience	21-30yrs	45	40.5	**100**
	30 and above	66	59.5	

4.2 Climate Data

4.2.1 Temperature, Rainfall and Sunshine intensity

Climatic variability is already affecting many natural systems around the world. Increases in temperature, change in precipitation patterns, widespread melting of snow and ice, and rising global average sea level are a common phenomenon. Some climate change is now inevitable and there is increasing evidence that it is already happening. With early, sustained and concerted global action to reduce greenhouse gas (GHG) emissions can limit the changes both to climate, and to the natural systems that maintain climate. Failure to significantly reduce emissions may fundamentally alter the Earth's climate system and commit future generations to more dangerous changes and variability. In the last three decades, the study area faced with frequent climatic variability and agro-ecological change. The average annual temperature of study district was relatively low than the current annual temperature. These trends increase in alarming rate from time to time synergic with the current climatic change. These changes brought about low production and productivity in economy and social aspect of community.

The climate of the Region in which Wanthoa district is one among it is formed under the influence of the tropical, which are characterized with high rainfall in the wet period from May to October, and has little rainfall during the dry period from November to April. The mean annual temperature of the Region varies from 17.3 to 28.3 degree Celsius and annual monthly temperature varies throughout the year from 27 to 33 degrees Celsius. The annual rainfall of the Region in the lower altitudes varies from 900-1,500 mm. At higher altitudes, it ranges from 1,900-2,100 mm. The annual evapo-transpiration in the Gambella reaches about 1,612 mm and the maximum value occurs in March and is about 212 mm. The region endowed with a vast marginal land, which is suitable for agriculture and other economic activities. The existing land cover (vegetation) types of the region are identified as cultivated land, forestland, woodland, water land, shrub land, grassland, settlement land. The figures below depicted the rainfall variation, temperature variation and sunshine intensity of the study area and the graph represent the distribution of the rain fall and temperature within the different months of the year in the study area.

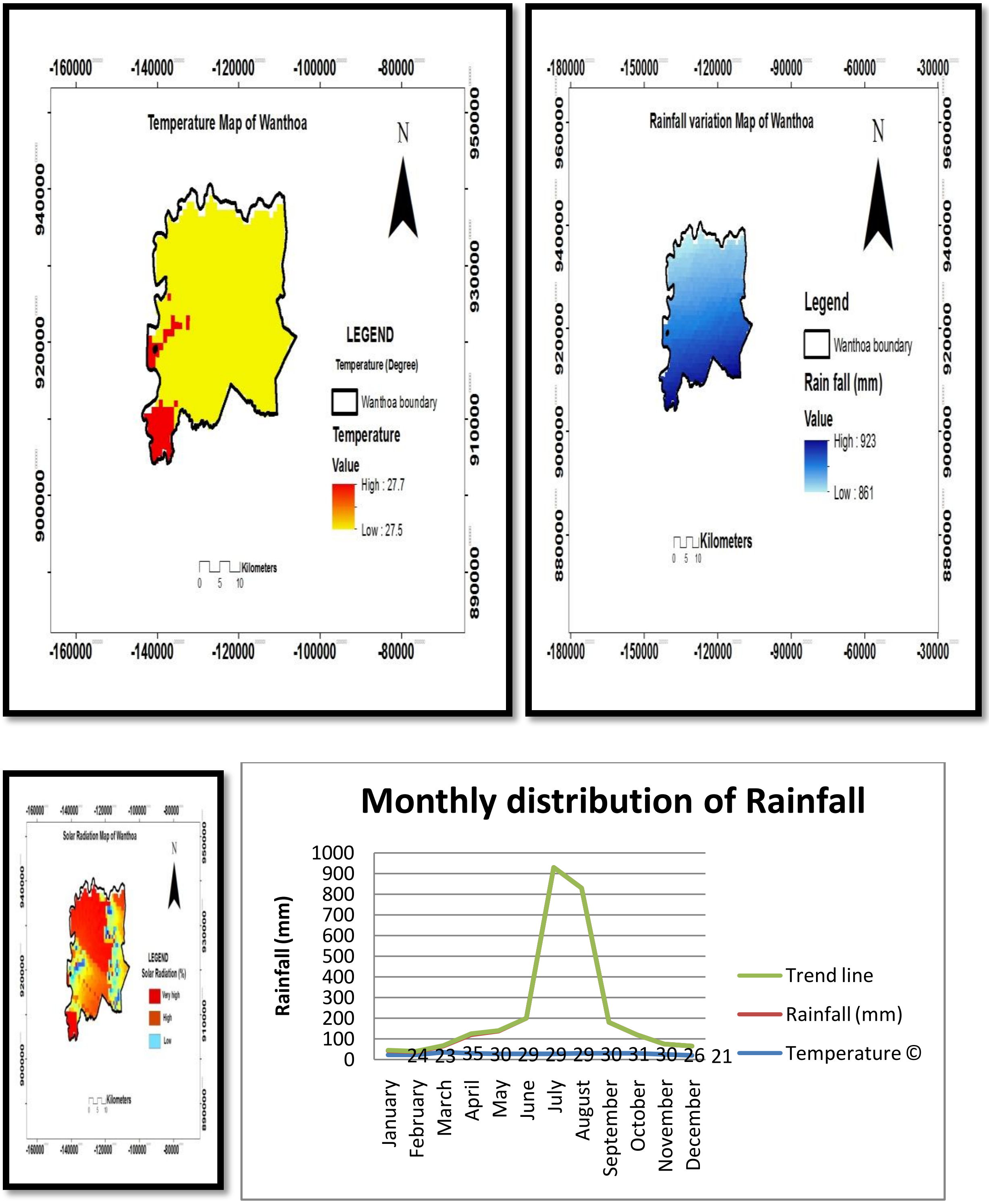


Figure 4:(A) show map of temperature;**(B)** indicaterainfall distribution map;**(C)** the Sunshine intensity map;**(D)** the Rainfall and Temperature variation in Wanthoa (Source: primary)

4.3 Soil Properties of Wanthoa district

4.3.1 Soil organic content, Soil ph and Soil Texture

Soil fertility maintenance is a major concern in tropical Africa, particularly with the rapid population increase, which has occurred in the past few decades. In traditional farming systems, farmers use bush fallow, plant residues, household use animal manures and other organic nutrient sources to maintain soil fertility and soil organic matter. Although this reliance on biological nutrient sources for soil fertility regeneration is adequate with low cropping intensity, it becomes unsustainable with more intensive cropping unless mineral fertilizers are applied (Mulongey and Merck, 1993).The lowlands of the Gambella region particularly Wanthoa district where the present study was conducted are not exceptions of these problems. However, no little effort has been done to maintain the fertility of the soils in the area and the locally available data of soil fertility status are insufficient. Because of continuous cultivation and intensive grazing of land without proper management resulted in decline in soil physical, chemical and biological properties, which aggravate the variability of land cover resources. Organic matter, which has an important influence on soil physical and chemical characteristics, soil fertility status, plant nutrition and biological activity in the soil (Brady and Weil, 2002), was highly affected by soil texture and slightly by land use types. The values increased from cultivated to grass land use soils across all land units. The organic matter content of the soils varied from land use to other land use according to the nature of use.

