LAND USE/ LAND COVER DYNAMICS AND ITS IMPACTS IN NADDA ASENDABO WATERSHED, SOUTH WESTERN ETHIOPIA

M.Sc. THESIS

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APPROVAL SHEET

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As thesis research advisor, we hereby certify that we have read and evaluated this thesis prepared under our guidance, by **Amanuel Abate Ararssa,** entitled "**Land Use/ Land Cover Dynamics and Its Impacts in Nadda Asendabo Watershed, South Western Ethiopia."** we recommend that it be submitted as fulfilling the thesis requirement.

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DEDICATION

I would like to dedicate this research work to my great lovely Father and Mother!!!

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my original work and all sources of materials used for writing have been dully acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University, College of Agriculture and Veterinary Medicine and is deposited at the university library. I solemnly declare that this thesis is not submitted to any other institutions anywhere for award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

Amanuel Abate Ararssa, the author, was born on October 11, 1986 in Amhara Regional State of North Wello, at Kobo Town. He attended his elementary and junior secondary school at Kobo Catholic, higher and senior secondary school. He then pursued his secondary school at Dessie Town Hotie comprehensive secondary school and Memiher Akalewelde preparatory school. After completing his senior secondary school education, he joined Jimma University College of Agriculture and Veterinary Medicine and graduated with B.Sc. Degree in Natural Resources Management in June, 2008. The author was employed in Albko Wereda Office of Agriculture and Rural Development in Food Security Project as work employer of Productive Safety Net Program (PSNP) for one year until he joined post graduate studies of Jimma University College of Agriculture and Veterinary Medicine to pursue a graduate study leading to a Master of Sciences degree in Natural Resources Management specialization in Integrated Watershed Management.

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ABBREVIATIONS

AAU	Addis Ababa University
DAS	Development Agent Supervisors
EMA	Ethiopia Mapping Authority
ERDAS	Earth Resources Data Analysis System
ETM+	Enhanced Thematic Mapper
FGD	Focus Group Discussions
GCP	Ground Control Points
GIS	Geographic Information System
GPS	Geographic Positioning System
Ha/yr	Hectare per year
ILRI	International Livestock Research Institute
LS/ hh	Livestock per household
LULC	Land Use Land Cover
m.a.s.l	Meter Above Sea Level
MSS	Multi Spectral Scanner
NRM	Natural Resources Management
NGOs	Non Governmental Organizations
PRA	Participatory Rural Appraisal
Qt/ha	Quintal per hectare
RS	Remote Sensing
SLMP	Sustainable Land Management Project
SPSS	Statistical Package for Social Sciences
SWC	Soil and Water Conservation
TM	Thematic Mapper
UTM	Universal Transverse Mercator

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ABSTRACT

Understanding of the driving forces of land use/ land cover change is essential for effective sustainable land resource management. Change in LULC can also negatively affect the potential use of an area and may ultimately lead to land degradation. Hence, this study was conducted to investigate land use/ land cover dynamics, its drivers and impacts in Nada Asendabo watershed, south western Ethiopia. It covers an area of 8,012 ha. Information is extracted from three period land sat images (1973 MSS, 1986 TM and 2004 ETM+). The impacts of land use/ land cover were investigated through socio-economic survey that involved household interview, key informants and FGD. Analysis of data was accomplished through integrated use of ERDAS imagine (version 9.2), Arc GIS (version 9.2) software and SPSS version 16.00 along with Microsoft office. Six land use/ land cover classes namely forest land, agricultural land, grass land, built-up area, reverine forest and bush land were selected for the study. Results from land use/ land cover change analysis showed an increase in agriculture land and built-up area from 19.16% and 1.46% in 1973 to 52.11% and 3.40% in 1986, 65.60% and 8.88% in 2004 respectively. The increase in agriculture land and built-up area was mainly at the expense of forest land, grass land, reverine forest and bush land. On the contrary, forest land, grass land, reverine forest and bush land decreased from 13.52%, 23.96%, 18.17% and 23.73% in 1973 to 5.28%, 20.54%, 6.30% and 12.37% in 1986, 4.75%, 8.5%, 4.36% and 7.91% in 2004 respectively. The result of socio-economic data analysis (the focus group participants and 96% of the sampled households) reported that agriculture, both crop and livestock productivity is declining. Clearance of vegetation has had an impact on the decline of agricultural productivity through soil fertility decline by the removal of vegetation cover and soil erosion. The removal of vegetation cover resulted in low availability of wood products, lack of livestock feed sources and reduced the overall income and income sources of farmers. Change in LULC negatively affect the potential use of an area and ultimately lead to soil and vegetation degradation and loss of productivity. Among many factors, the major production constraints was directly associated mainly with land use change. Among others, the major reasons for the decline in vegetation cover in the area include: expansion of cropland, harvesting of construction wood and firewood collection for domestic consumption. Increasing population is the major contributing factors. Hence, Studies of land use/ land cover dynamics can be used for land use planner, natural resource managers and policy makers to provide a management and decision process.

Key words: *GIS, Remote Sensing, land use/ land cove dynamics and watershed management*

1. INTRODUCTION

The rapid increase in human population and strive for growth in the standard of living has put great pressure on natural resources such as vegetation, soil and water. Through conversion and intensification of land use human have caused huge changes in the balance of natural ecosystems (Dale, 1997; Fenglei *et al.,* 2007). Land use/ land cover changes is a dynamic, widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities, which in turn drives changes that would impact the ecosystem (Gol *et al.,* 2010; Rahdary *et al*., 2008). In general, anthropogenic activities have significantly altered the earth's surface in some manner, hence resulting into an observable pattern in the land use/ land cover changes (LULC) over time (Zubair, 2006).

According to Zubair (2006), only few landscapes remain on the earth that are still in their intact natural state, the major causes of land use/ land cover dynamism being primarily associated with agricultural activities. Crop land and pastures are now among the dominant ecosystems on the planet, occupying more than 35% of the world's ice-free land surface (Paul and Lisa, 2011). Likewise, agricultural land expansion and the ensuring land degradation and land use/ land cover change introduces are serious environmental challenge in the highlands of Ethiopia. One of the negative impacts of LULC change is the loss of fertile top soil that has multifaceted implication (Kahsay, 2004). In several parts of the highlands agriculture has gradually expanded from gently sloping lands onto steeper slopes of the neighboring mountains. Despite this increase, agricultural productivity is lagging behind the population growth rate. At the same time, the per capita land holding is also expected to decline from an average of 1.76ha in 1985 to 1.1ha and 0.66ha in the year 2000 and 2015, respectively (IUCN, 1990).

The Ethiopian high lands, areas with elevation above 1500 m.a.s.l, cover about 500,000 km^2 and represent 43% of the country (Mohamed, 1995). It accounts for 95% of the regularly cropped land, hosts more than 70% of the livestock, and 90% of the economic activities of the country (FAO, 1986). These highlands are the centre of economic activity of the country and are characterized by enormous ecological, environmental and agricultural diversity (Alemneh, 2003; Kahsay, 2004). The early development of agricultural systems and human settlement in this agro-ecological zone may have been due to the favorable climatic and ecological conditions in these areas. It may be for this reason that the highlands have been settled for millennia and known for a similar long-standing agricultural history (McCann, 1995). The long history of settlement and high population pressure in the highlands has already brought about unsustainable agriculture practices. Such as rapid land use/ land cover changes.

Ethiopian agriculture faces the challenge of providing food for a growing population (Abate, 2010). One of the immediate problems facing Ethiopia today is land degradation, particularly loss of vegetation cover and soil erosion contribute significantly to low agricultural productivity. Similarly, the study area is known for its agricultural productivity. However, the agricultural sector in Ethiopia is increasingly being confronted with the pressure from a rapidly growing population and diminishing natural resources (Mulugeta, 2004). These are the main problems that engender biophysical land degradation and hamper sustainable agricultural development in the country (Jon and David, 1995). According to Mulugeta (2004), the lag in agricultural productivity advancement behind population growth has caused intense land use conflicts, particularly between the agricultural and the forestry sectors in Ethiopia.

The growing population and increasing socio-economic necessities creates a pressure on land use/ land cover (Fenglei *et al.*, 2007). According to Muleta (2009), the most important human factors recognized as change agents of LULC are the need to provide food for rapidly growing population this necessitates the expansion of agricultural land and the provision of land for the landless in order of self sufficiency. Generally, land use/ land cover changes can affect the socio-economic status of the rural population (Lambin *et al.*, 2000). Consequently, agricultural productivity that determines rural income levels and wealth can be affected by the LULC change. Change in LULC can also negatively affect the potential use of an area and may ultimately lead to land degradation and loss of productivity. The livelihood problems in marginal areas may be caused by natural resource degradation or by severe constraints in the realization of potential benefits from natural resources (Geist & Lambin, 2002).

In Ethiopia, limited number of studies has been conducted on LULC changes. On the other hand, rapid population growth has been forcing farm households to horizontally expand their farm fields. As a result, large areas, which were once under forest, bush and grazing land are now changed to cultivated land and expose to soil erosion resulting into environmental degradation and serious threat to the land (Amare, 2007). For instance, Kebede (1998) reported that temporal land use/ land cover change in the Munessa forest project area, and pointed to a continuous conversion of forest land to cultivated land. Kahsay (2004) estimated an increase in the land cover of cultivated land from 25% to 56.4% in 1972 and 2000 in the central highlands of Ethiopia. If this trend continues at these rates, area will no longer be able to support and supply agricultural productivity to the rest of the country and to the world at large and will soon fail to satisfy the demands of the human. Thus, understanding of the impacts of land use/ land cover dynamics in relation to agricultural productivity is considered to be the foremost option in designing sound and appropriate land use planning.

Generally, studies of LULC changes in Ethiopian highlands concentrate in the Northern Ethiopian highlands, areas early settled and where population pressure is relatively high (e.g. Belay, 2002). There have been very limited studies of similar topic in the southwestern regions of the country. Therefore, this particular study focused on the LULC dynamics and its consequent impacts in southwestern highlands. It is important to study the land use/ land cover dynamics and asses its drivers and impacts. Such a study will be used for land use planer and natural resource managers as a precursor to formulate and implement effective and appropriate strategies and provide a base line data for policy makers to develop appropriate land management plan. Hence, the output of this study could contribute to the sustainability of the catchment management and enable local governments to minimize the undesirable effects. Therefore, available data on LULC change can provide critical input to decision making of environmental management and planning the future (Selcuk, 2008).

The research questions focus, therefore on major problems ranging from those related to the physical environment and other related issues to priorities and strategies as well as possible linkages among these problems. Accordingly the specific research questions envisaged to be addressed in the study include:

- What was the area of land use/ land cover during the different periods?
- What are their major impacts for those changes in the study area?

The dynamics in land use/ land cover brings tremendous change in the agricultural productivity. However, few studies of land use/ land cover change provide an integrated assessment of the driving forces and consequences of those changes, particularly in Africa (Robin *et al*., 2000). On the other hand, very little information is available regarding all of such conditions and aspects in the study area. The present study was, therefore, undertaken to investigate and quantify land use/ land cover dynamics and assess its impacts on agricultural productivity in Nada Asendabo watershed, South Western Ethiopia.

2. LITERATURE REVIEW

2.1. General Over View of Land Use/ Land Cover Dynamics

Nature and more importantly human beings greatly influence the environment including land use, which is dynamic in nature (Sintayehu, 2006). Humans are directly or indirectly depend on the land. The growth of urban-rural population distribution and the impact of rapidly growing population on ecosystem goods and services are likely to become dominant factors in land use change in the decades (Eric, 2003). Thus, land is one of the key ecological resources that should be used properly to get sustainable production without damaging its potential to produce on long-term basis and to pass it over to the future generations at least with the potentials at the time it is received being maintained (Sintayehu, 2006). However, humans have been altering the earth's surface to produce food.

According to Zubair (2006) land use/ land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Today, only few models of land use change can generate long-term, realistic projections of future land use/ land cover changes at regional to global scales (Eric, 2003). The advancement in the concept of vegetation mapping has greatly increased research on land use/ land cover change thus providing an accurate evaluation of the spread and health of the forest, grass land and agricultural resources has become an important priority (Zubair, 2006). Understanding the complexity of land use/ land cover changes and their driving forces and impacts on human and environmental security is important for the planning of natural resource management and associated decision making (Efrem *et al.*, 2009).

The global land use/ land cover change is the result of the local process. To address the impact of such changes occurring in the area, emphasis should be given on local level processes. Generally, at whatever scale, knowing the trend of land use/ land cover change is the entry for analyzing it relation with trend of land degradation.

Land use/ land cover change in Africa is currently accelerating and causing widespread environmental problems and thus needs to be mapped (Bernard *et al.*, 2010). This is important because the changing pattern of land use/ land cover reflect changing economic and social conditions. Monitoring such changes is important for coordinated actions at the national and international levels (Bernard *et al.*, 2010). For example, frequent mapping of vegetated area by remote sensing is important for quick generation of information for government to inform them of the magnitude of the problem **(**Boakye *et al.*, 2008). Accurate information on land use/ land cover change and the underline forces behind is essential for designing a sound environmental planning and management.

Land use/ land cover change is influenced by various natural and human activities and processes. Spatial details play important role in these processes (White *et al.*, 1997). Other important determinants of changes in land use/ land cover include several types of policy such as human settlement and land tenure policy. Humans have been altering the earth's surface to produce food through agricultural activities for centuries. In the last few decades, conversion of grass, wood and forest lands into cropland and pasture has risen dramatically in the tropics (Houghton, 1994).

