IMPACT OF LAND USE LAND COVER CHANGE ON WOODY SPECIES DIVERSITY IN GECHI DISTRICT OF BUNO BEDELE ZONE, SOUTHWEST ETHIOPIA

MSc. THESIS

GIRMA MOSISA KUMSA

FEBRUARY, 2025

JIMMA, ETHIOPIA

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Submitted to the School of Graduated Studies of Jimma University College of Agriculture and Veterinary Medicine Department of Natural Resources Management in Partial Fulfillment of the Requirements for the Degree of Masters of science in Natural Resource Management by Specialization Forest and Nature Management

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February, 2025
Jimma, Ethiopia

SCHOOL OF GRADUATE STUDIES

JIMMA UNIVERSITY

COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

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We, the undersigned, member of the Board of Examiners of the final open defense by **Girma Mosisa** have read and evaluated his/her thesis entitled **"Impact of Land Use Land Cover Change and Woody Species Diversity In Gechi District of Buno Bedele Zone, Southwest Ethiopia"** and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree Master of Science in **Forest and Nature Management**

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DEDICATION

This thesis is especially dedicated to all my family members, for their love and devoted partnership in the success of my life.

STATEMENT OF THE AUTHOR

First, I declare that this thesis work is my bona fide work and all the sources of materials used for this thesis have been properly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc. degree at Jimma University and deposited at the University library to be made available to borrowers under the rules of the library. Brief quotations from this thesis are allowed without special permission, provided that accurate acknowledgement of the source is being made. Requests for permission for extended quotation or reproduction of this manuscript in whole or in part may be granted by the head of the department of Natural Resource Management when, in his or her judgment, the proposed use of the material is in the interest of scholarship. In all other instances, however, permissions must be obtained from the author.

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BIOGRAPHICAL SKETCH

The author was born on April 11, 1983 in Oromia Regional State, Buno Bedele zone, Dabo Hana district, about516 kilometer west of Addis Ababa. The author was born from his father Mosisa Kumsa and his mother Tujube Legese. He attended his elementary education (1-8): From 1990-1998, at Dabo Temo Elementary School and High school (9-12): From 1999-2002, Bedele Senior Secondary School. Then he joined Holota ATVET College in 2004 and graduated 2006 with diploma in Natural Resource Management. The author was employed and worked at Mako Woreda Agricultural and Natural Resource Office for 2 years as Development Agent and he again joined Jimma University in 2010 and graduated with B.Sc. degree in Natural Resource Management in April 24, 2014. After his graduation, He was served from since 2014 to 2021 at different position in Meko District and Dabo Hana District. He has been working in Dabo Hana Agricultural and Natural Resource Office, until he got the chance to rejoin Jimma University in October 2022 to pursue his MSc. study in the department of Natural Resource Management by specialization of Forest and nature management.

ACKNOWLEDGEMENTS

I would like to extend my deepest gratitude first and foremost to God, who created this world in his word and helps me in all aspects of my life. My sincere gratitude goes to my major research advisor, Desalegn Obsi Gemeda (PhD), and my research co- advisor, Dereje Bekele (ass. professor) for their unreserved advice, guidance, and constant encouragement. The meticulous comments I have received from them throughout my thesis work helped me complete it successfully. It was their skillful contribution and constant encouragement that made me strong to face every ups and down with confidence during the research study. My special thanks also go to all of my friends for their unreserved and tireless technical support, sharing of knowledge, and invaluable advice in every aspect of my thesis work. I would also like to extend my gratitude to the Gechi District Administration, Agricultural and Natural Resources Offices, PA officials, and community groups of the resettlement study area for providing me with the available data for the work. The community members in the study areas were so open and generous in providing their valuable time and knowledge. I am also grateful to the Jimma University College of Agriculture and Veterinary Medicine for providing me all the relevant data used as input for my research.

LIST OF ABRIVATION AND ACRONYMS

CSA	Central Statics Agency
EPRDF	Ethiopian People's Revolutionary Democratic Front
ETM	Enhanced Thematic Mapper Plus
FAO	Food and Agriculture Organization of the United Nations
GANO	Gechi Agriculture and Natural Resource Office
GCP	Ground Control Point
GIS	Geographic Information System
GLCF	Global Land Cover Facility
GPS	Global Positioning System
LUCC	Land Use Cover Change
LULC	Land Use Land Cover
MEFCC	Ministry of Environment and Forest and Climate Change
MLC	Maximum Likelihood Classification
MSS	Multi Spectral Sensor
ONRS	Oromia National Regional Estate
SNNPR	Southern Nations, Nationalities and Peoples Region
TM	Thematic Mapper
GPS	Geographical Position System
Yr	Year

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ABSTRACT

Globally, the alarming rate of deforestation and land use land cover changes are among the most significant drivers of environmental degradation and biodiversity loss. The study area has been influenced by rapid population growth, agricultural land expansion, deforestation, and poor management practices. This research aimed to assess the impact of land use and land cover changes on woody species diversity within the area. The study utilizing the cross-sectional research design. The study corporate both primary and secondary data including satellite imagery from 1983,1993,2003,2013 and 2023 sourced from USGS.A multi stage random sampling techniques was employed. The accuracy of LULC maps demonstrated a categorization accuracy between 85% and 93% with kappa coefficient exceeding 0.8, indicating strong agreement with the ground truth data. The Findings of the study revealed a significant decline of forestland from 1735.56ha to 1157.36ha, grasslands 1244.72ha to437.08ha from 1983 to 2023 in past four decades, beside increment was observed in agricultural land from12208.8ha to13044.9ha, settlement areas from (696.33ha to 1245.22ha, from 1983) to 2023, and water body increased 117.08 to117.96ha total areas from 1983 to 2023. When compared that to 2003, 2013, and 2023 image statistical values, the minimum value of 1983 was 0.14 and the maximum value was 0.28, while the 2023 minimum values were -0.11 and the maximum values were 0.44. The Shannon-Wiener Diversity Index value of the forest area was 3.23, and evenness was 0.86, in the study area. The study concludes that agricultural expansion and settlements are driven by food production demands due to population growth leading to notable decreasing in forest and grass land. This study recommended that impact assessment underscores the necessary for sustainable land management practices in resettlement areas for mitigate diverse ecological consequences.

Keywords: Land Use, Land Cover, Woody Diversity, Shannon Index, Evenness, GIS

1. INTRODUCTION

1.1. Background and Justification

Globally, the alarming rate of deforestation and land use land cover changes are among the most significant drivers of environmental degradation and biodiversity loss (Caravaggio, 2020; Hite and Seitz, 2021; Hossain *et al*., 2023). These changes are primarily fueled by human activities such as agricultural land expansion, deforestation, urbanization, and infrastructure development (Fagan *et al*., 2020; Winkler *et al.*, 2021; Hossain *et al*., 2023). At the global scale, approximately 31% of the earth's area is decreasing rapidly, with about 10 million hectares of forest lost annually between 2015 and 2020 (FAO, 2020; Kumar *et al*., 2022). The dynamics of natural landscapes into human-dominated systems disrupt ecological processes, reduce habitat availability, and threaten the survival of countless plant and animal species. Woody plant species, which play critical roles in maintaining ecological balance and providing ecosystem services, are particularly affected (Fagan *et al*., 2020; Hishe *et al*., 2021; Oluwajuwon *et al*., 2021).

In tropical regions where biodiversity is highest, Land use land cover change are accelerating at an alarming rate. Tropical forests, which harbor over 50% of terrestrial species, are being cleared for agriculture, logging, and settlement (Fagan *et al*., 2020; Muche *et al*., 2023). This loss not only threatens biodiversity but also undermines the critical role these ecosystems play in climate regulation through carbon sequestration and storage (Armentieres *et al*., 2019; Law *et al.*, 2022; Onoh *et al*., 2024). For example, tropical deforestation contributes approximately 10% of global greenhouse gas emissions annually (IPCC, 2021). Such changes are particularly evident in sub-Saharan Africa, where population growth and subsistence agriculture are the primary drivers of land conversion, leading to widespread habitat degradation and loss of species diversity (Morris *et al.*, 2010; Goll *et al*., 2014; Emiru *et al*., 2018; Slayi *et al*., 2024).

Ethiopia, one of the most bio diverse countries in Africa, has experienced significant LULCC over the past few decades (Muche *et al*., 2023; Assede *et al*., 2023). Historical trends reveal a dramatic decline in forest cover from about 40% in the early 20th century to less than 15% today (MEFCC,2018). Rapid population growth, combined with an increasing demand for agricultural land, fuelwood, and construction, has driven deforestation and degradation (Huang *et al., 2021*; Kullo *et al., 2021).* These changes have particularly affected Ethiopia's southwestern regions, which are known for their tropical forests and high levels of endemic species (Abera, 2023).

Gechi District, located in southwestern Ethiopia, exemplifies these challenges. The district is part of the Ethiopian tropical rainforest area and is characterized by rich biodiversity and a reliance on natural resources for local livelihoods (Abera *et al*., 2020). However, it has been subject to significant LULC changes primarily driven by agricultural expansion, logging, and settlement development of the specific study area. These shifts have led to the loss and fragmentation of natural habitats, threatening woody species diversity and the ecosystem services they provide. Woody species diversity in the study area is essential for soil protection, water regulation, carbon sequestration, and as sources of fuelwood, fodder, and non-timber forest products.

Despite the ecological and socio-economic importance of woody species, limited research has been conducted to assess the specific impact of LUL changes on woody species diversity in Gechi District. Understanding of this relationship is crucial for biodiversity conservation, climate change mitigation, and the sustainable management of natural resources. This study seeks to address the gap by evaluating the spatiotemporal patterns of LULCC and their implication for woody species diversity in Gechi District. The finding was providing evidence-based recommendations for sustainable land management and biodiversity conservation strategies in the study area.

1.2. Statement of the Problem

Land use and land cover changes, driven by population growth, agricultural expansion, deforestation, and settlement development, are among the leading causes of biodiversity loss and environmental degradation (Genet 2020; Hailu and Kidane, 2020; Roy *et al*., 2022).These changes are particularly pronounced in the study area. Where deforestation and habitat fragmentation threaten the survival of species and the ecosystem services they provided (Brandon, K., 2014; Adla, *et al*., 2022). In Ethiopia, a country renowned for its biodiversity, LULCCs have significantly reduced forest cover change and altered natural landscapes, contributing to the decline of species diversity and ecological resilience (Gessese, 2018; Degefu *et al*., 2021; Hailu *et al., 2024*).

Gechi District, located in southwestern Ethiopia, is part of the country's tropical rainforest region, which supports diverse woody plant species, which plays vital role in maintaining ecosystem stability and providing essential services, including carbon sequestration, soil fertility, and livelihoods for local communities (Abera *et al*., 2020). However, the District is experiencing rapid LULCC driven by the conversion of forests into agricultural land, overexploitation of forest resources, and unsustainable land management practices. These changes are leading to habitat loss, fragmentation, and a decline in woody species diversity, which threatens the ecological and socioeconomic stability of the study area.

Although studies on LULCC in Ethiopia have highlighted the general trends of deforestation and land degradation (Dibaba *et al., 2020*; Mariye *et al., 2022*; Asmare *et al., 2023; Fentaw* and Abegaz, 2024), little attention has been given to their specific impacts on woody species diversity in Gechi District. There is a lack of detailed, specific assessments that integrate spatial analysis and ecological field studies to understand the extent of these changes and their implications for biodiversity. This gap in knowledge limits the development of effective conservation strategies and sustainable land management practices tailored to the district's unique ecological and socio-economic context

This study seeks to address these challenges by analyzing the spatiotemporal dynamics of LULCC in Gechi District and evaluating their effects on woody species diversity. The finding was providing critical insights into the drivers and consequences of LULCC and informs the formulation of evidence-based interventions to conserve biodiversity and promote sustainable land use practices in the study area. Studying the extent and dynamics of Gechi district land use and land cover change and its impacts is an urgent need. Moreover, it helps to evaluate land use and land cover changes in the Gechi district and to analyze the impact of LULC changes on the environment and through the conversion of natural forest impact on climate change. Abound with the effects of these activities; LULC on biodiversity and ecosystem services was degraded in the study area

Therefore, the current study will be intended to fill the information gap regarding the impacts of the LULC conducted in the study area on woody vegetation composition and diversity. The information on the impacts of land use, land cover, woody vegetation composition, and diversity can help policymakers and land managers to assist in future plans for rational land use and policy decisions to design proper land management and biodiversity conservation.

1.3. Objectives

1.3.1. General objective

This study is aimed at assessing the impact of land use land cover change on woody species diversity in the study area.

1.3.2. Specific objectives

- To analyze the spatiotemporal trends of land use land cover change for the past four decades of the study area
- To evaluate the composition and diversity of woody species under LULC of the study area

1.4. Research questions

- What are major trends of land use/cover changes have occurred over the past four decades of the study area?
- What are the composition and diversity of woody species in forest of the study area?

1.5. Significance of the study

The results of the study can contribute meaningfully to the following areas of concern: the provision of supplementary teaching and reference materials in LULC and agricultural expansion; the result of a theoretical model that represents, more accurately, the sequences of cause and effect in LULC, in particular in the study area, in order to provide planners and policy makers with important lessons for solving the problems associated with LULC. This study was generated information that could help in tackling some of the problems that accompanied rapid impact of land use and land cover change, woody vegetation composition and diversity and conservation strategies of forest.

Therefore, it’s crucial to conduct studies on the impact of land use land cover change and woody species diversity. Due to the lack of knowledge and awareness regarding impact of LULC and its implication on conservation land cover change are in a problem. Additionally, there is inadequate information available about land cover change. As a result, this study was significantly contributed to the government, communities and individuals grasp of knowledge in the study area. From this study the Government, nongovernment organization, education institutions, policy makers and land managers and local community was benefited.