The average content of soil OM among land use types, were lower in cultivated land use types as compared to that of grass land, shrub land and others. The difference could be attributed to the effect of continuous cultivation that aggravates organic matter oxidation. The roots of the grass and fungal hyphae in the grassland soils are probably responsible for the higher amount of total organic matter (Uriosteet al., 2006). The results were in agreement with the findings of Negassa (2001) and Malo et al. (2005), who reported less organic carbon in the cultivated soils than grassed soils.The lowest pH value under the cultivated land could be due to continuous removal of basic cations by harvested crops and higher microbial oxidation that produces organic acids, which provide H ions to the soil solution and thereby lowers soil pH. These results are in agreement with those of several others (Gebeyehu, 2007; Papierniket*et al.*, 2007; Habtamuet*et al.*, 2009; and Fantaw and Abdu, 2011) who reported a substantial reduction of pH in surface soils subject to long-term cultivation compared to the uncultivated site. According to soil pH classification set by Tekalign and Haque (1991), the pH-H2O values in cultivated land use are rated as neutral to moderately alkaline and that of the grassland use system rated as neutral to strongly alkaline reaction. Based on the pH-H2O category, soils of the study site are not suitable for most land cover types , since most of essential nutrients become available at pH above 5.5 (Landon, 1991). Figure 5-7 describesSoil organic content, soil ph and soil texture of Wanthoa.

