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ANALYSIS OF URBAN EXPANSION THROUGH GIS AND REMOTE SENSING IN GULLELE SUB CITY OF ADDIS ABABA, ETHIOPIA

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Addis Ababa University

JUNE, 2025

ADDIS ABABA, ETHIOPIA

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ANALYSIS OF URBAN EXPANSION THROUGH GIS AND REMOTE SENSING IN GULLELE SUB CITY OF ADDIS ABABA, ETHIOPIA

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A Thesis Submitted to the Department of Geography and Environmental Studies, College of Social Sciences, Arts and Humanities of Addis Ababa University in partial fulfillment of the requirement for the Degree of Master of Arts in *Geographic Information System, Remote Sensing and Digital Cartography.*

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SCHOOL OF GRADUATE STUDIES

This is to certify that the thesis prepared by Zerihun Abebe entitled: “Analysis of Urban Expansion Through GIS and Remote Sensing in Gullele Sub City of Addis Ababa, Ethiopia,” and submitted in the fulfillment of the requirement for the Degree of Master of Arts in Geographic Information System, Remote Sensing and Digital Cartography complies with the regulation of the University and meets the accepted standards with respect to originality and quality.

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Chairman, Examining Committee

DECLARATION

This is a declaration that this research titled "Analysis of Urban Expansion Through GIS and Remote Sensing in Gullele Sub City of Addis Ababa, Ethiopia", is my original work, which was carried out under the guidance of Dr. Teferi Mekonnen. There has not been submitted and presented to any other institutions anywhere for the award of any academic degree, diploma, or certificate. All pertinent sources used in this study have been properly acknowledged.

Zerihun Abebe	**Signature**	**Date**
Name of Candidate	______________________	______________________

As Master research advisor, I hereby certify that I have read and evaluated this MA. Thesis prepared under my guidance.

Dr. Teferi Mekonnen	**Signature**	**Date**
Advisor	______________________	______________________

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LIST OF ABREVATIONS AND ACRONYMS

AABoFED: Addis Ababa Bureau of Finance and Economic Development.

CBD: Central Business District

CRRSA: Civil Registration and Residency Service Agency

CSA: Central Statistical Service

ESS፡ Ethiopian Statistical Service

ETM+: Enhanced Thematic Mapper plus

FAO: Food and Agriculture Organization

GIS: Geographic Information System

IDPR: stands for the Institute of Development and Policy Research

ILO: International Labour Organization

LULC: Land Use Land Cover

LRM: Logistic Regression Model

MOUDC: Ministry of Urban Development and Construction

MOUPHC: Ministry of Urban and Primary Health Care

MUDHCo: Ministry of Urban Development, Housing and Construction

RS: Remote Sensing

SSGI: Space Science and Geospatial Institute

UN: United Nations

UNCHCR: United Nations High Commissioner for Refugees

UNDESA: United Nations Department of Economic and Social Affairs

UNDP: United Nations Development Programme

UNICEF: United Nations International Children's Emergency Fund

USGS: United States Geological Survey

UTM: Universal Transverse Mercator

ABSTRACT

Urban expansion in Ethiopia is a significant phenomenon driven by rapid population growth, rural-urban migration, and socio-economic transformations. This study investigates the spatial and temporal dynamics of urban expansion in Gullele Sub-city, Addis Ababa, using Geographic Information System (GIS) and Remote Sensing technologies from 1993 to 2023. The study utilizes multi-temporal satellite imagery and spatial analysis to map land-use/land-cover changes, identify urban sprawl patterns, and measure the accuracy of classifications over different time periods. Socio-economic data and demographic characteristics are integrated to explore the relationships between urbanization and its impacts on agriculture, natural resources, and infrastructure. The findings highlight significant land conversion from agricultural to urban uses, driven by population pressures and policy inefficiencies. The study showed that the proportion of built-up area increased from 47.32 % in 1993 to 53.37% in 2023 (growing by 6.05%); agricultural land areas experienced a decrease from 4.97% in 1993 to 2.28% (decreased by 2.69%); Forest areas showed increase from 29.59% in 1993 to 31.43% in 2023(expanded by 1.84%) and finally Shrub land shows decrease from 19.12 to 12.92% in 2023 (shrinking by 5.2%). This has led to challenges, including displacement, environmental degradation, and inadequate urban infrastructure. The research concludes the existence of substantial urban expansion that calls for evidence-based urban planning, improved land-use regulations, and the application of geospatial technologies for effective resource management. This work provides critical insights for policymakers, urban planners, and stakeholders in addressing the challenges of urban expansion and promoting sustainable development in rapidly growing urban areas like Gullele Sub-city.

Keywords: *Urban expansion, GIS and Remote Sensing, Land use/Land cover,* Built-up Area. *Addis Ababa*

CHAPTER ONE
1. INTRODUCTION

1.1. Background of the Study

Urbanization is a process of socio-economic changes and a major indicator of regional development (Arfanuzzaman & Dahiya, 2019). The cityscape has rapidly transformed in recent decades in response to fast population growth and transition from rural to urban areas (Traore et al., 2020). Unprecedented growth in the global urban population over the past few decades has been witnessed in the rapidly expanding urban areas, particularly in developing Asian and African nations (Saghir & Santoro, 2018; Zhao et al., 2020). Urban growth has been accelerating because of rapid population growth and high demand of urban land for settlement and different service and industrial expansions (Sumari et al., 2020). Land use land cover change in urban areas has significantly increased in the past decades due to rapid urban growth (Xu et al., 2019). Therefore, different land cover classes such as forests, farms, mountain ranges and water bodies have changed into urban areas and infrastructures (Vafaei et al. 2021)

Urban growth describes the increased population concentration within certain society and economy through spatial demographic process (Bhatta, 2010). Urban growth occurs due to the natural population increase as well as in migration of rural dwellers into urban areas. Natural population increase rates in urban communities are usually lower than rural communities, where also unemployment problems and the lack of facilities in the rural communities are drivers of rural-urban migration and major reasons for urban growth (Cohen, 2006).

Worldwide, the number of people living in urban areas now surpasses those in rural areas. The year 2007 is significant as it marked the first occurrence of the urban population overtaking the rural population on a global scale, a trend that has persisted. In 1800, just 2 percent of the world's population resided in cities and towns, and this figure rose to 15 percent by 1900.

The speed of urbanization saw a significant rise in the 20th century, particularly after 1950, when less than 30 percent of the global population resided in urban environments. Projections indicate that by 2050, almost 70 percent of the world's population will be living in urban settings (Caldwell et al., 2012; Zhang, 2016) (Caldwell et al., 2012) (Sun & Caldwell, 2012; UNDESA, 2014; X. Q. Zhang, 2016). Prior to 1950, most of the urbanization took place in developed nations due to the industrial revolution in Europe and North America.

The degree of urbanization in Africa stands at a low 37.1% in comparison to developed regions such as Europe (72.7%) and North America (79.1%). Nevertheless, urbanization in developing nations, in general, is advancing at a much more rapid pace than in developed countries, potentially reaching annual rates of 3% or even 4% (Miniatlas Du Développement Global, 2004). This swift urbanization in the developing world is largely driven by rural-to-urban migration, economic growth and development, technological advancements, and high population growth rates (Beaudry & Schiffauerova, 2009).

Ethiopia ranks among the countries with the lowest levels of urbanization globally. Currently, just 22.5% of its population resides in urban areas (Ethiopia - Urban Population (% Of Total) - 2025 Data 2026 Forecast 1960-2023 Historical, n.d.).However, given the 2.73% total annual population growth rate, high rate of in-migration to towns, and increase in the number of urban centers, the rate of urbanization is increasing at a rate of 4.7% (*Ethiopia - Urban Population Growth (Annual %) - 2025 Data 2026 Forecast 1960-2023 Historical,* n.d.).Furthermore, the country's urban population is expected to grow on average by 3.98% and by 2050, about 42.1% of the total population is expected to be inhabited in urban centers (UN-HABITAT, 2007). Even though there are more than 900 urban centers in Ethiopia, Addis Ababa, its capital city, consisted of about 23% of the total urban population in the country (Kasa et al., n.d.).

In the past two decades, Addis Ababa City emerged as one of the fastest urbanizing cities in the East African Sub-Saharan region. In the absence of a regular use of geospatial information management systems, limited effort had been made to keep track of changes in the natural environment in the rapidly growing city for policy making in land administration. The ubiquitous energy radiated by the rapid urbanization rate in the area not only created unprecedented consequences by diminishing the quality of the environment and natural resources but it raises serious implications for land management in the city (MoUDHC,2018).

GIS and remote sensing methods are essential for examining urban growth. By utilizing remote sensing information and applying GIS mapping approaches, changes in urban regions can be tracked and recorded over time for particular development initiatives. Satellite Remote Sensing, with its frequent coverage and multi-spectral (MSS) capabilities, serves as an effective instrument to identify and monitor the changes occurring in both the urban center and its surrounding areas. The spatial dynamics of urban expansion in various directions across different time frames can be systematically mapped, tracked, and accurately evaluated using remote sensing data in conjunction with traditional ground information (Lata et-al., 2001).

The factors contributing to the land crisis in the region are clearly linked to social, economic, ecological, and policy-related aspects. Addressing these challenges in a large urban area requires current knowledge to effectively capture and analyze trends in land information. This will facilitate the management of urban growth and infrastructure development through informed planning and spatial designs, utilizing the latest geospatial technology such as Geographic Information Systems (GIS) and remote sensing. This study will explore the spatial effects of the rapid growth of the metropolitan Gullele sub-city by employing GIS and remote sensing techniques. The findings of this research will offer a valuable framework that can assist planners in enhancing land administration, which is critical for the efficient management of natural resources.

1.2. Statement of the Problem

As noted by (/MOFED/, 2018), Ethiopia currently experiences a total annual population growth rate of 2.73%, along with a significant influx of people moving to cities and a rise in the number of urban areas, resulting in an urbanization growth rate of 4.4%. Additionally, it is projected that the nation’s urban population will reach 80 million by 2050, up from the Ethiopia’s population is estimated to be between 132 million and 135 million people; it is anticipated that around 38.51% of the overall population will reside in urban regions (UN-HABITAT, 2018). Nevertheless, if this swift growth of the urban population is not managed effectively, it could lead to urban sprawl and demographic issues, as urban areas may face difficulties in providing employment, infrastructure, services, and housing.

Infrastructure and service delivery in many cities are already being compromised by expanding urban areas and limited municipal budgets, while the formal job market struggles to meet employment demands. Ethiopian cities face the danger of becoming less appealing for both residents and business activities. Furthermore, restrictions on rural-urban migration, such as the loss of land rights for individuals who leave rural regions, diminish the motivation to relocate to cities, which could ultimately hinder agglomeration and lower productivity and economic growth over time (Jones, 2006). Conducting spatiotemporal analysis and monitoring of urban growth dynamics is very important to understand the urbanization process. As noted by Vafaei, (2021 and Li, 2021), understanding the process of urbanization and its influencing factors is vital to grasp its environmental impacts around the world.

Long term and consistent analysis and mapping of urban growth is also crucial to track, project and understand trends of urban growth and address problems affecting sustainable urban development (Chen,2022 and Singh,2022). Human induced land use land cover changes are also another crucial issue to determine and address the challenges of sustainable urban growth (Singh,2022 and Kourtit,2020). So, monitoring and evaluating urban growth and its driving factors is very crucial and area of research for different scholars (Kourtit,2020 and Li,2018 and K D,2021).

Addis Ababa is among the fastest growing cities in Sub-Saharan Africa. Its geographical coordinates are approximately 9°2'N Latitude and 38°45'E Longitude, sitting at an average elevation of 2,400 meters above sea level. The city spans 540 square kilometers and is divided into eleven administrates known as "sub-cities." The seven outer sub-cities (Akaki Kality, Bole, Kolfe-Keranio, Gulele, Nifas-Silk-Lafto, Yeka, and Lemi Kura) make up 92% of the entire area (NT, 2019). These regions are experiencing significant urbanization in the peri-urban zones of the adjacent Sheger City, leading to issues such as the displacement of farmers, environmental degradation, and associated agricultural and infrastructure challenges (Lawayew Nega, 2020). Gullele sub-city has been selected purposively as the focus area for this study because it currently illustrates the impact of rising urbanization on the land tenure system in peri-urban regions of Addis Ababa.