Different studies have been showed the expansion of crop lands have expanded at the expense of natural vegetation, including forests and shrub lands (Solomon, 1994; Belay, 2002; Solomon, 2005). In Girmay (2003) study in Southern Wello, reported the decline of natural forests and grazing lands due to conversion to croplands. Expansions of cultivation, commonly into steeper slopes and marginal areas, may have been done without appropriate soil and water conservation measures. As a result, these lands become unproductive in short period of time, leading to soil erosion which latter treats to low productivity (Ephrem, 2008). Gessesse and Kleman (2007) also studied the pattern and magnitude of deforestation in the South-Central Rift Valley Region of Ethiopia. Zelalem (2007), Ecological and economic evidence have shown that decrease in land productivity is the major problems in Ethiopia. Sintayehu (2006) reported typical savannah grass lands are diminishing; 86.1% of savannah grass lands were changed to other land use systems in the three decades from 1973 to 2003. Crop lands area increased by about 385% between 1973 and 2003 from its total land area in 1973. However, contrary to other studies, majority of the bush land is increasing over the study period. The reasons for this being may be due to that the areas conversion of grass land into bush lands after the traditional rangeland management through burning.

Similarly, Merkebu (2010) reported that results from land cover change dynamics show an increase in agricultural land from 21.59% in 1973 to 51.76% in 2010, with mainly at the expense of grass land, forest land and shrub land respectively in Kutaber Wereda. On the contrary, forest land, shrub land and grass land decreased from 15.21%, 27.58% and 20.6% in 1973 to1.2%, 21.78% and 4.05% in 2010 respectively.

Some local and regional scale studies have attempted to identify the possible driving forces of change, quantify land use/ land cover changes, and to assess the impacts of those changes (Bilsborrow and Ogendo, 1992). The use of this study is that by understanding the past, it could be possible to make projections for the future. As mentioned previously, among the land use/ land cover changes occurring, the most significant historical change in land use/ land cover has been the expansion of agricultural land.

2.2. Concepts and Definitions of Land Use/ Land Cover

In many remote sensing changes detection studies land use/ land cover often used interchangeably. The cover of land (cities, fields, range land, forests, and wetland) reflects at the same time the use of land and the natural conditions within land use is taking place (FAO and EEA, 2009). Land use often corresponds to a land cover type and in these instances, the concepts are synonymous. For example, a grazing land is a land use but also describes the land cover. In cases like this where, there is a direct relational correspondence between land use and land cover; the two concepts are essentially identical (Ephrem, 2008). However, land cover and land use also could be seen separately (FAO and EEA, 2009). This differentiation is important because of some reasons.

Land cover refers to the biophysical state of the earth's land surface and immediate sub-surface including biota, soil, topography, surface and ground water and human structures (FAO and EEA, 2009; Turner *et al.*, 1993). On the other hand, land use refers to the functional dimension of land for different human purposes or economic activities (Campbell, 1987; FAO and EEA, 2009), the purposes for which humans exploit the land and its resources and human uses of land, or immediate actions modifying or converting land cover (De Sherbinin, 2002). Land use change is the conversion of land use due to human intervention for various purposes, such as for agriculture, settlement and infrastructure (Meyer and Turner, 1994) and land cover dynamics is result of complex interactions between several biophysical & socio-economic conditions which may occur at various temporal & spatial scales (Reid *et al*., 2000).

Land cover has gone under continuous change for long years. This change has occurred through the use of clearance of patches of land for agriculture and livestock production. This is because human production demands cannot be fulfilled without conversion of land cover. In the past two centuries, the impact of human activities on land has grown enormously because of population increase, technological development and the requirements (De Sherbinin, 2002), especially in the developing world. Studies on land use/ land cover changes are a global issue. Since it is directly related to the livelihoods of people.

In order to understand the various implications of land use/ land cover change, understanding of such change is essential. Turner *et al.* (1995) stated that the understanding of land use/ land cover relationship is linked with causes and consequences of its change. Since, the change in land cover leads to the change in land use. The fact that human beings are the major contributors to land use/ land cover changes and are the ones experiencing the consequences of these changes (Zubair, 2006). It will be of paramount importance to understand the interaction between humans and the terrestrial environment (Turner *et al.*, 1993). In Ethiopia, inappropriate agricultural practices, deforestation and overgrazing are affecting crop and livestock productivity of the rural poor and hence their livelihoods.

2.3. Techniques of Remote Sensing and GIS for LULC Dynamic Studies

In recent years, satellite remote sensing techniques have been developed, which have proved to be of immense value for preparing accurate land use/ land cover maps and monitoring changes at regular intervals of time. In case of inaccessible region, this technique is perhaps the only method of obtaining the required data on cost and time effective basis (Daniel, 2008). Remote sensing and geographic information systems (GIS) are important for the monitoring and mapping of land use/ land cover changes across a range of spatial and temporal scales, in order to assess the extent, direction, causes and effects of the changes (Daniel, 2008; Rob, 1998).

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in physical contact with the object, area or phenomenon under investigation (Lillesand *et al.,* 2004; Mironga, 2004). The remote nature of remote sensing technology allow us to make observations, take measurements and produce images of phenomena that are beyond the limits of our own senses and capabilities (Rob, 1998; Lillesand *et al.,* 2004).

The most useful characteristic of remote sensing in land use/ land cover change detection is the multi spectral and temporal resolution of the data (Mironga, 2004). The advantage of using remote sensing in land use/ land cover is that information from the same area could be easily obtained at different times, and this is important in change detection applications. Furthermore, remote sensing can provide the required data in short time with a reasonable accuracy and has an important contribution to make in documenting the actual change in land use/ land cover on regional and global scales (Lillesand *et al.,* 2004).

Geographic Information Systems (GIS) is a technology which enables the analysis of data related to entities that have geographic distribution and a system used for storing, manipulating, and retrieving spatially referenced data (Mironga, 2004). Geo-referenced data, land use/ land cover, crop type, or soils can be incorporated in a GIS to produce map layers. Development of RS and GIS technologies has lead to the advancement of mapping and interpretation techniques as a means of understanding and effectively managing the natural resource in a sustainable manner. At present, remote sensing in combination with GIS have given on land use/ land cover which in turn have created opportunities for improved assessments and analysis issues related with the LULC dynamics (Lillesand *et al.,* 2004).

2.4. Causes of Land Use/ Land Cover Dynamics

Land use/ land cover changes are affected by human-induced activities and growth, socio-economic factors, deterioration of vegetation cover, agricultural activities government policies, and environmental factors (Gol *et al.,* 2010). LULC may have significant impacts on the functioning of socio-economic and environmental systems that results the interplay between socio-economic, institutional and environmental factors (Turner *et al.*, 1993).

Although natural processes may contribute to changes in land use/ land cover, human activities and social factors were recognized to have a paramount importance for understanding of land use/ land cover change (Geist and Lambin, 2002). To understand the various implications of land use/ land cover change, an understanding of land use change is essential. Different human driving forces, mediated by the socio-economic setting and influenced by the existing environmental conditions, lead to an intended land use of an existing land cover, through the manipulation of the biophysical conditions of the land (Turner *et al.*, 1993).

Land use is constantly changes in response to the dynamic interaction between underlying drivers and proximate causes (Geist and Lambin, 2002). The driving forces of LULC change are generally subdivided into two groups: proximate causes and underlying causes. Proximate causes are the activities and actions of local people that directly affect land use in order to fulfill their needs from the use of the land. E.g. agricultural expansion, forest product extraction, infrastructure expansion and others that change the physical state of land cover. De Sherbinin (2002) explains the tropical deforestation in terms of immediate causation by multiple factors rather than single variables. Also he points out that agricultural expansion as the most prominent proximate cause, which is coupled with wood extraction and infrastructure expansion.

However, underlying causes are often external and beyond the control of local communities and are fundamental socio-economic and political processes that push proximate causes into immediate action on land use/ land cover including demographic, economic, technological, institutional and cultural factors (De Sherbinin, 2002; Geist and Lambin, 2002).

In Ethiopia, the main land use/ land cover changes are the conversion of vegetation cover to arable lands (Gete, 2000). Moreover, the major driving forces behind such pervasive LULC changes are identified as high population pressure, followed by land clearance for agricultural expansion, the lack of an appropriate land use plan and poor management practices (Taddese, 2002). The rapidly increasing population pressure on the highlands of

Ethiopia has led to vast changes in land use pattern mainly caused by increasing cultivated lands (Selamyihun and Tekalign, 2003). In the northern parts of Ethiopia, cultivated land showed slow but continuously increasing trend at the expense of forest and grassland over the last decades (Gete, 2000). Hurni (1990) have argued that the accelerated population increase was directly responsible for the expansion of cultivation land into marginal land of the mountain area. Generally, deforestation of forest and their conversion to continuous cropping have led to severe soil degradation and brought about significant change in the productivity and the ecosystem in Ethiopia highlands (Gete, 2000).

The impact of land use/ land cover change which leads to the degradation is severe on both the human society and ecosystems. Such impacts could be reduction in agricultural production and productivity, declining livestock productivity, vegetation resources and water resource as well.

2.5. Impacts of Land Use/ Land Cover Dynamics

In Ethiopia, inappropriate agricultural practices, deforestation and overgrazing affect the crop and livestock productivity of the rural poor, hence also their livelihood. These alterations of ecosystem services due to changes in land use/ land cover negatively affect the ability of biophysical systems to support human needs (Solomon, 2005). The land degradation which appeared in the area particularly in agriculture is a result of rapid LULC changes (Khalid *et al.*, 2010). 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 (Khalid *et al.*, 2010). 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, 2005). The land use affects the soils. The land use/ land cover is by far most important determinants of erosion in the highlands of Ethiopia (Woldeamlak, 2002). Among others the one factor that affect the productivity of the land are land use type.

Sutcliffe (1993) indicates that the immediate consequence of land degradation is reduced crop yield and livestock productivity followed by economic decline and social stress.

Hence, due to excessive land degradation reduced soil moisture capacity and structure of the soil lead to extremely low average crop yields per unit area (Kahsay, 2004).

Land use/ land cover change have an impacts on grazing land since it is affected by forms of land degradation such as over cultivation, over grazing, deforestation and others. According to Tamirie (1997), Ethiopia has about 60 million hectares of land for grazing. This figure has reduced to less than 55 million due to grassland conversion in to other land use/ land cover. An important factor contributing to the decline in fodder resources is the ever increasing human population, which resulted in an increase in cropland at the expense of traditional grazing areas such as bush lands, natural pasture and forests which have been aggravated since recently (Kahsay, 2004).

It is important to understand effects of spatial and temporal changes of land use/ land cover and demographic structure of their effects on landscape pattern that affect the grazing land (Amin *et al.*, 2011). ILRI (1999) indicate that human population is increasing drastically at about 3% a year, while cattle population is drastically cut by mortality caused by drought and the interaction of drought with high stocking rate. Livestock crash more regularly now, because of fewer grazing land. Past grazing lands have now either people in them, or are degraded or otherwise insufficient for sustaining livestock herds under stress (ILRI, 1999). The land currently under cultivation was a grazing area few years ago. Due to response to the changes, unsuitable and marginal or fragile lands are now brought under cultivation.

The deteriorating environmental conditions have also adversely affected the availability of feed resources, leaving the country's herds poorly nourished. Whether it is due to conversion of land to cultivation, or due to overgrazing, the removal of vegetation cover reduces the protective cover of the soil and minimizes the re-growth and restocking capacity of vegetation (Zerihun and Mesfin, 1990). According to Hoekstra *et al.* (1990), an expansion of cultivated land at the expense of bush land, grazing land, forest land caused by ever increasing human population, has strongly affected the number of livestock and quality of products. In addition, shrinking of grazing land would force the livestock to move into upper slope. This intern induces over grazing and soil erosion latter treats to productivity.

Vegetation plays an important role in maintaining atmospheric circulation (Byrne, 2001). This would alter the thermal dynamics of the atmosphere and suppresses rainfall, which would in turn, dry out more land, lakes, streams and rivers. In Ethiopia, population pressure is one of the underlying causes, and induces the clearing of forests for agriculture and other purposes; the attendant accelerated soil erosion is gradually destroying the soil resource (Hurni, 1990). Although forests may have existed in Ethiopia long before recorded history, the present day forest cover does not correlate with the historical human population, even though environmental problems such as drought, may also have contributed to this phenomenon.

One of the problems regarding forest cover in Ethiopia is the use of biomass energy sources. One obvious consequence of land use/ land cover change, particularly of deforestation is the shortage of fuel wood (Solomon, 2005). As population increases household energy consumption also increases. For the poor in rural areas, it is not only a source of energy but a means of income generation too. In Ethiopia, 85 percent of domestic energy consumption is derived from forest products (EFAP, 1994).

Vegetation cover and dead plant biomass are also used to reduce soil erosion by intercepting and dissipating raindrops and wind energy (Kahsay, 2004). However, once forestland is converted to agriculture, erosion rates increase because of vegetation removal, over-grazing, and continuous cultivation. On the other hand, there is a better understanding that forests burnt in certain parts of the world are important contributors to greenhouse gases and contributing to climate change (Kahsay, 2004). Generally, the overall these land use/ land cover changes had an impact on the vegetation cover.