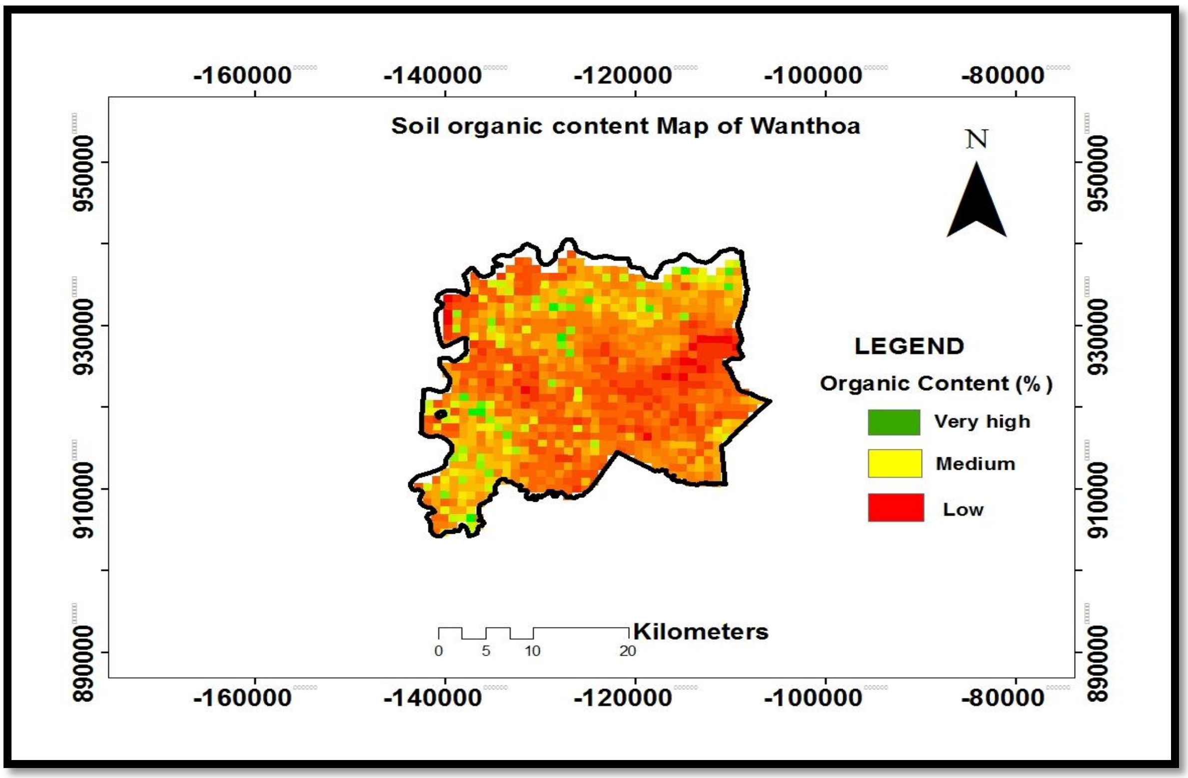


Figure 5: Soil organic content of Wanthoa

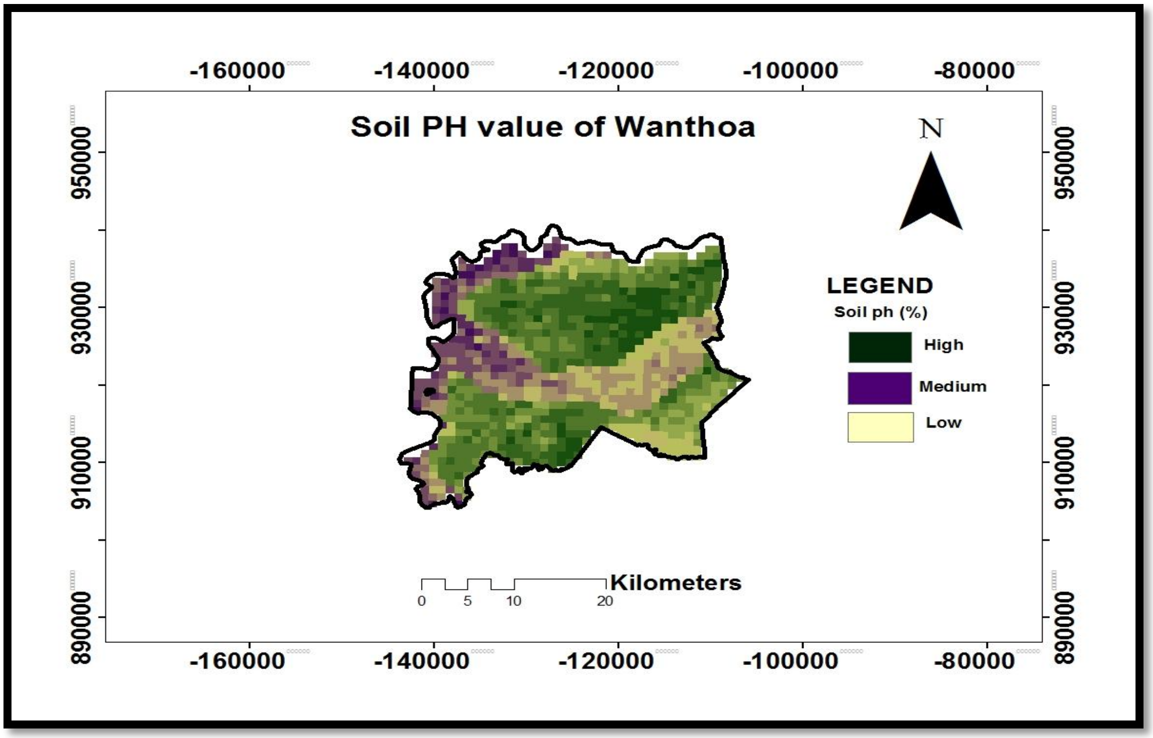


Figure 6: Soil pH map of Wanthoa

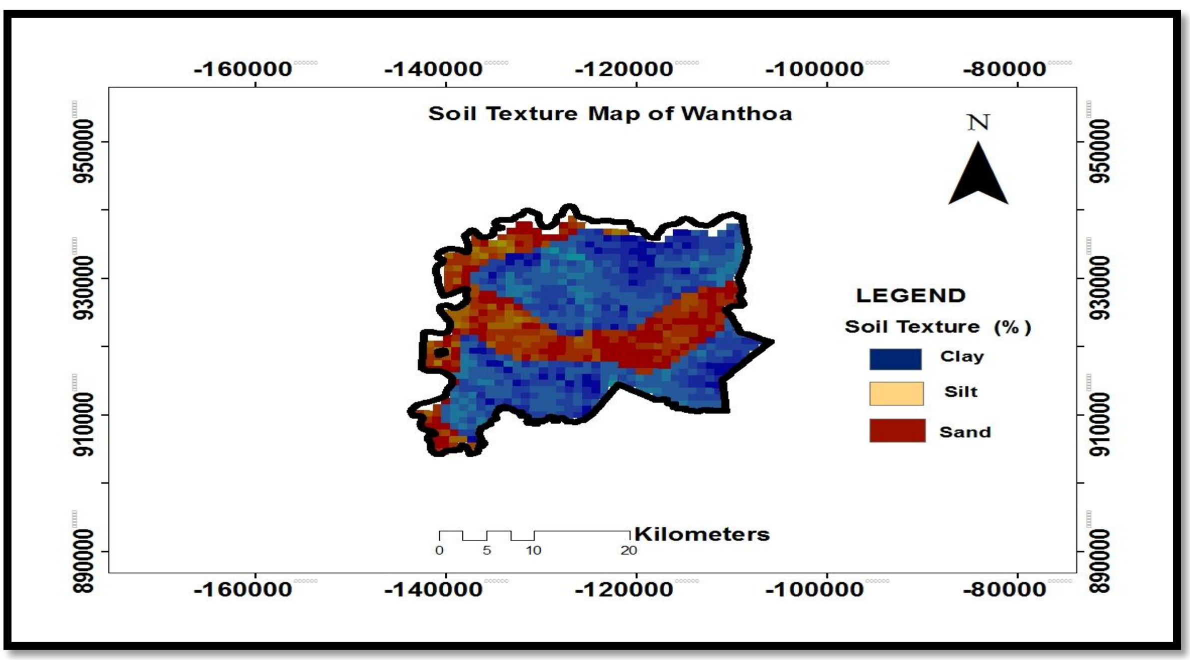


Figure 7: Soil Texture map of Wanthoa

4.4 Land use and land cover Variability

In the present study seven classes of land use and land cover were presented namely Agriculture land, Settlement land, forestland, grassland, woodland, and water body and shrub land. The land use and land cover dynamics is discussed in the subsequent sections. Agriculture land in the study area occupies the largest share of land cover class (29.77, 31.53 and 32.79 % in 2005, 2010 and 2019 respectively). This implies farmland has been extensively increased at the expense of grass, wood land forest land. This is due to increased demand because of population growth, additional farmland required to full filed food demand. As a result of extensive expansion of farm land, negatively contributed for the decrease of grass land, wood land by -0.76% and -0.36% in respective years from 2005-2010. Due to ever increasing of cultivated land farmers were exert pressure on forest, bushes/shrubs, grass and woodland and resulted for further accelerate erosion and degradation. Likewise, similar study elsewhere, alarming rate of population growth resulted for the change of land cover class through time (Turner 2009). Similarly, Shiferaw (2011), limited access of off-farm employment opportunity has made the farmers involved clearing of forest and further expanding cultivation into other types of land cover class.

Settlement in the study area has shown increased persistently in the time periods. The total area of land covered by settlement has increased by 20.32 % from 2005 to 22.55 % in 2010 and 23.08% in 2019 (Figs. 11, 12, 13, 14, 15 Table 4). This showed that settlement have gained positive increase by +4434 ha (+2.23%) in half of decade (2005-2010) and +1066 ha (+0.53%) in 2010 -2019. Other than other types of land use systems, the expansion of both rural and urban settlement took the largest share by converting other land use types for instance forest, woodland, and shrub as well as grassland.

Grassland One of the most dominant land cover in the study area was grassland it holds 43959 ha (22.11%) of the total land cove types in 2005 and the coverage has been decreased by 42437 ha (21.34 %) in 2010. Likewise, in the 2019 the share of grassland was increase by small amount +472 (+0.23 %). The decrease of grassland possibly was the result of growing demand of more arable land for agricultural cultivation and growing demand for newly formed household for settlement in the study area. Thus, conversion of grassland into farmland and settlement is the common phenomenon practiced in the area considered in the present study.

Woodland within the stated years has shown continuously decreasing trend from 11.86 % in 2005 to 11.50 %, and 10.50% in 2010 and 2019 respectively. With alarmingly and intensively declining trends in the first periods from 2005 to 2010 by 11.50 % and further in the second periods from 2010 to 2019 declined by 10.50 %. For the last 15 years, woodland was changed into other type of land cover classes. This is due to availability of farmland in collaboration with alarming rate of population growth negatively contributed for the decline of woodland.

Forest Land Another least dominant land use land cover class of the study area was forest resource, which ranged densely vegetated trees (natural forest), plantations, shrubs and bushes. The area covered by such forest could be evergreen and mixed forestland. From the total area of the district in 2005, the share of forest coverage has 2.31 %, in contrast the coverage slightly decreased into 1.79 % in the year 2010.The decrease in forest coverage corresponds to increase population number and extensive expansion of agricultural land. However, in 2019 it has still decrease to 1.31 %.

Water bodies include ponds, springs, streams, and rivers. In the study area water bodies covered only 12.18 %, in 2005 and a continuous decreased to 10.21 % in 2010 and this decrease had intensified up to 2019 which lead the land cover in to 9.61% .this indicated that water bodies had been affected by the expansion of other land cover which led its constant decreasing pattern. In the study periods for the last 15 years, it has decrease by -2.56 %.

Shrub land in the study area has shown a constant decrease in the whole 15 years. The total area of the land covered by shrub land has decrease from 1.42 % in 2005 to 1.21% in 2010 and 1.05% 2019 and the constant decrease of this land cover was resulted from the increase of some land cover, which included settlement, and agricultural expansion.Table 3 abovedescripts the land use land cover presented in the study and Figure 8 describes Land use, land cover map of Wanthoa 2005, 2010, 2019.The Table 4 below shows the share of land use, land cover variability in Wanthoa district within 15yr of study and the rate of change was calculated based on the following formula

$$\text{Annual Rate of Change} = \text{Area}_{yearx} - \text{Area}_{iyearx/}\, t_{yeari}$$

Where, Areai year x is area of cover i at the first date, Areai year x + 1 is area of cover i at the secondand t_{year} is period in years between the first and second scene acquisition dates.