Research shows an increasing need to model and assess the extent and location of urban expansion over time and space. Due to its considerable growth in recent decades, Addis Ababa has been selected as a case study. Moreover, when compared to other major cities and given its economic significance as a regional hub, it can be argued that there have been insufficient studies conducted so far. The city holds a multifunctional role, serving as the political, economic, and social center for UN offices, the African Union headquarters, and the focal point of geopolitics for the East African region. In spite of the Ethiopian government’s urban planning efforts, Addis Ababa has undergone rapid and often chaotic urban development in recent decades. Factors such as corruption, mismanagement, political instability, and economic challenges may affect urban planning, leading to significant and swift urban growth. The fast and uncontrolled expansion of urban areas, along with the rapid transformation of productive agricultural land, forests, and ecologically protected regions, has resulted in socio-economic and environmental challenges for the city of Addis Ababa.

Moreover, earlier research often focused on limited proximity and physical factors like the distance to major roads and slope, whereas this study aims to identify a broader range of physical and proximity factors influencing urban growth in the area under investigation. Additionally, there has been a lack of attention from many researchers in Ethiopia regarding the application of geospatial data and technologies to analyze the driving factors behind urban expansion.

Therefore, this study aims to address the gaps that earlier research has overlooked for various reasons in Addis Ababa and its neighboring towns.

1.3. Objectives of the Study

1.3.1General Objectives

The objective of this study is to detect and analyze the spatiotemporal changes in urban growth in Gullele sub-city of Addis Ababa city from the year of 1993 to 2023

1.3.2. Specific objectives

1. Generate urban growth map of the Gullele sub-city, in Addis Ababa city Administration.
2. Examine the underlying causes that drive rapid urban growth in Gullele sub-city.
3. Explore the implications of urban expansion on the adjacent neighborhoods of agricultural and non- agricultural communities.
4. Predict urban expansion for a sustainable urban growth.

1.4. The Research Questions

1. What does the extent and directionality of urban expansion in the study area?
2. What are the underlying causes that drive rapid urban growth and expansion in the Gullele sub-city?
3. How is urban growth and expansion implicating the land use land cover changes and effective management of natural resources?
4. In what ways are GIS and Remote Sensing technologies used to inform the implications of urban expansion to policy makers and planners?

1.5. Significance of the Study

This research may benefit a range of stakeholders. Primarily, it can assist policymakers, urban and regional planners, and administrators by supplying information that supports their decision-making processes. The research also helps to uncover patterns of urban growth, which is valuable for planning and managing natural resources, as well as for providing infrastructure in the study area. Additionally, the created map of urban growth serves to identify regions where environmental and natural resources are severely at risk, offering guidance on future directions and patterns of urban expansion. Lastly, it can be utilized as a resource for additional studies.

1.6. Scope of the Study

This research examines how effective GIS and Remote Sensing Technology are in assessing urban growth, utilizing GIS and remote sensing instruments based on data collected in the Gullele sub-city of Addis Ababa. The study investigates and assesses automated tools for urban expansion to deliver efficient and sustainable planning services for office users and the broader community.

1.7. Organization of the Thesis

The research is structured into five chapters, outlined in the sequence below. The first chapter provides the rationale for the study, introduces the research topic, defines the objectives of the research, and offers an overview of the thesis organization along with a statement of contribution. Chapter two explores the current state of relevant research domains, examining achievements, recent trends, and the challenges associated with urban expansion. Chapter three details the study areas and the methods and techniques that were utilized and developed. Chapter four showcases both numerical and visual results, followed by an interpretation and discussion of these findings. The final chapter, chapter five, summarizes the findings presented in the thesis and discusses potential directions for future research in this field.

CHAPTER TWO
2. Review of Related Literature

This chapter discusses the fundamental concepts and significance of urban expansion, including urban growth and its drivers, trends associated with urban growth, the impacts of urban expansion, and the theoretical frameworks alongside Remote Sensing (RS) and Geographic Information Systems (GIS). Additionally, it aims to investigate the outcomes of previous relevant studies conducted in various regions.

2.1 Review of Related Concepts

Urban expansion, as discussed in Schmidt & Kedir (2009), refers to the transformation of cities into more urbanized areas along with a shift in patterns. Urbanization is characterized by a growing population residing in urban regions. It can also be understood as an increasing proportion of a nation's population living in urban zones, alongside a decrease in the portion of people living in rural settings. The majority of urban growth is attributed to net migration from rural to urban areas, natural population growth, and the reclassification of rural communities as urban (Dero et al., 2021). Urban expansion is an increase in the number of people living in towns and cities and results in the growth in the size of the urban population and the extent of urban areas. These changes in population leads to other changes in land use, economic activities and culture (Manuh & Yemeru, 2019).

The concept of Urbanization: encompasses a broad and multifaceted definition. It represents a fundamental transformation that low-income rural communities experience as they modernize and integrate with higher-income communities. Urbanization signifies a complex, non-spatial shift in lifestyle; it describes a social process that involves changes in behavior influenced by the effects of urban environments on society. (Yang, 2019) defined urbanization as: Urbanization is more than just growing the population of cities and their geographic territory. More significantly, it involves a total shift from a rural to an urban lifestyle in terms of social security, employment, and industry structure. The term urbanization is now understood in a more comprehensive sense. It refers to the physical expansion of urban communities, characterized by the migration of people from rural regions to cities. Thus, urbanization encompasses more than just the rise in population within urban areas; it also involves changes in the economic, political, and social structures of the community.

The concept of Urban growth: refers to the rising concentration of population in specific societal and economic areas as a result of spatial demographic processes (Bhatta et al., 2010). It takes place because of either a natural increase in population or the movement of people from rural areas to cities. Generally, the rates of natural population growth in urban areas tend to be lower than in rural communities, compounded by issues such as unemployment and inadequate facilities in rural regions; thus, the primary driver of urban growth is the migration from rural to urban locations (Cohen, 2006).

The concept of Urban sprawl: is understood as a form of urbanization that expands physically in a poorly managed manner. It represents an unfavorable development pattern (Adaku, 2014). Both the EEA and Adaku (2014) describe urban sprawl as a model of low-density expansion in urban areas, often taking place on agricultural land. This form of urbanization is characterized by a spread that occurs horizontally and uncontrolled, extending from urban centers into the surrounding rural regions, thereby creating peri-urban spaces. Urban sprawl is found in both high-income and low-income nations, albeit at different rates and in varied forms. Despite the various definitions of urban sprawl, there are two key characteristics shared among them: inefficient land use and low density. Typically, urban sprawl results in the creation of distinct, poorly planned residential zones that are inadequately served and populated in a scattered manner (Pirozzi et al., 2012).

The concept of peri-urban area: represents the urban edge at the outskirts of a city. The phrase "peri-urban area" describes the region characterized by a blend of urban and rural communities that exists in-between (an urbanized rural area). It is viewed as an interaction zone between the boundaries of urban and rural areas. In conclusion, the definition of peri-urban areas extends beyond just a physical location; rather, it illustrates a dynamic transitional process from a rural environment to an urban one. The structure of peri-urban areas is diverse and constitutes less intricate urban spaces, which encompasses both legally established and informally developed settlements (Maryati & Humaira, 2015; McConville & Wittgren, 2014).

The concept of Land cover: refers to the physical and biological characteristics of the land surface, encompassing both natural resources and human-made structures (Sajjad et al., 2012). In contrast, land use pertains to how people utilize land and oversee its resources through various activities; it represents the application of land cover for a range of purposes.

The concept of Land use change: refers to the alteration of land cover that occurs due to conversion and/or modification to meet human requirements. This change can happen either by completely converting the classification of land cover from one type to another or by altering certain characteristics of the land cover without complete conversion (Kumar et al., 2010; Mundhe & Jaybhaye, 2014).

2.1.1. Urban Expansion analysis and Basic Ideas

The phrase "urban expansion" refers to the increase in size of built-up areas in terms of space or physical development. The growth of urban land is a primary measure used to assess the degree of urbanization. Urban expansion is a distinctly observable feature of the process when viewed from a spatial perspective. According to (Bloch et al., 2015), it is characterized as the transformation of land from non-built-up categories to developed built-up land over a period of time. A city can experience urban growth without physically expanding if this increase accommodates within the existing boundaries of settlements. On the other hand, expansion may take place without growth when new developments are introduced to support lower population densities within an established community. According to (Cohen, 2006), there are theories and explanations that can support the current Addis Ababa case which is engulfed by Sheger city but the following possibilities can exit for its expansion:

The possible scenarios for an urban growth without expansion:

Absorption of Growth Within Existing: Boundaries Urban growth can occur without expansion if the increased population is absorbed within the existing settlement boundaries. This can happen through densification, where existing areas are redeveloped to accommodate more people without increasing the overall area of the city. For example, a city might focus on vertical development, building taller structures to increase housing capacity while keeping the overall footprint of the city the same. Another way urban growth can occur without expansion is through infill development. This involves filling in vacant or underutilized spaces within the existing urban area, such as abandoned lots or underdeveloped areas, to increase housing and commercial capacity without expanding the city's boundaries.

Lower Population Densities, Thes Expansion can happen without an increase in population if new projects are established to promote lower population densities within a community. For example, a city might extend its borders to introduce green spaces, parks, or recreational facilities, which would decrease the population density in the current urban area while enlarging the city's overall size. The other scenarios for an urban growth without expansion is Urban sprawl, where development spreads out over a larger area without significant population growth, is another example of expansion without growth. This can occur when cities expand their boundaries to accommodate low-density residential and commercial developments, leading to a larger urban area without a corresponding increase in population. These scenarios highlight the complexities of urban growth and expansion, demonstrating that both can occur independently of each other. (Angel et al., 2022).

Cities can use several strategies to manage urban growth within existing boundaries. The following strategies include some of them:

1. Densification: Redeveloping existing areas to accommodate more people without increasing the overall area of the city, often through vertical development.
2. Infill Development: Filling in vacant or underutilized spaces within the existing urban area to increase housing and commercial capacity without expanding the city's boundaries.
3. Participatory Urban Decision-Making: Involving stakeholders in the decision-making process to guarantee that urban development plans are responsive to local needs and circumstances, promoting a bottom-up approach.
4. Smart Growth Strategies: Implementing policies that prioritize sustainable urban development, such as mixed-use development, public transportation, and green spaces, to manage growth within existing boundaries.
5. Land Use Control Strategies: Implementing policies to manage land use around urban growth boundaries, such as controlling random expansion through Urban Growth Boundaries (UGBs), to ensure that urban development is organized and sustainable.
6. Phased Development Programs: Managing land through phased development programs to ensure that public facilities and services are available to support the growing population.
7. Developer Contributions: Requiring developers to cover either a portion or the entirety of the expenses associated with fulfilling the increased demand for public facilities and

services to guarantee that the expanding population receives adequate support. These strategies can help cities manage urban growth within existing boundaries, ensuring that the increased population is accommodated without expanding the city's overall (Hwang & Byun, 2003).

2.1.2 The Status of Urban Expansion

2.1.2.1 Urban Expansion in Developing Countries

The global population is becoming increasingly urbanized, with Africa and certain areas of Asia emerging as focal points for urban growth. Since the 1950s, Africa's urban population has been on the rise, reaching 40 percent of the continent's total by 2014 and expected to rise to 56 percent by 2050. Following a period of rapid urbanization after gaining independence, growth slowed during the 1990s but accelerated again in the 2000s. It is projected that Africa's urban population will likely be three times larger by 2050, with Africa and Asia together contributing to nearly 90 percent of the global increase in urban populations (UNDESA, 2014).

According to UNDESA (2018), future growth in the global urban population is anticipated to be highly concentrated in a limited number of countries. Combined, India, China, and Nigeria are projected to contribute to 35% of the world's population increase from 2019 to 2050. Currently, the regions with the highest urbanization rates include Northern America (82%), Latin America and the Caribbean (81%), Europe (74%), and Oceania (68%). Conversely, Africa remains predominantly rural, with only 43% of its population residing in urban areas.

By the year 2050, the continent's total population is expected to approach nearly 2.5 billion individuals, with approximately 55% residing in urban areas. This represents a notable rise, considering that less than 10% of Africa's population lived in urban regions back in 1950. The majority of the growth in urban populations is occurring within small- and medium-sized cities located in mid-latitudinal Africa. While Africa's rapid rates of urban growth make it comparable to other swiftly urbanizing regions, it is crucial to highlight that the fundamental factors driving urban expansion in Africa differ significantly from those seen in other parts of the world (Parnell & Pieterse, 2014).

The growth of urban populations in Africa will lead to an increase in urban land area. Urban land across the continent is projected to rise by almost 600% between 2000 and 2030 (Seto et al., 2012). This anticipated urban growth is concentrated in five specific areas: the Nile River in Egypt, the coastal region of West Africa along the Gulf of Guinea, the northern banks of Lake Victoria spanning Kenya, Uganda, as well as extending into Rwanda and Burundi, the Kano area in northern Nigeria, and the greater Addis Ababa region in Ethiopia. Aside from the Nile River, all four of these areas are situated in nations that the UN classifies as having high fertility rates (UN, 2011).