2. LITERATURE REVIEW

2.1. The Concept and Definition of Land Use and Land Cover

Land cover refers to the physical and biological cover over the surface of the land, including water, vegetation, bare soil, and/or artificial structures (Juliev, *et al.,* 2019). Land use**:** Natural scientists define land use in terms of syndromes of human activities such as agriculture, forestry, and building construction that alter land surface processes including biogeochemistry, hydrology, and biodiversity. Social scientists and land managers define land use more broadly to include the social and economic purposes and contexts for and within which lands are managed, such as subsistence versus commercial agriculture, rented vs. owned, or private vs. public land (Ellis, 2007).Pixels: Smallest units of an image (Juliev, *et al.,* 2019).

2.2. Land use/Land cover Studies in Ethiopia

Globall and particularly in Ethiopia land is used for growing crops, trees, and animals for food, building land for homes and roads, or recreation. Most of the land is used by small farmers who farm to earn a living. Land-use/cover changes are influenced by a variety of factors operating on more than one spatial and temporal level and acting not in isolation but in intricate webs of place and time-specific relationships. Several theories, originating in the Natural and Social Sciences and, most recently, in interdisciplinary research, have been advanced to describe and explain land-use and land-cover change (Regasa *et al*., 2021). Land-use change occurs initially at the level of individual land parcels when land managers decide that a change towards another land-use or land-utilization type is desirable. Aggregately, individual land-use decisions produce land-use/cover changes at higher spatial levels. Land managers respond, however, mostly to internal and external influences on the land-management unit, and their decisions are influenced by their traits and local environmental conditions as well as by the immediate and broader environmental, socio-economic, institutional, and political settings within which the land unit is embedded. A first distinction, thus, emerges between those factors that are pertinent to the level of the individual land parcel (the microlevel) and those that apply to higher spatial/organizational levels (the macro level).

At both the micro and macro levels, the factors influencing land use and land cover change are broadly distinguished further into biophysical and societal, depending on their origin (Alemayehu *et al.,* 2019; Juliev *et al.,* 2019). Biophysical and societal factors at the micro and macro levels are intricately interrelated and interdependent. Local weather conditions are affected by and affect the regional and global climate. Local soil and ecosystem types are determined by and determine regional soil and ecosystem types. The decisions of individual land managers are influenced, sometimes strongly, by decisions of persons or organizations at higher levels so that, in essence, local land-use change is often the result of higher-level decisions, as Blaikie and Brookfield have demonstrated. Land-use and land-cover changes produce environmental and socio-economic impacts that frequently feedback and modify the biophysical and societal factors causing them (Alemu *et al.,* 2015).

Due to the lack of rapid population growth and intensification of agriculture, smallholders need more land to grow their crops and earn a living. It leads to deforestation and land-use conversion from other types of land cover to agricultural land. Studies conducted in Ethiopia show that there were significant changes in LULC in each country in the second half of the 20th century. Most of these studies show that deforestation and the invasion of cultivation into the surrounding areas were the major causes of land degradation, especially in the highlands of the country (Daniel, 2008). For example, in the Tigray Highlands of northern Ethiopia, agricultural land has increased significantly over the past 41 years at the expense of natural vegetation (forests and shrubs), creating road construction, expansion of settlements, and demographic pressure associated with forests.

In Ethiopia, the land is used for several purposes, such as to grow crops, trees, and animals for food, as building sites for houses and roads, or for recreational purposes. The majority of lands in Ethiopia are being used by smallholders who farm for subsistence. With the rapid population growth and in the absence of agricultural intensification, smallholders require more land to grow crops and earn a living; it results in deforestation and land-use conversions from other types of land cover to cropland (Regasa *et al*., 2021). Several types of research in Ethiopia show that there were considerable land use and land cover changes in the country. The majority of the studies found that croplands have expanded at the expanse of natural vegetation, including forests and shrublands; for example, Bewket (2013); Abebe (2017) in the northern part of

Ethiopia; Zeleke and Hurni (2001) in the northwestern part of Ethiopia; Kassa (2003) in the northeastern part of Ethiopia; and Denboba (2005) in the southwestern part of Ethiopia. Kassa (2003) reported in his study in southern Wello the decline of natural forests and pastures due to the conversion to arable land. Bewket (2003) reported increased forest patches (eucalyptus tree plantations) and cultivated land at the expense of grazing land in both the Chemoga basin in northwestern Ethiopia and the Sebatbet Gurage land in south-central Ethiopia. Land use and cover changes in and around Mount Jeller between 1971/72 and 2000 resulted in the expansion of arable land at the expense of grassland (Gebrehiwet, 2004).

Hadgu (2008) confirmed this reduction in natural vegetation and expansion of farmland over 41 years in Tigray, northern Ethiopia. He concluded that population pressure was an important reason for the recent expansion and strengthening of agricultural land. However, most empirical evidence shows a strong link between land use, land cover changes, and socio-economic dynamics. The need for cultivable land, pasture, and firewood as the population grows. Areas of residence are also expanding to meet the growing demand for food and energy and the livestock population. Therefore, population pressure, lack of awareness, and poor management are believed to be the major causes of deforestation and the deterioration of natural resources in Ethiopia.

2.3. Extent of Forest Cover Change in Ethiopia

The extent of forest cover change in Ethiopia is closely linked to the ongoing population growth. More people generally lead to increasing demand for land for living and for agricultural production; for instance, the southwestern part of the Ethiopian Highlands had still been completely covered by montane rainforests. Shifting cultivation, which had been practiced for centuries within the area, had not been really a threat for the forest resources. The situation changed with new settlers migrating from the central and northern parts of the country to south-west Ethiopia. With the new settlers, a new farming system was introduced that was not adapted to the environmental conditions in the area (Reusing 2000).

In the mid-1960s, following the promulgation of a series of forest legislation, another round of extensive deforestation took place, this time despite the efforts of the government to put a stop to it. The legislation placed all large forests under state ownership and put severe restrictions on the use and management of private forests. To most people, the new law was yet another example of the state extending its tentacles over all natural resources and denying individuals rights of access to them (Rahmato, 2001; Getahun & Gitima, 2020). Another scenario during the imperial regime regarding forest resources was the expansion of large-scale commercial agriculture, which was actively encouraged by the state, at the expense of the forests with the objective of increasing agricultural production (Eshetu, 2014).

Massive destruction of forest resources occurs during the transition period in Ethiopia (the early 1990s). Because state forestry posed a threat to peasant livelihoods, it encroached on farmland, evicted households living in and near it, and took away land that was customarily used for grazing. Many of the forests in question were enlarged by expropriating farmland and pasture (Eshetu 2014; Getahun & Gitima 2020). Also, the primary results from the accuracy assessment are adjusted area estimates calculated by combining sample and map area estimates and their associated confidence intervals. The adjusted area estimate for forest loss is 1.1 million ha +/- 0.91 million ha, and for the forest, the gain is 0.4 million ha +/- over the period 2000-2013, which corresponds to an annual forest loss of approximately 70,000 ha/yr and an annual forest gain of approximately 30,000 ha/yr. This estimate is used as the activity data. The relatively high annual forest area gain in the Dry Afromontane biome gives some evidence that Ethiopia is already implementing several mitigating actions that aim to restore forest resources (MEFCC, 2016).

2.4. Ethiopian challenges to natural woody species regeneration

2.4.1. Changes in land use and land cover

Various studies have revealed that land use changes have been done at the expense of forest cover and that this has had a considerable impact on woody species regeneration in Ethiopia (Tolessa *et al*., 2017; Badesso *et al*., 2020). Cultivated land increased by 20.8 percent (1973-1986), and human settlements increased by 31.1 percent (1986-2001), whereas forest cover declined by 14.7 percent (1973-1986) and 38.5 percent (1986-2001), and shrublands decreased by 25.9 percent (2001-2015) (Tolessa *et al*., 2016). Forest health and regeneration have been harmed by land conversions to cereal agriculture and settlement with agroforestry based land management (Kassa *et al*., 2017).

Between 1973 and 2013, a substantial loss of woods (54 percent) was recorded in Ethiopia's central rift valley, whereas agricultural land rose by 38.78 percent, grassland increased by 11.12 percent, and bare land increased by 40 percent (Mesfin *et al*., 2020). The degree of the disturbance that directly or indirectly affects woody species regeneration is generally shown by a loss in woody species cover across a large area. Land fragmentation and cover change have a direct impact on tree regenerative potential (Teketay, 2005), as well as an indirect impact on seed germination and survival due to changes in resource quality. It depletes seed sources, reduces appropriate regeneration, and reduces seedling recruitment in woody species.

2.5. Driving Factors of Forest Cover Change in Ethiopia

2.5.1. Direct/ Proximate Driving Factors

Expanding agricultural activities (burning and removing of the tree and overgrazing), fuel wood and charcoal, and resettlement expansion programs leads to deforestation and forest degradation (Walle *et al*., 2011; Oljirra, 2019; Getahun & Gitima, 2020). The main direct drivers of deforestation are generally agreed to be logging and the expansion of agriculture and infrastructure. Demand for wood fuels drives much of Ethiopia’s forest degradation. Though the role of firewood in forest degradation is somewhat contested, charcoal dominates cooking energy choices in urban areas, and uncontrolled fires and livestock grazing in forests are widely recognized to contribute to forest degradation (Zerga & Gebeyehu, 2016). More studies (Zerga & Gebeyehu, 2016; Danano *et al*., 2018; and MEFCC, 2017) identified the proximate driving factors like:

Agricultural practices: Ethiopia’s forests are increasingly under threat as the growing population requires more fuelwood and agricultural products, which leads to farmland expansion, including commercial farms. For instance, the large-scale investment agricultural schemes, both private ones and state-owned ones, have been significant drivers in Gambella, Benishangul-Gumuz, and Afar regional states (MEFCC, 2016). The main drivers associated with agricultural expansion are: firewood consumption and pasture land expansion decline forest land (Danano *et al*., 2018).

Fuel wood and charcoal: The major drivers are raising demand for forest products like fuelwood and charcoal. For example, in Ethiopian, Somali, and Afar regional states, charcoal is produced by almost all rural households as one of the core livelihood income sources (MEFCC, 2016). According to FAO (2015), Ethiopia harvested more than 76 million m^3 of wood for fuel in 1993 and 101.1 million m^3 in 2011, the most of any country. The country consumes over 100 million m3 of fuelwood each year, and in 2013 alone, consumption was 124 million m3 of wood products (MEFCC, 2017).

Resettlement expansion: Most of the resettlement programs recently have been undertaken in Bench-Maji, Kaffa, Dawuro, Sheka, South Omo zones, and Basketo special district, as well as in the western lowlands of Tigray and Amhara regional states throughout the year. In Southern Nations Nationalities and Peoples Regional State (SNNPRS) and Oromia National Regional State (ONRS), the resettlement sites were covered either with dense forests or wooded grassland prior to the implementation of the resettlement. Most of the woodland has been replaced by arable land for the cultivation of cash and food crops (Moti *et al*., 2011; Eshetu, 2014).

2.5.2.Indirect/Underlying Driving Factors

Substantial studies indicated underlying driving factors of forest cover change in Ethiopia include economic factors (challenges to forest management and investment), institutional factors (poor governance and land tenure system), technological factors, cultural factors (Eco culture transformation), demographic factors (rapid population growth with high rate of natural increase), and biophysical factors including slope of land, climate variability, and droughts (Moges *et al*., 2010; Kaimowitz, 2012; Getahun & Gitima, 2020). In the same manner, more than 50 percent of the tree cover has disappeared due to indirect factors (Kaimowitz 2012; Getahun & Gitima 2020).

Economic factors and challenges of forest investment and management: Formally recognized private foreign investment in Ethiopia's forestry sector, described here as activities involving forestation, reforestation, and market creations of non-timber forest products, is currently limited. Of the handful of foreigners who made inquiries about investment opportunities to a government forestry official over the past few years, only one was moving forward with developing a business plan and securing appropriate permissions (Guillozet *et al*., 2011; Getahun & Gitima 2020).

Institutional factors are is underlying driving factors of forest cover change in Ethiopia, which include competing for jurisdictional authority over activities affecting forests, weak enforcement capacity, political inferiority of forestry to agriculture, inexperience in enforcing reforestation regulations, unclear tenure arrangements and boundaries, and unclear reporting requirements (Guillozet *et al*. 2011; Getahun & Gitima 2020).

Land tenure system and weak policy

Land privatization is a topic of considerable dispute in Ethiopia. The government owns all forest and agricultural land, granting usufruct rights to citizens in the case of farmland and maintaining all management authority in the case of forestlands (Guillozet *et al*., 2011). Uncertain land tenure system leading to low people investment, including lack of ownership, triggers illegal logging and the so-called tragedy of commons (Assefa & Bork 2014). Likewise, weak policy implementation on land use, low capacity of forest institutions, land use conflict, and policy discrepancy are aggravating forest cover loss in Ethiopia (Moges *et al*., 2010). The incentives that are stipulated by the forest policy are not implemented in Ethiopia to the required level, and thus, most forest users are unaware of them. The revision of the forest proclamation is almost finalized, and the draft forest proclamation takes into account the current changes in the institutional set up at the federal level and capitalizes emerging opportunities such as climate benefits of forests (MEFCC, 2018).

Technological factors: wood product demand is growing fast in Ethiopia due to population growth. The construction sector boom, growth in urbanization and urban population, and growing middle class are driving rapid growth in demand for wood and other forest products (FSR 2015; MEFCC, 2017).

Eco culture transformation: Empirical research made by Regassa *et al*. (2017) in the Gedeo zone, southern part of Ethiopia, described that the Gedeo experienced extensive ecocultural transformations after they became part of greater Ethiopia in the early twentieth century. Also, their study argued, the Gedeo youth engaged in cutting trees for firewood, charcoal, and construction materials, and the truck drivers loaded the resulting lumber to sell in nearby towns. On the other hand, a bit further into the hinterlands from the main road, are the elders who continue their sacred beliefs and practices of agroforestry, which protect trees from being cut down, harbor diverse aspects of the ecosystem, and sustain a long-standing coexistence. While Gedeo elders are worried about the decline of indigenous knowledge and the rise of environmental degradation, the youth and government authorities interpret human-environment relations differently.