Land use/ land cover change also has impacts on local and regional climate and water resources (Solomon, 2005). The LULC also affect runoff, evapo-transpiration and surface erosion in a watershed (Yacob, 2010). Land cover has various properties that help to regulate water flows both above and below ground. The destruction of vegetation cover affects rainfall amount. For example, tree canopy and leaf litter can help reduce the impact of raindrops on the ground, hence reduce soil erosion, while roots hold the soil in place and also absorb water. In the absence of vegetative cover, soil erosion will result and the effects of this phenomenon have been detailed previously (Kahsay, 2004).

A massive removal of forest in the Amazon has led to a decrease in evaporation and precipitation in the region (Turner *et al.*, 1995). LULC changes also, especially vegetation cover, affect water and energy balances (Houghton, 1995). According to Turner *et al.* (1995), certain land use types have significant impacts beyond the proportion of their spatial extent. Land use/ land cover characteristics and water cycle have many connections. The type of land cover, obviously, can affect both rate of infiltration and run off amount by following the coming precipitation (Houghton, 1995).

In the past 50 years, the construction of dams and reservoirs has become important part of human induced land cover changes. Impacts of land cover changes that occur due to artificial water body are beyond their proportion of aerial extent. The type of land cover, obviously, can affect both rate of infiltration and runoff amount. According to Turner *et al.* (1995), both surface and ground water flows are significantly affected by type of land cover. Low level vegetative cover could also affect infiltration and could lead to reduced ground water levels and therefore the base flow of streams (Dagnachew *et al.*, 2003).

3. MATERIALS AND METHOD

3.1. Description of the Study Area

3.1.1. Location

The study area is located in Nada Asendabo watershed, Omo Nada Woreda, Jimma zone of Oromia Regional State. It is located close to Gilgel Gibe dam and about 260 km South West of Addis Ababa. The site is located between 7^0 36’ 00.87’’ - 7^0 41’ 05.72’’ N latitude and 37^0 16’ 55.88’’ - 37^0 14’ 40.73’’ E longitude (Figure 1). It cover an area of 8,012 ha.

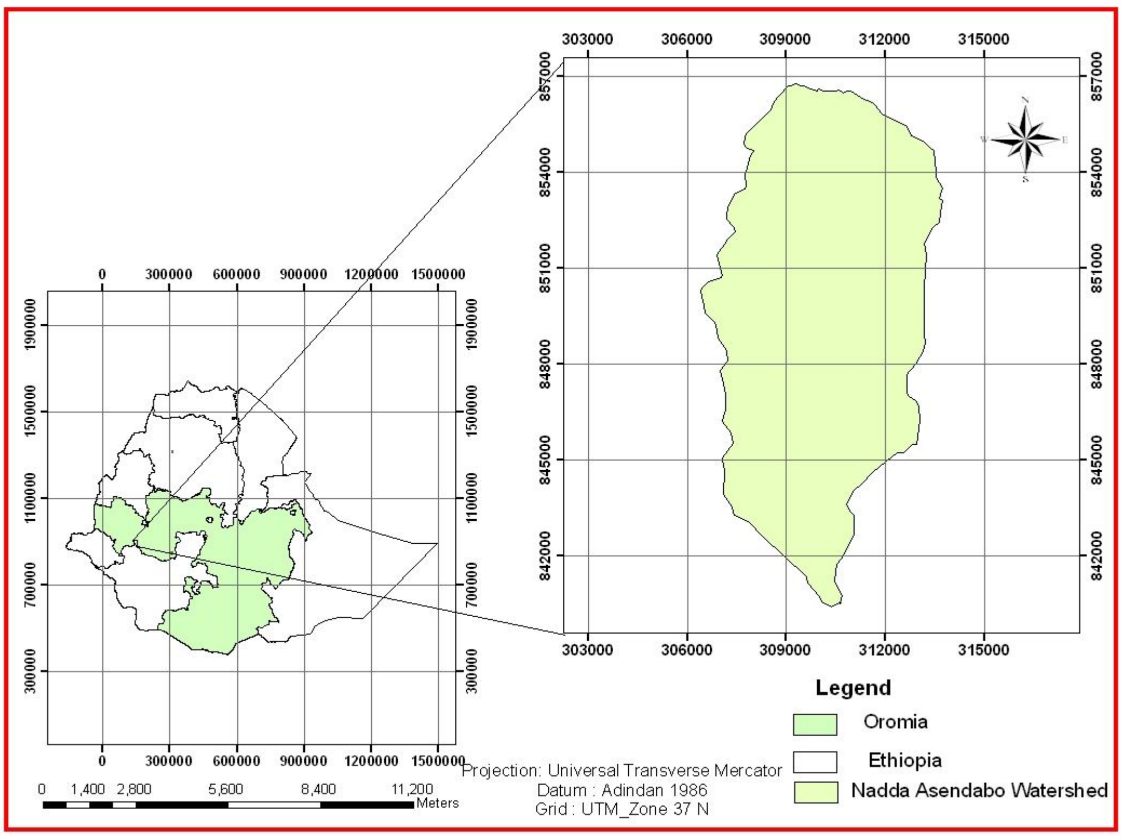

Figure 1. Location map of the study area.

3.1.2. Topography and Soils

The area is characterized by gentle, flat and undulating topography with the altitude ranging from 1650 – 2200 m.a.s.l. The upper part of the area is generally gentle slope. the lower part is with plain or flat. The drainage from this sub-watershed flow in to Gilgel Gibe dam.

According to Van Ranst *et al.,* (2011), the major reference soil groups in the Glgel Gibe catchment are Nitisols, Acrisols, Ferralsols, Vertisols and Planosols. Texture range from clay to loam clay or sandy clay. The middle and high altitude soils are less rich in nutrients due to the fact that they have been under human land use for long (SLMP, 2009).

3.1.3. Climate

The area is characterized mostly by hot moist tropical agro-climatic zone. The rainfall of the area is bimodal, with unpredictable short rains from March to April and the main season ranging over June to September. The minimum and maximum annual rainfall is ranging from 1066 to 1200mm with a mean annual temperature of 18-25^{O}C (SLMP, 2009).

3.1.4. Socio-economic characteristics

The study area is inhabited majority by Oromo people and the people are predominantly Muslim followers. The most important social and economic problems are the low level income and the high population growth rate with declining agricultural production. The economic bases of the community in the area are in rain fed farming practices, some irrigation and free-range livestock rearing. Mixed agriculture remains to be the main livelihood activity. The major cultivated crops include maize, teff and sorghum. Average land holding size is <2 hectare per household (SLMP, 2009).

In general, activities other than agriculture seem to be very limited. In the area agriculture is an important household resource that played significant role to household food security, income generation, food supply and transportation for supply of manure and fuel. Cattle, sheep, goat, donkey and mules are the most common domestic animals raised in the area. Rangeland is common grazing system in the area (SLMP, 2009).

3.1.5. Vegetation

The elders of the surrounding have stated that 50 years past most of area was covered with indigenous trees such as *Poducarpus* and *Juniperus*. Later agricultural land expansions have resulted in destruction of forest trees and treat to even wildlife (SLMP, 2009).

On the other hand, before Derg (the previous government) resettlement program had been undertaken during that time some parts of the area were cultivated to cereal crops. Moreover, the existing farming condition shifted the previous practices and the local resources of the area (Mohamed, Personal communication). At the present, unsustainable management of the natural resource is manifested by cultivation of hillsides and steep slopes, clearing trees, changing grassland into cropland, soil erosion and less water infiltration due to devotion of vegetation, and organic matter deterioration are resulting in overall loss of land productivity. The people in the watershed have underlined that expansion of degradation is highly correlated with population growth and of course unwise use of land.

3.1.6. Land use/ land cover around the watershed area

Result made from the visit of the area and PRA tools done, the following major land use/ land cover type were identified. Presently, the majority of the remaining forests of the watershed are found on the hills and sloppy area of upstream parts of the watershed. Majority of the watershed parts of the study area is covered by mainly agricultural land and followed by homesteads. Reverine forest found along with the stream basin and bush land cover which is spreading only in some parts of the watershed. Grass lands are found also as interspersed among agricultural land. Homesteads are located over the area in all parts and mainly along the main road networks and along the stream network.

3.2. Data collection procedures

Remote sensing, PRA tools and socio-economic survey techniques were employed to quantify land use/ land cover change and to assess the impact of this change in the study area.

Remote senesing data and topo map with the scale of 1:50,000, from EMA (Ethiopia Mapping Authority) were used as supporting spatial data for delineating the boundary of the study watershed. GPS Germen was also available and used for GCP. Multi-temporal land satellite images of three periods: 1973, 1986 and 2004 were obtained from Horn Africa and used as data sources for land use/ land cover change dynamic study (Table 1).

Table 1. Satellite images used for the study

Land sat Types	Date of Acquisition	Spatial Resolution (m)
Land sat-MSS	January 1973	56.75mX56.75m
Land sat-TM	March 1986	28mX28m
Land sat-ETM+	February 2004	28mx28m

A preliminary field survey had been conducted to get a general view on the physical condition of the area, such as the vegetation cover, land use/ land cover type and topography of the study area.

GPS points during field work have been used in the collection of GPS points as the support for the image classification. More than 155 sample training sites have been collected. 56 agricultural land, 28 bush land, 13 grass land, 10 forest land, 29 built- up area, 19 reverine forest. Along with the above mentioned methods of data gathering the very great concern of this research, majority of the data were extracted from the satellite images relevant for the study.

A structured questionnaire, focus group discussions and key informant interviews were used to assess the impact of land use/ land cover change on agricultural productivity in the Study area. Socio-economic data were obtained from randomly selected heads of households and from six group discussions within the watershed. In addition, transect walks involved direct observation, questioning, listening, discussing and learning about the current land use/ land cover dynamics were carried out. Data was also collected from both DAS and wereda Agriculture and rural development office.

To collect the necessary house hold data a carefully designed questionnaire, consisting of interconnected questions, was employed using the following procedure. To select the peasant household heads (respondents), the total number of household heads of the study area was obtain from SLM project that works on the watershed. After getting the total number of household heads in the watershed it was determining total sample size of the survey. A total of 126 households were sub-sampled for the household questionnaire, however only 90 heads of household were interviewed for technical reasons. The number of sample household farmers selected for the questionnaire was determined using the formula developed by (Cochran, 1977 as cited in Bartlett *et al.*, 2001).

$$no = \frac{z^2 pq}{d^2} \rightarrow n = \frac{no}{1 + \frac{no - 1}{N}}$$

Where;

n_o = the desired sample size Cochran's (1977), when population is greater than 10000

n = number of sample size when population is less than10, 000

Z = 95% confidence limit i.e. 1.96

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

q = 1-P i.e. (0.9)

N = total number of population

d = Precision or degree of accuracy desired (0.05)

3.3. Analyzing Land Use/ Land Cover Dynamics

The acquired multi-temporal images were processed following standard image processing procedures that comprise image enhancement, rectification and classification. This has allowed the extraction of information on land use/ land cover condition and quantification of changes and its rate over the past 31 years using multi temporal GIS analysis. The land use/ land cover conditions of three different periods have been compared and the rate, change dynamics and quantity of change have been calculated. Collection of secondary data related to the study and discussions with local informants and GPS points were also collected to assist the study. The whole procedure followed is summarized in the chart below (Figure 2):

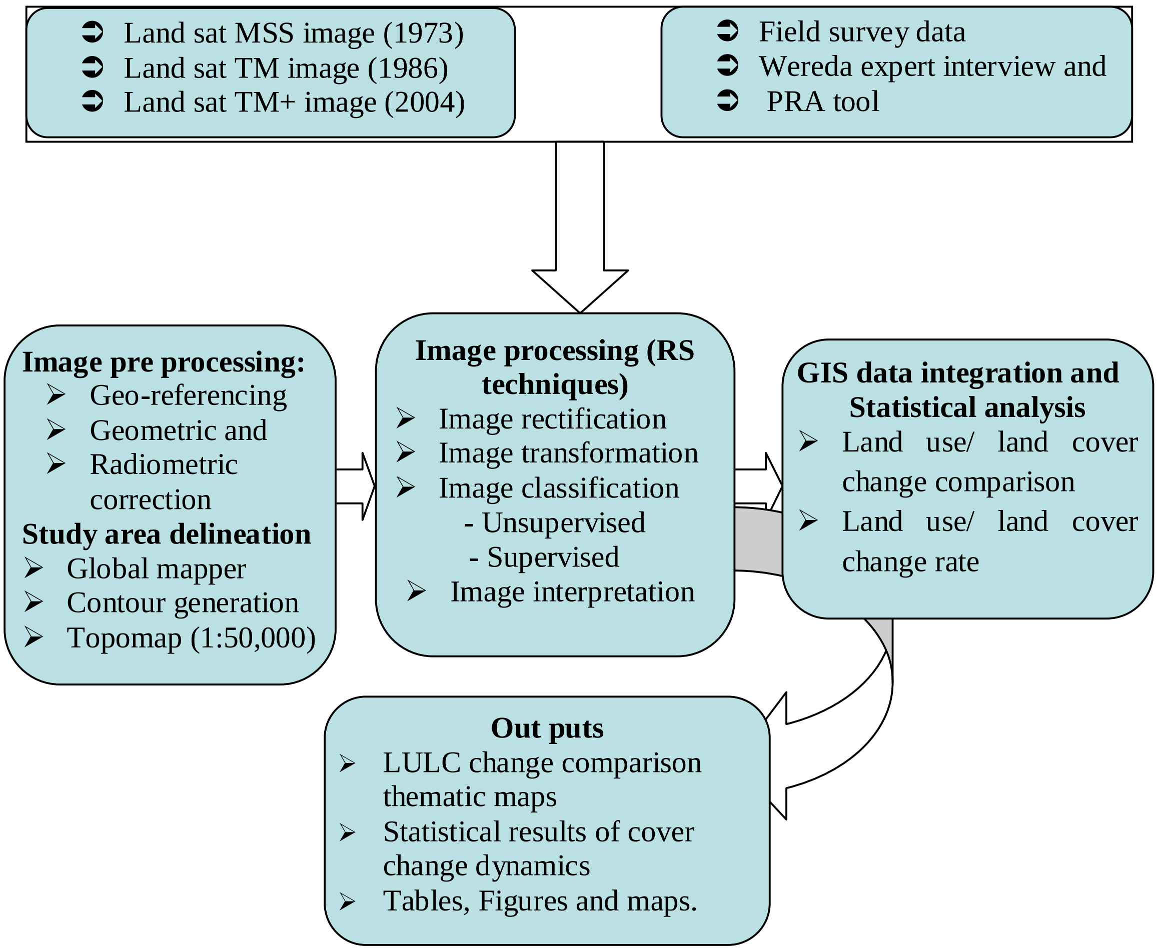

Figure 2. Flow chart showing methods for land use/ land cover classification

To investigate the changes that occurred during three periods the three years, six land use/ land cover categories were distinguished: agricultural land, forest land, riverine forest, bush land, grazing land, and built-up area (Table 2). A combination of information collected from the field, topographic map and local people knowledge and satellite images was used in the analysis of land use/ land cover change and in preparing the land use/ land cover maps. A pattern was selected for each of the six categories.