2.1.2.2 Urban Expansion in Ethiopia

Ethiopia's urban population is experiencing rapid growth. In 2012, it was estimated that only 17.3 percent of the population lived in urban areas, making Ethiopia's share one of the lowest globally, significantly lower than the Sub-Saharan Africa average of 37 percent. However, this situation is expected to change significantly. Based on data from the Ethiopian Central Statistics Agency, the urban population is anticipated to increase nearly threefold from 15.2 million in 2012 to 42.3 million by 2037, growing at an annual rate of 4.8 percent. Analysis for this report suggests that urban expansion will occur even more quickly, at approximately 5.4 percent per year. This would result in the urban population tripling even sooner, by 2034, with 30 percent of the nation's population living in urban areas by 2028.nin

Approximately 20 percent of Ethiopia's population resides in urban areas, making it one of the least urbanized nations in sub-Saharan Africa. Nevertheless, the country experiences one of the highest rates of urban growth, estimated at 4.1 percent, even by developing country standards. This rate significantly surpasses the national population's average growth rate, which is around 3 percent annually. The urban expansion rate was only 6 percent in 1960, increasing to 11 percent in 1984 and 14 percent in 1994, reaching about 17.2 percent by 2013, with projections suggesting it will reach 30 percent of the population by 2025 (MUDHCo, 2014).

Ethiopia is the second most populous nation in Africa and is among the least urbanized countries, with only 21% of its population living in urban areas, similar to many other developing nations. The urban population is primarily located in Addis Ababa, which serves as the primate city and accounts for 28.43% of the entire urban population (Fekadu, 2014). The national level data reveals notable regional differences in urban population distribution and trends. For instance, Addis Ababa stands at 28.4%, while Tigray has 15.2% and Gambela only 9.62%. Addis Ababa has achieved complete urbanization, whereas Gambela features the lowest urban population at an average of 9.62% (Tsegaye, 2010). The regional distribution of urban residents and the patterns of urban growth display a range from nearly 100% in Addis Ababa to just 8.7% in SNNPR. Every region, without exception, has shown significant growth since the 2017 survey conducted by the Central Statistical Agency (CSA) (Terfa et al., 2019).

2.1.2.3 Urbanization in Addis Ababa Gulele Sub-City

As reported by CSA (2015), 24% of Addis Ababa's population lives below the poverty line. Meanwhile, data from AABoFED (2015) shows that 26.1% of residents experience food poverty. In this situation, women are more impacted by poverty compared to men. When considering a broader definition of poverty, the overall poverty rate in the city is considerably higher. According to the Multidimensional Poverty Index (MPI) from the Oxford Poverty and Human Development Initiative, 48.7% of Addis Ababa's residents are either poor or at risk of poverty (OPHI, 2015). Additionally, the trend indicates a steady decline from earlier years.

Another aspect of the city's social situation is inequality. The IDPR (2015) estimates that the 2015 Gini coefficient of real consumption per capita, which measures income inequality, was 0.32. When compared to many other cities throughout the world, this is a relatively low number. It is also important to note that throughout the previous ten years, the trend in the Gini coefficient showed a steady decline.

Ethiopia's capital, Addis Ababa, is located in the central Ethiopian plateau, which is surrounded by the Great Rift Valley and has mountain systems aligned north-south (Nath et al., n.d.). The highest capital in Africa and the third highest in the world, it is situated between latitudes 09°02'N and longitudes 38°44'E. Its elevation ranges from 2000 to 2800 meters above sea level. Its hills, rivers, and streams make up its geography. Mount Wochecha to the west and Mount Entoto to the east are roughly the same height as Mount Yarer to the east, which encircles the city (Tamiru et al., 2008).

The entire metropolis is thought to be 54000 hectares in size, with roughly 22,000 hectares set aside for green space. Only roughly 7900 hectares of the 22000 hectares of land set aside for green framing are thought to have been covered with trees. The updated Addis Ababa master plan calls for the forestation of 12,500 hectares (AACG, 2010; CSA, 2010).

The country's low level of development and the fact that a sizable portion of the urban population lives below the poverty line are the primary causes of socioeconomic problems. People are unable to build residential homes because of the high cost of building and the low income of the bulk of the population. However, the ongoing migration of people into cities and towns is making the issue worse and worse (Melese et al., 2021).

It is nearly hard to meet the housing needs of the growing urban population due to the dire economic situation. Because of this, a vast majority of people are now compelled to live in overcrowded, unsanitary, informal slums and squatter communities that lack basic utilities and infrastructure. Due to globalization, the cost of living in cities has risen more than it has in the past. Most people are incapable of saving any kind of money. Food, clothing, and other household expenses account for the majority of the relatively little money spent. Thus, there is nothing left to build a hose. The majority of households, including those in kebele rental housing units, are currently dealing with this serious issue in the majority of Ethiopia's urban districts (Taye, 2013).

With a population of 428,986, Gulele is an expanding sub-city located in the city's northern section. Gulele sub city occupies 3119.1 hectares of land, with an average population density of 38.36 persons per hectare. The sub city is currently separated into 546 blocks, 200 Sefeers,73 sub woredas, and 10 woredas. Two woredas and four sub woredas are where one of the five chosen road routes crosses the sub city.

2.2. Causes and Driving forces of Urban Expansion

The fast-growing urban population is the main factor driving urban expansion. Both migration to urban areas and natural population expansion have contributed to this. When births exceed deaths, the population naturally grows. An individual, household, or group moving permanently to a new location outside of their community of origin is referred to as migration. Even though it is negligible when compared to domestic migration, foreign migration is also rising. Undocumented migrants, labor migrants, and refugees are all considered forms of international migration. One aspect contributing to urban growth is migration, both domestic and foreign (Bhatta, 2010).

Internal migration the movement of individuals from rural to urban areas within the nation—has become increasingly important in recent years. Because urban regions offer superior basic services as well as additional specialized services that are not available in rural locations. There is a greater variety and number of jobs available in urban areas. Health is another crucial factor. To take care of their medical needs, people especially the elderly are often forced to move to cities with access to doctors and hospitals. Natural population growth contributes significantly to urban growth in all countries, but migration from rural to urban areas is much more important in many developing countries. Other factors include a greater variety of entertainment alternatives (theaters, movie theaters, restaurants, etc.) and a better level of education. Social communities in densely populated urban areas may also be significantly more diversified, which facilitates the meeting of people who are similar to oneself (Bhatta, 2010). Sprawl could result from unregulated urban growth brought on by this fast urban population expansion.

Because of their rapid growth, urban communities are increasingly unable to provide essential services including energy, transportation, healthcare, education, sanitation, and physical security. Because governments cannot pay to maintain metropolitan regions and provide basic services, there are major environmental concerns and massive sprawl in these places.

2.3. Effect of Urban Expansion

2.3.1. Socio-Economic Effects

The country's low level of development and the fact that a sizable portion of the urban population lives below the poverty line are the primary causes of socioeconomic problems. People are unable to build residential homes because of the high cost of building and the low income of the bulk of the population. However, the ongoing migration of people into cities and towns is making the issue worse and worse (Melese et al., 2021).

The current state of the economy has made it nearly impossible to meet the growing urban population's housing needs. As a result, the vast majority of people are now compelled to live in overcrowded, inadequate, unofficial slums and squatter communities that lack basic utilities and infrastructure. Globalization has caused the cost of living in cities to rise higher than it has in the past. Most individuals are unable to save a certain amount of money. Food, clothing, and other household necessities are the main uses of a relatively small sum of money. As a result, nothing is left for building the hose. This is the main issue that the majority of households, including those in kebele rental housing units, are currently facing in the majority of Ethiopian cities (Taye, 2013).

CSA (2015) reports that 24% of Addis Ababa's population lives below the poverty level. However, 26.1% of the population lived in food poverty (AABoFED, 2015). In this instance as well, poverty disproportionately affected women. However, the degree of poverty in the city is far higher when a more comprehensive definition of poverty is used. The Multidimensional Poverty Index (MPI) of the Oxford Poverty and Human Development Initiative indicates that 48.7% of Addis Ababa's population is either poor or at risk of becoming so (Alkire et al., 2015). A steady decline from prior years is also evident in this trend.

Another aspect of the socioeconomic situation in the city is inequality. The Gini coefficient of actual consumption per capita for 2015 is predicted to be 0.32, indicating income inequality (Hammett & Gough, 2016). Comparing this number to many other cities throughout the world, it is relatively low. Notably, the Gini coefficient trend has been steadily declining over the last ten years.

2.3.2. Environmental Effects

Aside from providing clean air, water, soil, and food to metropolitan areas, agricultural lands on the outskirts of urban populations are also crucial because they operate as buffer zones to reduce the adverse environmental effects of urban systems. These locations are regarded as a transition between rural areas' natural ecosystems and urban landscapes (Doygun, 2009).

The majority of earlier research shows a wide range of adverse effects on the human-environment relationship in metropolitan areas that are spread out (Du et al., 2013). Urban sprawl is associated with the loss of nearby agricultural land. According to (Du et al., 2013), encroachment onto agricultural areas is a profit-driven process that also results in inefficient land usage. Agricultural fields are therefore seriously threatened by urbanization. Problems with food security result from this as well since it impacts agricultural products, the market, and the long-term capacity to produce food and fiber. According to (Heimlich and Anderson., 2001), as the population grows, more agricultural land is being turned into urban areas, resulting in the loss of agricultural land and modifications to the agricultural practices of the remaining lands. The primary causes of urban expansion over agricultural lands are rising population density and the poor incomes from farming in comparison to the large profits from construction.

Environmental impacts include:

- Soil erosion is more common, land becomes less fertile, and production declines as a result of changes in the physical, chemical, and biological properties of the soil. This makes desertification more likely.
- Increased heat island effect: Compared to cities with green cover, those with high levels of informal urbanization are twice as likely to experience excessive heat days and high temperatures.
- As fossil fuels are consumed more frequently and the natural carbon sink (trees and flora) is lost, the air quality changes and greenhouse gas concentrations rise.
- Realization of urban areas due to migration of farmers and villagers to the city

2.4. Policy Implication

2.4.1. The Urban Development Policy

The Urban Development Policy, which guides the focus of the package on urban development and good governance, was approved by Ethiopia's council of ministers in 2005 (Washington & Carbonell, n.d.). The package of Ethiopia's urban development plans and programs is summed up in the Urban Development Policy. Agriculture Development Led Industrialization, Industrial Development Strategy, federalism, democratization, and public service reform form the foundation of the National Urban Development strategy document's central topic. The policy's overarching goal is to make sure that plans drive the expansion and development of Ethiopian cities and towns and to establish competitive, integrated, sustainable development hubs that are adequately receptive to the requirements of their residents. According to the policy, cities and towns should be able to generate prosperity for their residents as well as for the rural communities in their immediate hinterlands and beyond. In order for cities and towns across the country to do this, they must function as hubs for business, industry, and the services necessary to promote comprehensive and sustainable economic growth. The suggested policy directions are meant to facilitate cities' ability to fulfill these functions and promote rapid and just growth in general. The policy document outlines detailed policy proposals for housing development, public services, urban grading, planning and environmental protection, democracy, good governance, capacity building, Micro and Small-Scale Enterprises (MSE), and facilitating the supply of land and infrastructure. Ethiopia's urban development strategy employs an integrated approach that includes objectives including infrastructure development, employment creation, property ownership promotion, and urban environment enhancement (Asfaw et al., 2011). It is stressed that environmental protection should receive adequate attention from the government, urban administration, and citizens in order to prevent traffic and pollution, which may worsen as cities grow and develop (Ministry of Urban Development and Construction, (MOUDC) 2012). Large infrastructure investments, particularly in Addis Ababa, have been made as part of the program's statewide implementation.

2.4.2. Implementing bodies and Land Use Regulation

The master planning approach was used for the majority of local plans throughout Ethiopia's brief urban planning experience over the past few decades. More than 120 urban districts have had master and development plans with 20- and 10-year planning periods created by the National Urban Planning Institute (NUPI), which was later renamed the Federal Urban Planning Institute (FUPI).These plans were important tools for urban development and helped to manage and regulate development activities, but they are criticized for being inflexible and concentrating primarily on physical aspects while trying to fill gaps and meet future demands. Participatory planning was viewed in these plans as merely introducing stakeholders to the already-finalized urban plans. Recent planning initiatives, such as the Addis Ababa plan, have demonstrated a move away from master planning's completely unprioritized land use strategy and toward a strategic, prioritized, flexible, issue-based, and participatory planning approach. Development issues, including social and economic ones, were prioritized. Despite differences in nomenclature and planning methodologies, regional governments created planning organizations and cities and private consultants played a larger role in creating urban plans. Support and regulatory tasks became the focus of the Urban Planning, Sanitation, and Beautification Bureau, which was formerly the FUPI.