Demographic factors: One of the most frequently cited underlying causes of forest decline is population pressure. That more population should translate into more deforestation and thus higher pressures to degrade forests makes intuitive sense. With an increased population, there would be more families in search of land for agriculture or looking for fuelwood or timber (Contreras-Hermosilla, 2000). In addition, demographic characteristics, mainly population density and rate of natural increase, are indirect factors for forest cover conversion through the growing needs for additional lands for farming and grazing as well as demands for tree products (Gessesse & Bewket 2014). Furthermore, expanding population resulting in actual human and animal populations exceeding the carrying capacity of the land also has a great impact on forest resources (Danano *et al*., 2018).

Biophysical factors Climatic factors such as insufficient and variable rainfall, unpredictable variation in rainfall patterns within and between seasons, the occurrence of intermittent but serious drought periods that affect forest cover, and biological factors including diseases and pests (Kelbessa & Girma 2011). The temporal climatic changes and variability have also affected the phenology of vegetation cover in all Eco-regions of Ethiopia. For example, greenness onset shifted to earlier periods, and the growing period lengthened in most eco-regions. The shift is triggered by the shift in the rainfall and temperature pattern, but temperature relates inversely to vegetation greenness and cover (Workie & Debella, 2018). In addition, deforestation is negatively related to slope, elevation, and distance to roads, forest edges, and aspects (Danano *et al*., 2018).

2.6. Remote Sensing as a Tool for Land use/land cover Study

Remote sensing and Geographic Information Systems (GIS) are providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of earth-system function, patterning, and change at local, regional, and global scales over time. Such data also provide a vital link between intensive, localized ecological research and the regional, national, and international conservation and management of biological diversity (Ernani and Gabriels, 2006). 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 contact with an object, area, or phenomenon under investigation (Lilles and Kiefer, 2004). It provides a large variety and amount of data about the earth's surface for detailed analysis and change detection with the help of various spaceborne and airborne sensors.

It presents powerful capabilities for understanding and managing earth resources. Remote sensing has been proven to be a very useful tool for LULC change detection. Change detection and monitoring involve the use of several multi-date images to evaluate the differences in LULC due to various environmental conditions and human actions between the acquisition dates of images. Successful use of satellite remote sensing for LULC change detection depends upon an adequate understanding of landscape features, imaging systems, and methodology employed about the aim of the analysis (Yang & Lo, 2002). With the availability of historical Remote Sensing data, the reduction in data cost, and increased resolution from satellite platforms, Remote Sensing technology appears poised to make an even greater impact on monitoring land-cover and land-use change (Rogan & Chen, 2004). In general, change detection of LULC involves the interpretation and analysis of multi-temporal and multi-source satellite images to identify temporal phenomena or changes through a certain period. Remote sensing data are the primary source for change detection in recent decades and have made a greater impact on different planning agencies and land management initiatives (Yang and Lo, 2002).

2.7. Land cover and land use classes

In almost any classification process, it is rare to find clearly defined classes that one would like. Before collecting training samples, the land cover classes should be known to make the classification easier (Bekalo, 2009). The classification nomenclature derived from Anderson *et* *al.'s* (1976) land cover classification for remote sensing was used and is modified based on detailed physiographical knowledge of the researcher about the study area. The most common land use and land cover classes are agricultural land, settlement, forest, grazing land, and water body; those were identified, and the description of each land use and land cover type was given based on FAO (2010).

Table 1: Land Use/Cover Type and their Respective Definition

Land use/Land cover classes	**Description**
Agriculture land	Land used for cultivation of crops, the total of areas under Arable land and Permanent crops land under irrigated and rainfall and land under temporary meadows or fallow and chat plantations in the farmland, trees, and rural homesteads but dominated by farmland.
Forest land	Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ and including a range of plantation forest types with one common feature and dominated by, *Eucalyptus spp, Gravili arobusta, cupreseslusitanica,*etc plantations.
Grazing Land	It is the area covered with both communal and private pasture lands which Retain the grass cover for a year and above. Here it is most time includes grasslands, shrublands, woodlands, wetlands, and the desert that are grazed by domestic livestock or wild animals.
Settlement/built up	A small town’s share of an urbanized area, including its markets, roads, and institutions such as schools, clinics, courts, and others
Water body	All water bodies include freshwater lakes, rivers, streams, ponds as well as marine water environments.

Adopted from (FAO, 2010)

3. MATERIAL AND METHODS

3.1. Description of the Study Site

3.1.1. Location

The study was conducted in Gechi District, Buno Beddelle Zone, Oromia Regional State, and south-western Ethiopia. Gechi district is located at 462 km from Addis Ababa and 18 km from Beddelle, Zonal capital city from Bedele. This district has a 64,972.7-hectare area, and it's delineated by Bedele district in the west, Berecha district in the east Didessa River in the north, Beddelle district also in the south. Geographically, it is found between 35^0 10′ 0″–35020′ 0″ E and $8^0$10 ′ 0″- $8^0$54′ 0″ N.

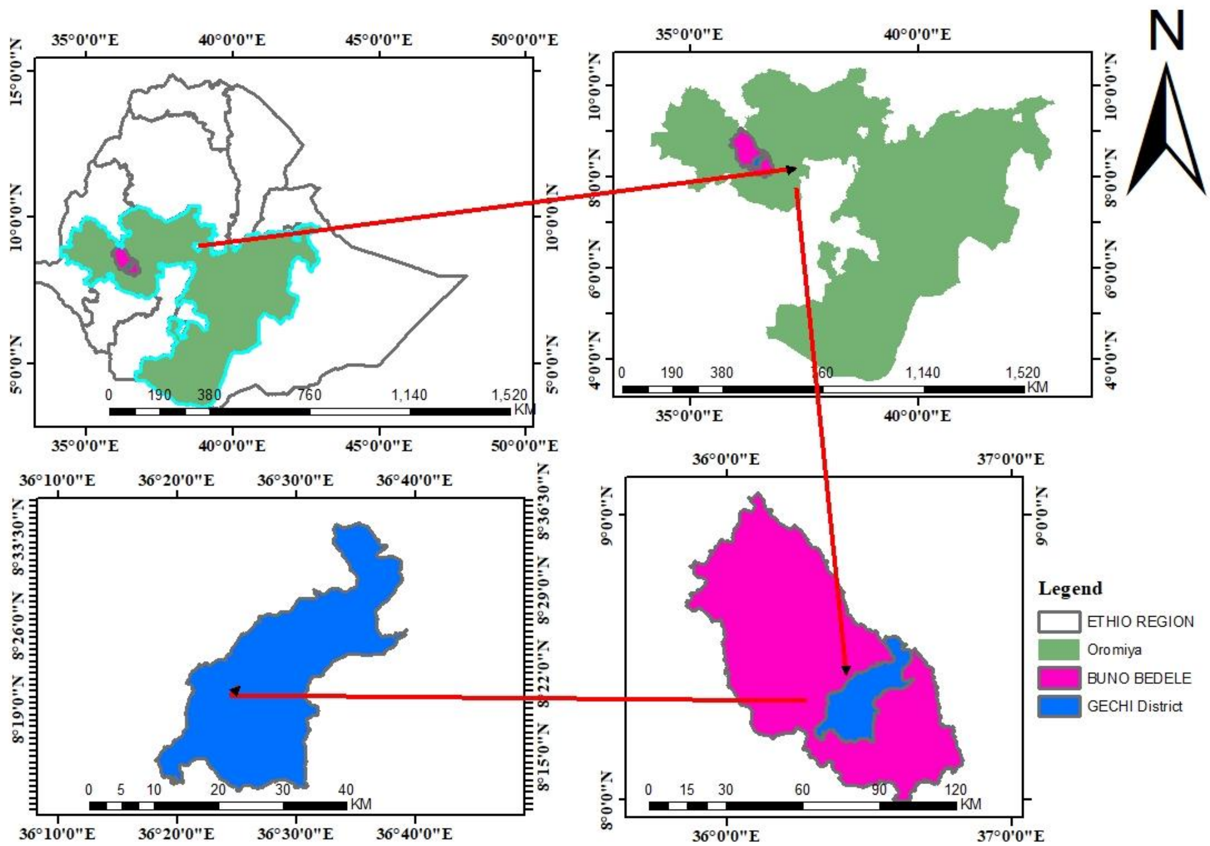

Figure 1: Map of the study area

The elevation of the district varies from 1200 to 1600 meters above sea level. The distribution of the mean annual rainfall is bimodal and irregular, ranging from 900 to 2100 mm. This is because the agro-ecological zone and season both have an impact. The district experiences the highest rainfall totals in the summer (June, July, and August) and the lowest totals in the spring (April and May). The typical annual temperature for the districts is between 15 and 20 degrees Celsius. The two types of soil that are most prevalent are loam (which makes up about 80%) and sandy loam (20%). Over half of the district's land is farmed. The district's primary production is agriculture, which also accounts for a considerable portion of the district's population's major crop. Maize, sorghum, teff, barley, wheat, finger millet, nut, and perennial crops including coffee, mango, banana, and chat are the principal crops farmed in the district. The forest was a home for wild animals such as lions (Panthera leon), leopards (Panthera pandus), hyenas (Crocuta crocuta), African buffaloes (Syncerus caffer), bushbucks (Tragelaphus scriptus), common baboons (Papio cynocephalus), warthogs (Phacochoerus africanus), bushpigs (Potamochoerus larvatus), pythons (Python sebae), porcupines (Hystrix cristata), colobus monkeys (Colobus guereza), common duikers (Sylvicapra grimmia), and vervet monkeys (Cercopithecus aethops), among others. The district is divided into two agro-ecologic zones: mid-highland, which makes up 15% of the area, and lowland, which makes up 85% (GANO, 2023).

3.1.2. Population

A total of 125,674 people live in the 34 kebele (KAs) of the Gechi District, including 62,537 (49.8%) men and 63,137 (50.2%) women. Urban dwellers make up 14% of the total population. Protestant makes up27 % of the population, while Islam makes up 41% and Orthodox Christian makes up32% (GANO, 2023).

3.1.3. Topography

A total of 125,674 people live in the 34 kebele (KAs) of the Gechi District, including 62,537 (49.8%) men and 63,137 (50.2%) women. Urban dwellers make up 14% of the total population. Protestants make up 27% of the population, while Islam makes up 41% and Orthodox Christians make up 32% (GANO, 2023).

3.1.4. Climate

Kolla, Dega, and Woina-dega are agro-ecological zones of the Gechi District, respectively. Altitude and rainfall distribution vary between these agro-ecological zones. Belg and Maher are the two main rainy seasons, and the rainfall distribution is bimodal in nature. Maher has a long rainy season that lasts from May to the end of September, while Belg has a short rainy season that starts in January and ends in April. The yearly precipitation ranges from 900 to 2100 mm on average for minimum and maximum amounts.

3.1.5. Soil

The soil has a light blue, a typically rough texture, and is well-drained. The majorities of the soils are weak structurally and have low bulk densities, making them susceptible to erosion. Soils in the Gechi District are divided into different textural groups. Typically, the three varieties of soil that make up the district—Red 22%, Brown 48%, and Black 30%—are used to identify it. Vertisol, Camisole, and Rigosol are the three most prevalent soil types. Vertisol is the predominant type of soil in the region (GANO, 2023).

3.1.6. Natural Vegetation Coverage

Gechi district is among those consecrated with a wealth of woody species vegetation. The district once had dense natural woods covering it, but owing to human influence, these woody species of vegetation are occasionally becoming less common. According to GANO (2023), only 8% of the district's land area is currently covered by forests. Common tree species in the study area include Cordia *africana, Croton macrosrachyus, Acacia abyssinica, Hagenia abyssinica, Podocarpus falcatus, Albizia gummifera, Olea africana, Sesbania sasban, Ficus vasta, and Eucalyptus camal* (GANO, 2023).

3.1.7. Economic Activities

The district's main economic sector is agriculture. The district's residents rely heavily on mixed agriculture, or the production of both crops and cattle, for their means of subsistence. Wheat, haricot beans, peas, beans, sorghum, millet, and barely are the main field crops farmed in the region. The district grows coffee, tea, sugarcane, avocado, mango, timber trees, and other perennial crops. Most cropland in the Gechi District is interspersed with animals, including

239,543 chickens being raised and 82,391 cattle, 28,101 sheep, 63,777 goats, and 14,119 equines (GANO, 2023).

3.2. Methods

3.2.1. Research design

There are different types of research methods. For this study the cross-sectional research method was used. However, for the purpose of this study, the researcher selected the cross-sectional study is a type of research design in which researchers collect data from many individuals at a single point in time. In a cross-sectional study, the investigator measures the outcome and the exposures in the study participants at the same time. Descriptive Research Design approach and mixed research design was used. The concurrent mixed approaches enable to gather quantitative and qualitative data and are gathered at the same time (Airasian *et al.* 2009). The purpose of mixed-method design is to collect data from different sources and apply the triangulation method to enhance and improve the quality of the data during the analysis and interpretation

3.2.2. Types of data and sources

For this study, both qualitative and quantitative data were used. These data were obtained from primary and secondary data sources. The primary data source was households, field surveys, and GPS measurements, whereas secondary data was used, including satellite images. LULC datasets were generated from Landsat imagery (Table2).