Table 2. Land use/ land cover classes considered in image classification and change detection

LULC class	General description
Forest land	This unit represents both natural and fragmented plantation forest areas that are stocked capable of producing timber and other wood products. It includes areas covered by trees forming closed or nearly closed canopies.
Reverine forests	Area covered by natural vegetation and planted trees along the rivers and many small streams. The identification of the land use/ land cover types in to each single land use/ land cover type was impossible because all of them are found almost in the same width of strip in a very mixed pattern.
Bush land	Land covered by small trees, bushes and shrubs, in some cases mixed with grasses and less dense than forests.
Grazing land	Are those lands where small grasses are the predominant natural vegetation used for grazing and browsing. It also includes grass, natural pasture and some grass lands.
Agricultural land	This category includes area allocated for annual rain fed and irrigated cultivation and currently under crop, fallow and land under preparation. The class may also include small inter-field cover types as well as farm infrastructure.
Built-up area/ Homestead	This category includes residential of town, institutions (e.g. church, mosque, school, health center and so on) and dispersed rural settlements and homestead. The merged land cover type of these land use/ land cover types was practical instead of separately identified their areal extents having similar spectral value

The land use/ land cover of the study area was analyzed after interpretation of land use/ land cover on land sat satellite image of the study area and its surroundings. All the three images were originally radio-metrically and geo-metrically corrected, and geo-referenced to Universal Transverse Mercator (UTM) projection at WGS 84. Image interpretation is the extraction of differentiated classes of land use/ land cover categories from remotely sensed data.

Among these land use/ land cover types some of them are homogenous units of the main land use/ land cover type while some are a combination of mixed cover types due to its difficulty to separate because of its similarity and their intermingled pattern and negligible size relative to the other land use/ land cover types.

Usually, farm plots encircle rural settlements. Some lands are categorized under other land cover types. The land use/ land cover classes were separated on the basis of their image characteristics. For instance, built up area were differentiated from agricultural land by their high reflectance (brightness) and their associations with particular locations following the rout of the river and many small streams (reverine forests). Bush land was also differentiated from forest land by their finer texture.

However, there was no significant contrast in tone between agricultural land and grass land. Hence, it was necessary to evaluate characteristics such as pattern and association. Thus, agricultural land was separated from grassland mainly on the basis of the lines of hedges bounding the individual cultivated plots and also the narrow, but linear to curved features of the traditional conservation structures. However, the two classes were categorized under one land cover class (*i.e.* cultivated land).

3.4. Data Analysis

3.4.1. The land use/ land cover dynamics data analysis

Analysis of land use/ land cover dynamics was analyzed using Arc GIS 9.2 and ERDAS IMAGINE 9.2 soft ware. Different land use/ land cover categories were distinguished using different techniques such as local people know logy, PRA tools and visual observation. Performing image analysis is an inevitable task to extract meaningful information from remotely sensed data. So, an effort was made to use the remotely sensed data with different level of image processing methods.

Training site selection for field work and pre-field analysis

Unsupervised classification was conducted and the land use/ land cover classes were classified. Since it is difficult to rely on unsupervised classification to describe all the land use/ land cover types, thus interpreting satellite images should be complemented by field inventory. Based on the results from unsupervised classification sample training sites were also selected for data collection during fieldwork using Germin GPS receiver all representative class waypoints were collected from the study area as supportive.

Based on the final image classification samples which were prepared during field work stage; all the available images were classified in to six land use/ land cove types by applying unsupervised classification method. Meanwhile, the land use/ land cover maps were generated from the years 1973, 1986 and 2004 satellite image. Similarly, the extent of the change for each land use/ land cover type to another land use/ land cover type was also determined in terms of area (ha) and percentage rate. The details are presented in the results and discussion.

Image Enhancement and Interpretation

Satellite image contains detailed record of features on the ground at the time of data acquisition. In relation to this (Lillesand *et al.*, 2004) suggested image interpreters should have good power of observations coupled with imagination and it is important that the interpreters have a thorough understanding of the phenomenon and geographic region under study. In addition to this, to increase the visual distinction between features the amount of information that can be visually interpreted from the data and to extract important summarized statistical data.

Land use/ land cover change rate

The land cover map for the three period series of images is analyzed based on land use/ land cover types area comparison and land use/ land cover changes using tables and graphs. The changes over 31 years were analyzed and rate of change for each land use/ land cover type is calculated. Besides, various types of summary statistics were documented. In the mean time, the rate of land use/ land cover change for the two periods from 1973 - 1986 and 1986 - 2004 can be computed using the following simple formula:

$$r=(Q2-Q1)/t$$ ---------------------equation1

Where, r = rate of change

Q2 = recent year land use/ land cover in ha

Q1 = initial year land use/ land cover in ha and

t = interval year between initial year and recent year

3.4.2. Socio-economic data analysis

The socio economic data was rearranged, cleaned, coded and the pre-coded questionnaires were summarized. To analyze the socio-economic data, descriptive statistics were utilized with the help of Statistical Package for Social Sciences (SPSS) version 16. In addition, Microsoft Office Excel was used for analysis of some statistical material.

There were parameters that required ranking. Hence, Indices were calculated to provide ranking of reasons of production constraint, reasons for shortage of livestock feed, causes of soil erosion, causes of deforestation in the study area. The indices were calculated as follows; first sum up for the number of household ranked for each individual value, secondly multiply each of the rank by the overall reasons. Finally, the sum of each individual value divided by the overall reason will give the index value. The index value was determined using the formula developed by (Tesfaye, 2008).

Index = Sum of (8 X number of household ranked first + 7 X number of household ranked second + 6 X number of household ranked third + 5 X number of household ranked fourth + 4 X number of household ranked fifth + 3 X number of household ranked six + 2 X number of household ranked seven + 1 X number of household ranked eight) given for an individual reason, criteria or preference divided by the sum of (8 X number of household ranked first + 7 X number of household ranked second + 6 X number of household ranked third + 5 X number of household ranked fourth + 4 X number of household ranked fifth + 3 X number of household ranked six + 2 X number of household ranked seven + 1 X number of household ranked eight for overall reasons, criteria or preferences.

4. RESULTS AND DISCUSSION

Results from land use/ land cover dynamics and socio-economic survey are presented and discussed as follows:

4.1. Land Use/ Land Cover Dynamics

4.1.1. Land use/ land cover class change for 1973, 1986 and 2004

For a clear and informative comparison of the land use/ land cover change area value for the periods of 1973, 1986 and 2004 summarized in Table 3 below. More of forest land, grass land and reverine forest cover and bush land existed in 1973 and 1986 maps but were reduced in the 2004 map (Table 3). The latter map showed a predominance of agricultural land and built up area instead. Generally, there was a continuous change taking place for most LULC types over the whole study period.

Table 3. Comparison of area under different land use/ land cover types during 1973, 1986 and 2004.

Land use/ land cover types	Years					
	Area for 1973(ha)	Area in (%)	Area for 1986(ha)	Area in (%)	Area for 2004(ha)	Area in (%)
Bush land	1901	23.73	991	12.37	634	7.91
Reverine forest	1456	18.17	505	6.30	349	4.36
Agricultural land	1535	19.16	4,175	52.11	5255	65.60
Grass land	1920	23.96	1,646	20.54	681	8.50
Built - up area	117	1.46	272	3.40	712	8.88
Forest land	1083	13.52	423	5.28	381	4.75
Total	8,012	100.00	8,012	100.00	8,012	100.00

Figure 3, 4, and 5 below show that land use/ land cover class distribution by the respective years (1973, 1986 and 2004) for the study area. In 1973, (Figure 3) the dominant land use/ land cover classes were grass land and bush land that are found in all parts of the watershed (middle, lower and upper) part covering 1920ha (23.96%) and 1901ha (23.73%) respectively. Forest land and reverine forest that were found mostly in the lower catchment and middle parts of the watershed accounted about 1083ha (13.52%) and 1456ha (18.17%), respectively. Built-up area accounted for 117ha (1.46%), agricultural land was only 1,535ha (19.16%) in the watershed during this period.

On the map of the 1986 (Figure 4) agricultural land predominates covering 4,175ha (52.11%) of the watershed followed by grass land with 1,646ha (20.54%). Bush land, which dominated around lower part of the catchment and on rugged topography covered 991ha (12.37%); reverine forest 505ha (6.3%), forest land that was concentrated in the upper catchment near the Nada town covered 423ha (5.28%) and built-up area covered 272ha (3.40%) of the total area coverage.

In 2004 (Figure 5) agricultural land still dominated covering 5,255ha (65.60%), followed by built-up area with 712ha (8.88%), bush land 634ha (7.91%), reverine forests 349ha (4.36%), forest covering only 381ha (4.75%) and grass land 681ha (8.50%) of the total area coverage.

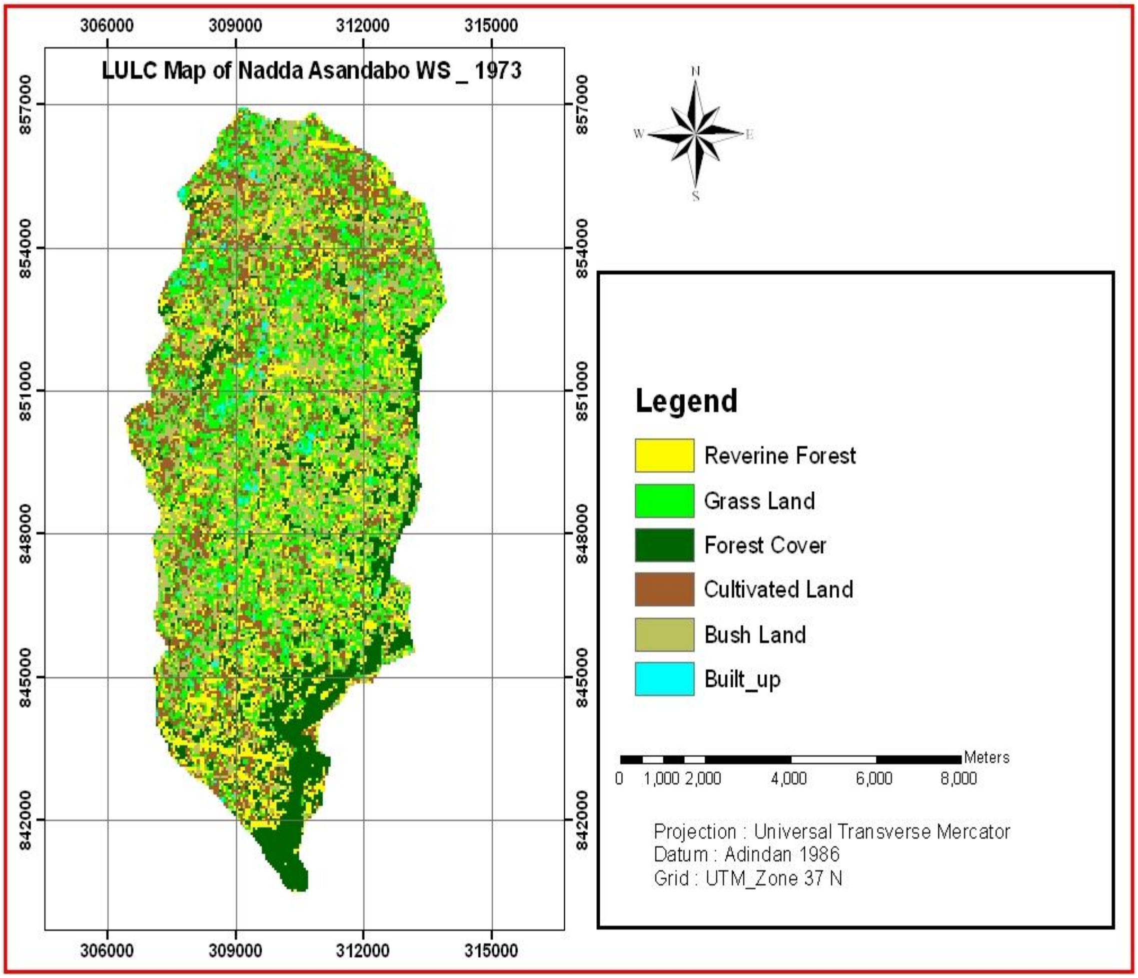

Figure 3. Land use/ land cover map of Nadda Asendabo Watershed in 1973.