There have been several master plans since Addis Ababa's founding, but very few have been carried out. For 20 years (1986–2006), a master plan of Addis Ababa was created to guide and regulate the city's growth (ORAAMP, 1999). Plots could only be used for the purposes specified under the master plan's strict land use zoning. In order to uphold the law, developed sites are left undeveloped, which has an impact on the city's land supply system. This problem was made worse by the city administration's failure to adequately manage and regulate these undeveloped plots, making them susceptible to unlawful subdividing. The structure and master plan utilized in the city for ten years, until 2012, were created by the Office for the Revision of Addis Ababa Master Plan Project (ORAAMP) between 1999 and 2002. The purpose of ORAAMP's updated master plan was to provide for flexibility in the land use zoning. Mixed-use zoning has been widely implemented to enable a comprehensive and adaptable strategy. However, due to the limited capacity and the long-standing zoning custom that still applies to the technicians, its execution appears to be ineffectual. When attempting to interpret the land use restrictions, this has consequently affected the land provision process. The urban poor cannot afford this rule. The Addis Ababa City Planning Project Office has been revising the master plan since 2012. The agency is housed within the Addis Ababa city government's land development and management bureau. The creation of a polycentric city focused on mass transit is one of the main tenets of the current integrated structural design. Eighteen them center organization, road and transportation, industry, tourist and history, green, and social services are covered in the comparatively participatory planning process.

2.5 Theories of Urbanization

The population transition from rural to urban areas, the steady rise in the percentage of people residing in urban areas, and the ways in which each culture adjusts to this change are all referred to as urbanization. The progress of urbanization cannot be reversed. The first recorded urban area or city was in India about the middle of the third millennium BC 116 in the Indus Valley Civilization. As a result, there are a number of urban theories, some of which date back to the early stages of civilization. The majority of urban theories are developed from some of the following:

1. Suburbanization

Suburbanization is defined as "beyond the city" and describes the outskirts of major cities worldwide. Cities spread outward as they grow, leading to the development and growth of suburban or peripheral areas. High density, rising urban land prices, pollution, and advanced transportation and communication infrastructure all contribute to cities' expansion onto the periphery. Since these suburban areas might not have their own political unit, it is the duty of the municipal government to provide basic facilities in these areas. (Ernest Burgess, 1925).

2. Dependency Theory

According to the dependency theory, only when agriculture is advanced can urban areas grow and flourish. Developing nations provide developed nations with inputs. Because of this, developing nations attract more foreign investment in both the agricultural and non-agricultural sectors. Developed agriculture pushed out farmers and workers in rural areas, while emerging industries draw workers because of the wide range of jobs available in cities. (Gunder Frank, 1966).

3. Theory of Spatial Disparities

According to the notion of spatial disparities, differences in geographically privileged and disadvantaged areas, a city's political significance, economically advantageous policies, etc., all contribute to the creation of disparities. The society was split by spatial formations. In addition to causing migration, the issue of spatial inequities puts strain on urban facilities. (Kim, Sukkoo, and Robert Margo. 2004).

4. Migration Theories

For different urban areas, migration can be both a problem and a solution. A few of the many ideas of migration are covered below.

a) Buffer Theory of Migration

According to the buffer theory of migration, "the workers who are imported on a temporary basis due to creation of shortfall of laborer will return." However, assuming that workers will return is inappropriate. Migration isn't always a good strategy to adjust. Therefore, the Buffer's migration law is impractical. (De Haas H., 2005).

b) Stouffer's Law of Intervening Opportunities

It says that "The number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities". According to Stouffer, if there are favorable prospects between the departure location and the final destination, the migrant will choose to live there rather than at their intended final destination. According to Stouffer, the number of migrants was more influenced by the opportunities available in each place than by factors like population and distance. (Samuel A. Stouffer, 1940).

c) Migration Theory of Neo-Classical Economists

According to neo-classical economists, the primary driver of labor movement is the disparity in wages between two regions. These disparities in pay are typically caused by labor supply and demand in a given area. (Massey et al., 1993).

d) Push and Pull Factors Theory

Numerous push and pull components form the foundation of the push and pull theory. Push factors are those aspects or elements that make a person want to leave the location they now reside in because they are negative. Pull factors are things that draw people to a place for a variety of reasons. Pull forces include things like better job possibilities, better living conditions, a healthy environment, etc., while push factors include things like less job prospects, natural disasters, war, pollution, poverty, and housing. (Everett S.Lee., 1966).

e) Urban Bias Theory

It focuses on urban areas' political perspectives. According to this view, government policies favor urban areas. Rural areas of a country have a bigger population than metropolitan ones, despite the fact that urban areas offer more services. Migration from rural to urban regions is a result of this. (Michael Lipton, 1960s & 1970s).

5. Lewis Two Sector Model

Urbanization is aided by industrialization and specialization. Lewis provides a two-sector model of modern urban industrial growth that is highly productive. Lewis makes the assumption that labor-intensive industrial units can absorb labor-rich agricultural units. However, agricultural migrants are not always able to assist and support the expansion of these enterprises. Therefore, the Lewis model's primary drawback is its presumption that workers in rural and agricultural areas possess the skills and capacity to find work in urban businesses. (Sir W. Arthur Lewis, 1954).

6. Concentric Zone Theory

According to Ernest Burgess' Concentric Zone model, metropolitan regions are separated into zones that radiate out from the central business district. It suggests allocating specific land uses and resident groups to specific zones according to socioeconomic status and ease of access to the city center. Cities are seen by the model as ecosystems that compete for land close to the urban core. (Ernest W. Burgess, 1925).

7. The Bid Rent Theory

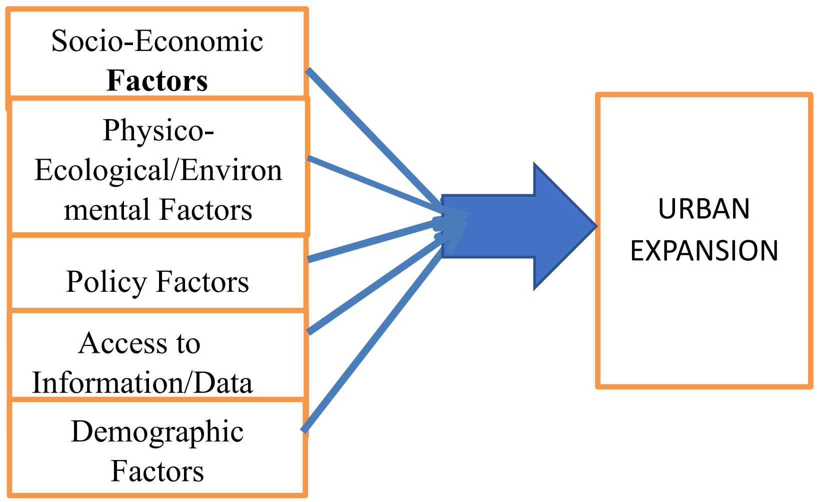
A geography economy theory is the Bid Rent Theory (BRT). Instead of land production, it is based on geographic location. It speaks to the demand and cost of real estate. Different land users would compete with each other for land near the city center, according to the BRT. The underlying premise of this notion is that the more accessible a place is, the higher the consumer concentration. There is a greater likelihood of making more money. As a result, people are willing to pay a premium to own land in the central business area or inner city. The term "bid rent" refers to the amount that different users pay for the land. (Johann, H., v. T. (1826). & William A., (1964).

8. Modern Theory of Urbanization

In the middle of the 20th century, modern theory was formed. It put out the notion that industries can only grow and develop through the introduction and application of sophisticated production techniques and contemporary technology, which make economic progress feasible. Modern economists, like classical economists, believe that urbanization cannot occur without industrialization. (Sociology Institute, Urbanization Theories: From Classical to Contemporary Perspectives,. 2023).

2.6 Conceptual Framework

Figure 1: Conceptual framework for urban expansion analysis



Source: Mundhe, N. N., & Jaybhaye, R. G. (2014). *Impact of urbanization on land use/land covers change using Geo-spatial techniques. /adapted/*

The conceptual framework illustrates how various factors influence urban expansion through the application of specific measuring tools. Socio-economic factors, physiological/environmental factors, policy factors, access to information/data, and demographic factors serve as the primary variables driving urban expansion. These factors provide critical data and insights that are analyzed using tools such as Geographic Information Systems (GIS), remote sensing, maps, graphs, and charts. The measuring tools act as intermediaries, enabling the quantification, visualization, and understanding of how each factor contributes to urban growth. This framework highlights the interdependence between these variables and the role of technology in facilitating evidence-based urban planning and decision-making processes to manage expansion effectively.

CHAPTER THREE
3. METHODOLOGY OF THE STUDY

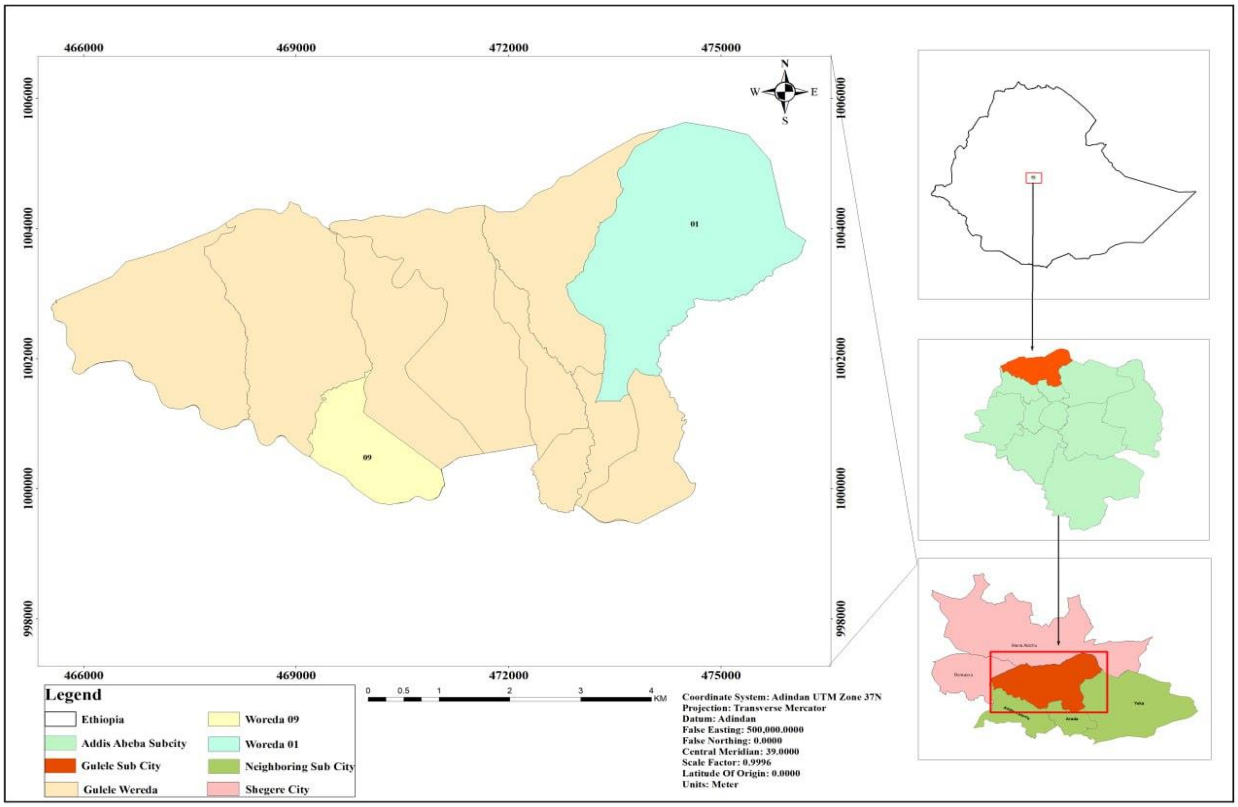
3.1. Description of the Area

3.1.1. Location

Located almost around the geographical center of Ethiopia, Addis Ababa serves as both the country's capital and the diplomatic hub for Africa. It is also home to regional headquarters for organizations such as the ILO, UNDP, UNCEF, FAO, UNHCR, and others. AACAIB (2004) states that it is located between latitudes 08°55' and 09°05' North and longitudes 38°05' East.

Gullele Sub-City is part of the Addis Ababa City office administration and is situated inside the Addis Ababa City Government. At the highest point of the Entoto Hill, which we now refer to as Entoto Park, and in some areas of Chaka Park in the north, Gullele is one of the eleven sub cities in Addis Ababa's northern region. It is ringed by hills and traversed by numerous streams. It is located in the northern region of Addis Ababa and is bounded to the north by Sheger City and Sululta Town in the Oromia Region, to the south by Arada Sub City, to the east by Yeka Sub City, and to the west by Kolfe-Keraniyo Sub-City. With 10 woredas, the sub-city occupies an approximate total area of 3633.901 hectares (Socio-economic profile of Addis Ababa 2015). Its astronomical ranges are 9° 00' 00" to 9° 7' 30" N and 38° 40' 00" to 38° 48' 30" E. The following map shows where it is.