Table 2: Remote sensing data used in the study

Date of acquisition	Sensor	Path/row	Multispectral band	Spatial resolution	Source
1/20/1983	TM	175/055	1 to 5and 7	30*30	USGS
7/13/1993	TM	175/055	1 to 5and 7	30*30	USGS
1/20/2003	ETM+	175/055	1 to 5and 7	30*30	USGS
1/15/2013	OLI/TIRS	175/055	1 to 5 and 9	30*30	USGS
1/16/2023	OLI/TIRS	175/055	1 to 5 and 9	30*30	USGS

3.2.2.1. Satellite data and processing

There are different methods and techniques in order to use input data to reach the success of a desired goal. However, it highly depends on the availability of input data and quality of information. The data sets were used in this study: satellite images and ground truth data. A satellite image of 1983, 1993, 2003, 2013, and 2023 was used for this study. For this study, satellite images were downloaded freely from the USGS website http://www.earth explorer. Usgs.gov and acquired from the land sat of was obtained from TM (1983,1993), ETM+(2003), and 2013 and 2023 was obtained from OLI to assess the land use land cover change. In 1983 historical land use patterns might represent a time when traditional land use system and forest cover were less disturbed, offering, a contrast to modern, intensified land use practices. In January and February during a dry season was selected not only suitable for obtaining cloud-free images but also assumed that confusion in spectral contrast between forest and non-forest green vegetation such as agricultural and grasslands could be minimized during dry seasons. For the quality of image classification, ground truth was taken from a field study of all land use (forest, grazing land, cultivated land, and settlement). The ground truth data was collected during field work by reading GPS Garmin 72H and used for land use land cover classification of 2023, and in addition, Google Earth and preprocessed imagery were used for accuracy assessment.

3.2.2.2.Image Enhancement and layer stacking

To increase interpretability of the image, removing cloud cover on some portion of the image of Landsat TM 1993 haze reduction technique was employed, and during layer stacking, different bands of TM, ETM+2003, and OLI, 2013 & 2023, excluding the thermal band, were considered for layer stacking.

3.2.3. Sample size and sampling technique

During the selection of the study sites, a multi-stage random sampling technique was used. At the first stage, a district was chosen, and secondly, peasant associations (PAs) or districts were identified using stratified random sampling of lulc types. For this study, six kebeles were purposefully selected by considering deforestation rate and land use conversion for collecting the required biophysical data. Accordingly, the extent, type, and pattern of LULCC may vary among the respective areas. As a result, a good representation of the dynamics in LULCC in the area was captured by identifying areas dominantly settled by each group and stratifying during the sampling process. The required biophysical and socioeconomic data first was collected through detailed socioeconomic assessment, which was conducted by different tools such as focused group discussion (FGD), household survey, key informant interview (KII), and field observation (FO). The selection of households to be interviewed was undertaken through random sampling technique. A sample of 189 households was selected from the total household of the sample kebeles (from households), and then after, the researcher will select household heads by a specific interval.

To calculate a specific interval (k), the researcher was used use this formula: k =N/n (k = specific interval, n = sample size, N = sample frame). The starting number selected by using the day-coding method. The Yamane (1973) for sample size determination at a 93% confidence level with a 7% margin error, as shown in (EQ.1). Previous studies (for instance, Hussain and Thapa, 2012; Fahud *et al*., 2018; Fahd *et al*., 2020) used a 7% margin of error.

$$n = \frac{N}{1+N(e)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

n=sample size, N=study population or sample frame, e=93% accuracy or 7% error

Where n is the required sample size, N is the total number of households in the selected study area, and e is the exactness value (the level of precision), set as ±7% (P=0.07).

$$n = \frac{N}{1+N(e)^2} = \quad n = \frac{3026}{1+3026(0.07)^2} = n = \frac{3026}{1+3026(0.0049)} = n = \frac{3026}{16} = 189$$

So the sample size of the study area is 189. When the sample confidence interval is 93% and the error is 0.07%. Numbers of sample households for each sample district were determined probability proportionally among the total sample households of the six kebeles. Based on the data obtained from the Gechi district land administration office, total households of the six kebeles were 3026.

Table 3: Total households and number of households selected

No	Name of District	Total no of house hold	Sample size
1	Wakale kebele	504	32
2	Mannisa kebele	556	35
3	Yaballo kebele	498	31
4	Chitubosonu kebele	487	30
5	Haro kebele	501	31
6	Didesa kebele	480	30
Total		3026	189

The survey was conducted through direct interviews with household members using structured and semi-structured questionnaires. An interview was conducted with family heads (family household), and in the absence of family heads (women household), it was made with an appropriate representative and knowledgeable member of the household.

3.2.4.Vegetation sampling

The forest patches were selected purposefully to determine the species composition and diversity of woody vegetation in the study area. One forest patch namely Wagammasi was selected from the study area for woody species composition and diversity analysis. Four transect lines were laid down, starting from the top of the ridge to the bottom of the valley, and there were 3 plots on one transect line in the forest. All trees and shrubs (20 m x 20 m), laid down and identified in the plots, each quadrat, for all plants having diameter at breast height (DBH) ≥ 2.5 cm, the circumference measurements were made at breast height (around 1.3 m) by using measuring tape and following the methods described by Martin, (1995). Since stems born from the same root were considered a single plant during the census of woody vegetation, the diameter of stems at the breast height was measured separately for each branch and summed. The sample quadrats were laid down along transects at a distance of 100 m from each other using a measuring tape meter and a 200 m interval between transacts.

3.3. Methods of data collection

3.3.1. Socio economic data collection

The researcher used both primary and secondary data sources in this research thesis. Primary data for this study was collected by using observation, questionnaire, personal interview, and focus group discussion.

A. Observation: by using the observation method of data collection, data was collected for the present past of four decades and the consequences of LULC change by intense observation of six kebeles in the study area.
B. Questionnaire: The researcher distributed the questionnaire to 189 households. For the sex distribution of sample size, the researcher was used to select proportional to their household head size. So the questionnaire was used to ask the 189 households. The main

data that were gathered through the questionnaire were the family size of household heads, land use pattern, family planning level of household heads, sources of farmland for households, sources of energy for households, livestock size of households, economic status of households, education level of household heads, land holding size of households, and sources of incomes for households. To collect data through a questionnaire, the researcher used the two enumerators.

C. Key informant interview: KI was done to interview the natural resources management administrator of Gechi District, six *kebeles* administrators, and ten elders who are familiar with the previous and present LULC, causes and consequences of driving of LULC, cultural and social dimension of relationship of forest, the pattern of population growth and its impact on forest coverage, and forest conservation strategy. To select elders, the researcher needed the support of *kebele* administrators and enumerators, and also the researcher tried to get lists of household heads from different offices and select elder household heads from lists. The main target to select elders from other household heads for key informant interviews is that elders have more know-how about the previous LULC the impact on their locality.

D. Focus group discussion, A group containing 8-10 elderly people with very good knowledge of the study area was selected for an in-depth interview and focus group discussions on issues like population changes and their consequences on land use/cover, and also the researcher was discussed with six focus groups to collect information about woody species diversity. Each focus group includes ten people. Totally, 45 male household heads, 15 female household heads, and one natural resource management expert were involved in FGD. And the researcher considered the age structure of household heads. To conduct FGD, the researcher used one assistant. Parallel with primary sources of data, the researcher used secondary data sources from the agriculture sector office`s report, natural resources management office reports, and published and unpublished materials.

3.3.2. Woody vegetation data collection

The vegetation data all trees, shrubs, and herbs, including vascular epiphytes were recorded from the systematically established quadrats along each transect. Species those were readily identifiable and recorded in the field. For species that were difficult to identify in the field, local people, especially two elders, who were more likely to know the plant's local name, were interviewed, and their local name was recorded, as well as a later scientific name, was identified using plant identification by referring to the publication with the help of Flora of Ethiopia and Eritrea (Hedberg *et al*., 2006) and “Useful Trees and Shrubs for Ethiopia” (Azene, 2007). In each quadrant, number and diameter at breast height (DBH at 1.3 m) were measured for trees and shrubs by tape meter, respectively. The starting point of the first transect line was located randomly. To avoid the edge effects, all the sample plots were established at least 50 m from the forest edges or roads inside the forest (Feyera & Demal, 2001).

3.4. Method of Data Analysis

3.4.1. LUL Classification

Satellite imageries of 1983, 1993, 2003, and 2013 and 2023 were downloaded from USGS and GLCF. Multi-temporal raw satellite image data was imported to Erdas Imagine 10.3 image processing software. Then, these images were layer stacked, georeferenced to their corresponding latitude and longitude by using a georeferenced digital map of the study area, and projected to WGS 1984_ UTM_ zone _37North. Different image mosaicking, subseting, and radiometric enhancement (histogram equalization, haze reduction, noise reduction, and normalization) techniques were applied to the raw TM, ETM+, and OLI Landsat images. The scene difference problems of different sensors and satellite images were removed by using normalization techniques of radiometric correction. Then supervised classification methods were applied to Erdas Imagines 10.3. Among different classification algorithms, maximum likelihood was used for supervised classification by taking the ground control points for six major LU/LC class categories.

3.4.2. Accuracy assessment analysis

Error matrices were designed to assess the quality of the classification accuracy. The Kappa coefficient was also used to assess the classification accuracy. The overall accuracy and Kappa statistics calculated by using formula as follows

$$OA= \frac{Number\ of\ pixels\ correctly\ classified}{Total\ number\ of\ pixels} \text{.................................... Equation (2)}$$

Where, OA=overall accuracy; Diagonals in error matrixes table represent sites classified correctly according to reference data while Off-diagonals are miss classified. Kappa (K ˆ): It reflects the difference between actual agreement and the agreement expected by chance.

3.4.3. Change detection analysis

To examine the land use/land cover change detection and the rate of its changes, the post-classification comparison change detection method was employed. This kind of change detection method identifies where and how much change was occurring. Then the whole study period (1983–2023) was classified into four sub-periods (1983 to 1993; 1993 to 2003; 2003 to 2013; and 2013 to 2023 (1983–2023), which includes the entire years of study periods. Then, the paired overlay was performed through spatial analysis in GIS in order to detect, compare, and analyze patterns and directions of changes and to quantify the rate of change, gains, losses, total change, and net change of LULC that occurred during the time period considered in the study area as determined by Pontius *et al. (2004).* To determine the magnitude, trend, and rate of land use/land cover changes in the resettlement, the area comparison analysis was made by subtracting the total area of each class of 1983 from 1993, 1993 from 2003, 2003 from 2013, 2013 from 2023, and 1983 to 2023, in which the result could be positive (increasing) or negative (decreasing). The percent and rate of land use/land cover change was computed by the following formula as described by Demissie *et al.* (2017).

$$Percent\ of\ change = (A - B)/B \text{ .... Equation [3]}$$

$$Rate\ of\ change = (A - B)/C \text{...Equation [4]}$$

Where A is area of LULC (ha) in time 2, B is area of LULC (ha) in time 1; C is Time interval between A and B in years. Pearson's correlation was used to analyses the relationship between population and land use land cover of 1983 to 2023.

3.4.3 Woody species composition and diversity analysis

The Shannon diversity index was computed for vegetation species evenness and vegetation species richness by computing a formula; Shannon diversity (H') and evenness (E') indices are also calculated as a measure to incorporate both species richness and species evenness, or a measure of heterogeneity (Begone *et al*., 2006).

$H' = -\sum_{s}^{n} pi * lnpi$ ....Equation[6]

Pi = is the proportion of individuals found in the ith species (ranges 0 to 1); and

(Pi=n/N=n = number of individuals of a given species; N = total number of individuals

H' = species diversity index.

Pi = is the proportion of individuals found in the ith species (ranges 0 to 1); and

n = number of individuals of a given species; N = total number of individuals found

The Shannon evenness was calculated: - The Shannon evenness or equitability was calculated as

E=$\frac{H'}{lnS}$ o r E=$\frac{H'}{Hmax}$ equation... [7]

Where: H' = species diversity index;

ln = natural logarithm

3.4.4. Socioeconomic data analysis

The socio-economic data was coded, rearranged, and cleaned, and the pre coded questionnaires entered were summarized. To analyze the socioeconomic data, descriptive statistics was utilized with the help of the statistical package for social science (SPSS) version 20, and in addition, Microsoft Office 2003 will be used for the analysis of some statistical material. Descriptive statistics like percentages and frequencies were analyzed and presented in the form of tables.

4. RESULTS AND DISCUSSION

4.1. Socio-economic characteristics of respondents

The socio-economic results of study area show in terms of gender were male households. The education status of the study area was the majority of house hold are learned the primary schools. In terms of religious the result shows the majority of the households follow Muslim religion. The marital status of the study area was married households.

Table 4 the socio-economic characteristics of respondents

Variables	Category	Frequency	Percent
Gender	Male	183	96.8
	Female	6	3.2
	Total	189	100
Age	18-30	61	32.3
	31-64	128	67.7
	Total	189	100
Education	Illiterate	30	15.9
	1-8 grade	116	61.4
	9-12grade	32	16.9
	Level I-IV	11	5.8
	Total	189	100
Religion	Orthodoxy's	21	11.1
	Muslims	152	80.4
	Protestants	16	8.5
	Total		100
Marital status			
	Married	177	93.65
	Single	2	1.05
	Widow	3	1.59
	Divorced	7	3.7
	Total	189	100

4.2. Land Use Land Cover Classification and Dynamics (1983–2023)

The result showed that into a finite number of individual classes based on their data file values. If a pixel satisfies certain set of criteria, it is assigned to the class that corresponds to those criteria.

In this study, land use land cover was classified as cultivated land, forest cover land, settlement, grass land, and water body. The land use land cover classifications of 1983, 1993, 2003, 2013, and 2023 are shown in Figure 2.

4.**2.1 Accuracy Assessment of LULC maps**

Accuracy assessment of LULC maps Table 5 displays the accuracy assessment for the identified LULC types. For the years 1983, 1993, 2003, 2013, and 2023, the overall categorization accuracy ranges from 85 to 93%. According to Muche *et al*. (2023), a very good Kappa value should fall between 0.70 and 0.85. In this study, the classified images exhibited a kappa coefficient above 0.80. As a result, the validation data set revealed a very strong agreement between the categorized images and the ground truth data. The classification accuracy of the study matched the recommendation that there must be at least 80% accuracy for sensor data. The study results are in line with the study of Tilahun and Teferie (2015) Mathewos *et al*. (2022), a very good Kappa value should above 0.8.