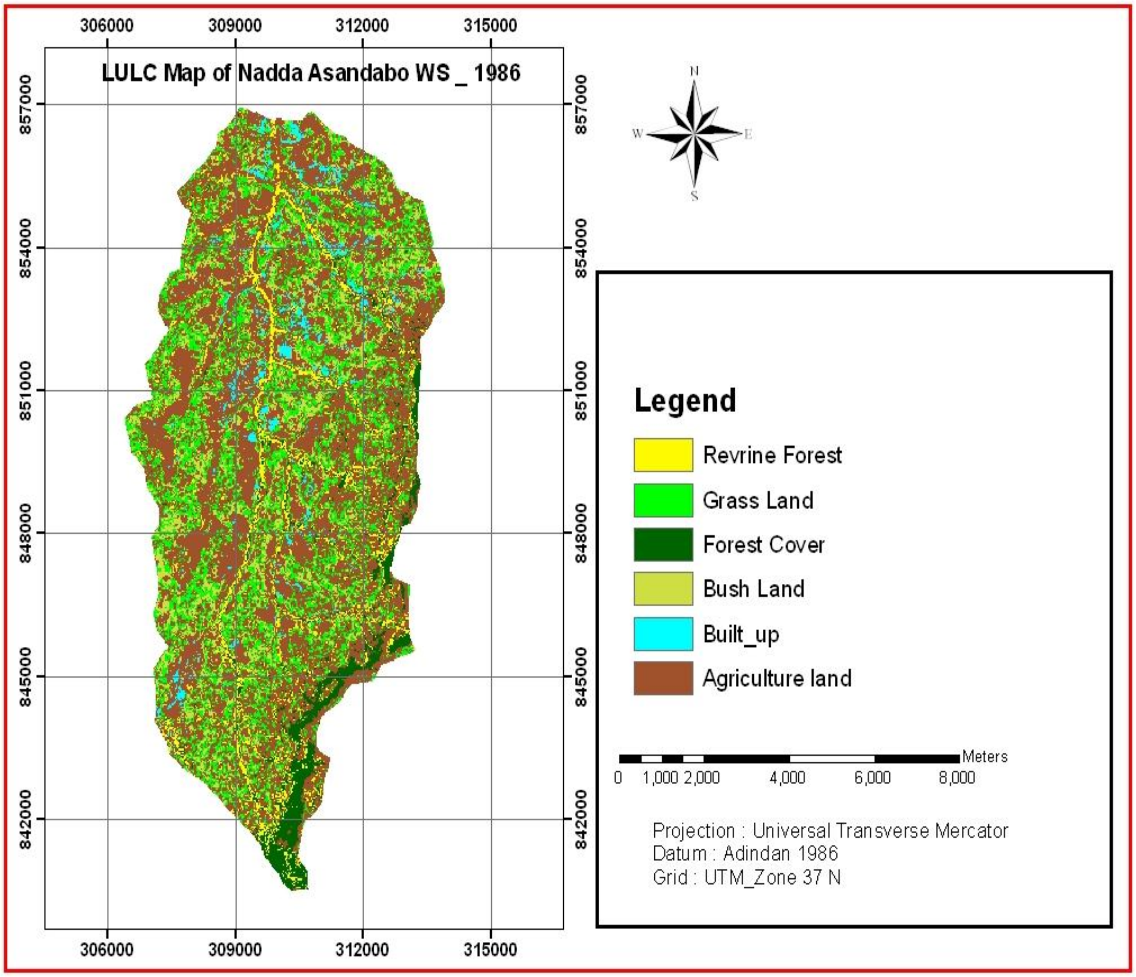

Figure 4. Land use/ land cover map of Nadda Asendabo Watershed in 1986

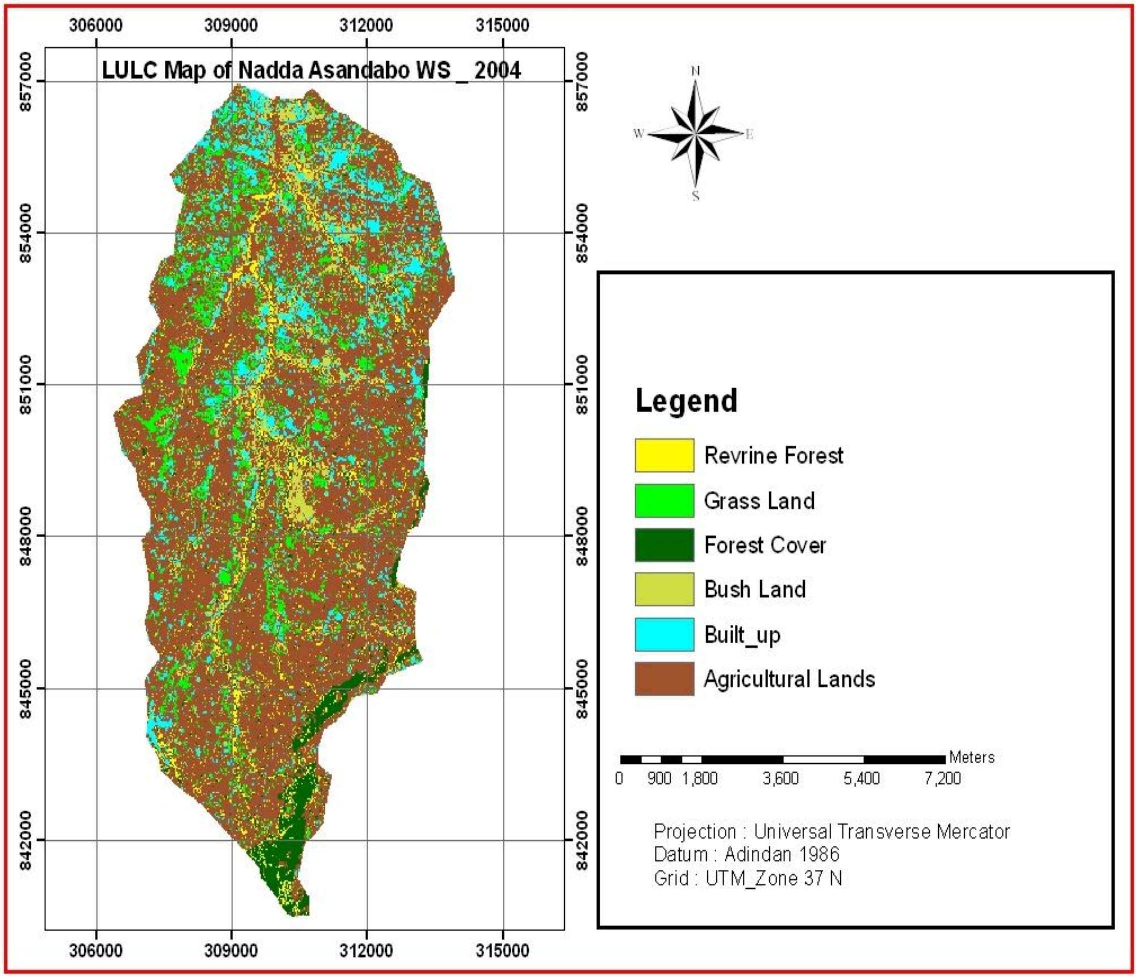

Figure 5. Land use/ land cover map of Nadda Asendabo Watershed in 2004

4.1.2. Rate of land use/ land cover change

The dynamics in land use/ land cover change from 1973 to 2004 is discussed by separating them into two: the first period from 1973 to 1986 with 13 years gap, and the second period from 1986 to 2004 that has 18 years gap (Table 4). The results showed that in both period's agriculture and built-up areas increment, while the rest showed a decline in area coverage. During the first study period (1973 to 1986) agricultural land increased by 2640ha, which is approximately equivalent to 203.08 ha/yr (Table 4), whereas the increment for the built-up area was 155ha (11.92 ha/yr).

During the second period the rate of increase in agricultural land was 1080ha (60 ha/yr), less than the first period. For built up area the rate was 440ha (24.44 ha/yr). In contrast, the other land use/ land cover classes decreased both in the first and second periods. The reason for this increment was due to population pressure to sustain their life. The largest decline was observed for reverine forest that decreased by 951ha (73.15 ha/yr) during the first period followed by bush land and forest land (Table 4). During the second period the largest decline was for grassland that decreased by 965ha (53.61 ha/yr).

Table 4. Rate of land use/ land cover change in the study period

Land use/ land cover types	1973 to 1986		1986 to 2004		1973 to 2004	
	Area Change (ha)	Rate of Change (ha/yr)	Area Change (ha)	Rate of Change (ha/yr)	Area Change (ha)	Rate of Change (ha/yr)
Forest land	-660	-50.77	-42	-2.33	-702	-22.64
Agricultural land	2,640	203.08	1080	60.00	3,720	120.00
Grass land	-274	-21.07	-965	-53.61	-1,239	-39.97
Built-up area	155	11.92	440	24.44	595	19.19
Reverine forest	-951	-73.15	-156	-8.66	-1107	-35.71
Bush land	-910	-70.00	-357	-19.83	-1267	-40.87

Overall, agricultural land show the highest rate of change for 1986 to 2004, by 60.00 ha/yr increment and built-up 24.44 ha/yr for the same time but grass land show the highest negative value which is -53.61 ha/yr followed by bush land by an amount of -19.83 ha/yr.

The rates of change in land use/ land cover units have not been uniform across the board. The variations are distinct; increases in small-scale farming carried out by resource poor farmers are held accountable for decreases in areas covered by grass land, forest land, reverine forest land and bush land. This is also similar to the findings of Bernand *et al.* (2010); dynamics of land use/ cover trends in Kanungu district, South-Western Uganda.

Generally, grassland, forest land, bush land and reverine forest showed a continuous decline. This is believed that the agricultural and built-up areas expanded at the expense of grass land, forest land, bush land and reverine forest.

The observed trends of increasing agricultural land and built-up areas and decreasing grass land in the area could be explained by: First, the population growth forced the farmers to till and expand their lands in greater extent than before to cope up with the conditions and to sustain their life Second, infrastructure expansion on the expense of grass land, forest land, and bush land has contributed to the reduction of those land use/ land cover types in the area. However, this change also alters to cultivated land.

Some earlier studies in some area indicated that many households were abandoning unproductive grazing land and the increasing population pressures have an impact on natural resources degradation. Example, (Sintayehu, 2006), reported that due to unsuitability and shortage of grazing land caused by increasing shift towards cultivation, grazing area have been abandoned. The study revealed that most of the potential grazing areas have been affected by human and natural factors. Even though it has continuous gain in total bush land overtime its high loss of bush land and grass land latter changed to cultivation land signifies a negative outcome of combined long-term efforts of grass land conservation.

The expansion of agricultural land during the first study period at the expense of other lands indicated increased pressure on agricultural land latter reduces the productivity due to its resources exploitation, unsustainable cultivation and soil fertility decline. From conversations with local farmers it was revealed that there was indeed a big shift in the use pattern of the watershed during this period because of farmers' attractions towards cropping on the area. These days cultivation through conversion of grazing land or bush lands to cultivated lands is becoming a must to the area due to high population pressure. In this condition, as mentioned the local communities the expected livestock death is high and it should be supplemented with crop grain for household consumption and as source of income.

4.1.3. The general pattern and areal extent of land use/ land cover change

The following pictures showed land use/ land cover types in some part of the study area taken from the field and give a good impression of the site. Those are grass land, built-up area, agricultural land, bush land, reverine forest and forest land respectively.

Figure 6. Photos showing land use/ land cover classes in the study area

The pattern of change for forest cover showed a decrease between 1973 and 1986 (first period) and 1986 and 2004 (second period). In 1973 the area under forest cover was 1083ha of the study area which declined to 423ha in 1986 and 381ha in 2004 (Table 3). This decline happened throughout the study period. Of the total forest area in 660ha were cleared in the first period. The decrement of forests during the second study period is in small amount due to the fact that the area is not accessible for cultivable land and recently, the conversion of vegetation to agricultural land has slowed because almost no land was left for further expansion. The annual clearance of forest cover in the first and the second study period considered was 50.77ha and 2.33ha, respectively (Table 4). During the entire period, even though the rate is slow forest cover was converted into other land use/ land cover which were existed in the base year.

The transformation of forest land throughout the study period was due to an increasing demand for agricultural land. Local elders believe that the little existing forests were planted by the derg regime. In general, forest lands are found only in steeper slope as it shown in result. The removal of the remaining forest enhances soil erosion and land degradation which latter treats to low agricultural productivity.