Figure 2 : Location map of the study area



Source: Shape file SSGI/2006/

3.1.2. Physical characteristics of the Study Area

Addis Ababa city, capital of Ethiopia, is situated in the plateau of central Ethiopia in the North-South oriented mountain systems neighboring the Great Rift-Valley (CRRS, 2023). It is located between the geographical coordinates of 09°02'N latitude and 38°44'E longitude, with an elevation ranging from 2000-2800msl.The topography is constituted by hills, streams, and rivers. To the east of the city, Mount Yarer is roughly the same height as Mount Entoto, and to the west, Mount Wochecha (Beyene, 1999; Tamiru et al, 2005; Kebede & Tadesse, 1990). It is believed that the metropolis is 54000 hectares in total, with 22,000 hectares of that area set aside for green space. It is estimated that trees have covered only roughly 7,900 hectares of the 22,000 hectares of area set aside for green frames. The Addis Ababa master plan has been updated to include 12,500 hectares of forest cover (AACG, 2010; CSA, 2010).

Due to its high altitude, the study region enjoys a favorable climate with ideal rainfall and temperatures. The average annual rainfall in Addis Ababa is approximately 1127 mm, according to meteorological statistics, with the majority of this rainfall falling between July and September.

The region's typical monthly temperature fluctuates throughout the year from 8 and 12 degrees Celsius at the lowest and 20 to 25 degrees Celsius at the highest (AACG, 2010; CSA, 2010).

The sub-city of Gulele which is the focus of this study area, is situated near Addis Ababa's northern boundary, which is surrounded by mountains. Forests, primarily of eucalyptus trees, cover the majority of these mountains. These forests, which are included in the city's green spaces, are beneficial to the ecology and the economy.

3.1.3. Demographic characteristics of the Study Area

The sub-city has a total population of 428,986 with around 49% male and 51% female. Males make up the majority of the sub city's recent in-migrant population. The registered number of family heads is 74,036. Fertility, mortality, and migration are the three most important demographic variables influencing population size, growth, structure, and distribution (CRRSA - Civil Registration and Residency Service Agency, 2023).

According to ESS the total population of Ethiopia estimate had reached 109.4 million by July 2024, Addis Abeba has a total population of 3.6 million. The city is entirely urban, with no rural residents within its administrative bounds. Addis Abeba, with an estimated size of 530.14 square kilometers (204.69 square kilometers), is home to 22.9% of Ethiopia's urban people. Its population density is 5,165.1 inhabitants per square kilometer (13,378/sq km).The city is currently divided into 11 sub-cities for administrative purposes. There are 99 kebeles in those eleven sub-cities right now. Akaki Kaliti (181292), Nefas Silik Lafto (316108), Kolfe Keraniyo (604,226), Gullele (428,986), Lideta (201613), Kirkos (667381), Arada (212009), Addis Ketma (359,735), Yeka (488,537), Bole (308714), and Lemi Kura are the 11 sub-cities of the city. Gullele is Addis Abeba's third-most populous sub-city. For administrative purposes, the sub-city is currently divided into ten Woredas, which provide basic public services at the local level.

Table 1 : Population of Gullele sub city by Woreda (2023)

Woreda	**Number of house holds**	**Number of private homes**	**Registered Number of residents**	**Number of people who leave at camps**	**Number of un documented residents**	**Total number of residents**
1	3880	2416	1464	1	562	**36109**
2	3390	978	1485	240	481	38041
3	6532	1956	3012	248	-	44286
4	6340	4927	2887	3	88	65518
5	31332	3853	639	492	14	36330
6	1989	1176	971	0	262	34315
7	5090	3481	1609	1	1	50377
8	3706	2471	1343	86	74	42763
9	8342	4005	3955	2200	33	**47100**
10	3430	3174	256	1	-	34147
Total	74,031					**428,986**

Source: CRRSA **(2023)**

3.1.4. Socioeconomic Characteristics of the Study Area

Currently, the most common difficulties encountered in the sub-city are unemployment, housing, poor educational quality, and health concerns, as well as inadequate market infrastructure, trash disposal issues, and a lack of recreational facilities for youngsters. (Gullele Sub-city Strategic Plan, 2008). Other issues in the sub-city include migration. According to data from the sub city commerce and industry bureau, the Kebele textile and garment sub sector, particularly weaving, is significantly concentrated in the sub city. Shiromeda, Kechene, and Addisu Gebiya weavers are common in the sub-city. The majority of the sub-city's population has medium or lower living standards, which are primarily characterized by low-standard informal activities (Gullele sub city strategic plan, 2008).

3.2. Research Approach and Design

3.2.1. Research Approach

This thesis research used a mixed type, specifically embedded design, qualitative and quantitative research approach to meet its goals. Qualitative research is characterized by its suitability for small sample sizes and the wide applicability of semi-structured and open-ended questionnaires. In contrast, quantitative surveys with closed-ended questions will be conducted in certain areas or for certain types of objectives where a greater number of samples are needed. Al thorough initial survey was carried out to determine the study's goal, utilizing both qualitative and quantitative research techniques as necessary.

3.2.2. Research Design

The study's research design combines a cross-sectional, descriptive, and explanatory research approach. Descriptive research seeks to determine the nature of a situation as it exists at the time of investigation (Ary et al., 1990). After consulting with the Woreda/district officials, a group of locals was chosen to gather information on their current living conditions in their previous locations or adjacent village. As a result, in the districts chosen, the proposed population was surveyed using questionnaires. Furthermore, this method has been used to analyze the urban growth status and factors influencing the urbanization rate of the selected locations, as well as to validate the study model.

According to Ary et al. (1990), descriptive research aims to ascertain the nature of a situation as it is at the time of the investigation. Following a conversation with the Woreda/district officials and surrounding villages. In the chosen districts, the proposed population has thus been surveyed using a questionnaire style. Additionally, this approach has been used to validate the study model and evaluate the urban growth status and factors influencing the rate of urbanization in the chosen areas. Next, the use of an empirical research approach is considered. Qualitative, quantitative, or combined methods are typically used in empirical research (Johnson & Onwuegbuzie, 2004). The research purpose focuses on assessing urban growth and expansion utilizing GIS and remote sensing techniques. Accordingly, the need to address or relevant data on the spot through observation and open discussions is a land, while also covering a large number of respondents in distant and nearby areas through closed-ended questionnaires, both quantitative and qualitative methods have been used and employed in data collection. Face-to-face interviews, focus group discussions, structured and semi-structured, open and closed ended questionnaires were used in this research thesis to meet the study objectives and hypotheses in the research model.

3.3. Target Population

The target population involves the expansion affected communities in Gullele sub-city with a total of 83,209 people (CRRSA, 2023) in the Gullele sub-city of Addis Ababa city administration and adjoining rural areas, from sub-city **27,459** total of targeted population have been selected.

3.3.1. Sampling Design

Random sampling methods and non-probability purposive sampling will be used at various stages of the sampling design to get representative data, as samples will be chosen from the population groupings. To make the conclusions indicative of the actual scenario, which is the entire Gullele Sub-city, a probability stratification method will be used to address all strata stakeholders.

3.3.2. Sample Size Determination

It is recommended that researchers use the largest sample feasible, despite the fact that there is no easy formula that can tell us how big a sample is required. We are aware that a bigger sample size is likely to be more representative of the population. Conversely, estimates from smaller samples are typically less accurate than those from larger ones; in other words, the sampling error decreases with increasing sample size. Generally speaking, the required sample size, n, is equivalent to the following if we wish to estimate N in a population with an error no larger than "e" by computing a confidence interval:

Where, the total population of Gullele =428,986 (CRRSA, 2023)

According to the discussion with the residents who live more than 30 years in the study area and the district staffs, almost one third of the residents are directly or indirectly affected by the expansion scenario. Hence the researcher took 33 percent of the available residents in the area. The selected populations are from two woredas of the study area because of majority of the residents who lives in these woredas are peoples who live many years in the study area.

Total population of target population=N=27,459 (Sum of the selected two woreda's)

36,109 =Woreda 1 36,109 x0.33= 11,916 residents
47,100 =Woreda 9 =15,543 residents
=**27,459** are total of targeted population

$n = N/(1 + Ne2)$

Where, n = Sample size, N = Total number of households in the study area, e = Precision level which is set at 5 or 10% in different social studies but here sample size was calculated using 5% to get more accuracy.

n=27,459(1+27,459) (0.05)2=**394**

Since each Woreda has a different population, the sample size chosen was proportional to the size of each woreda's population. The proportionate distribution of sampled data among distinct strata is feasible with the proportional allocation (Rajpar and Barrett, 2019).

Using the following formula, the sample size at the Woreda level was calculated:

$ni = n.Ni/N$ for i=1, 2

Where; n1 =sample size at Woreda 1=out of target population (11,916)

n2=sample size at Woreda 9 =out of target population (15,543)

$n1$ = 394.11,916/27,459 = 170(43%)

$n2$ = 394.15,543/27,459 = 224(57%)

$\boldsymbol{ni}$: Sample size for I th stratum (in this case, each selected kebele); n: Sample size for the entire two woreda's household (394 in this case); $\boldsymbol{Ni}$ denotes the total number of households (residents) in the ith stratum; N denotes the total number of households in all two strata. Statistical Package for Social Sciences (SPSS) software was used to analyze the data.

3.4 Methods and types of collected data

The nature, objective, and technique of data analysis, as well as the study's scope, all influence the data collection methods. However, based on the purpose of this study both primary and secondary data were used. The main methods used for primary data collection were key informant interviews and field observation, whereas Secondary data were collected from Satellite images, Google earth, published and unpublished books and articles and auxiliary materials.

Satellite images were composed in different ways in order to identify surface features in the study area. True colour composite usually known by RGB 321 combination where band 3 reflects red colour, band 2 reflects green and band 1 reflects blue colour. Another composite called "false colour composite" which uses an RGB combination of 432. Band 2 corresponds to green, Band 3 to red, and Band 4 to the NIR infrared in this band combination. This combination gives better visualization in identifying vegetation which looks red in 432 combinations.

3.4.1. Sources of Data

Data from several sources were gathered for the study. Firstly, original information is gathered from field survey, interviews with key informants and Questionnaires. Survey data were collected by researcher assistants which were oriented and pre trained during data collection. Whereas secondary data were collected from different years of Landsat satellite images. Additionally, for this study, additional auxiliary data were also gathered from various published and unpublished sources, including books, journals, the internet, research papers, and article documents.

These different sources of satellite image were used to obtain data based on their spatial resolution which helps for better visualization and interpretation. Table 2 provides a summary of the image attributes in detail.

Table 2 : Available imagery data and their sources

Data type and sensor	**Acquisition date**	**Path and row**	**Source**	**Resolution**
Landsat 5 TM	1993	168 & 055	USGS	30M
Thematic Mapper Plus (ETM+)	2003	168 & 055	USGS	30M
Landsat 8(OLI)	2013	168 & 055	USGS	30M
Landsat 8(OLI)	2023	168 & 055	USGS	30M
Shape file for study area	2006	----------	SSGI	----

3.4.2. Software used

Data processing and visualization were carried out using widely used and well-known image-processing software. Mainly for data processing ARCGIS 10.8 and ERDAS IMAGINE 2015 were used in this study. Detail software and their function have been discussed below in Table 3.

Table 3 : Software and its major application area

Software	Purpose
ArcGIS 10.8	For clipping the study area image, to calculate the LULC class matrix between images taken at various times, for computing areas, map layout preparation, and conversion of raster to polygon…etc.
ERDAS Imagine 2015	For LULC change detection, processing data and statistical computation
GPS	To collect ground control points (GCPs)
SPSS	To process, manage and analyze the data collected
Google Earth pro	For verification, visualization and interpretation of Satellite images.