Table 5: Accuracy assessment for classified image

Land use	1983		1993		2003		2013		2023	
land cover	user Accuracy	Producer Accuracy	User Accuracy	Producer Accuracy	User Accuracy	Producer Accuracy	User Accuracy	Producer Accuracy	User Accuracy	Producer Accuracy
Cultivated land	92.78	93.75	82.47	93.02	83.51	93.10	84.50	94.25	86.60	94.38
Forest land	100	88	100	75.86	100	78.57	100	78.57	100	84.62
Grass land	91.67	75.86	87.50	65.83	91.67	68.75	91.67	68.75	91.67	68.75
Water body	73.33	100	73.30	100.00	92.31	92.31	73.30	100	73.30	100
Settlement	88.46	100	88.46	88.46	73.33	100	96.15	96.15	96	96.15
over all accuracy	93.75		85.33		86.96		88.04		89.13	
over all kappa	0.87		0.786		0.81		0.82		0.84	

Source: Own computation (2024)

4.2.2 Land Use Land Cover Classifications

Based on the supervised image sorting method system, LULC in the study area was classified into five types, namely cultivated land, forestland, grassland, water body, and settlement area using GIS techniques (Table6).

Table 6: Land use land cover classification of the study area

land use land cover classes	1983		1993		2003		2013		2023	
	Area in(ha)	Area (%)	Area in(ha)	Area (%)	Area in(ha)	Area (%)	Area in(ha)	Area (%)	Area in(ha)	Area (%)
Cultivated land	12208.8	76.29	12372.1	77.31	13225.8	82.65	13391.9	83.879	13044.9	81.52
Forest land	1735.56	10.85	1613.17	10.08	1161.09	7.26	929.81	5.74	1157.35	7.23
Grass land	1244.72	7.78	1200.28	7.42	796.89	4.98	596.25	3.68	437.08	2.73
Settlement	696.33	4.35	699.93	4.37	701.65	4.38	967.52	5.97	1245.22	7.78
Water body	117.08	0.73	117.08	0.73	117.08	0.73	117.08	0.73	117.96	0.73
Total	16002.5	100	16002.5	100	16002.5	100	16002.5	100	16002.5	100

As shown in Table 6 above, the largest proportion of land use/land cover in the 1983 was cultivated land and forest land, which occupied 1208.8 ha (76.29%) and 1735.56 ha (10.85%) of the total LULC of study area, respectively. Grassland, settlement, and water body LULC types, on the other hand, occupied 1244.72 ha (7.78%), 696.33 ha (4.35%), and 117.08 ha (0.73%), respectively. The study area is dominated by cultivated land and forest land. In 1991, Ethiopia's land use policy under the Derge government encouraged farmers to maintain forest resources; however, the study area's forest resources were negatively impacted since they were replaced by resettlement programs. This analysis confirms that the most extensive forest cover depletion was within the four periods. During these periods, the majority of the lost vegetated area was immediately converted to cropland. According to the study area in four past decades, forestland was preserved during the initial study period, but decreasing patterns in its conversion to agriculture were seen over time. As a result, from 10.85% (1735.56 ha) in 1983 to 10.08% (1613.17 ha) in 1993 to 7.26% (1161.09 ha) in 2003, 5.74% (929.81 ha) in 2013, and 7.23% (1157.35 ha) in 2023, the share of cultivated land has significantly increased and decreased in 2023, where the forest land decreased and increased in 2023 (Figure 2).

This study in lined with the study findings of declining forestland cover have been reported in various parts of the country (Kidane *et al*., 2012; Minte *et al*.; Deribew and Dalacho, 2019; Hailu *et al*., 2020; Mathewos *et al*., 2022; Mosisa *et al*., 2022; Muche *et al*., 2023). These studies concluded that accelerated population growth and subsequent urbanization proceeded to drive uncontrollable resource utilization and expansion of agricultural lands and settlements at the expense of forestland, which led to the LULC transitions. This study might be related to the community's rising demand of land for farming, settlements, and grazing, as well as to institutional and policy considerations.

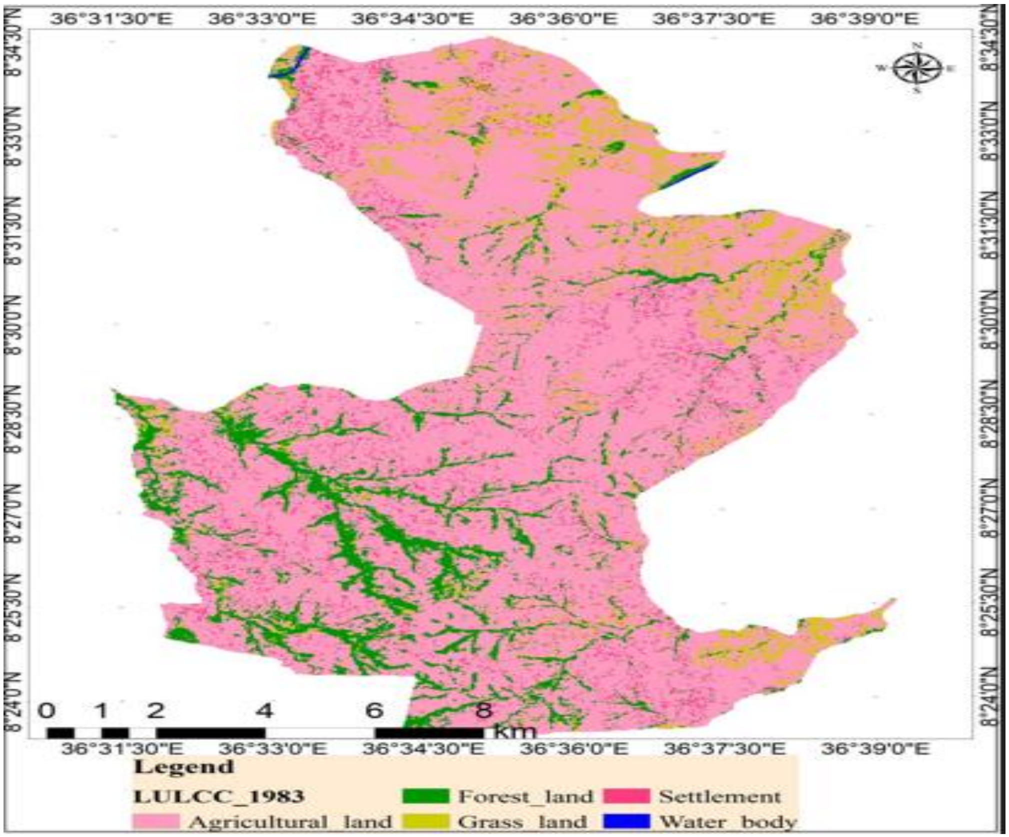

Figure 2: The LULC map of study area in 1983

As shown in Table 6, the largest proportion of land use/land cover in the 1993 was cultivated land and forest land, which occupied 12372.1 ha (77.31%) and 1613.17 ha (10.08%) of the total LULC of the study area, respectively. Grassland, settlement, and water body LULC types, on the other hand, occupied 1299.28 ha (7.42%), 699.93 ha (4.37%), and 117.08 ha (0.73%), respectively. The extent of cultivated land and settlement was increased where the forest land and grass land were dramatically decreased in the study area, respectively.

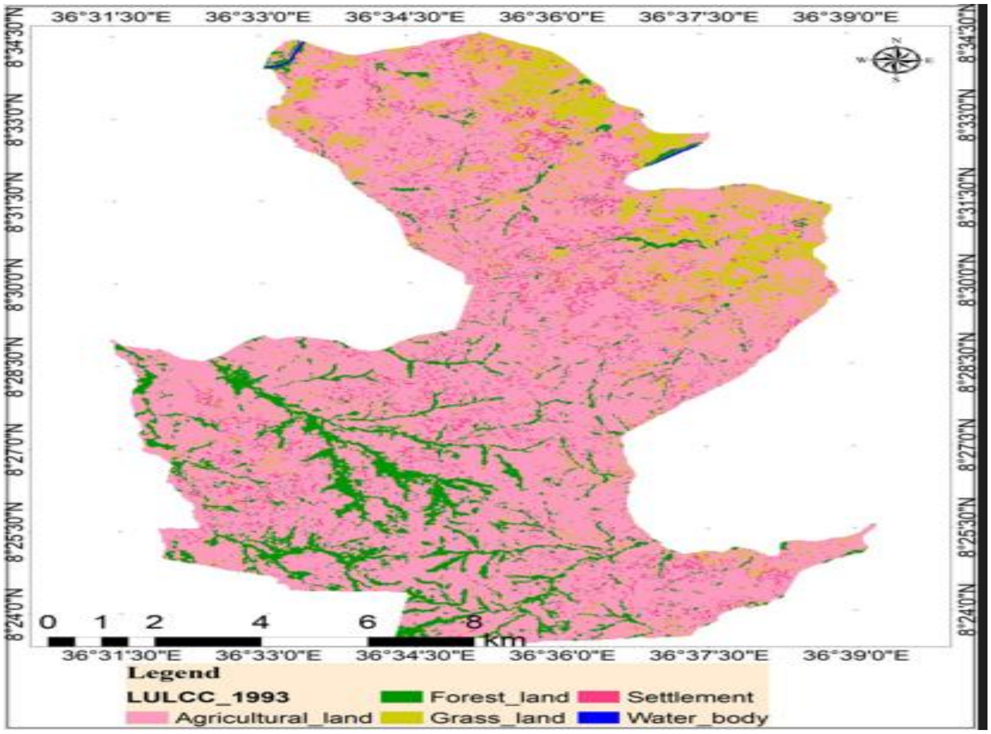

Figure 3: Map of land use land cover change in 1993

The extent of the settlement increased in line with the trend of the cultivated land from 1983 to 2023 in the study area. It covered an area that was roughly 699.93 Ha (4.37%) in 1993(Table 6). the findings of the land use and land cover classification from the 2003 (Figure 3, Table 6), showed that around 1161,17 ha (7.26%) of the area was forestland, where 796.89 ha (4.98%) was grassland, 13225.8 ha (82.65%) was cultivated land, 701.65 ha (4.38%) was settlement, and 117.08 ha (0.73%) was water body, respectively. These findings demonstrate that cultivated and forestland areas dominated the LULC of the 2003 (study area. Beyamo *et al*. (2010), confirmed that, from 1973 to 2005, there were 4516.92 ha of cultivated land in Shashogo Woreda, Southern Ethiopia, but by 2010, there were 20,872 ha. This showed that cultivated land increased by 362% during the 37-year period in the studied Shashogo Woreda. In another study by Mathewos *et al*. (2019) in 1985, cultivated land increased by 23.35%; cultivated land in southern Ethiopia's Bilate-Alaba sub-watershed significantly increased in size in 2017 by 15.71%. In the Gumara watershed of the Lake Tana Basin, northwestern Ethiopia, between 1957 and 2005, it was found that cultivated and settlement land increased by 21.9%, whereas forestland, shrubland, grassland, and wetland decreased by 85.3, 91.3, 76.1, and 72.54%, respectively (Wubie *et al*., 2016).

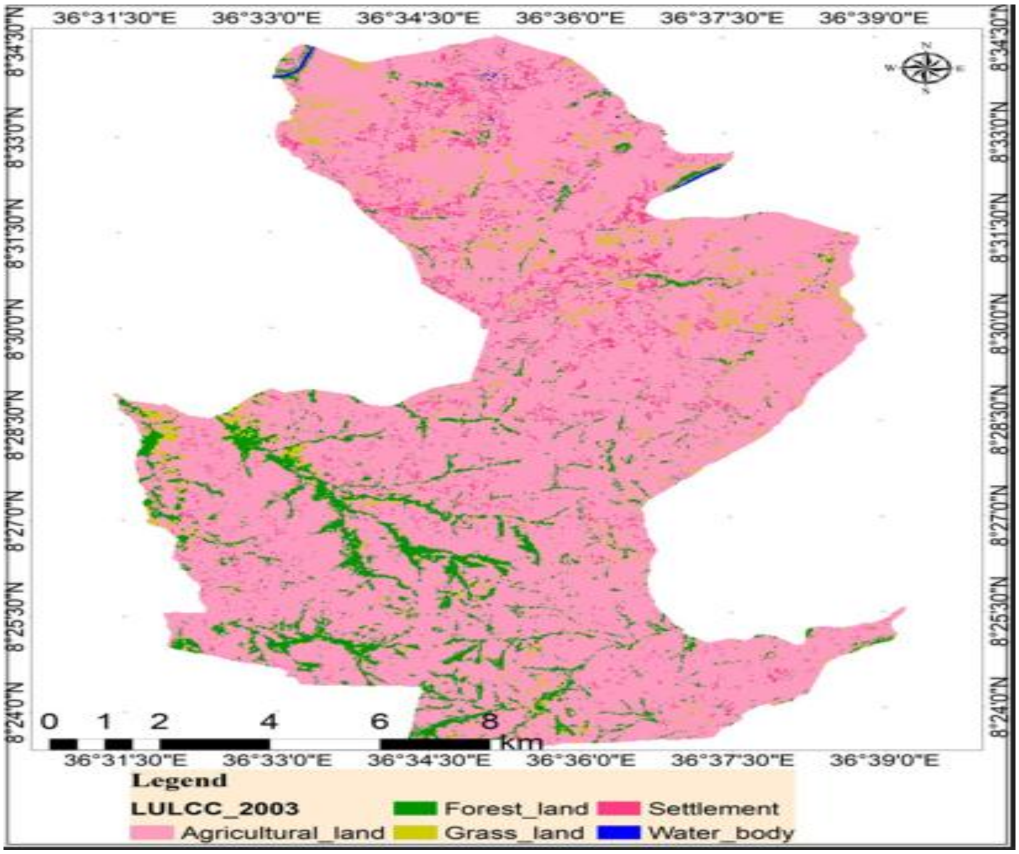

Figure 4: Map of land use land cover change in 2003

Moreover, the results of land use land cover classification from the 2013 (Figure 5) indicated that about 929.81 ha(5. 74%) was forestland, 596.25 ha (3.68%) was grassland, 13391.9 ha (83.87%) was cultivated land, 967.52 ha (55.97%) was settlement, and 117.08 ha (0.73%) was water body. This result showed that cultivated land was dominant in study area. This result in line with the study of Gebreslassie (2014), in the Huluka watershed, who reported, the cultivated land and settlement increased while forestland and grassland decreased in study area