Grass land category covers the highest area coverage in 1973. Its pattern of change showed decrease by 274 ha and 965 ha in the first and second study periods respectively. In the 31 years, this category was reduced over the original grass land, which existed at the base year. Between 1986 and 2004, almost 50 percent of grass land converted. The shrinking of grass land in the study period was due to this expansion of cultivated land.

Among the six land use/ land cover types; cultivated land is the most converted land use/ land cover type during the entire study period. Of the total study area, agricultural land constituted 19.16 %, 52.11% and 65.60 % in the years 1973, 1986 and 2004 respectively. In line with this finding, Kahsay (2004) identified an increase in the cultivated land from 25 % to 56.4 % in 1971/72 and 2000, respectively, in the central high lands of Ethiopia. An expansion of agricultural land was observed at the expense of bush land, grass land, forest land and reverine forest. The result of dynamics data showed that the major problem for farmers in the study area is shortage of cultivable land.

Some parts of the wereda town in the watershed is part of the study area and was not difficult to identify both on the land sat satellite images. In the 1973 image, this town was located at the somehow in small recently, it expands and very small village in the surrounding area. A small village at the downstream and middle part of the watershed was also clearly visible in the 2004 satellite imagery but there was less sign of built up in both previous satellite images. Data observation showed that currently there are many built-up areas in the villages including a primary school, health center, church and mosques.

The area under reverine forests which includes all natural, planted and wood lot trees along sides of the river was higher during the year of 1973 and show a significant change during the first study period, while it deceased by small amount in the second period. One of the major reasons for this change is the expansion of newly established villages following the river and around the irrigable land, agricultural expansion and for grazing land purposes.

The area under bush land was higher in 1973 but it was diminished in 1986 and 2004. The annual decreasing rate of bush land is -70 ha, -19.83 ha and -40 ha in the year 1973 to 1986, 1986 to 2004 and 1973 to 2004, respectively. The increasing demands for cultivated land, grazing land and fuel wood have contributed to the deterioration of bush land.

4.2. Land Use/ Land Cover Dynamics and Its Impacts: the Interplay

4.2.1. Crop productivity and production constraints

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 crop productivity is low as compared to levels some years ago.

There was an increasing trend of productivity for some years past that could be due to high fertility of the soil and the new land best for agricultural production due to high agricultural expansion and new technological adoption. Meaning, there was agricultural expansion into previously uncultivated areas, which usually takes place at an extensive and constant technological level; and agricultural intensification on already cultivated land. Intensification involves the substitution of land with labor or capital-intensive technology such as improved seeds and fertilizer.

According to the interviewed household and data on crop yield average production varies among different landscapes and between crops. As the respondents stated, the main reasons for the declining in agricultural productivity mentioned the production preference, the production constraints was directly associated mainly with land use change. Constraint preference rank in the area was presented. Among many factors, low fertility, improved seed scarcity and unaffordable price of fertilizer were the first, second and third main reasons with an index values of 0.214, 0.195 and 0.172, respectively.

When the field survey was conducted, a number of gullies, sheet and rill erosion had been created on the catchment area. This indicated that the severity of soil erosion through gullies on the farm land had contributed to the soil fertility decline in the study area. The occurrence of gullies in the study area is mainly associated with accelerated erosion and the instability of steep terrain after the land is cleared of permanent vegetation cover and is exposed to heavy rain. This is also constrains farmers both by removing fertile soil from agricultural land, reducing the size of their land holding and contributing to the loss of crop yield.

Table 5. Ranking of major constraints for decline in crop production of the study area (%)

Production constraints	Ranking							
	1st	2nd	3rd	4th	5th	6th	7th	Index
Land degradation/low fertility	53.33	10.00	21.11	10.00	3.33	1.11	1.11	0.214
Improved seed scarcity	20.00	36.66	22.22	13.33	5.55	1.11	1.11	0.195
Unaffordable price of fertilizer	15.55	22.22	22.22	14.44	22.22	0.00	3.33	0.172
Minimum farm land	2.22	1.11	3.33	13.33	24.44	36.66	18.88	0.092
Pest/ diseases/ weeds	1.11	14.44	24.44	33.33	14.44	5.55	6.66	0.147
Lack of extension service	3.33	4.44	3.33	2.22	6.66	44.44	35.55	0.078
Erratic rain fall	4.44	11.11	3.33	13.33	23.33	11.11	33.33	0.105

Index = sum of [7 for rank 1 + 6 for rank 2 + 5 for rank 3+ 4 for rank 4 + 3 for rank 5 + 2 for rank 6 + 1 for rank 7] for a particular production constraint divided by sum of [7 for rank 1+ 6 for rank 2 + 5 for rank 3 + 4 for rank 4+ 3 for rank 5 + 2 for rank 6 + 1 for rank 7] for the overall production constraints for decline in crop production of the study area.

In any economy where agriculture is the main activity, agricultural output per household is an important measure of welfare. It is frequently feared that, where population is growing rapidly, the pressure on natural resources may increase and is expected to fall natural resources which latter treats to low agricultural productivity. Hence, output per hectare is an important indicator of productivity, also of sustainability, since falling outputs indicate deterioration in the natural resource base.

According to group discussions with the sampled households, high population pressure in the area caused demand for bush land, reverine forest land and forest land on the upper catchment area to expand agricultural land and for their fuel wood and other wood products which accelerates the soil erosion and fertility decline. All of these problems contributed to reduction for agricultural production.

Similarly, the results of remote sensing data on land use/ land cover change also show an increasing trend of agricultural land during the study periods. This increase in an area of agricultural land was mainly at the expense of bush land, grass land and other vegetated area clearance. 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.

4.2.2. Livestock production and production constraints

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. The land use/ land cover dynamics data shows that, highly declining of grazing land that affects the availability of feed resources for the livestock. According to the socio-economic survey data, the trends of the number of livestock show the declining manner as shown below Figure 7.

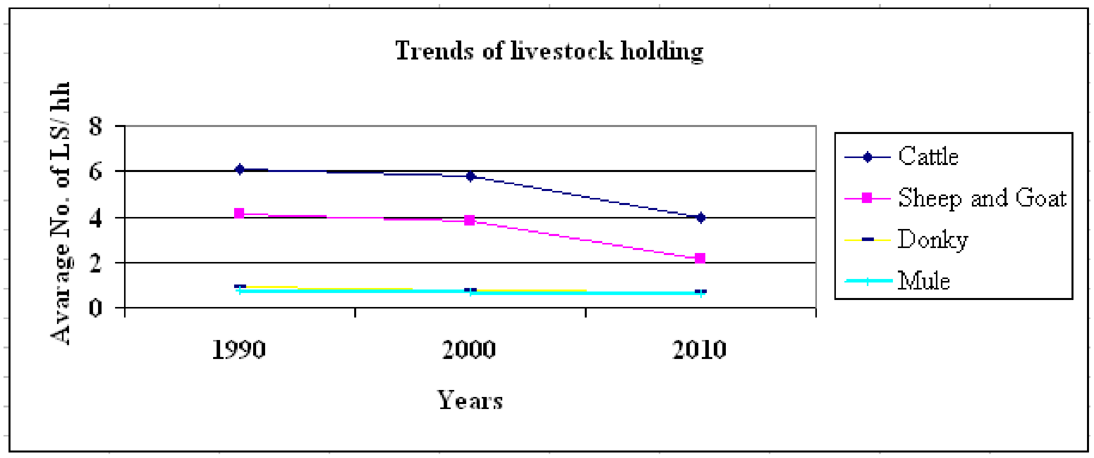

Figure 7. Trends of livestock holding of sampled households (n=90)

The reasons for the declining of livestock number are many. Among this the major reasons are shown in Table 6. Generally, 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, expansion of settlements and inadequate rainfall as the 1st, 2nd , 3rd, 4th and 5th Rank respectively, according to their major reasons.

Table 6. Reasons for shortage of livestock feed as the respondent's perceived (%)

Reasons for shortage of livestock feed	Ranking					
	1st	2nd	3rd	4th	5th	Index
Grass land changed to cultivated land	87.77	8.88	1.11	1.11	1.11	0.320
Decrease in productivity of grazing land	3.33	33.33	31.11	22.22	10.00	0.198
Conversion of bush land to cultivated	0	34.44	34.44	18.88	12.22	0.194
Expansion of settlements	4.44	16.66	16.66	18.88	43.33	0.148
Inadequate rainfall	4.44	6.66	16.66	38.88	33.33	0.146

Index = sum of [5 for rank 1+ 4 for rank 2 + 3 for rank 3 + 2 for rank 4 + 1 for rank 5] for a reasons for shortage of particular livestock feed divided by sum of [5 for rank 1+ 4 for rank 2 + 3 for rank 3 + 2 for rank 4 + 1 for rank 5] for the overall Reasons for shortage of livestock feed as the respondent's perceived

According to the study, 96% of interviewed households depend on agriculture (both crop production and livestock production). However, results of socio-economic survey showed that soil fertility loss, soil erosion, crop yield decline and the reduction in livestock numbers have occurred. These were mainly due to removal of vegetation cover and increasing demand of agricultural land and forest products induced by population pressure in the study area. These problems may reduce the overall income and income sources from agricultural production and can affect the livelihood of rural households in the study area.

Since the demand for cropland has come into increasing competition with that of grazing land, the availability of grazing area and livestock feed shows a declining trend. The expansion of settlement and grass land degradation has also contributed to this problem. Hoekstra *et al*. (1990) 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.

In the focus group discussion issues on the concepts of land resources (specifically, soil, water and vegetation) resources, problems and causes of land use/ land cover change, land resources management, etc. were discussed. Participants in all catchment parts have almost the same view. Participants describe land resources as physical and biological entity that include soil, water, vegetation, farm land, grazing land and from which humans; domestic and wild animals sustain their lives. As of the interaction between human and land resources, they viewed that human beings obtain benefits from land such as food, water, wood for fuel and construction purposes and so on. Meanwhile, they believe that due to the population pressure the impact of human activity in unsustainable use of land is degrading these resources.

Regarding the issue on whether communities have managed their land resources properly, the community believes that, they are not using it in the proper way. Participants describe social, economic and institutional factors as the causes for land degradation. Land use change leads to land degradation that have an impact on agricultural productivity, the environment, and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g.

erosion). The current farmlands owned by watershed community of the study area have many gullies.

Deforestation due to increased demand for fuel wood, construction, conversions of forest land to farmland, over grazing and continuous cultivation due to population pressure are identified as the major proximate causes of land use/ land cover change. The growth of population is accelerating for the land use/ land cover change. Thus land is fragmented and farmers are compelled to cultivate on hillsides and steep slopes. The exposure of land to erosive forces due to the above mentioned activities exacerbate the deterioration of the quality of the land. Because of this participant recognized that, farm land, grazing land and forest have lost their productivity.

Sustainable Land Management provides strategic focus to the implementation of sustainable land management. SLM is a knowledge-based procedure that integrates land, water, vegetation and other environmental management to meet rising food while sustaining livelihoods and the environment. However, farmers are reluctant to manage their lands and use the opportunity. Despite significant difference in land management practices participants of focus group discussion of the communities have a common perception on how to bring about sustainable agriculture in their respective communities. They believe that protecting the land from erosive forces by physical and biological measure activities and managing grazing land properly by the community participation can lead to sustainable agriculture. By integrating crop and livestock production and conserving the land resources properly and conserve the natural resources in the area can enhance the productivity.

4.2.3. Farmers' perception on soil erosion

Communities in study area have common perception on the problems of land resources degradation. Moreover, they recognize the benefits of sustainable land resources management to the sustenance of rural people. Farmers in study area believe that ecologically sound land resources management allows land to fit for cultivation. In addition, they believe that integrated land resources management can assure the sustainability of agriculture. Besides land degradation, farmers recognized that land resources management enables communities to effectively utilize the natural resources in a sustainable manner. During field observation money land degradations were observed. The following Figure 8 shows the extent of land degradation respectively in some part of the study area.

Figure 8. Examples of degraded area with gully formation in some parts of watershed

Source: Field survey, 2011

Farmers in the study areas have clear idea about the consequences of land degradation. They understand that land degradation not only diminish of the productivity of the environment but also reduces the availability of resources and the potential benefits that could be obtained from the natural resources. Farmers also have common perception on land resources degradation that can cause adverse effects on the ability of families or household units and communities to support themselves.

Understanding farmers' perceptions of soil erosion and its impact is important in promoting soil and water conservation strategies. Soil erosion is a common problem in the study area. Farmers in the study area believe that they face problem of soil erosion in their farm land and grazing land. They infer the presence of soil erosion by rills and gullies, sheet erosion, and stream bank in their surroundings. There is no distinct boundaries to classify the erosion types however, one can classify by observing the measure of erosive power. The survey result of current erosion damage showed that gully erosion was the most prevalent form in the study area. The respondents infer that gully erosion is more faced in the study area.