3.5. Techniques and Methods of Data Analysis

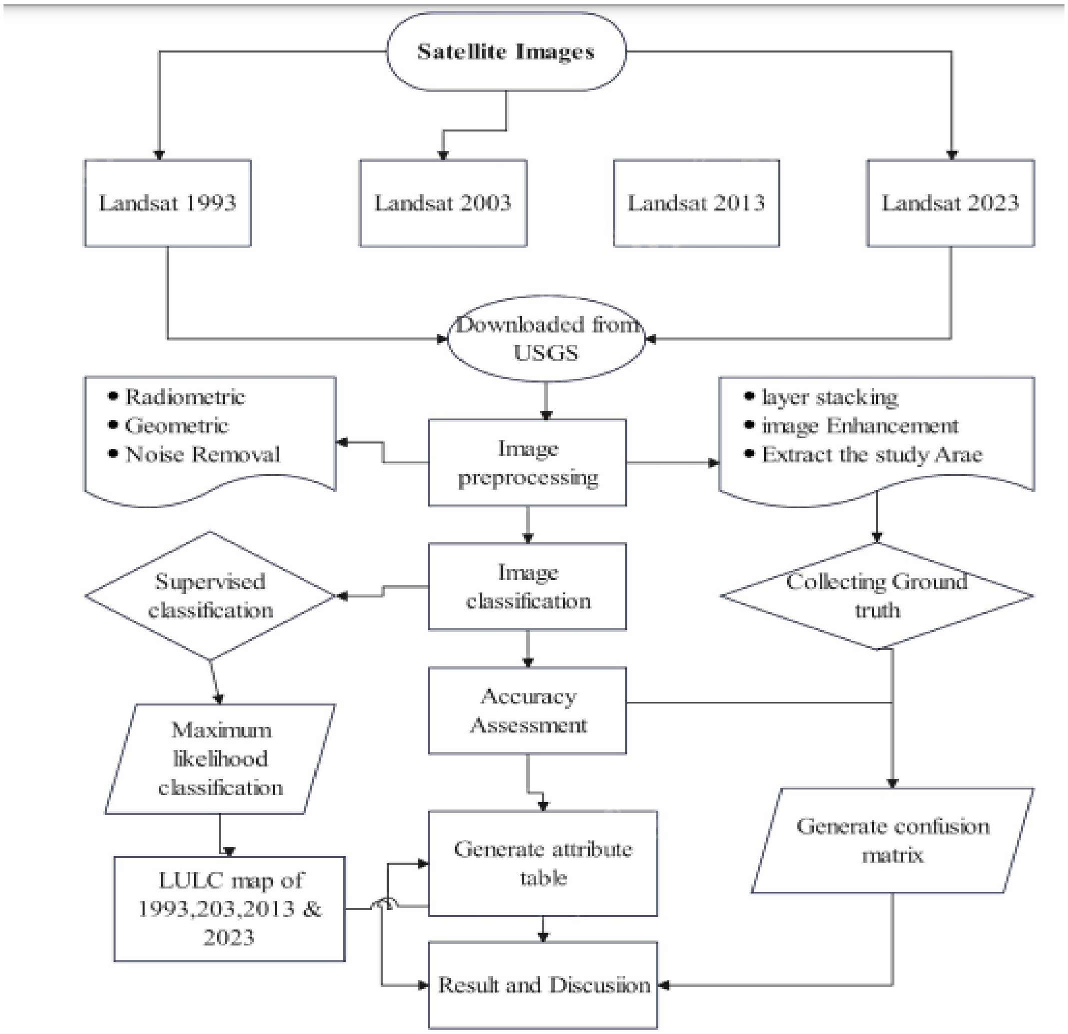
3.5.1. Image pre-processing techniques

Before employing digital photos for various applications, image pre-processing techniques are essential stages. The Landsat picture obtained from the USGS website is not complete enough for immediate use. As a result, image pre-processing is required to prepare the raw data for various applications. As a result, the obtained photos were pre-processed before being classified into several urban LULC classes to analyze urban expansion and its effects on the research area. This image processing covers image pre-processing techniques such as layer stacking, which combines layers to prepare them for categorization. Image recognition (supervised classification). Furthermore, post-classification is performed using ERDAS 2015 software, and spatial reference of the Universal Transverse Mercator (UTM) zone 37N projection with datum World Geodetic System (WGS) 1984 UTM is performed using ArcGIS10.8 software to produce the study area's LULC map in 1993, 2003, 2013 and 2023.

Landsat images from 1993, 2003, and 2013 were classified using supervised methods of maximum likelihood algorithm techniques to classify urban LULC from 1993, 2003, 2013, and 2023 in order to see how LULC changes over time, identify pixels with specific spectral characteristics, and determine the different land use/cover classes represented by these groups.

The research area's land use and cover were extracted from Landsat satellite images in 1993, 2003, 2013, and 2023. The availability of additional data for images classification determined the study durations. The United States Geological Survey (USGS) was offering the Landsat images (path 168, row 55) for free download at http://earthexplorer.usgs.gov/.

Figure 3 : Flow chart of Methodology used



Source: Source: Mundhe, N. N., & Jaybhaye, R. G. (2014). *Impact of urbanization on land use/land covers change using Geo-spatial techniques*

3.6. Conceptual Model

3.6.1. Logistic regression model

Unlike knowledge-based methods, LRM is an empirical statistical model that is data-driven and used to discover and ascertain the factors that influence changes in urban growth. The availability of well-structured, high-quality data related to the study affects the selection of explanatory factors in developing nations like Ethiopia. Free and open sources will provide the majority of the geospatial data used to identify the most important factors and how they relate to urban expansion.

Previously, several studies were conducted using spatial logistic regression models such as linear regression and logistic regression to establish the links between urban growth and its drivers (Ou et al., 2016; Wu et al., 2016).

For example, linear regression was used to forecast LULC changes on urban edges, whereas logistic regression was used to explain spatial patterns of land development. However, the most commonly used statistic is BLRM, which allows researchers to investigate the relationship between binary dependent and multiple predictor factors (Sarkar & Rashid, 2022).

In this study, a statistical model known as BLR has been used to generate probability maps of urban growth and ascertain the relationships between the predictor variables and urban expansions (built-up area growth). In order to ascertain the empirical relationships between binary dependent and many independent variables, the BLRM model is a statistical technique that is frequently employed to forecast future changes in urban growth and trends of LULC changes (Verburg et al., 2019). (Alqurashi & Kumar, 2019). The independent factors are categorical/continuous, while the dependent variable is a binary/dichotomous class variable with presence (1) and absence of urban growth (0).

The study was done under the hypothesis that the likelihood of a nonurban cell converting to an urban cell would follow the logistic regression curve. So, the most frequent and widely used formula for computing logistic regression is given below:

$Y=a+b1x1+b2x2+\ldots+ bmxm$……………………………………………………1

$Y=loge\ (P1/-P) =logit\ (P)$……………………………………………………2

$P(Z=1) =ey/1+ey$…………………………………………………….…3

Where, X1, X2 ….Xm are predictor variables and Y is the linear combination of predictor variables indicating linear relationships.

The parameters b1, b2 ….bm are the regression coefficients to be estimated in the analysis processes. The other parameter Z denotes the binary response of the variables (0 or 1) and, P represents the probability of occurrences of a new unit, i.e., $Z = 1$.

For this study, urban growths in Gullele sub-city were used as a dependent variable for the study years from 1993 to 2023. So, the driving factors/explanatory variables were selected based on different procedures. First and foremost, the probable explanatory variables were identified based on literature review (Eyoh et al., 2012; Myagmartseren et al., 2020).

Then, a total of 13 explanatory variables were identified and categorized into three groups: environmental, socio-economic and proximate factors.

The explanatory or predictor variables and interpretation that are used in this research are:

1. Dis. to forestland, The distance between a household's residence and the closest forest land, where forestry-related activities like deforestation and other economic activities are prohibited, is the other element included in this study. As a result, forest-restricted areas have a detrimental effect on urban settlement, which indirectly affects urbanization. (Liu et al., 2019).

2. Dis. to water bodies, another motivating aspect is the distance between a household's residence and the closest sources of water, as access to water is necessary for farming, drinking, cleaning, and other construction projects, among other uses. (MOUDC) 2012), observed the adverse and noteworthy correlation between water bodies where pollution has a substantial impact on urban growth and expansion.

3. Dis. to CBD, The central business district (CBD) distance is the distance between a household and the closest local market, and research indicates a strong and positive correlation between market distance and new urbanization as well as socioeconomic activity (MoUDHC, 2015). This suggests that a family that lives far from the market centers and other built-up facilities is less likely to engage in urbanization activities.

4. Dis. to existing built-up area, Distance to existing built-up areas is the other proximity factor. The distance between household home and the nearest local market and other infrastructural facilities (Feleke, S. and Zegeye, T, 2005) noted the positive and significant association of a distance in the existing built-up facilities with the new urbanization and socio-economic activities. This indicates that a household living at a distance from the existing built-up facilities and market centers is less likely to enroll in urbanization activities.

5. Dis. to the main road, Distance to main roads is also investigated as one of the driving factors influencing urban expansion. The distance between household home and the nearest local market and other infrastructural facilities (Feleke, S. and Zegeye, T, 2005) noted the negative

and significant association of market distance with the urban expansion adoption of new urbanization and farm marketing practices. This indicates that a household living at a distance from main roads and market centers is less likely to enroll in urbanization activity.

6. Slope, Slope is the other topographic factors influencing urban growth since some areas like steep slope and uncomfortable topography /elevation than gentle and manageable land escapes and slopes (MoUDHC (2015).

7. Aspect, Aspect is the other topographic factors influencing urban growth since some areas like high potentials for different physical, economic and environmental aspects (MoUDHC (2015).

8. Elven, Elevation is the other topographic factors influencing urban growth since some areas like high and uncomfortable topography /elevation than lower and manageable land escapes (UNHABITAT,2010).

Socio-economic and personal data

9. Age: Age of farmers: This variable is continuous and can be quantified in years. The likelihood of settling in other new locations will decline as the family head's age rises. Young individuals tend to be more mobile for their active lives than older people who have settled down (UNHABITAT, 2010).

10. Education; The household's education level is a dummy variable with a value of 1 if the respondent household is literate and 0 otherwise. It is apparent that as one's degree of education rises, so does the household's exposure to new ideas and knowledge, allowing the household head to seek out new markets and infrastructure.

11. Sex…Sex type is one factor for the expansion of urbanization since search for labor job and business has a relative difference on men and women migrants. More men are migrating to look for labor job and other economic sector in a peace time than women who migrate mostly in war and other uncertainty situations (MoUDHC (2015).

12.Mar.stat, Marital status…Martial status has significant effect for urban expansion and people migration. The rate of migration to urban areas is higher on single people than married once due to the difficulty in mass movement for economic uncertainty in their previous rural areas (UNHABITAT, 2010).

These variables have chosen and reconfirmed depending on literature reviews, field observation and discussion with local experts.

Table 4 : Variables of logistic regression model

Variables	Description of Variables	Nature of data	Shape
Dependent (Y)	Urban growth		
Y=0	No Urban growth	Dichotomous	Polygon
Y=1	Urban growth	Dichotomous	Polygon

Independent

Variables	Description of variables	Nature of data	Shape
Dis_Forest	Distance to forestland	Continuous	Line
Dis_Water	Distance to water bodies	Continuous	Line
Dis_CBD	Distance to Central Business Dist.	Continuous	Point
Dis_Urban	Distance to existing built -up	Continuous	Point
Dis_Mird	Distance to main road	Continuous	Line
Slope	Slope	Continuous	Line
Aspect	Aspect	Continuous	Line
Elevation	Elevation	Continuous	Line

Researchers are primarily concerned with the degree of multicollinearity in logistic regression rather than whether it exists at all. Additionally, the more multicollinearity there is, the more likely it is to produce issues.

3.7. Ethical Consideration

Ethics of research refers to the morals of investigation or intervention with regard to minimal abuse or disregard of social and psychological wellbeing of persons, community and/or animals participate in the research work.

A researcher directly and indirectly participates in research and follows all ethical principles of scientific and social science research through interaction with concerned body. All concerned body in this study have informed about the purpose of the study and confidentiality issues before starting the research work.

Researcher have submitted an official letter to the organizations selected to get necessary data for the research work and to obtain permission to conduct field survey prior to starting data collection at the study area.

CHAPTER FOUR
4. RESULTS AND DISCUSSION

This chapter presents and discusses results from the classified Landsat images of TM 1993, ETM+ of 2003, 2013 and 2023 images and field survey conducted with sampled households. LULC of the four periods, magnitude and rate of LULC changes, factors contributing to land-use change and their influences on the environment and livelihoods of society as well as measures being taken to mitigate negative externalities also presented and discussed.

4.1. Land Use Land Cover of the Study Area.

For the purpose of observing the land use land cover of the study area, it is undoubtedly paramount important once to select major classes. Accordingly, only the most important major LULC classes in the study area is selected. These classes are Agricultural land, Built up areas and Forest and shrubland.