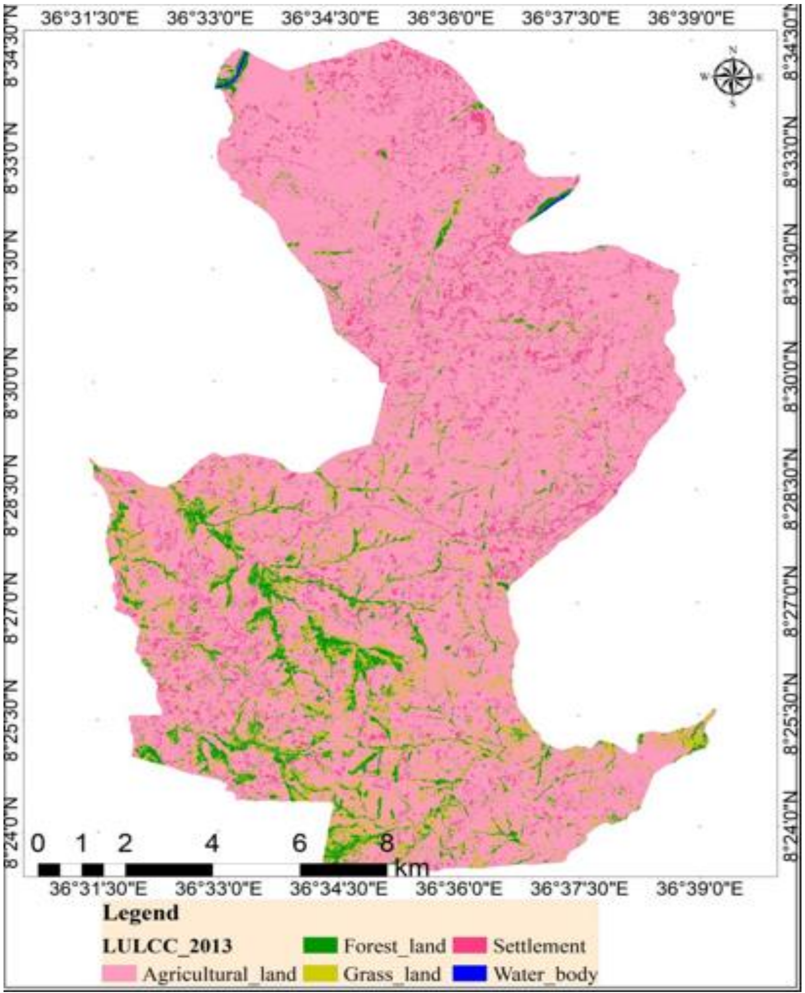

Figure 5: Map of land use land cover change in 2013

Generally, the results of land use land cover classification from the 2023 (Figure 6) indicated that about 1157.35 ha (7.23%) was forestland, 437.08 ha (2.7%) was grass land, 13344.9 ha (81.51%) was cultivated land, 1245.22 ha (7.88%) was settlement, and 117.96 ha (0.73%) was water body. This result showed that cultivated land was dominant. The results of LULCC 2023 show that the forest land, settlement, and water body increased in little beat while the cultivated land and grass land decreased. The forest land was increased in 2023; this is due to the restoration and afforestation tree planting campaign of Green Legacy, while the water body was increased due to the Arjo Didessa dam constructed in the study area.

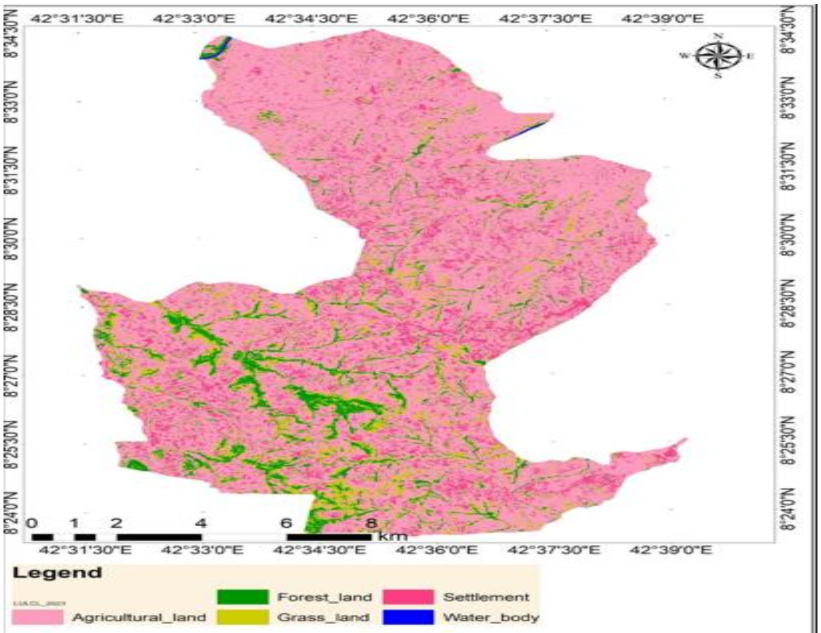

Figure 6: Map of land use land cover change in 2023

4.2.3 The Temporal LULCC Dynamics in study area (1983-2023)

The LULCC dynamics and the rate of change are discussed by linking the rate of alteration of each LULC class over the period measured. The rate of change in each LULC class could provide the information to make a comparison among the different classes. Hence, the land use and land cover change of the five periods was analyzed based on the temporal and annual rate of change (Table 7).

Table 7: Temporal land use dynamics from 1983-2023

land use	1983	1993	2003	2013	2023	Temporal/ absolute change				
land cover classes	Area in(ha)	Area in(ha)	Area in(ha)	Area in(ha)	Area in(ha)	1993-1983	2003-1993	2013-2003	2023-2013	2023-1983
Cultivated land	12208.8	12372.1	13225.8	13391.9	13044.9	163.3	853.72	166.07	-347	836.1
Forest land	1735.56	1613.17	1161.09	929.81	1157.35	-122.39	-452.08	-231.27	227.54	-578.21
Grass land	1244.72	1200.28	796.89	596.25	437.08	-44.44	-403.39	-200.64	-159.32	-807.64
Settlement	696.33	699.93	701.65	967.52	1245.22	3.59	1.72	265.87	277.7	548.89
Water body	117.08	117.08	117.08	117.08	117.96	0	0	0	0.88	0.88
Total	16002.5	16002.5	16002.5	16002.5	16002.5					

Source: own computation (2024)

In 1983-1993, there were 12208.8 ha (76.29%) of cultivated land this number was raised to 12372.1 ha (77.3%) and the absolute change (temporal change) 163.3ha/year in a decade. From 1993 to 2003, it was increased to 13225.8 ha (82.65%), and the absolute change 853.72ha/year. In 2013-2023, it was increased to 13391.9 ha (83.87%) and decreased to 133044.9 ha (81.51%) in 2023. According to this, a -347ha/year absolute change or temporal decline was observed over the course of 10 years, from 1983 to 2023 the cultivated land a temporal increase 836.1ha/year was seen in past four decades. The percentage of change from 1983 to 1993 it increased 1.34% over the decade.1993-2003(6.9%) the percentage of change increase was observed over the course of 10 years, from 2003 to 2013 (1.26%), the percentage of change it increased over the decade. from 2013 to 2023, a temporal/absolute change increased was observed by 2.66%; and a 6.85% absolute change increase was seen from 1983 to 2023. The research area had absolute change growth in cultivated land of 836.1ha/year over the 40-year period from 1983 to 2023.

In 1983, grassland covered 1244.72 ha (7.78%), which fell to 1200.28 ha (7.42%), 796.89 ha (4.98%) in 2003, 596.5 ha (3.68%) in 2013, and 437.08 ha (2.7%) in 2023. This study, in line with studies by Minte *et al*. (2018); Birhanu *et al*. (22019); Regassa (2021), Tesfay *et al*. (2022), and Muche *et al*. (2023), who reported that the grass land decreased and shifts to cultivated land and settlements in different parts of Ethiopia. In Ethiopia, LULC changes are persistent events where cultivated land and settlements are dominant in the rural landscape while grassland was shrinking (Alemu *et al*. 2015; Dibaba *et al*., 2020; Hailu *et al*., 2020). This result showed that between 1983 and 2023, a 40-year period, a -578.21ha/year in forest land decline and in grassland -807.64ha/year temporal decline was realized in, and between 1993- 2003, -452.68ha/year in forestland was declined and in grassland -403.39ha/year temporal change decline was realized between 2003 to 2013, around -231.27% in forest land, and in grassland -200.64ha/year temporal decline was realized. Between 2013 and 2023, 227.54ha/year in forest land, increment was observed while in grassland -159.32ha/year was declined. The result of this study consistent with the study of Tadese *et al*., (2021), reported that the agricultural and settlement increased while the grass land was declined, from 1987 to 2017.

The coverage of settlement area in 1983 was 696.33ha (4%); 2023 was increased to 1245.22ha (7.8%) in study area. A temporal change 1983-19933.59ha/year, 1993-2003 1.72ha/year, 2003-2013,265.87ha/year,2013-2023,548.21ha/year increase was observed in the 40-year period in the study area, respectively. As a whole, there was a decrease in grassland and forestland; nevertheless, a progressive increase in cultivated land and settlement area in the study area was observed. In general, the water body and forest land increments were observed from 2013 to 2023, while cultivated land decreased from 2013 to 2023 in the study area over a 40-year period in the study area, respectively. This study similar to the study of Tadesse *et al*. (2017; Minte *et al*. (2018); Mengist *et al*. (2021); Mathewos *et al*. (2022); Muche *et al*. (2023) , who reported large-scale conversion of grassland into agricultural land and settlements throughout their study. On the other hand, a community afforestation effort in a degraded hilly section of the watershed led to a 27% increase in forestland in the Chemoga watershed of the Blue Nile (Bewket, 2002).

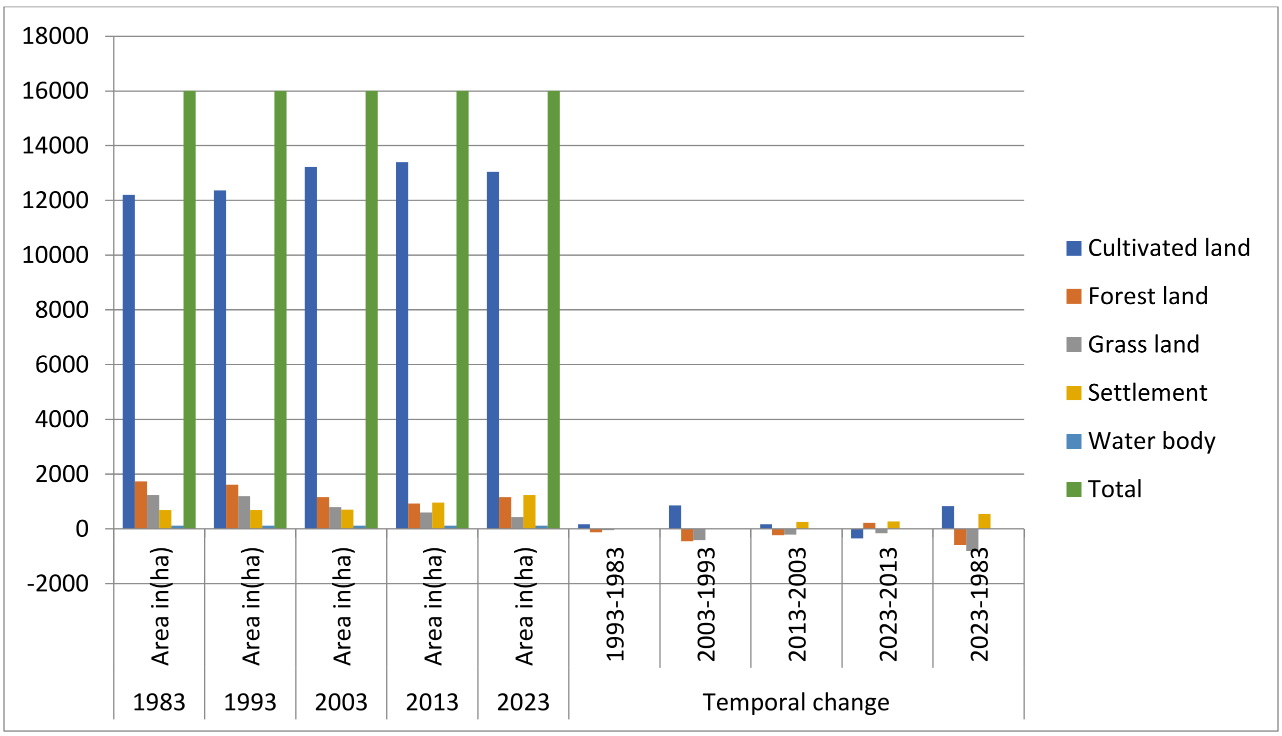

Figure 7: Net land use land cover change of 1983-2023

The cultivated land area displayed the highest positive rate of change, and settlement displayed the second-highest positive rate of change, while grassland and forestland both presented a negative rate of change in the study period between 1983 and 2023.