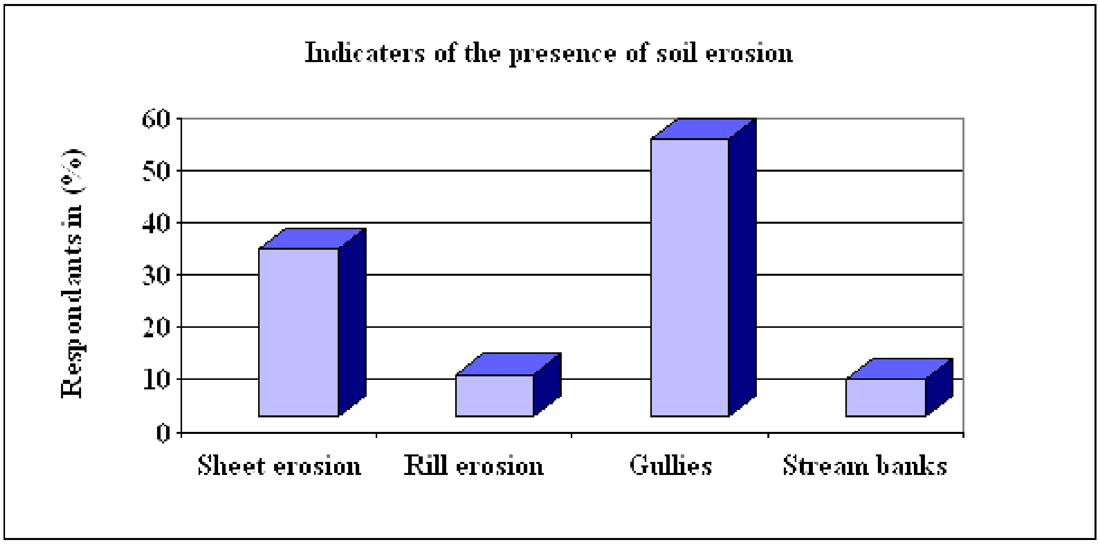

Figure 9. Indicators of the presence of soil erosion as perceived by farmers

The main causes for soil erosion ranked by respondents are presented in (Table 7). Accordingly, deforestation, continuous cultivation, poor crop husbandry, steep slope cultivation and overgrazing are the first, second, third, fourth and fifth preferred reasons with an index values of 0.286, 0.268, 0.162, 0.110 and 0.175 respectively.

Table 7. The main causes for the soil erosion as the respondents perceived (%)

Causes of soil erosion	Ranking					
	1st	2nd	3rd	4th	5th	Index
Deforestation	48.88	30.00	6.66	3.33	11.11	0.286
Continuous cultivation	46.66	45.55	2.22	1.11	4.44	0.268
Poor crop husbandry	2.22	16.66	18.88	46.66	15.66	0.162
Steep slope cultivation	2.22	1.11	11.11	28.88	56.66	0.110
Overgrazing	0	6.66	61.11	20.00	12.22	0.175

Index = sum of [5 for rank 1 + 4 for rank 2 + 3 for rank 3 + 2 for rank 4 + 1 for rank 5] for a Causes of particular soil erosion divided by sum of [5 for rank 1+ 4 for rank 2 + 3 for rank 3 + 2 for rank 4 + 1 for rank 5] for the overall causes of soil erosion.

In most parts of Ethiopia, poor farming practice, which includes intensive tillage of the soil, tillage of steep slopes, absence of fallow and lack of effective soil and water conservation practice, aggravates the rate of soil erosion. Thus, in general environmental degradation, particularly, soil erosion affects the soil and contributes to loss of productivity.

For instance, the results of remote sensing showed that the expansion of cultivated land was mainly through the conversion of other land use, which may induce soil erosion and fertility decline, hence also crop yield reduction. Studies by (Feoli *et al*., 2002) indicates that the conversion of forest land and bush land into crop land has resulted in the loss of the vegetation cover and has caused severe soil erosion Similar studies (Thanh *el al*., 2009) in mountainous areas of Northern Vietnam, increasing population has forced agricultural production to expand into uplands. This trend resulted in decreasing forest resources with associated soil erosion and resource degradation (Thanh *el al.*, 2009) which later treats loss of productivity.

4.2.4. Farmers' perception on deforestation

Knowledge of farmers' perceptions and attitudes toward land degradation is an important step to tackling the problem. Deforestation is the major problem in study area. Very small land covered with natural vegetation remains in the study area. That is some bush land and some forests on the hilly terrain and along the rivers and near the stream. According to the land use/ land cover dynamics result showed decline of vegetation cover as well as interviews with the sampled household heads, most respondents stated that some years back majority of the study area was covered by vegetation, whereas today it has declined at an alarming rate.

According to the survey result, farmers recognized that multiple factors contributed to vegetation cover change in the area. The major causes were as assigned by the respondent's expansion of crop land, construction of wood harvest; local fuel wood consumption and soil fertility decline were identified as the respective index value (Table 8) of among many factors.

Table 8. Farmers' perception as to the causes of deforestation (%)

Causes of deforestation	Ranking								
	1st	2nd	3rd	4th	5th	6th	7th	8th	Index
Expansion of crop land	92.23	6.66	1.11	-	-	-	-	-	0.219
Due to fertility decline	-	27.77	22.22	20.00	3.33	17.77	4.44	4.44	0.141
Construction of wood harvest	2.22	46.70	16.66	17.77	11.11	4.44	-	1.11	0.168
Local fuel wood consumption	-	8.88	41.3	26.7	14.44	4.44	2.22	2.22	0.146
Construction of furniture	-	7.77	12.22	11.11	41.11	18.88	7.77	1.11	0.118
Weak government forest law	4.44	1.11	2.22	8.88	8.88	25.6	37.8	11.11	0.083
Unclean owner ship	-	-	1.11	6.66	12.22	11.11	33.33	35.55	0.075
Charcoal burning and sell	1.11	1.11	2.22	8.88	8.88	18.88	14.44	44.44	0.062

Index = sum of [8 for rank 1+ 7 for rank 2 + 6 for rank 3 + 5 for rank 4 + 4 for rank 5 + 3 for rank 6 + 2 for rank 7 + 1 for rank 8] for the particular causes of deforestation divided by sum of [8 for rank 1 + 7 for rank 2 + 6 for rank 3 + 5 for rank 4 + 4 for rank 5 + 3 for rank 6 + 2 for rank 7 + 1 for rank 8] for the overall causes of deforestation.

Hurni (1990) also reported in his study that, population pressure is inducing the clearance of forests for agriculture and other purposes, such as wood for fuel, construction and industry, and this contributes to accelerate soil erosion which is gradually destroying the soil resource. Moreover, the causes of deforestation are complex, the rapid rate at which the population increased over the decades is the major factor contributing to the accelerated rate of deforestation in Ethiopia. The immediate causes are the need for farming and grazing land, the demand for fuel wood and construction materials, repeated fire out breaks, and movement of political center (Desta, 2001).

The decline of vegetated area indicates that, as the population increased over time, the intensity of conversion of forest to farmland, grazing land and settlement increased. Consequently, fragmentation of land resources and availability of farm land is decreasing and steep slopes and hillsides were cultivated. Soil degradation in Ethiopia can be seen as a direct result of the past and present agricultural practices. According to the key informants and field observation, the dissected terrain, the extensive areas with high slope, and the high intensity of rainfall lead to accelerated soil erosion once removal of vegetation occurs. Some of the farming practices within the highlands encourage erosion. During field observation steep slope cultivation were observed. Figure 10 showed the steep slope cultivation in some part of the study area.

Figure 10. Examples of expansion of farm land in steep slope parts of the study area

Source: Field survey, 2011

Rural households are totally dependent on biomass for energy. The most important sources of energy in the area were fuel wood, cow dung and crop residues. Among these sources fuel wood is the most widely preferred and used source of energy. Fuel wood is the major source of energy since there have no other options to use for their energy source. The use of forests as the only source of energy has accelerated land degradation. Only some sampled households use the cow dung, crop residue and other sources of energy.

The interviewed households mentioned that the impact of the removal of this vegetation contributed to the lack of availability of both fuel wood and construction materials in the area. The majority of the interviewed households have a positive attitude to planting trees as a solution to reducing the shortage of wood resources in the area. However, they pointed out that lack of locally adapted tree seedlings as the constraint to tree planting in the study area.

Having alternative means of income reduces overall dependence on agriculture and forests which in turn, diminishes pressure on land and thus reduces the impact of population growth on the land. Thus population pressure has a negative effect on land because more bushes and trees are cut for fuel and cultivation of marginal areas. The same holds true for the study area, where there was a large family size per household showing increased population pressure with little or no off-farm employment that can supplement the income from agriculture; they depend almost entirely on the agriculture.

4.2.5. Land management practices in the study area

The measures taken to mitigate problems of land degradation were not as such practices in the study area except some physical structures in some parts of the watershed. It was observed that, land covered by gully erosion is totally lost in the downstream due to the absence of gully control measures by the community. Farmers in some parts of upstream area of the catchment use simple structures such as cutoff drains, check dams and soil bunds in their crop fields.

Field observations indicate that soil conservation measures using other physical structures and tree planting are very less in watershed area. The lesser the effort made by the community in to mitigate the prevailing problems of soil erosion, the higher will be the degradation of soil which in turn further aggravates problems of land degradation. Moreover, the farm land was unproductive to the extent that many farmers to produce more products.

The field observations also indicated that deeper and wider gullies, rills, and other features of land degradation were observed with less protection measures. This may be due to farmers giving less attention on problems of land degradation and absence of intervention measures by government and nongovernmental organizations before some years back.

It was interesting to note that the communities have common perception of land degradation due to deforestation affecting ecosystem. The effects of deforestation perceived by farmers include the loss of soil fertility, reduction in agricultural production, decrease livestock production, reduction of forests and sedimentation occur since, Gilgel Gibe dam is near to watershed in the study area.

Based on the information obtained from all data sources, there was only few involvement of community in conservation activities. Moreover, other conservation measures are not practiced specially in downstream catchment. The misuse and/or mismanagement of forest have aggravated the further problem of deforestation resulting to land degradation. As the respondents perceived the communities in the village can contribute to the protection of forest in the following measures: Participate in afforstation and reforestation, reduces pressure on forests by tree planting and respect rules and regulation.

5. SUMMARY AND CONCLUSION

Land use/ land cover change analysis are the major information required for planning and decision making. This study used an integrated approach to understand past and the present conditions of the study area. The study comes up with the following major findings; generate thematic land use/ land cover maps for change comparison using land sat images and analysis of land use/ land cover dynamics. Such as rate of land cover change, conversion matrix, socio-economic data analysis for its impact on agricultural productivity have been done.

Six land use/ land cover classes (forest land, agricultural land, grass land, built-up area, reverine forest and bush land) was identified. Based on the findings of the study land use/ land cover classification change analysis for the study periods revealed that dynamism and it was found that there is rapid increase in cultivated land and built up area, while there is a decreasing trend in grass land, forest land and bush land. Increasing agricultural land from 19.16% to 52.11% and 65.60%, and built-up area was from 1.46% to 3.40% and 8.88% during the 1973 to 1986 sand 2004 respectively. In contrast, reduction in area of land from 13.52% to 5.28% and 4.75% forest land, 23.96% to 20.54% and 8.50% grass land, 23.73% to 12.37% and 7.91% bush land, 18.17%, 6.30% and 4.36% reverine forest land during the year 1973 to 1986 and 2004 respectively. The results also show that the extent of agricultural and built up area has increased the whole periods at the expense of mainly grass land, forest land, reverine forest land and bush land.

This is prevalent phenomena and the resource degradation due to unsustainable land resources management, removal of vegetation cover, population growth and the associated expansion of farming and increasing demand for resources are imposing threat on the productivity. The high population pressure contributed to the clearance of vegetation for the expansion of new agricultural land, homestead, fuel wood consumption and other livelihood needs which further exacerbated the degradation of natural resources latter aggravated low agricultural productivity.

In the study area, the vegetation cover was converted to cultivated land and built-up area. As a result, land degradation occurs and productivity is decreasing; consequently, the current crop yield per unit area is gradually declining. Similarly, the number of livestock per household also declined due to the low availability of livestock feed, caused by the conversion of grazing area to other land uses, decrease productivity of grazing land, conversion of bush land to cultivated land, expansion of settlements.

It is thus essential that land resources have to be properly managed to sustain productivity. In contrast, the absence of such proper natural resources management has led to the further degradation of the natural resources latter treats to the land degradation and productivity decline. Thus, the results also indicated that unless some conservation measures have been taken timely it would seriously damage the food security of the area.

The main conclusion of this study is that, among other factors, the cover change in the study area may affect natural resources and reduce agricultural productivity on which the livelihood of the local community depends for both subsistence and income generation. Therefore, the current trends in land use/cover must be improved, towards the resources management and conserving of the existing vegetation and other natural resources in the study area through community participation and using sustainable land resources management plan so that agricultural productivity can be improved and can sustain the livelihood of the people.

Recommendations

- Land use/ land cover dynamics is paramount importance data as it is the most important base line data in resource allocation since, resource allocation is important for sustainable land use management planning. Therefore should be used as a main input during land use planning.
- Recently, the conversion of vegetation to agricultural land has slow down because almost no or only few lands were left for further expansion. Improved diversification of other farm and off-farm income generating activities, and introduction and dissemination of other technologies, in order to reduce pressure on natural resources should be given serious attention.
- Strong and effective policy interventions such as forest policy and land ownership have to be implemented to protect any remnant vegetation, together with forest development activities. These should actively involve and be done in collaboration

with all concerned stakeholders (such as local communities, government and NGOs) for effective management of natural resources.