Table 5 : Description of each land use class

LULC Types	**Description of each land use class**
Agricultural land	Lands set aside for the purpose of cultivating agricultural crops; this group includes both land that is being farmed and land that is being prepared.
Built-up Area	Land dominated with houses and huts in rural villages and small towns (also encompassing commercial areas, urban and rural communities, and industrial zones).
Forest	Areas covered by natural and/or plantation trees
Shrub land	Places with a cover of short trees, bushes, and shrubs interspersed with grasses.

source: (Kidane et al., 2019)

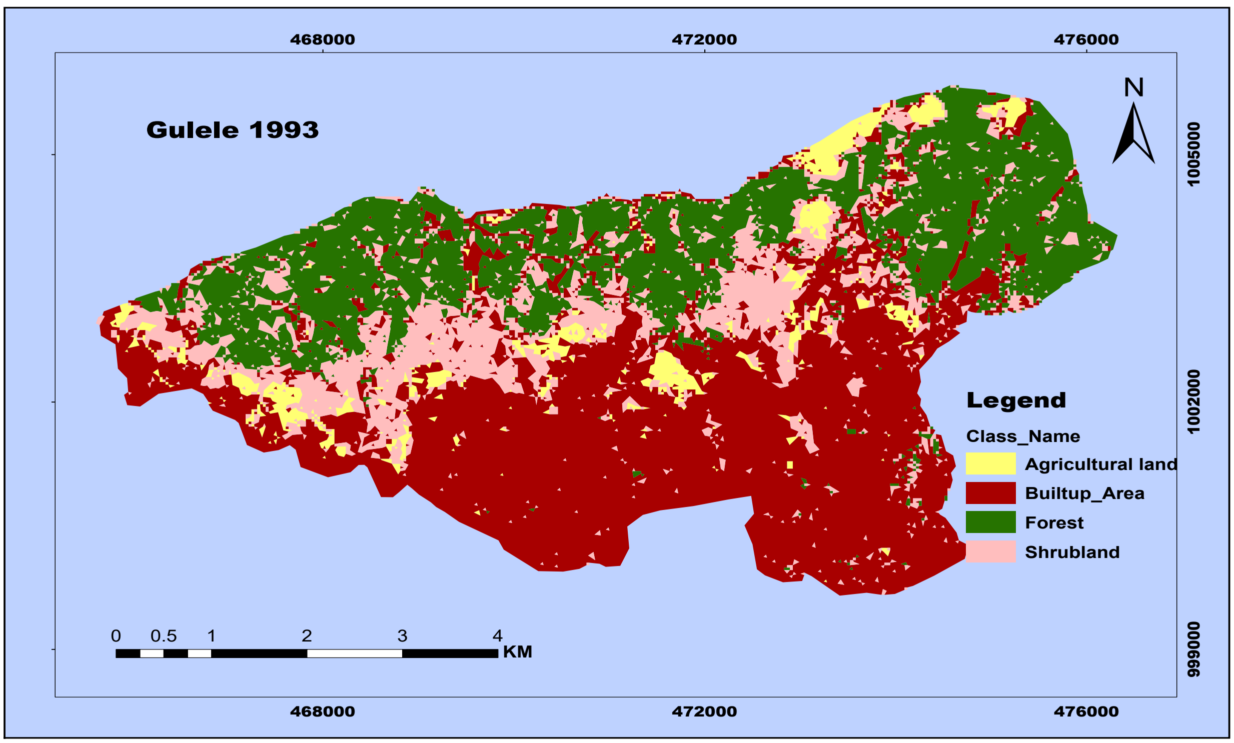
4.1.1. Land use land cover of the study area in 1993

The result obtained from the classified Landsat image of 1993 show that; the dominant land cover of the study area within this period is Built-up area which account 1729.14ha (47.32%) of the total study area. The other dominant land cover class is forest, shrubland and Agricultural land which account 1081.13ha (29.59 %), 662.15ha (18.12%) and 181.42ha (4.97 %) respectively.

Table 6 : LULC status and trends of dynamics in 1993

Class Name	**Area**	**Percentage**
Agricultural land	181.42	4.97
Built-up Area	1729.14	47.32
Forest	1081.13	29.59
Shrubland	662.15	18.12
TOTAL	**3633.90**	**100**

Figure 4: Result of Image classification and land cover/land use 1993



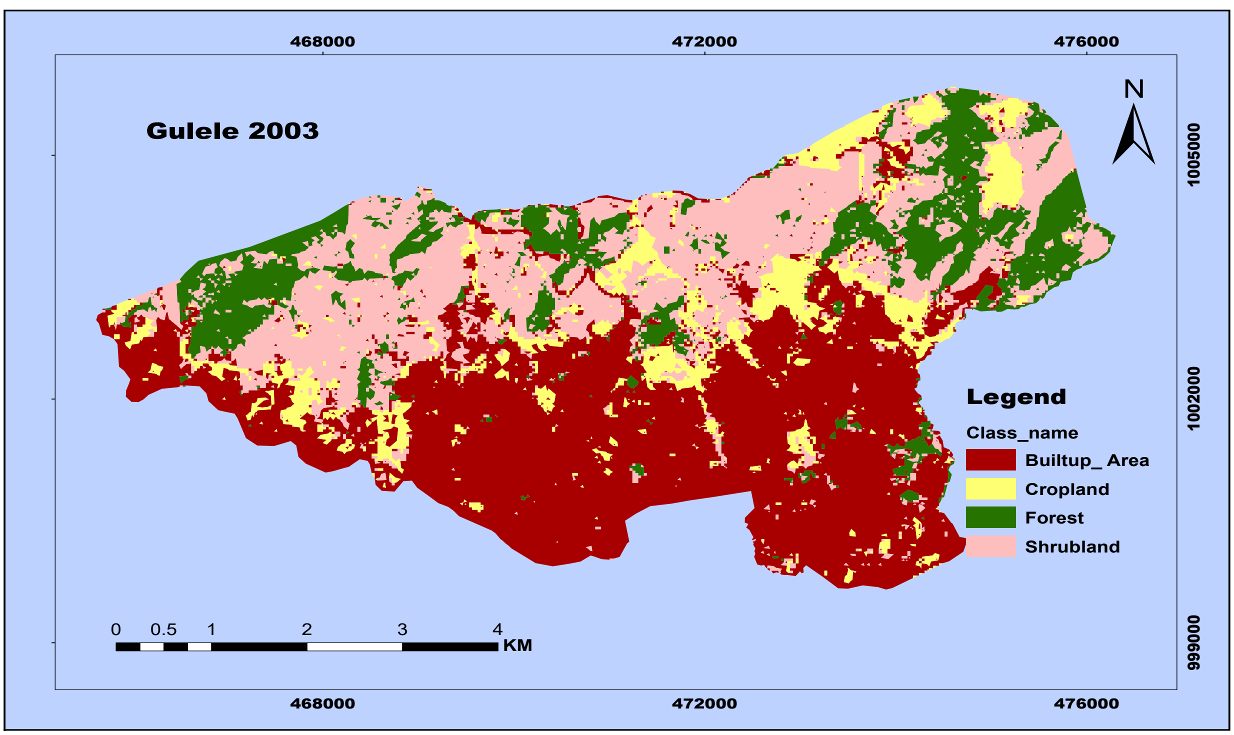
4.1.2. Land use land cover of the study area in 2003

The classified Landsat image of 2003 shows that of 1619.69 ha (44.57%) of the study area is covered with Built-up area. The agricultural land, on the other hand increased in to 409.22 ha or 11.26 %. Forest decreased to 558.5 ha or 15.37%, and shrubland increased to 1046.56 ha or 28.8 % of the area respectively (Figure 4.2).

Table 7 : LULC status and trends of dynamics in 2003

Class Name	Area/ha	Percentage (%)
Built-up Area	1619.69	44.57
Cropland	409.22	11.26
Forest	558.50	15.37
Shrubland	1046.56	28.80
TOTAL	**3633.90**	**100**

Figure 5: Result of Image classification and land cover/land use 2003.



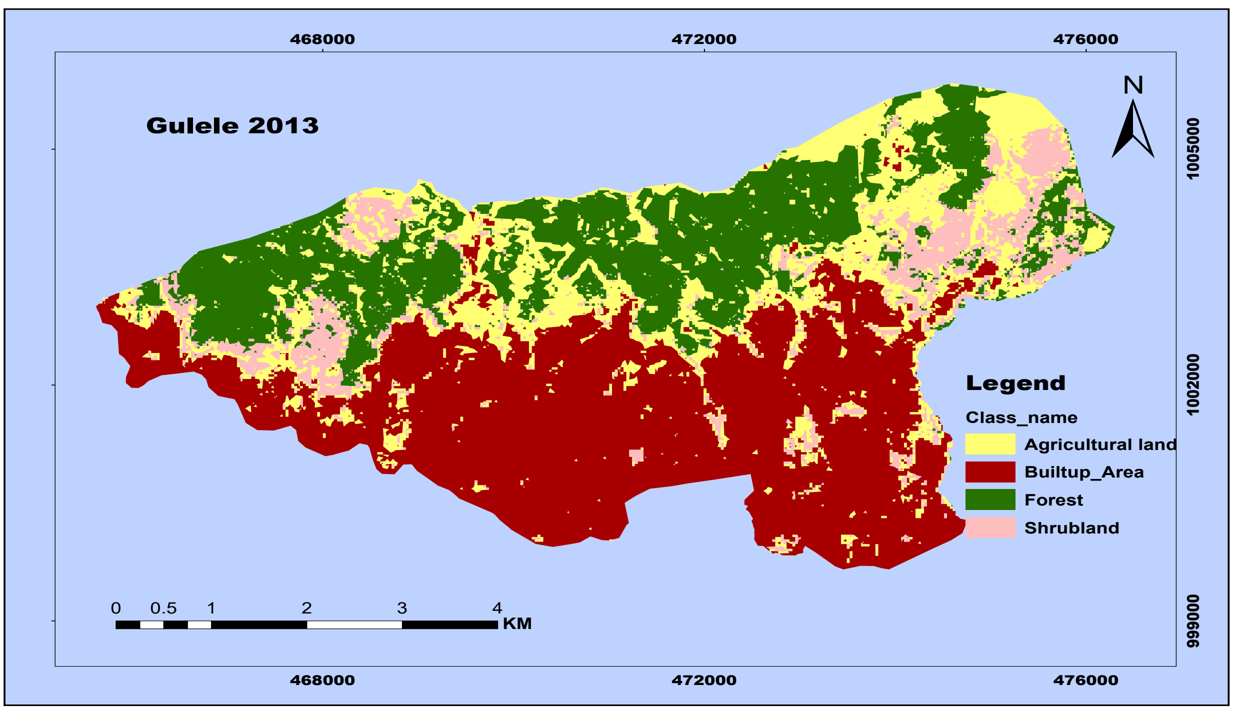
4.1.3. Land use land cover of the study area in 2013

Furthermore, land use land cover image classification for 2013 from ETM+ satellite image shows that that agricultural land and forest land shows increase in area in to 798.62ha (21.98%) and 936.5 ha (25.77%) respectively, whereas Built-up areas and shrublands show a dramatic decline and they account 1561.23ha (42.96%) and 337.56ha (9.29%) respectively within the period.