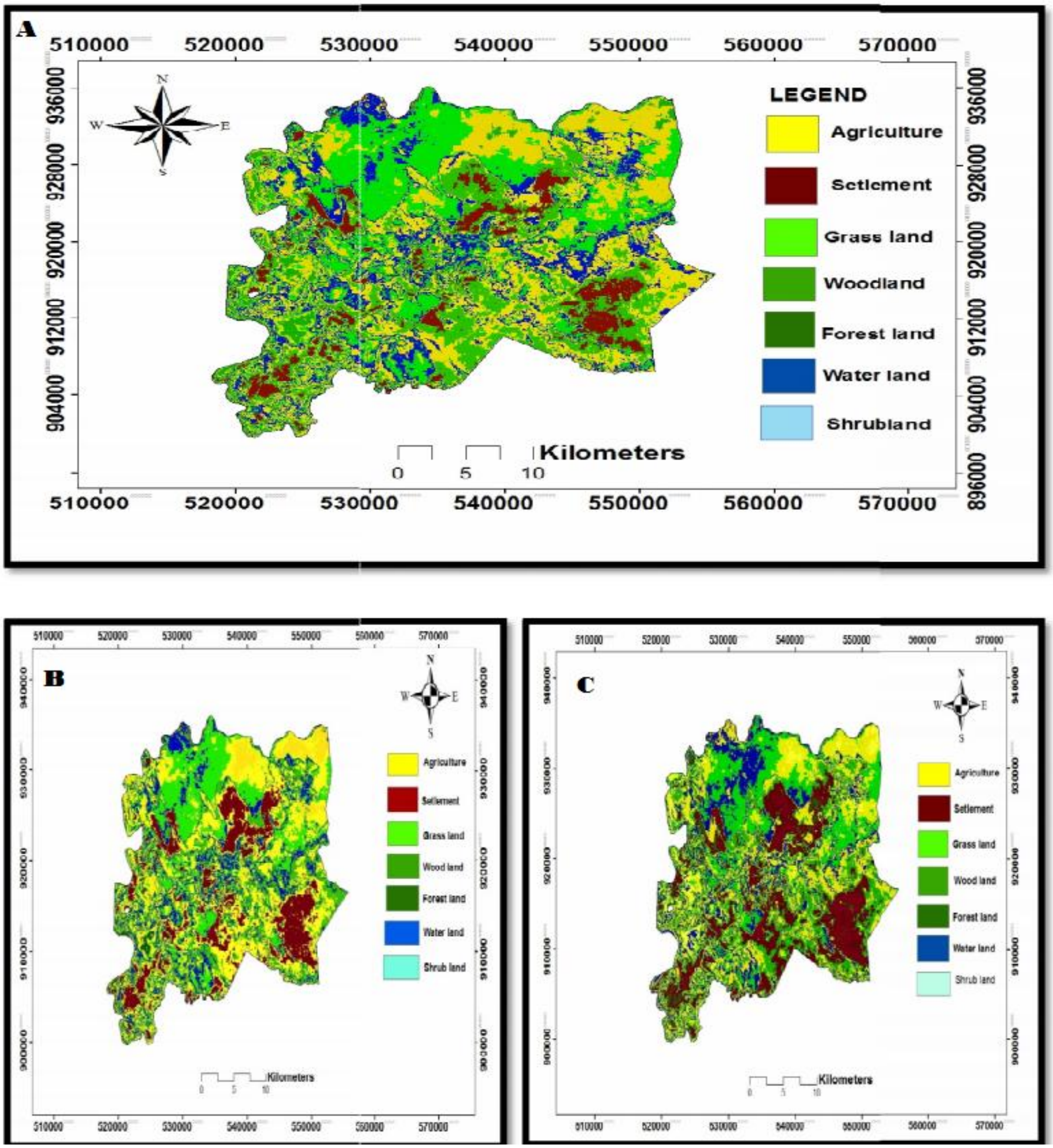


Figure 8:(A) Land cover map of Wanthoa 2005;**(B)** Land cover map of Wanthoa 2010;**(C)** Land cover map of Wanthoa 2019

Table 4: Land use/ Land cover class variation (source: primary)

LULC Name	Area (ha) 2005	(%)	Area (ha) 2010	(%)	Area (ha) 2019	(%)	Rate of change (ha) 2005-2010	%	Rate of change (ha) 2010-2019	%
Agriculture	59193	29.77	62377	31.37	65193	32.37	+3184	+1.60	+2816	+1.41
Settlement	40403	20.32	44837	22.55	45903	23.08	+4434	+2.23	+1066	+0.53
Grass land	43959	22.11	42437	21.34	42909	21.58	-1522	-0.76	+472	+0.23
Wood land	23595	11.86	22867	11.50	20895	10.50	-728	-0.36	-1972	-0.99
Forest land	4602	2.31	3572	1.79	2702	1.31	-1030	-0.51	-870	-0.43
Water land	24223	12.18	20311	10.21	19123	9.61	-3912	-1.96	-1188	-0.59
Shrub land	2842	1.42	2416	1.21	2093	1.05	-426	-0.21	-323	-0.16
Total area	**198817**	**100**	**198817**	**100**	**198817**	**100**	-	-	-	-