The annual rate of change in each LULCC class could provide the information to make a comparison among the different classes from the initial year 1983 to 2023.

Table7: annual rate of land use land cover change from 1983-2023

land use	1983	1993	2003	2013	2023	Annual rate of change				
land cover classes	Area in(ha)	Area in(ha)	Area in(ha)	Area in(ha)	Area in(ha)	1993-1983	2003-1993	2013-2003	2023-2013	2023-1983
Cultivated land	12208.8	12372.1	13225.83	13391.9	13044.9	16.33	85.37	16.61	-34.7	20.9
Forest land	1735.56	1613.17	1161.09	929.81	1157.35	-12.19	-45.2	-23.13	22.75	-14.45
Grass land	1244.72	1200.28	796.89	596.25	437.08	-4.44	-40.33	-16.72	-20.06	-20.19
Settlement	696.33	699.93	701.65	967.52	1245.22	0.35	0.17	26.58	23.14	13.72
Water body	117.08	117.08	117.08	117.08	117.96	0	0	0	0.087	0.021
Total	16002.5	16002.5	16002.5	16002.5	16002.5					

In addition, the annual rate change of forestland from 1983-2023 by rate of change 14.46ha/year, percentage of change (-33.32%). This indicates gradual decline of forestland over the 40-year period. The annual rate change of the grass land from 1983-2023, - 20.17ha/year and percent of change (64.84%) This indicate gradual decline of grassland over the 40-year period. This indicates gradual decline of forestland and grassland between 1983 to 2023.Between 1983and2023, cultivated land increased by 6.85%and annual average increase of 20.9ha/year. This indicates a gradual expansion of cultivated land over the 40-year period. Settlement between 1983 and 2023, the settled area increased by 78.79 % with an average annual increase13.72ha/year. This indicates significant expansion of settlement over 40 year's period possibly due to population growth and urbanization. This study in line with the study of Desta & Fetene, (2020), in the Lake Ziway watershed, cultivation and settlement LULC categories increased by 45%, 10.9%, and 141.4%, respectively.

Generally, the annual rate of change of the forestland and grassland of the study area results shows shrinking in study area, while the cultivated land and settlement result shows expansions. This study results consistent with the study of different parts of Ethiopia, Forest and agriculture land decreased, whereas home gardens, agroforestry/settlements, and grassland increased across East Africa (Maitima, 2009); cultivated land and settlement area increased, whereas forestland and bare land decreased in Jimma Geneti District, Western Ethiopia (Hailu *et al.,* 2020). While cultivated areas and settlements expanded, woods and grassland decreased in extent over the observation period (Tefera, 2011); the reverse trend was observed in the Gog District, Gambella area of southern Ethiopia (Othow *et al*., 2017). While forest and grassland were reduced, cultivated land and settlement area rose (Gashaw *et al*., 2017; Berihun et al., 2019). Mathewos *et al*. (2022) noted that although forest and rangeland decreased, settlement and agricultural land rose. While grazing land and Acacia forests decreased, bare land, cultivated land, and shrub land increased in the central Rift Valley Basin (Mathewos *et al*., 2022). Sewnet and Abebe (2018) showed the rise in areas covered by cultivated land and settlements and forests; on the contrary, grassland decreased considerably.

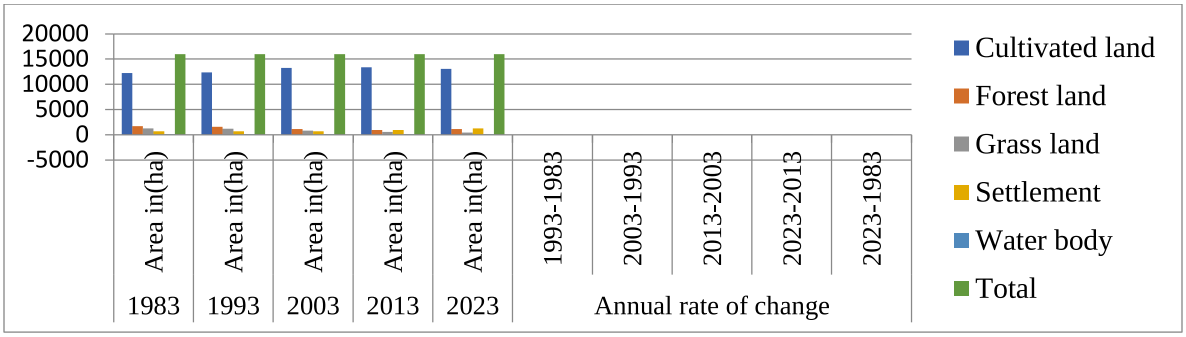

Figure 8: LULCC Rate change

4.2.4. Land Use Land Cover Dynamics Matrix

For the LULC change matrix in this study, the post-classification method was used to detect LULC change from 1983 to 1993 and 2003 to 2023. From the five LULC classes (Table 6). The land use land cover change matrix shows that the pattern of forest cover area decreased from 1735.56 ha to 1613.17 ha from 1983 to 2003. It further reduced to 1735.56 ha during the period between 1983 and 2023. This indicates that net forest cover change has been declined by 578.21 ha and -455.83 ha in the intervals between 1983 and 2023 and 1993 and 2023, respectively.

Table 8: Land use land cover change Matrix of study area1983-1993

		1993.00					
		Agricultural land	Forest_land	Grass_land	Settlement	Water_body	grand total
Change From 1983.	Agricultural	12202.60	1.79	1.38	2.54	0.49	12208.80
	Forest_land	48.01	1611.06	69.74	6.66	0.09	1735.56
	Grass_land	121.00	0.12	1067.42	55.28	0.90	1244.72
	Settlement	0.43	0.20	59.31	635.45	0.94	696.33
	Water-body	0.08	0.00	2.43	0.00	114.66	117.17
	grand total	12372.12	1613.17	1200.28	699.93	117.08	16002.58

The result of the land use land cover dynamics matrix (1983–193and 2003–2023) of the study area shows that during the indicated period a significant land use land cover change matrix exists (Table 8).

Table 9: Land use land cover change Matrix of study area1993-2003

		2003.00								
		Agricultural land	Forest_land	Grass_land	Settlement	Water_body	grand total	loss in Ha	% loosed	net change
Change	Agricultural land	11286.32	251.46	345.37	488.07	0.88	12372.10	1085.78	8.78	853.73
From 1993.00	Forest_land	556.20	902.43	50.13	103.70	0.71	1613.17	710.74	44.06	-452.08
	Grass_land	811.13	5.67	383.48	0.00	0.00	1200.28	816.80	68.05	-403.39
	Settlement	570.97	1.53	17.73	109.34	0.36	699.93	590.59	84.38	1.72
	Water_body	1.21	0.00	0.18	0.54	115.13	117.06	1.93	1.65	0.02
	grand total	13225.83	1161.09	796.89	701.65	117.08	16002.54			
	gain in Ha	1939.51	258.66	413.41	592.31	1.95				
	% gained	14.66	22.28	51.88	84.42	1.67				
	unchanged	85.34	77.72	48.12	15.58	98.33				
	persistence	11286.32	902.43	383.48	109.34	115.13				

Table 10: Land use land cover change Matrix of study area1993-2003

		2013.00								
		Agricultural land	Forest_land	Grass_land	Settlement	Water_body	grand total	loss in Ha	% loosed	net change
	Agricultural_land	12625.83	9.38	0.39	590.23	0.00	13225.83	600.00	4.54	-180.93
	Forest_land	59.03	1093.50	0.05	0.68	7.82	1161.09	67.59	5.82	-3.74
2003.00	Grass_land	360.04	45.10	390.34	0.49	0.92	796.89	406.55	51.02	-359.81
	Settlement	0.00	9.37	46.30	644.81	1.17	701.65	56.84	8.10	543.57
	Water_body	0.00	0.00	0.00	9.00	108.05	117.05	9.00	7.69	0.91
	grand total	13044.90	1157.35	437.08	1245.22	117.96	16002.50			
	gain in Ha	419.07	1147.97	436.69	654.99	117.96				
	% gained	3.21	99.19	99.91	52.60	100.00				
	unchanged	96.79	0.81	0.09	47.40	0.00				
	persistence	12625.83	1093.50	390.34	644.81	108.05				

Area of forest cover was reduced in the study area between 1983, 1993, and 2003. This might be due to the fact that the forest cover might be converted to other land cover types. While the agricultural land and the settlement increased because they gained from other land use conversions.

Table 11: LULCC matrixes of 1983-2023

		2023								
		Agricultural_land	Forest_land	Grass_land	Settlement	Water_body	grand total	loss in Ha	% lossed	net change
	Agricultural land	12130.94	88.485	0.853	151.65	0.17	12372.098	241.158	1.9492086	672.8011
	Forest_land	419.84	1068.104	20.751	104.45	0.02884	1613.1738	545.06984	33.788661	-455.828
1993	Grass_land	443.5	0.6052	384.15	370.967	1.06	1200.2822	816.1322	67.995027	-763.206
	Settlement	49.64	0.0075	30.9516	617.606	1.72	699.9251	82.3191	11.76113	545.2942
	Water_body	0.9791	0.144297	0.371048	0.546266	114.98	117.02071	2.040711	1.7438887	0.938129
	grand total	13044.8991	1157.345997	437.076648	1245.219266	117.95884	16002.5			
	gain in Ha	913.9591	89.241997	52.926648	627.613266	2.97884				
	% gained	7.006256568	7.710917671	12.10923719	50.40182746	2.525321544				
	Unchanged	92.99374343	92.28908233	87.89076281	49.59817254	97.47467846				
	Persistence	12130.94	1068.104	384.15	617.606	114.98				

Table 11 showed that regarding land use and land cover, there was a considerable increase in the area of cultivated land (12208.36 ha) during the period 1983–2003 in the study area, even though the specific portion of its extent was converted to grass land (29.54 ha), to forestland (212.49 ha), and to settlement area (15.52 ha).

Table 12: land use land cover matrixes of 1983 to 2003

		2003.00								
		Agricultural land	Forest_land	Grass_land	Settlement	Water_body	grand total	loss in Ha	% lossed	net change
	Agricultural_land	11950.00	212.49	29.54	15.52	0.81	12208.36	258.36	2.12	1017.46
	Forest_land	730.62	913.86	83.37	7.38	0.33	1735.56	821.70	47.34	-574.47
1983.00	Grass_land	400.38	30.78	668.50	144.72	0.34	1244.72	576.22	46.29	-447.83
	Settlement	144.22	3.96	15.21	532.40	0.54	696.33	163.93	23.54	5.32
	Water_body	0.60	0.00	0.27	1.63	115.06	117.56	2.50	2.13	-0.48
	grand total	13225.82	1161.09	796.89	701.65	117.08	16002.53			
	gain in Ha	1275.82	247.23	128.39	169.25	2.02				
	% gained	9.65	21.29	16.11	24.12	1.73				
	unchanged	90.35	78.71							

4.2.5. Species diversity and compositions of woody species under different Land use of the study area

An overall of 42 woody species 24 trees and 18 shrubs/liana species, belonging to 34 plant families, were recorded from the study area with 24 quadrats across forest area. The plant species diversity is mostly influenced by human impacts in LULC change. The overall Shannon diversity indices of woody species of the study area, forestland was 3.23 and evenness values (J) was 0.86, diversity of woody species in study area. This study finding is almost consistent with the result of Getahun and Anteneh, (2016), Hana *et al*. (2018) who reported that species evenness for Keja Araba natural forests and Tula natural forests in southwest Ethiopia was 0.79 and 0.86, and the species evenness for the natural forest at Belete Forest, southwest Ethiopia.

Variables	
	Forest
Species richness	42
Species abundance	1903ha-1
Shannon (H)	3.23
Evenness (J)	0.86

From all the species identified in all quadrants, the growth form composition of the woody species was 24(57.5%) trees, 15(35.71%) shrubs and 3(7.1%) climbers. This study agrees with the study of Buchura et *al*. (2019) who reported that in forest woody species were dominated by trees and the composition 26(63.4%) tree, were shrub 15(36.5 was dominated by trees.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The study demonstrated the impact of land use, land cover, and woody vegetation diversity. The result of land use and land cover change over the four decades showed that agricultural land expansion and settlement was increased because of interest to meet feed for food and population growth. The forest and grazing land in the study area decreased. It could be that peoples in study area heavily depend on natural resources for fuel wood and construction materials, as well as the production of charcoal and fuel wood as additional sources of income, which facilitates the depletion of the forest, while because of population growth, grazing land was converted more into agricultural land. In this study, an attempt has been made to use geospatial techniques to detect the land use and land cover change in the Gechi district of the study area using three sets of Landsat imagery. The results indicated that there was a clear change in the spatial extent of the forest cover within the 40-year period. Expansion of farmland and settlement resulted in increases while the decline of both in the forest and grassland areas. Normalized difference vegetation index (NDVI) and net land cover change revealed that the forest cover changed respectively between 1983 and 2023. The NDVI values between 1983 and 2023 indicated a clear increment of forest, and the total net change of forest was still a clear decline in forest cover within the 40-year period. The woody species diversity needs conservation of management activities for sustainable management and reduces human disturbances.

5.2. Recommendations

Based on the results, the following recommendations are put forward or suggested to be effective in the study area.

- The RS and GIS are important tools or technologies to understand and use to continuously evaluate and monitor the trend of land use and land cover change status by resettlement, and data sets at regional and national levels inform policy decisions.
- Conservation management and Priority to be needed for some species, such as *Cordia africana, Prunus africana,* and Ekebegia capensis, which are endangered due to human disturbance consumption used for timber and for other purposes.
- Further research will needed impact of land use land cover change and climate change to conserve the bio diversity of the study area.
- To guarantee effective food security, a diversified livelihood strategy by integrating agriculture to produce on small land sizes to increase production and productivity should be well needed to reduce farmland expansion and demand for food by enhancing forest conservation and increasing carbon.
- The off-farm and non-farm income agriculture will be needed to reduce the farmland expansion for land less house hold in study.