- Proper soil and water conservation structures and biological conservation measures to reverse the effect of gullies and land degradation should be undertaken. Develop methods through which the vegetation can be improved (such as soil bund and cut of drain maintenance) and biological measures of tree planting should be encouraged. Farmers should encourage to plant trees on their homesteads, hillsides and degraded lands instead of cutting trees from the existing forest.
- There should be well organized and effective policy intervention to protect the remaining vegetation and avoid further extinction. Some areas like the surrounding escarpments, agriculturally non suitable and marginal lands should be protected as the forest area.

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APPENDICES

APPENDIX I

GROUND TRUTING POINTS FOR LAND USE/ LAND COVER CLASSES

No	UTM Coordinate points		Field Check based LULC
	Latitude	Longitude	
1	310588	840754	Agricultural land
2	310415	840992	Grass land
3	310258	841186	Forest land
4	310345	841443	Forest land
5	310167	841232	Forest land
6	310185	841545	Forest land
7	310239	842139	Forest land
8	310350	842660	Forest land
9	310073	842178	Forest land
10	310259	843161	Forest land
11	310038	842950	Agricultural land
12	309526	842445	Built- up area
13	309382	842010	Built- up area
14	308757	842232	Built- up area
15	308900	846291	Built- up area
16	311457	849464	Built- up area
17	311081	849669	Built- up area
18	310882	849877	Grass land
19	310599	849869	Grass land
20	310380	849378	Bush land
21	310227	849310	Reverine forest
22	310111	849188	Reverine forest
23	309973	848958	Agricultural land
24	309853	849105	Agricultural land
25	309753	848639	Built- up area
26	309533	848470	Reverine forest
27	309464	848343	Reverine forest

GROUND TRUTHING POINTS (Continued)			
28	309395	847921	Built- up area
29	309349	847975	Reverine forest
30	309075	846832	Agricultural land
31	308690	846325	Reverine forest
32	308288	845818	Reverine forest
33	308257	845941	Agricultural land
34	307938	845534	Agricultural land
35	308051	845416	Grass land
36	308164	845429	Homesteads
37	307996	845270	Agricultural land
38	307817	845314	Agricultural land
39	307563	845000	Grass land
40	307164	844933	Grass land
41	307246	844975	Agricultural land
42	307237	845297	Agricultural land
43	307392	845874	Agricultural land
44	307282	845920	Agricultural land
45	307567	846242	Agricultural land
46	307415	846316	Bush land
47	307317	846646	Bush land
48	307477	846711	Bush land
49	307334	846938	Bush land
50	307505	846927	Grass land
51	307536	847170	Grass land
52	307596	847403	Grass land
53	307121	847467	Agricultural land
54	307050	847661	Bush land
55	307123	847994	Bush land
56	307204	848213	Bush land
57	307386	847989	Agricultural land
58	307329	847968	Agricultural land
59	307441	848266	Agricultural land

GROUND TRUTHING POINTS (Continued)			
60	307527	848550	Built- up area
61	307781	849106	Built- up area
62	307879	849399	Built- up area
63	307859	849910	Agricultural land
64	308221	850562	Agricultural land
65	308581	850499	Agricultural land
66	307690	850345	Bush land
67	307302	850021	Bush land
68	306966	849971	Grass land
69	306532	849843	Built- up area
70	309876	854998	Bush land
71	310602	854625	Agricultural land
72	310423	854622	Reverine forest
73	310284	854582	Reverine forest
74	310285	854305	Reverine forest
75	310168	853881	Built- up area
76	309976	854000	Grass land
77	310011	854246	Grass land
78	310000	854520	Agricultural land
79	310065	854601	Agricultural land
80	309763	854821	Bush land
81	309238	854763	Agricultural land
82	308894	854723	Agricultural land
83	308459	854345	Agricultural land
84	307745	853829	Built– up area
85	307480	853323	Built– up area
86	307224	852476	Agricultural land
87	307145	851731	Built– up area
88	306599	850497	Built– up area
89	307501	843361	Built– up area
90	307544	843545	Built– up area
91	307393	844021	Built– up area

GROUND TRUTHING POINTS (Continued)			
92	307357	844479	Built– up area
93	307647	844252	Built– up area
94	308301	844648	Agricultural land
95	308011	844918	Agricultural land
96	307654	844482	Agricultural land
97	307554	844154	Grass land
98	307353	843463	Built– up area
99	308956	844045	Reverine forest
100	309063	844194	Agricultural land
101	309297	844377	Agricultural land
102	309504	844466	Agricultural land
103	310066	844859	Built– up area
104	310120	844925	Reverine forest
105	310256	844806	Agricultural land
106	310519	844678	Agricultural land
107	310833	844422	Reverine forest
108	310903	844356	Reverine forest
109	311048	844315	Reverine forest
110	310988	844507	Reverine forest
111	310988	844507	Reverine forest
112	310916	844575	Bush land
113	310877	844902	Agricultural land
114	310788	845393	Agricultural land
115	310742	845569	Agricultural land
116	310788	845716	Built- up area
117	311056	845853	Agricultural land
118	3103 82	845241	Agricultural land
119	310146	845189	Bush land
120	309684	845003	Bush land
121	309421	844790	Agricultural land
122	309325	844759	Reverine forest
123	308923	844548	Agricultural land

GROUND TRUTHING POINTS (Continued)			
124	308720	844545	Agricultural land
125	307882	844063	Built– up area
126	308161	843028	Built– up area
127	308576	842873	Agricultural land
128	308796	842718	Agricultural land
129	309097	842653	Reverine forest
130	309129	842720	Reverine forest
131	309241	842811	Bush land
132	309464	842834	Bush land
133	309617	842894	Agricultural land
134	310000	843191	Agricultural land
135	310189	843267	Bush land
136	310372	843380	Bush land
137	310384	843402	Bush land
138	310316	843472	Bush land
139	310277	843528	Bush land
140	310182	843563	Agricultural land
141	309983	843559	Agricultural land
142	309458	843467	Agricultural land
143	309065	843474	Agricultural land
144	308908	843359	Reverine forest
145	308477	843323	Built– up area
146	308100	843576	Built– up area
147	307526	843740	Bush land
148	308537	854448	Bush land
149	309988	855104	Bush land
150	310000	855120	Bush land
151	310120	855243	Agricultural land
152	310182	855202	Agricultural land
153	310226	855094	Agricultural land
154	310114	854903	Bush land
155	310000	855000	Bush land

APPENDIX II

HOUSEHOLD SURVEY QUESTIONNAIRES

❖ Household Identification and their socio-economic condition

1. Code of respondents_____________, Date of the interview______________
2. Name of Interviewer ______________________, Age _________ Sex __________
3. Family size _____ Female ______Male________
4. Name of PA _________________
5. Marital status. Married ____ 1; Single _____2; Divorced ______3; widowed ____4.
6. Educational status: Illiterate _____1, 1-4 grade ___2, 5-8 grade ____3, 9-12 grade ____ 4; above 12 grade____5.
7. Occupational status: Crop production ______1; Livestock rearing ______2; both crop production and live stock rearing _____ 3; vegetable production and small scale trade _______ 4; Others (please specify) ______5;
8. Was the household head born in this Kebele? Yes1______ No______ 2
9. If your answer is **no**, for how longer you lived in this PA? (In year)________

Part I. Households Assets

A) Land holding, its productivity and productivity constraints

1. How much land do you own currently _____ (ha), 20 years back from now______(ha)?
2. How did you acquire the land (the condition of access)? 1st distribution_____1; occupied without any permission______2; Inheritance________3; Gift______4.
3. What are the Major land use/ land cover types in your area and their trends (changes) within the specified time period indicated below? Say Increased or Decreased for each land cover/ land use type at each time period and rank among each land cover/ land use type based on the area coverage.

No	Land use/ land cover type	In the last 25 years	In the last 10 years	In the current year	Remarks
1	Forest land				
2	Cultivated land				
3	Grazing land				
4	Built-up area				
5	Bush land				
6	Reverine forest				

4. Do you observe change in the level of crop yield on your cultivated land? (i).Yes (ii). No

If yes, has it been increasing or declining? (i). Increased (ii). Declined

4.1. Average crop productivity (Quintal per hectare) from all your own plots over years

No	Crop type	Productivity trends		
		Before 20 years	After 10 years	In the current year
1	Maize			
2	Teff			
3	Sorghum			

5. Crop production (Quintal) from all your plots (own and leased in) during previous cropping season?

Field No	Area in hectare	Ownership		Purpose	
		Owned	Leased	cultivated	Grazing
1					
2					
3					
4					

6. Is your crop production decreasing? A) Yes B) no

6.1. If your crop production trend was declining, rank the production constraints accordingly

N<u>o</u>	Major Production constraints	Rank	Remark
1	Soil degradation/ erosion/ low fertility		
2	High improved seed price and seed scarcity		
3	Unaffordable price of fertilizer		
4	Minimum farmland		
5	Pests /diseases/ weed		
6	Lack of extension service		
7	Erratic rainfall and drought		

B) Livestock production and production constraint

1. How money live stock does you own? _____________

No	Livestock	Livestock trends		
		Before 20 years	After 10 years	In the current year
1	Cattle			
2	Goat and Sheep			
3	Donkey			
4	Mule			

2. Where do you livestock graze? 1) Both Common and private land; 2) Private land 3) Common land; 4) Move to other places; 5) others, specify______
3. Has grazing area decreased around the village currently when compared to past? 1__ Yes 2)__No
4. If **yes**, what are the causes for this change and reasons for the shortage of live stock feeds

No	Major reasons	Rank	Remark
1	Grassland changed to crop land		
2	Decrease productivity of grazing land due to fertility decline		
3	conversion of wood and shrub land to cropland		
4	In adequate rain fall to grow sufficient grass		
5	Expansion of new settlements		

C) Natural Vegetation cover

1. What was the trend of the previous vegetation cover (woods and shrubs) of your village when compared with the past 20 year period? 1) Increasing; 2) Decreasing;
2. If there is a **decreasing** trend in vegetation cover and productivity, what are in your opinion the major reasons of damage these resources in your area?

No	**Major reasons**	**Rank**	**Remark**
1	Expansion of crop land		
2	Due to soil fertility decline		
3	Construction wood harvest		
4	Local fire wood consumption &sell		
5	Construction of furniture		
6	Weak government forest law enforcement		
7	Un clear owner ship		
8	Charcoal burning and sell		

Part II. Soil and vegetation degradation and management practice

Section A. Soil erosion

1. Have you faced soil erosion problem in the surrounding? ______1) Yes______2) No.
2. If yes, how do you infer that there is soil erosion? Sheet erosion _____ 1) Rill erosion___2) Gullies ____3) stream bank _____4) others _____5.
3. What do you think are the causes of soil erosion?

No	**Causes of soil erosion**	**Rank**	**Remark**
1	Deforestation		
2	Continuous cultivation		
3	Poor crop husbandry		
4	Steep slope cultivation		
5	Over grazing		

4. Did you take any measure to protect erosion? Yes ____________1, No____________2

5. If yes, what measures did you take? 1) Terraces, 2) Tree planting, 3) Stone bunds, 4) Check dams, 5) Soil bunds, 6) cut-off drain maintenance and 7) other, specify______

Section B vegetation degradation

1. Do you observe problem of deforestation in your area? Yes ___1, No____2
2. If deforestation is a problem in your village, is there a practice of community participation in forest conservation? Yes ___1, No____2
3. If yes, how do communities in the village contribute to the protection of forest? 1) Participate in afforstation programs, 2) Reduce pressure on forest by planting multipurpose trees and 3) Respect rules by laws and regulation of local governments and the community.

Section C Fuel resources

1. What are the main sources of fuel for household? (Rank) Wood ____ 1, Cow dung ___2, Crop residues ____3; Kerosene ____ 4; others____5
2. What are the main sources of fuel wood? Homestead ____1; purchasing ____2; Colleting from open forest____3; others ____4;

Some attitude measurement towards land degradation and management

1. Attitude measurement towards land degradation

Description	Agree	undecided	Disagree
Land productivity (yield) decline			
Increased soil erosion			
Manages and controls the uses of resources			
Lack of drinking and irrigable water			
Reduction of forests and bush land			
Loss of biological diversity			
Reduce livestock production			

2. Attitude measurement towards land management practices

Description	Agree	undecided	Disagree
Investment in soil and water conservation practices is profitable			
Physical measures on farmland, hill-side and gullies			
Biological measures: to stabilize physical SWC structures			
Agricultural measures agro forestry practices			
Increases production and reduce expansion of farm land			
Design and control land use management plan			
Change in type of crops grown and crop rotation			
Implementation of SWC activities that integrate physical with biological measures			
Avoid improper cultivation practices on farmlands			
Community participation in resources conservation is the greatest way of land management			

Part III Focus Group Discussion

1. What do you understand when we say land resource?
2. What are the major driving forces that pose threat on land resources in this community?
3. Are land resources in this farming community degrading or are they in the normal state?
4. If you agree that land resources are degrading can we point out the major causes and their effect?
5. Which of the problems can be alleviated by community participation? Why and how?
6. Is there an opportunity to integrate land and water management? If yes, is the community utilizing the opportunity? If not, what are the problems and their solutions?
7. How can communal resources such as forests, grazing areas, etc. be managed in this farming community?
8. How can we bring sustainable agriculture within this community?
9. Do you have additional issues to forward points discussed?

Thank you!!!