Source: primary

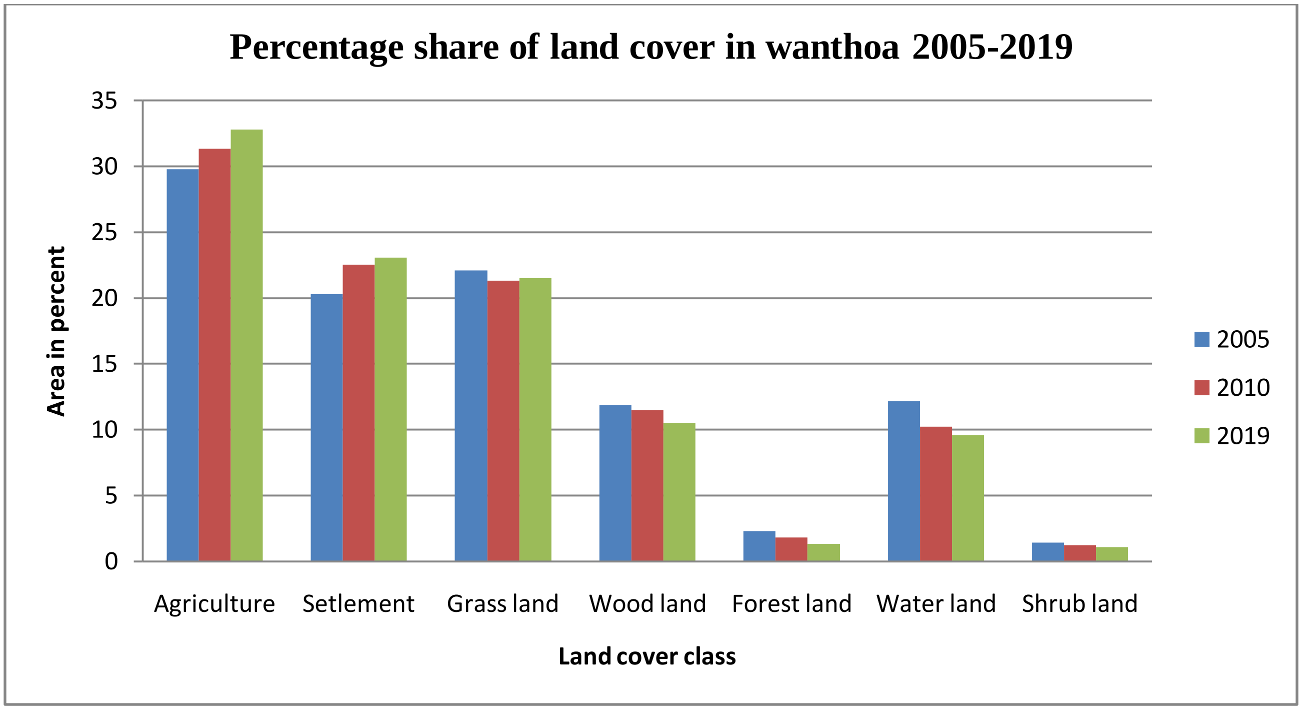


Figure 9: Percentage share of land use land cover 2005-2019

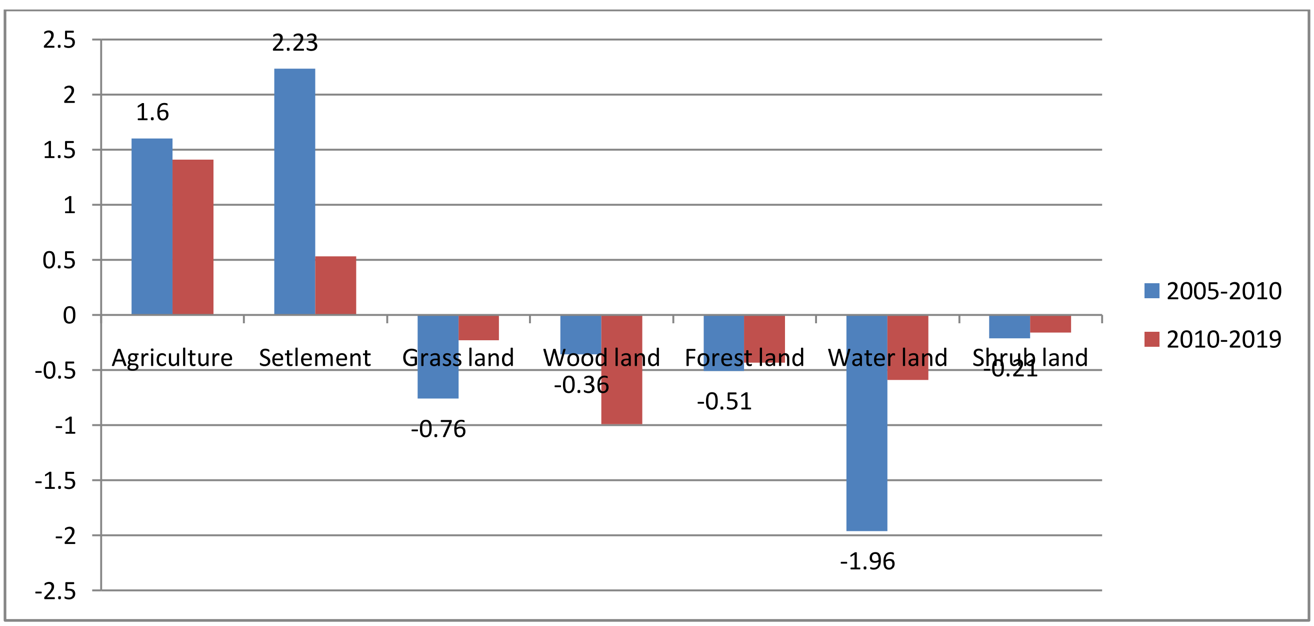


Figure 10: Rate of change of the land cover 2005-2019

4.4.1 Rate of land use and land cover change in Wanthoa 2005 – 2010

Table 5: Land covers variability 2005-2010

LULC Name	Area (ha) 2005	(%)	Area (ha) 2010	(%)	Rate of change 2005-2010	%
Agriculture	59193	29.77	62377	31.37	+3184	+1.60
Settlement	40403	20.32	44837	22.55	+4434	+2.23
Grass land	43959	22.11	42437	21.34	-1522	-0.76
Wood land	23595	11.86	22867	11.50	-728	-0.36
Forest land	4602	2.31	3572	1.79	-1030	-0.51
Water land	24223	12.18	20311	10.21	-3912	-1.96
Shrub land	2842	1.42	2416	1.21	-426	-0.21
Total area	**198817**	**100**	**198817**	**100**	**-**	**-**

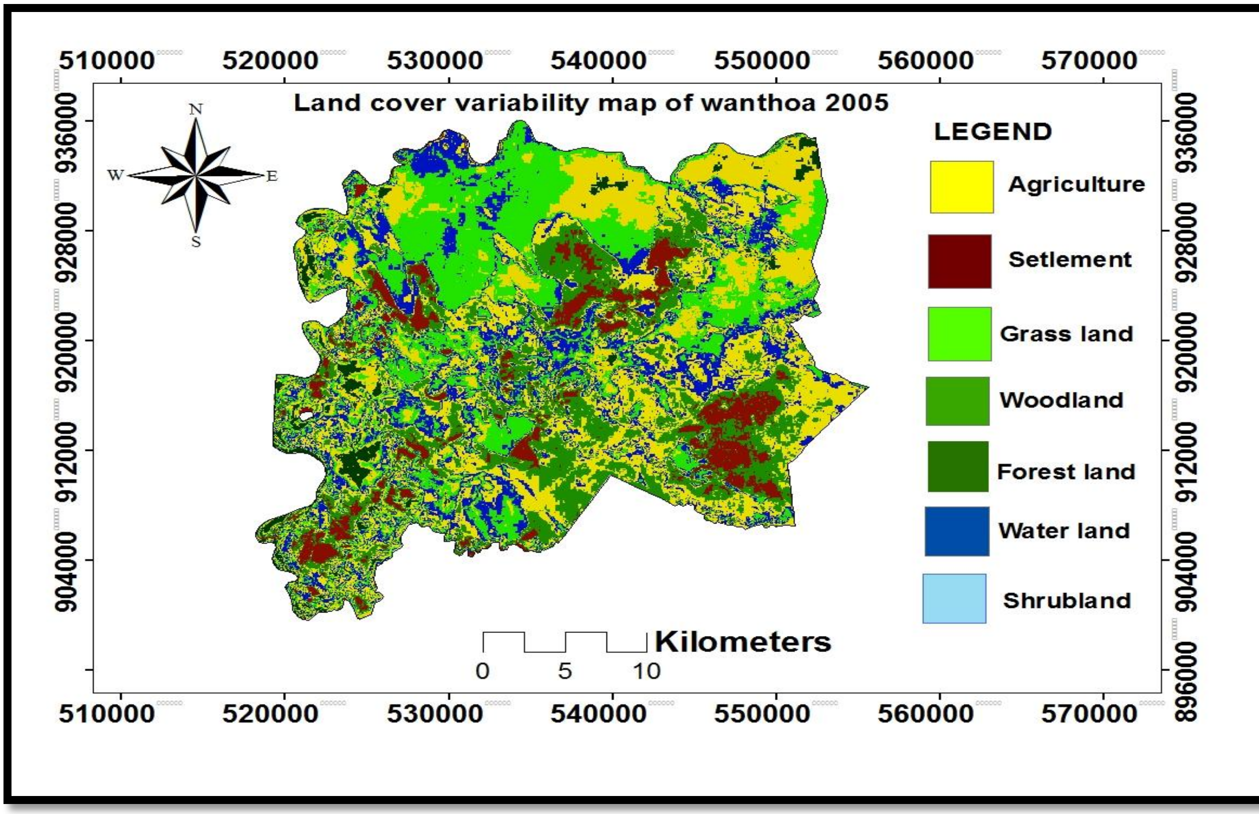


Figure 11: land cover variability Map of wanthoa 2005

The rate of changes of agriculture land, grassland, forestland, water body woodland, shrub land and settlement area cover for the study area have already been presented in Table 4. This result indicated that though resource is fixed, there was various rate of change in different land cover types. However, the rate of change of different land cover types has slightly variables among them. The analysis indicated that between 2005 and 2010, agriculture land and settlement area has increased with the rate of +1.60% and +2.23% respectively caused for the out flow of grass land, wood land and forest land; in the same periods grass land, wood land, forest land and water body was decreased by -0.76%, -0.36% , -0.51% and -1.96% respectively.