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AppendexTable1:Woody species Diversity recorded format 2023

Woody species plant were recorded from nonresettlementr area

No	Local name (A/Oromo) S	Scientific name	Family Name	No.	G/F
1	Abbayyii	Maesa lanceolata Forssk.	Myrsinaceae	10	shrubs
2	Abiraango	Oxyanthus speciosus	Rubiaceae	22	shrubs
3	Akuukkuu	Flacourtia indica (Burm. F)	Flacourtaceae	1	trees
4	Akuukkuu	Sysygium guineense (Willd.)	Myrtaceae	1	trees
5	Bagge	Combretum paniculatum	Menispermacea	4	Shrubs
6	Bosoqa	Sapium ellipticum (Krauss) F	Euphorbiaceae	5	trees
7	Buruurii	Psychotria orophila Petit	Rubiaceae	12	trees
8	Cayii	Celtis africana Burm.f.	Ulmaceae	15	shrubs
9	Birbirsa	Podocarpus falcatus (Thunb	Podocarpaceae	2	trees
10	Dambi	Ficus thonningii Blume.	Moraceae	2	trees
11	Dhama'ee	Nuxia congesta	Loganiaceae	12	trees
12	Dhummuugaa	Justicia schimperiana	Acanthaceae	6	shrubs
13	Diiboo	Rothmania urcelliformis	Acanthaceae	15	shrubs
14	Doophoo	Landolphia buchananni	Apocynaceae	53	Trees
15	Eebicha	Vernonia amygdalina	Asteraceae	1	shrubs
16	Gagama	Olea copensis ssp mororpa	Olea	4	trees
17	Gatamaa	Schefflera abyssinica	Araliaceae	5	trees
18	Hadheessa	Teclea nobilis Del.	Rutaceae	2	trees
19	Halalee	Byttneria catalpitiolata	Sterculiaceae	10	trees
20	Hincinnii	Pavonia urens Cav.	Malvaceae	40	shrubs
21	Kombolcha	Maytenus arbutifolia (A.Rich)	Celastraceae	6	shrubs
22	Lolchiisaa	Berseama abyssinica Freser	Melianthaceae	4	shrubs
23	Lookoo Adii	Diosporyus abysssinica	Ebenaceae	27	trees
24	Lookoo Gurracha	Diosporyus abyssinica	Ebenaceae	25	trees
25	Muka Foonii	Clutia abyssinica Jaub.	Euphorbiaceae	8	shrubs
26	Qacamaa	Myrsina africana	Myrsinaceae	1	shrubs
27	Qolaatii	Mimusops kummel A. DC.	Sapotaceae	4	trees
28	Saacoo	Agave sisalana Perr.	Agavaceae	20	shrubs
29	Sarxee	Dracaena steudneri	Dracaenaceae	3	shrubs
30	Si'oo	Allophylus abyssinicus	Sapindaceae	4	trees
31	Soolee	Pittosporum viridiflorum	Pittosporaceae	47	shrubs
32	Sootalloo	Millettia ferruginea	Pittosporaceae	19	trees
33	Ulaagaa	Ehretia cymosa Thonn.	boraginaceae	6	shrubs
34	Ulmaayyii	Clausena anisata (Wild.) Ber	Rutaceae	24	shrubs
35	Urgeessaa	Premna schimperi Engl.	Lamiaceae	1	shrubs
36	Waddessa	Cordia africana Lam	Boraginaceae	8	trees
37	Somboo	Ekebergia capensis Sparrm.	Meliaceae	4	trees
38	Qararoo	Pouteria adolfi friederici	Sapotaceae	4	trees
39	Agamsa	Carissa edulis (Forsk.) Vahl.	Apocyanaceae	2	shrubs
40	Hidda Gafarsaa/Geebbo	Paullinia pinnate L.	Sapindaceae	2	shrubs
41	Hambaabbeessa	Albizia gummifera (J.F.Gume	Fabaceae	4	trees
42	Xaaxessaa	Rhus ruspolii Engl	Anacardaceae	1	shrubs

7. APPENDIX

Confusion matrix of the year 1983

	Class name	Ground truth data							
		Agricultur	Forest_lan	Grass_land	Settlement	Water_body	Row Total	User accuracy	KC for each Category
	Agricultural_land	90	1	6	0	0	97	92.78%	0.8491
Classified Image	Forest_land	0	22	0	0	0	22	100.00%	1
	Grass_land	0	2	22	0	0	24	91.67%	0.9011
	Settlement	2	0	1	23	0	26	88.46%	0.8681
	Water_body	4	0	0	0	11	15	73.33%	0.7164
	Column Total	96	25	29	23	11	184		
	Producers Accuracy	93.75%	88.00%	75.86%	100.00%	100.00%			

Overall Accuracy = 86.96%
Overall, Kappa Coefficient = 0.8096

Confusion matrix of the year 1993

	Class name	Ground truth data							
		Agricultur	Forest_lan	Grass_land	Settlement	Water_body	Row Total	User accuracy	KC for each Category
	Agricultural_land	80	4	10	3	0	97	82.47%	0.6709
Classified Image	Forest_land	0	22	0	0	0	22	100.00%	1.00
	Grass_land	0	3	21	0	0	24	87.50%	0.8487
	Settlement	2	0	1	23	0	26	88.46%	0.8656
	Water_body	4	0	0	0	11	15	73.33%	0.7164
	Column Total	86	29	32	26	11	184		
	Producers Accuracy	93.02%	75.86%	65.63%	88.46%	100.00%			

Overall Accuracy = 85.33%
Overall, Kappa Coefficient = 0.7865

Confusion matrix of the year 2003

	Class name	Ground truth data							
		Agricultur	Forest_lan	Grass_land	Settlement	Water_body	Row Total	User accuracy	KC for each Category
	Agricultural_land	81	4	10	2	0	97	83.51%	0.6871
Classified Image	Forest_land	0	22	0	0	0	22	100.00%	1.00

	Grass_land	0	2	22	0	0	24	91.67%	0.8991
	Settlement	2	0	0	24	0	26	92.31%	0.9104
	Water_body	4	0	0	0	11	15	73.33%	0.7164
	Column Total	87	28	32	26	11	184		
	Producers Accuracy	93.10%	78.57%	68.75%	92.31%	100.00%			

Overall Accuracy = 86.96%
Overall, Kappa Coefficient = 0.8096
Confusion matrix of the year 2013

	Class name	Ground truth data							
		Agricultur	Forest_lan	Grass_land	Settlement	Water_body	Row Total	User accuracy	KC for each Category
	Agricultural_land	82	4	10	1	0	97	84.54%	0.7067
Classified Image	Forest_land	0	22	0	0	0	22	100.00 %	1.00
	Grass_land	0	2	22	0	0	24	91.67%	0.8991
	Settlement	1	0	0	25	0	26	96.15%	0.9552
	Water_body	4	0	0	0	11	15	73.33%	0.7164
	Column Total	87	28	32	26	11	184		
	Producers Accuracy	94.25%	78.57%	68.75%	96.15%	100.00%			

Overall Accuracy = 88.04%
Overall Kappa Coefficient = 0.8255
Confusion matrix of the year 2023

	Class name	Ground truth data							
		Agricultur	Forest_lan	Grass_land	Settlement	Water_body	Row Total	User accuracy	KC for each Category
	Agricultural_land	84	2	10	1	0	97	86.60%	0.7404
Classified Image	Forest_land	0	22	0	0	0	22	100.00 %	1.00
	Grass_land	0	2	22	0	0	24	91.67%	0.8991
	Settlement	1	0	0	25	0	26	96.15%	0.9552
	Water_body	4	0	0	0	11	15	73.33%	0.7164
	Column Total	89	26	32	26	11	184		
	Producers Accuracy	94.38%	84.62%	68.75%	96.15%	100.00%			

Overall Accuracy = 89.13%
Overall Kappa Coefficient = 0.8403

Questionaries' of the research thesis

1. Survey questioners

1. HOUSEHOLD QUESTIONNAIRE 1.Kebele name /Village Name____________________________ 2.Name of the person who filled the questionnaire: ______________________________ 3. Date on which the questionnaire was filled: __________/_________/2024 E.C.

HOUSEHOLD QUESTIONNAIRE FOR LAND USE AND LAND COVER CHANGE STUDY BASIC HOUSEHOLD INFORMATION (Fill appropriate information or tick by putting ("√") 1. Occupation: _________________________ 2. Age: __________ 3. Sex: 1. Male ______ 2. Female_______________ 4. Marital Status: 1. Married_____ 2. Unmarried______ 3. Divorced ______ 5. Windowed ____________ 5. Other (specify) _________________________

Total family size by age group and gender:

Age group	Male	Femal	Total
0-14			
15-30			
31-64			
>65+			

6. Religion: 1. Orthodox Christian______ 2. Indigenous faith ______ 3. Muslim _____ 4. Protestant ______________ 5. Other (Specify) _____________________

7. To what Ethnic group do you belong? 1. Oromo____ 2. Amhara_____ 3. Other (specify) __________________

8. Educational status: (1-8) ____ 4. Secondary (9-12) ____ 5. Tertiary (12+) _______ diploma/Dig;_______

9. Status in the kebele: 1. Migrant__________ 2. Non-Migrant_________

10. If you answered ―Migrant‖ to question No. 9: how long have you been here? _____

11. If you answered ―settlers‖ to question No. 9 where did you live before? __________

Land use/cover change

12. How do you perceive the change in the following land use/cover in the last 40 years or between 1983-2023 and now? (Years in E.C.).

1. Increased 2. Decreased 3. No change 4. Don‘t know

Land use/cover type	2023	2013	2003	1993	1983	Comment, if any
Forest land						
Grass land						
Settlement land						
Cultivated land						
Water body						
Grazing Land						

13. If you perceive an increase in land use/cover change in the last forty years, what factor or factors do you think might have caused it? (You may give multiple answers)

1. Population increase

2. Expansion of agricultural land

3. Introduction of new development projects

4. Deforestation

5. Other, specify ____

14. List the problems you are personally faced with due to increases in land use/cover change. List them in order of importance).
____
____

Land holding and property ownership

15. Total land holding in hectare. 1. Now ____ 2. 10 years ago____ 3. 20 years ago ___ 30 years ago 40 years ago

16. Is it common to have more children in order to obtain more land? 1. Yes 2.No 3. Don't know

17. How do you use your farm land currently? 1. Once in a year 3. Always 2. Twice a year 4. Other, Specify___________________

18. Do you think that land is becoming scarce in your kebele? 1. Yes, it is becoming scarce ____ 2. No, it is abundant _____ 3. No Change____

19. If your answer for question 18 is yes, why is land become scarce (You may give multiple answers)? 1. Because of population increase 2. Because the proportion of fertile land is diminishing 3. Land has fallen in fewer hands 4. Land has been converted to non-agricultural uses 5. Land has been given to developers 6. Other,
Specify____

20. How do you rate your crop production from your plot(s) over the last 40 years? 1. Increasing 2. Decreasing 3. No change

Environmental Issues

21. Say YES (1) or NO (2) if the following are major environmental problems in the area? (Multiple answers are possible) 1. Deforestation_____________ 3. Soil erosion_____________ 2. Deterioration of water points_________ 4. Inadequate rainfall_______ 5. Other, specify_____________

22. If deforestation is one of your answers for No. 21, what might have caused this problem? Be circling it. 1. An increasing demand for firewood_______________ 2. Expansion of agricultural land______________ 3. Cutting of trees for construction_______________ 4. Cutting of trees to generate income________________ 5. Other, specify____

23. Are there forest use and management strategies normally adopted by the local communities yet?

What are the major forest species and their use categories commonly known among the communities?

2. CHECKLIST FOR FOCUS GROUP DISCUSSION AND IN-DEPTH INTERVIEW Elderly

1. How do you see the population and LULCC since the 4 decades?

2. What effect does this result on the ecology, population?

3. What are the major land use and land cover types some 40 years ago and now?

4. Is there land use and land cover change in the kebele?

5. Would you explain the extent of the change?

6. Which resources are more affected due to land use and land cover change?

7. In your opinion what are the factors /reasons for these significant changes?

8. How did you rate population change in the kebele?

9. Why many people are coming to this area to resettlement?

10. From the four regimes, when did population grow fast? Why?

11. What were the most important economic activities in 40 years ago?

12. Explain the current economic activities in the kebele?

13. What effects they bear on you (if any)?

14. What are the vegetation composition, species, and diversity? is it decrease or increase?

15. Is there timber production in your kebele? For what purpose?

Experts

1. How do you rate population dynamics in the PA (for the last 40 years or so)?

2. What effect(s) did population dynamics impose on the PA?

3. How do you rate the extent of land use/cover change in the PA

4. Would you please explain the pattern of change in land use/cover in the PA?

5. Which factors did you expect play a prominent role?

6. How do you explain the livelihood changes occurred in the PA?

7. In which one of the three regimes that land use/cover change was high? Why?

8. Would you list down the major land use land cover in the PA?

9**.** What are the major forest resources (timber and non- timber products) commonly used by the local communities? (Please, list the major forest products in order of importance)

Appendix 4: Woody plant species diversity assessment data collection sheet

Study site: Region: Oromia Zone: Buno Bedele District:Gechi Kebele: ____________________

Name of data Collector: __________________Date (day/month/year) ____/___/2024 Line/Transect: _____ Plot No: ______ GPS reading; Longitude (X): __________ Latitude (Y): ____________________ Altitude/ Elevation:

No	Local name	Scientific name	Family Name	DBH	Height(m)	Growth form

Growth form: T= Trees, S= Shrubs, T/S = Tree/Shrub.