Rate of land cover changes of wanthoa 2010-2019

Table 6: land cover variability 2010-2019

Land use land covers	Area (ha) 2010	(%)	Area (ha) 2019	(%)	Rate of change 2010-2019	%
Agriculture	62377	31.37	65193	32.37	+2816	+1.41
Settlement	44837	22.55	45903	23.08	+1066	+0.53
Grassland	42437	21.34	42909	21.58	+472	+0.23
Wood land	22867	11.50	20895	10.50	-1972	-0.99
Forest land	3572	1.79	2702	1.31	-870	-0.43
Water land	20311	10.21	19123	9.61	-1188	-0.59
Shrub land	2416	1.21	2093	1.05	-323	-0.16
Total	**198817**	**100**	**198817**	**100**	**-**	**-**

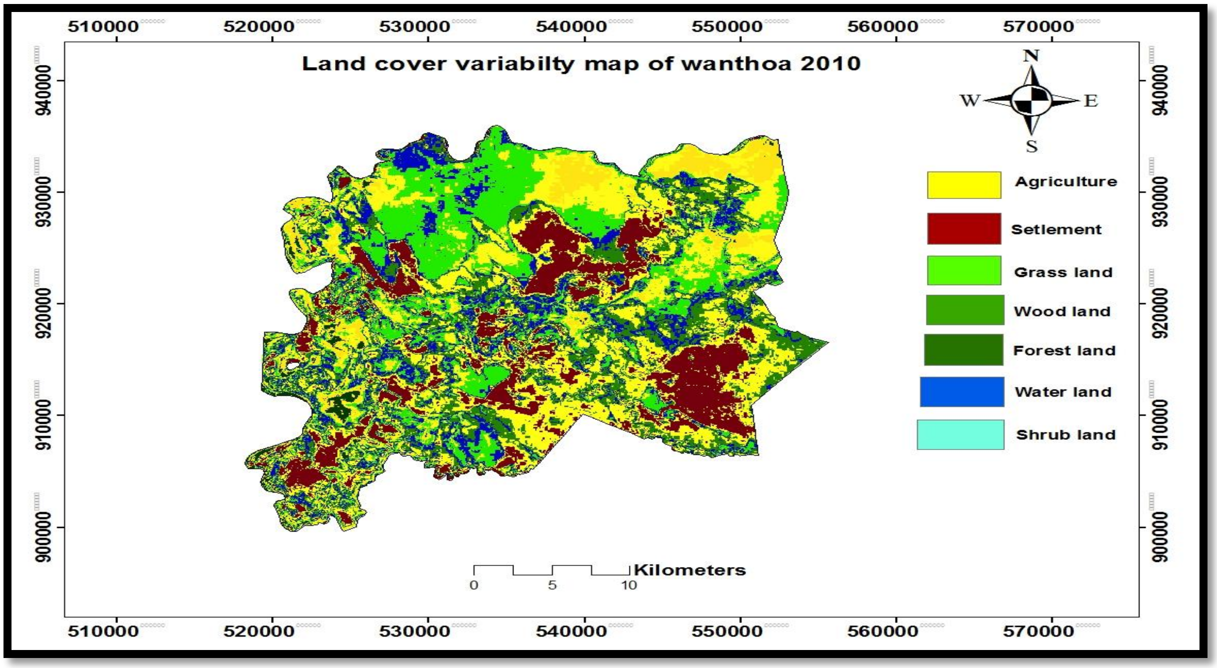


Figure 12: land covers variability map of Wanthoa 2010

Likewise between 2010 and 2019 expansion of farmland and settlement persistently increased with a rate of +1.41% and + 0.53%. Unlike in the first periods, unexpectedly with increasing rate of settlement and farm land between 2005 and 2010 there was a decrease of gain in settlement which is an outcome of some instability in the district which left some people leave their resident. In the second periods of study years between 2010 and 2019 the share of forest and shrub land coverage surprisingly decrease which was attributable to household and community level deforestation practice which let forest and shrub land lose part of their land -0.43% and -0.16% respectively.

Table 7: land cover variability 2005-2019

Land use land covers	Area (ha) 2005	(%)	Area (ha) 2019	(%)	Rate of change 2010-2019	%
Agriculture	59193	29.77	65193	32.37	+6000	+3.01
Settlement	40403	20.32	45903	23.08	+5500	+2.76
Grassland	43959	22.11	42909	21.58	-1050	-0.52
Wood land	23595	11.86	20895	10.50	-2700	-1.35
Forest land	4602	2.31	2702	1.31	-1900	-0.95
Water land	24223	12.42	19123	9.61	-5100	-2.56
Shrub land	2842	1.42	2093	1.05	-749	-0.37
Total	**198817**	**100**	**198817**	**100**	-	-

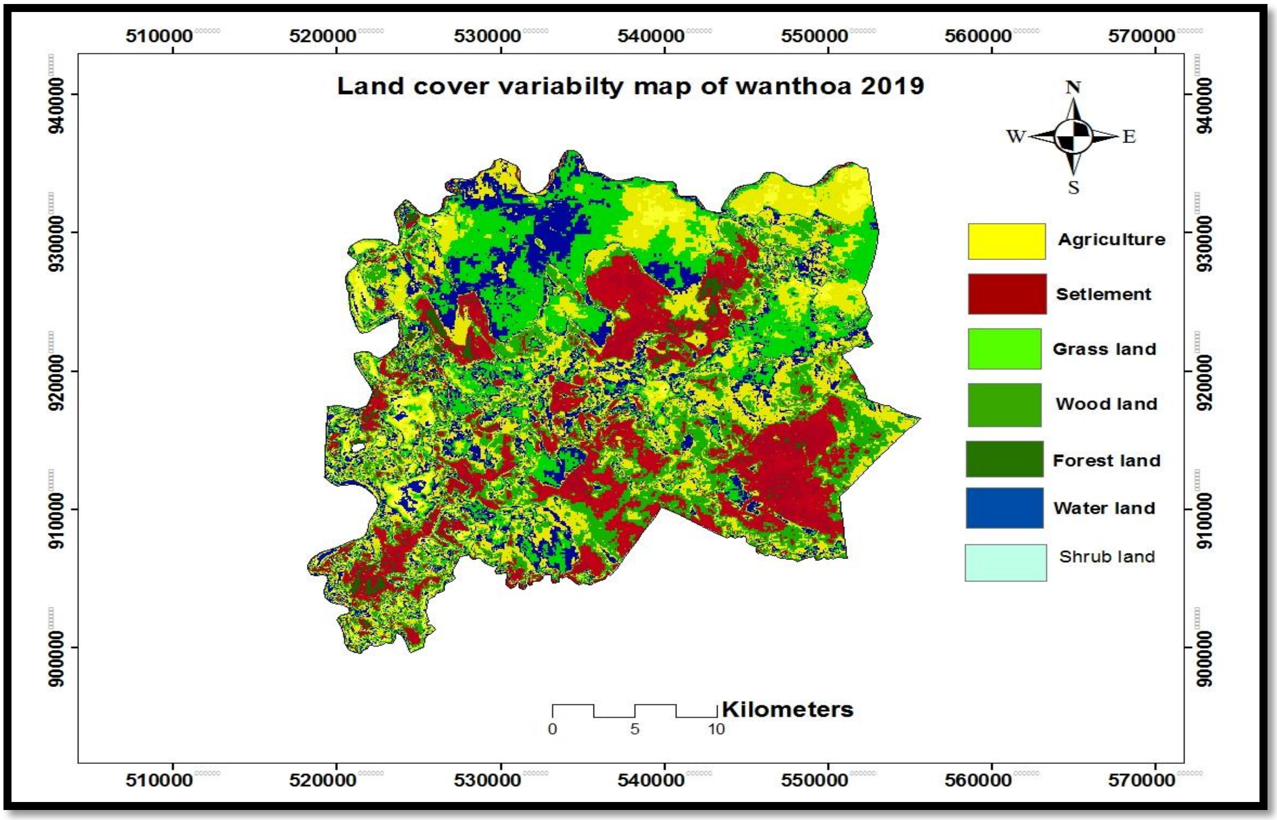
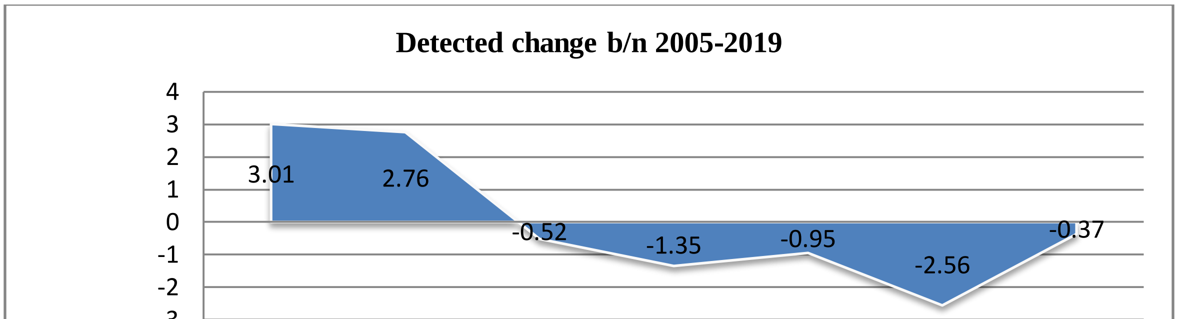


Figure 13: land covers variability Map of Wanthoa 2019

The study found that the change in the land covers variability in the area mostly affected some land covers in which most of some land covers are hardly change. This showed that from the whole time period between 2005-2019 agricultural land and settlement land received positive gain +3.01, +2.76 respectively.In other hand grass, woodland lost some of their land coverage which leads to their decrease in the area of extent of their coverage by -0.23, and -0.99 percent. Due to increase of some practice in the area, forest, shrubs land and water occupied area become small and lost much of their land extent than any others land cover by-0.43%,-0.16%,-0.59% respectively.(Figure 10).

4.4.2 Change detected between 2005-2019

Accordingly the study founded thatchange was detected in different land use class between 2005 and 2019 which indicated that grass land, wood land shrub land and forest land cover class lost much of their land in the expend of agriculture land and settlement land.this showed that these land cover for the sack of others land use decrease by -1522,-728,-426 and -1030 hectare of land respectively between 2005 and 2019. In other hand these two land use types which are agriculture land and settlement land receive much of their gains from the above mentioned land use types by +3184 and +4434 hectare of land respectively within the same time frame that's 2005-2019. Within this study, the researcher found that, the entire classes of the study have gone some change in which most of the land cover received negative transformation to other land use. Therefore, within the entire 15yrs of study, agriculture and settlement receive a positive change which is 6000 and 5500 hectare of land that's is (+3.01 %) and 2.76% of land respectively while others land cover which include grassland, woodland, forest land, water and shrub land received a negative change that's -0.52%,-1.35%,-0.95%,-2.56% and -0.37% respectively see the following Figure below: Detected land covers change 2005-2019 (primary sources)



	Agriculture	Setlement	Grass land	Wood land	Forest land	Water land	Shrub land
2005-2019	3.01	2.76	-0.52	-1.35	-0.95	-2.56	-0.37

Figure 15: Detected land covers variability 2005-2019

4.4.3 Cause of land use and land cover change

Even though the extent time periods of event occurrence are variables, various human and natural, factors are the main cause for land use, land cover dynamics (Meyer and Turner 1994). However, the effect of settlement expansion, agricultural increase on land cover dynamics is controversial, elsewhere in many literatures rapid rate of population growth rate one of the root causes for the change of land cover dynamics.

According to (Barbier and Burgess 1996), as it negatively affecting the land cover, the study concluded that rapid settlement expansion and agricultural extension has negative role in availability of resource. On the contrary, particularly in the highlands of Ethiopia in which population pressure is intense resulted for resource variation and degradation (Grepperud 1996). Table 5 shows the causing factors for land cover variability in Wanthoa

Table 8: factors of land cover variability

Factors of LULC		No of respondents	Percentage share (%)
1	Construction purpose	44	39.63
2	Cultivation purpose	45	40.54
3	Wood and Timbers	15	13.51
4	Commercial purpose	5	4.50
5	Others factors	2	1.80
6	**Total**	**111**	**100**

Source: primary

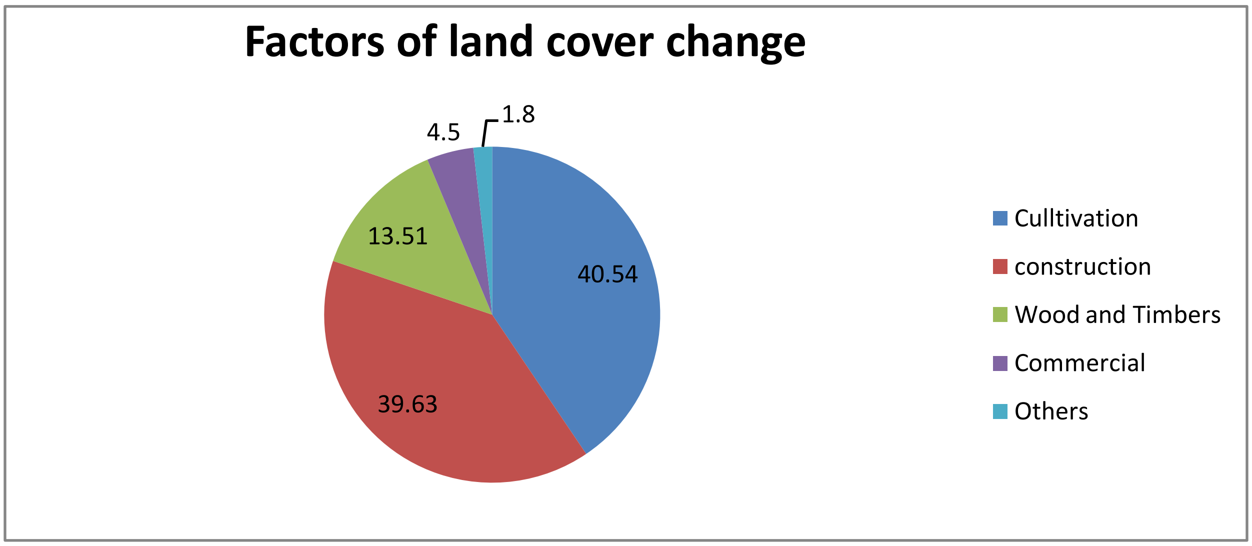


Figure 14: Factors of land cover change

Likewise, elsewhere in many part of Ethiopian high lands, pressure associated with populations has argued negative implication on forestland, grazing land, barren land, riparian vegetation and farmland (Tekle and Hedlund 2000).It is true to Wanthoa district where rapids settlement expansion, agricultural extension and others factors had increase the shortage of land cover resources, removal of forest cover and soil erosion which degrade the land. In addition, shortage of land cover resources forced people to cultivate grassland, woodland and shrub land. Therefore, resource become more vulnerable for further erosion and degradation consequently shifted to other land use land cover class in different period.

CHAPTER FIVE

5. Conclusion and Recommendation

5.1 Conclusion

Land cover changeundertaken major natural resource,economic, social, infrastructure and other human activities. However, Changes in the condition and composition of land use/land cover affects the livelihood of rural communities directly or indirectly. As a result, this review goes through different studies to synthesize different literatures and provide information that could be useful for understanding the impact of land use/land cover change upon rural livelihood and how the land is being changed over different time.

In the last 15years land use and land cover change have undergone considerable change in the Wanthoa district. The analyses also provide valuable insight into the extent and nature of changes that have taken place in the past. Land use activities were more towards agricultural encroachments and settlement expansions at the cost of forest cover and grassland, wood land, shrub land. The results indicated that land cover changes occurred in the district

Within the study area, in the period of 15yrs agriculture (+9.20%), woodlands (−12.92%) and settlement (+11.98%) areas have been common. grassland cover decrease - 2.44%. over the period of 15yrs indicated that agriculture and settlement expansion in the area have take little leap forward in which they are in bench of taking some area of others land cover in the district. Further, depletion of forest cover (-70.31%) and shrub land revealed that they were not only affected by agricultural and settlement expansion but it was also a combination of some others activities in the area which include commercial exploitation of forest practice in the area except in few areas which have compensated to expansion of settlement areas and cultivated lands in the district.

The soil of the area is mostly clay soil which is also not a good to support the growth of land cover in the areaas much as possible due to its low ph and compaction in the time of rain and become crack in dry season. Therefore, due to this nature of soil in the district, land covers have also undergone change in the last fifteen years.

5.2 Recommendation

The changes in land use and land cover resources aggravate many problems. The land use and land cover change observed in the study area would have a negative impact on both the environment and socio-economic settings if it's being continuous in the area of study. Susceptibility to land cover resources is understood that these land cover variability can be influenced or degraded by human activities. In reality, land cover resources are degraded not only by agricultural and settlement expansion activities, but also due to other human factors which include commercial extraction of land resources for wood and timber and others. However, all these activities were taken in to consideration, because the unplanned actions such as illegal logging, exploitation of forest resources for fuel wood and charcoal production as well as expansion of agricultural lands are the main factors that cause others land cover degradation and land use change.

- Study verified that household level survey data provide an equally important source of information and even additional details which were extracted regarding the magnitude, driving forces of LULC changes. The study found that significant LULC change has occurred in the study area, with associated land resource variability. The prominent cause includes many things such as exploitation of forest for settlement, and wood fire, logging, commercial exploitation and agricultural expansion. Within the study area, the researcher recommend the following;
- Due to the increase of land cover change in the area, which is facilitated by the community activity on land cover resources, such as construction which contributed 39.% and cultivation which held 40.66% in the area together with logging and wood or timber. These activities if the community still uses extensive exploitation of land cover, it will lead into desertification, erosion which can degraded the land. Therefore, it need some measure to be taken which include planting tree, protecting of the land cover not to be depleted in extensive and unwise use.
- As a result of this, government intervention by establishing policies to protect the environment, creating awareness in the community by carrying out some training related to the benefit of land cover and its effect when they are extensively removed needs to be applied in Wanthoa district. The combination of all these agents including the participation of the community and others NGOs, the problem would be minimized.

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APPENDIX I

Jimma University
College of Social and Humanities
Department of Geography and Environmental Studies
ProgrammeM.Sc in GIS and Remote Sensing (Regular)

This questionnaire is prepared by M.Sc Researcher who studies Master of Science Degree in,**GIS and Remote Sensing.** The research title is Assessment of the land use land cover resources variability using GIS and Remote Sensing technologies. The case of Wanthoaworeda, Gambella Regional State, Ethiopia
Name of researcher: **ChambangWuorChol**

General Instructions:
I request your ability and corporation with me to get accurate data from you according to the questions that are given here below.
Thank for your time and corporation.

I. Please fill up the questionnaire according to the items of the questions.
II. Please do not try to use political terms while answering the questions.
III. During the process put the answers of each question on the space provided if it is open ended question and encircle the choice or tick mark as required if it close ended question.

General information of respondents

Date of interview **___/___/___ E.C**
___/ ___/ ___ G.C

Note: Please fill, encircle or tick the labeled respondent's background provided below.

*Region (Kilil):*______________________ *Area (zone):* ______________
*District (Woreda):*__________________ *Village (Kebele):*_______________

Marital Status: ☐ Single ☐ Married ☐ Widow/Divorce

Age: ☐ 15-30 30-5☐ 50 a☐ above

Sex: ☐ Male ☐ Female

Employee status ☐ Worker ☐ Unemployed

Source of income: ☐ Government ☐ Self ☐ Other

Level of Education: ☐ Primary ☐ Secondary ☐ 10+3 ☐ 12+3/4/5/6

Nationality: Ethiopian ☐ Non-Ethiopian ☐

Types of land cover

1. **Land covers types**

Note: You can tick the box for items which is in the farm.

☐ Grassland For☐ landWater, pond or l☐

☐ Desertwoodland o☐rs specified ☐ ☐ ☐

2. **Land use types**

☐ Agriculture ☐ Settlement (include built up)

☐ Irrigation others☐ecified---

QUESTIONAIRES

1. What are the cause of land use/ land cover variability in wanthoa?--
2. What are the factors that facilitated the extensive land covers variability in Wanthoa within the last 15yrs?--
3. What magnitude of change have you ever seen in the district within 15yrs?---
4. What is the reaction of government or community as the result of existing land covers change in the area? --

THANK YOU IN ADVANCE FOR YOUR CORPORATION