Table 8 : LULC status and trends of dynamics in 2013

Class Name	Area/Ha	Percentage (%)
Agricultural land	798.62	21.98
Built-up Area	1561.23	42.96
Forest	936.50	25.77
Shrubland	337.56	9.29
TOTAL	**3633.90**	**100**

Figure 6: Result of Image classification and land cover/land use 2013



4.1.4. Land use land cover of the study area in 2023

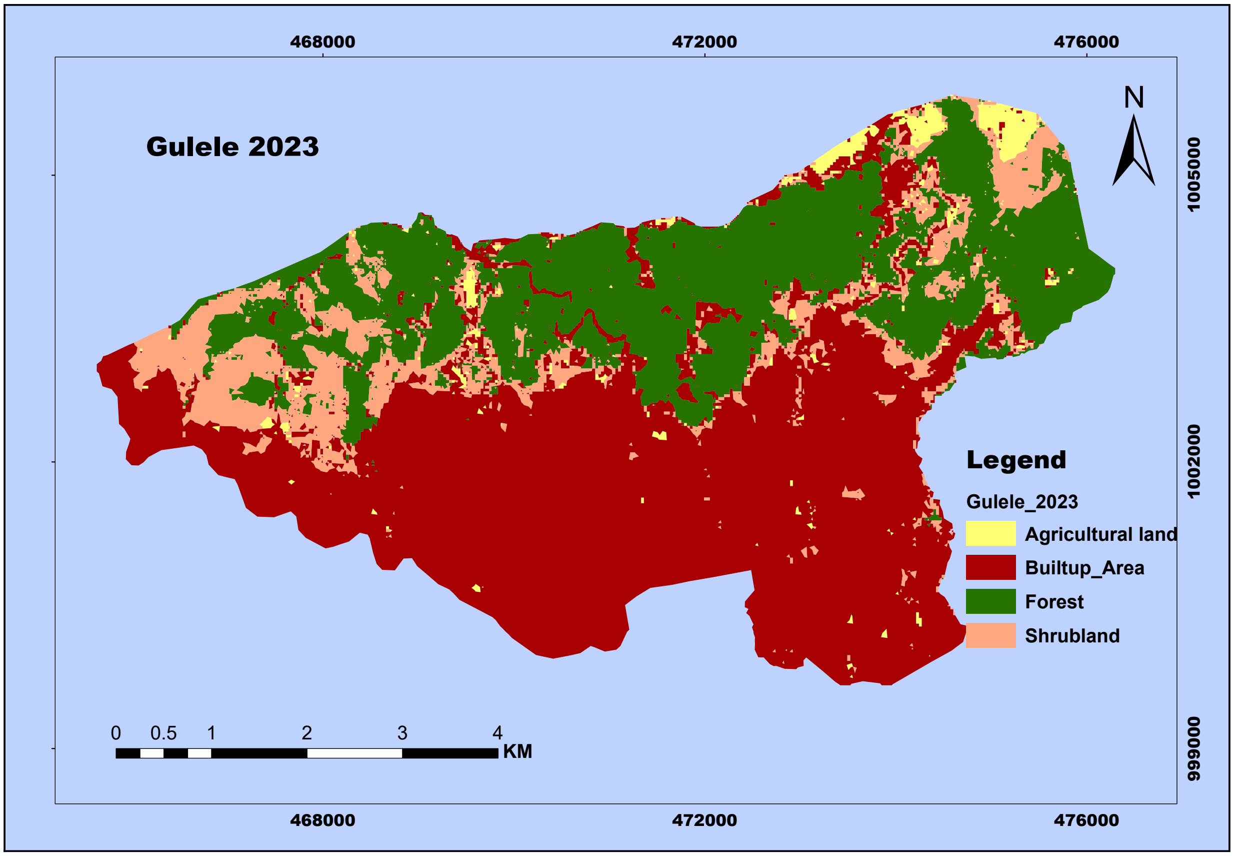
The land use and land cover (LULC) distribution for the year 2023 reveals a varied landscape in terms of urbanization, natural vegetation, and agricultural activity. A significant portion of the land, **53.37%**, is dedicated to built-up areas, showing a significant expansion of the built-up area. indicating an urban developed region. In contrast, **31.43%** of the land is covered by forests, highlighting the presence of substantial natural vegetation. Agricultural land, however, occupies only **2.28%** of the total area, suggesting that farming is not the primary land use, possibly due to limited arable land or a shift towards other economic activities. Additionally, **12.92%** of the land consists of shrubland.

Overall, the data reflects a study area with a high degree of urban development, considerable natural forest coverage, and a minimal emphasis on agriculture Table (9).

Table 9 : LULC status and trends of dynamics in 2023

Class Name	**Area**	**Percentage**
Agricultural land	82.75	2.28
Built-up Area	1939.40	53.37
Forest	1142.26	31.43
Shrubland	469.69	12.92
TOTAL	**3633.90**	**100**

Figure 7: Result of Image classification and land cover/land use 2023



4.2. Accuracy Assessment

4.2.1. Accuracy Assessment

Once images had been classified (supervised) then accuracy assessment of an image classification was done by creating the classification error matrix. In this confusion matrix, classification results were compared to ground truth and google earth data. A measure for the overall classification accuracy can be derived from this table by counting how many pixels were classified the same in the satellite image and on the ground and dividing this by the total number of pixels. After classification of satellite images, the accuracy of the classification derived from remote sensing sources is required to be assessed. One of such a method is the use of a confusion matrix which is produced from the random sample of individual pixels/clusters compared to known cover conditions over the same pixel areas.

The accuracy assessment table evaluates the classification performance of Land Use and Land Cover (LULC) categories: Agricultural land, Built-up areas, Forest, and Shrubland. The table highlights the user's accuracy for each category, reflecting the proportion of correctly classified samples within the respective classes.

2023

Table 10 : Accuracy evaluation result of classified image 2023

LULC Class	Agricultural land	Built-up Areas	Forest	Shrubland	Total	Users Accuracy
Agricultural land	8	0	0	0	8	100%
Settlement	0	46	0	0	46	100%
Forest	0	0	28	1	29	97%
Shrub land	0	0	7	10	17	59%
Total	8	46	35	11		

Overall Classification Accuracy =91%

Overall, Kappa Statics = 88%

The Agricultural land and Built-up areas classes achieved perfect accuracy, with 100% of samples correctly classified into their respective categories. Forest Land also showed high accuracy, with 97% of its samples correctly classified, though a minor misclassification occurred with one sample being identified as Shrubland. However, the Shrubland class demonstrated the lowest user's accuracy, at only 59%, indicating significant confusion with Forest Land, as 7 out of 17 Shrubland samples were misclassified as such.

2013

Table 11 : Accuracy evaluation result of classified image 2013

LULC Class	Agricultural land	Shrub land	Built up area	Forest land	Total	Users Accuracy
Agricultural land	20	2	1	0	23%	87%
Shrub land	0	10	0	0	100%	100%
Built up area	4	0	43	0	47%	91%
Forest land	0	3	1	16	20%	80%
Total	24	15	45	16		

Overall Classification Accuracy =89%

Overall, Kappa Statics = 84%

The Agricultural land class achieved an 87% user's accuracy, with 20 out of 23 samples correctly classified. However, minor confusion occurred as 2 samples were misclassified as Shrubland and 1 as Built-up Area. Shrubland demonstrated perfect classification with 100% user's accuracy, showing no misclassification among its samples. Built-up Area performed well, achieving a 91% user's accuracy, although 4 samples were mistakenly classified as Agricultural Area. Forest Land exhibited the lowest user's accuracy at 80%, with 16 samples correctly classified, but 3 were misclassified as Shrubland and 1 as Built-up Area.

2003

Table 12 : Accuracy evaluation result of classified image 2003

LULC Class	Agricultural land	Shrub land	Built up area	Forest	Total	Users Accuracy
Agricultural area	2	0	0	0	2	100%
Shrub land	0	17	1	0	18	94%
Built up area	0	4	49	0	53	92%
Forest land	0	11	0	14	25	56%
Total	2	32	50	14		

Overall Classification Accuracy = 84%

Overall, Kappa Statics = 74%

Agricultural Area achieved perfect classification, with 100% user's accuracy, as all 2 samples were correctly classified. Shrubland demonstrated strong performance with 94% user's accuracy, although 1 sample was misclassified as Built-up Area. Built-up Area also showed high accuracy at 92%, with 49 correctly classified samples and minor confusion as 4 samples were misclassified as Shrubland. Forest Land had the lowest user's accuracy at 56%, with 14 samples correctly classified but significant misclassification, where 11 samples were assigned to Shrubland.

1993

Table 13 : Accuracy evaluation result of classified image 1993

LULC Class	Agricultural land	Built up area	Shrub land	Forest	Total	Users Accuracy
Agricultural land	12	1	1	0	14	86%
Built up area	1	45	3	0	49	92%
Shrub land	0	0	17	9	26	65%
Forest	0	0	2	9	11	82%
Total	13	46	23	18		

Overall Classification Accuracy = 83%

Overall, Kappa Statics = 75%

Agricultural Area achieved 86% user's accuracy, with 12 correctly classified samples, though minor misclassification occurred with 1 sample each assigned to Built-up Area and Shrubland. Built-up Area exhibited strong performance with 92% user's accuracy, with 45 correctly classified samples, but 1 and 3 samples were misclassified as Agricultural Area and Shrubland, respectively. Shrubland showed moderate performance, achieving 65% user's accuracy, with 17 correctly classified samples but substantial misclassification as 9 samples were incorrectly assigned to Forest Land. Forest Land demonstrated 82% user's accuracy, with 9 correctly classified samples, though 2 samples were misclassified as Shrubland.

4.3. Rate of Land use/ land cover change (gain and loss)

To drive LULC changes of the study area satellite images of 1993, 2003, 2013 and 2023 have been considered. The whole-time range has been segmented into two; 1993 – 2003, 2003– 2013, 2013-2023 and finally the overall change (1993 – 2023) has been assessed. The rate of change (difference in area from the final to the initial state of each land use/cover category over the specified time period or number of years in each period) across the study period has also been analyzed based on the statistical data derived from the images.

4.3.2. LU/LC change between: 1993 to 2003

The Land Use and Land Cover (LULC) data from 1993 to 2003 reveals significant shifts in land distribution. Agricultural land experienced a dramatic increase, growing from 4.97% in 1993 to 44.57% in 2003, with an area expansion of 1438.27 ha (a +29.6% change). In contrast, the built-up area saw a substantial decline, shrinking by 1319.92 ha (a -36.06% change), from 47.32% of the land in 1993 to 11.26% in 2003. The forested area also faced a significant loss, decreasing by

522.63 ha (a -14.22% change), from 29.59% to 15.37% of the total land. On the other hand, shrubland increased by 384.41 ha (a +10.68% change) (Table 4.10)

Table 14 : Extent of land use/cover change in 1993-2003

LULC category	**1993**		**2003**		**Rate of change (ha)**	
	Area	%	Area	%	Area	%
Agricultural land	171.42	4.97	1619.69	44.57	1448.27.27	29.6
Built-up Area	1720.14	47.32	409.22	11.26	-1319.92	-36.06
Forest	1081.13	29.59	558.50	15.37	-522.63	-14.22
Shrubland	662.15	18.12	1046.56	28.80	384.41	10.68
TOTAL	**3633.90**	**100**	**3633.90**	**100**		

4.3.3. LU/LC change between: 2003 to 2013

When comparing 2003 LU/LC classification with 2013 LU/LC classification, there are changes that showed decrease or increase in particular land use land cover. The land use land cover categories, which showed increase are only Built-up area and Forest. In 2003, 409.22ha (11.26%) of the study area covered by built up area which was increased to 1561.23ha (42.96%) in 2013 with the rate of 31.7ha. Also, Forest increased from 15.37% in 2003 to 27.77% in 2013. On the other hand, the land use land cover categories like agricultural land and Shrubland showed decreasing pattern with 1619.69 ha (44.57%) ,1046.56ha (28.8%) to 798.62ha (21.98%),337.56ha (9.26%) respectively during the 2003 and 2013. average rate of changes was (-22.59% and -19.80%) respectively (table 4.11).

Between 2003 and 2013, the region experienced significant urbanization and forest recovery, alongside a decline in agricultural land and shrubland. The most striking change is the explosive growth of built-up areas, highlighting a period of intense urban expansion. The increase in forest cover suggests successful conservation or restoration efforts, while the loss of shrubland and agricultural land points to broader changes in land-use priorities, including potential shifts towards more urbanized or environmentally protected spaces.

Table 15 : Extent of land use/cover change in 2003-2013

LULC category	**2003**		**2013**		**Rate of change (ha)**	
	Area/ha	%	Area/ha	%	Area/ha	%
Agricultural land	1619.69	44.57	798.62	21.98	- 821.07	- 22.59
Built-up Area	409.22	11.26	1561.23	42.96	1152.01	31.7
Forest	558.50	15.37	936.50	25.77	378	10.4
Shrubland	1046.56	28.80	337.56	9.29	- 709	- 19.80
TOTAL	**3633.90**	**100**	**3633.90**	**100**		

4.3.4. LU/LC change between: 2013 to 2023

The Land Use and Land Cover (LULC) data from 2013 to 2023 reveals significant shifts in the distribution of land types. Agricultural land saw a sharp decline, decreasing by 715.87 ha (a 19.7% reduction), from 21.98% of the land in 2013 to just 2.28% in 2023. In contrast, built-up areas grew by 378.17 ha (a 10.41% increase), from 42.96% of the land in 2013 to 53.37% in 2023. On the positive side, forest areas increased by 205.76 ha (a 5.66% rise), growing from 25.77% of the total land in 2013 to 31.43% in 2023. Similarly, shrubland saw a moderate increase of 132.13 ha (a 3.63% rise), growing from 9.29% of the land in 2013 to 12.92% in 2023.

Overall, the 2013-2023 period shows a reduction in agricultural land and an increase in built-up areas, reflecting ongoing urbanization. However, there is also positive growth in forest and shrubland, suggesting that some land is transitioning back to natural or semi-natural states. This combination of urban expansion and environmental recovery may indicate a complex pattern of land-use change driven by economic, social, and environmental factors (Table 4.12).

Table 16 : Extent of land use/cover change in 2013-2023

LULC category	**2013**		**2023**		**Rate of change (ha)**	
	Area/ha	%	Area/ha	%	Area/ha	%
Agricultural land	798.62	21.98	82.75	2.28	- 715.87	- 19.7
Built-up Area	1561.23	42.96	1939.40	53.37	378.17	10.41
Forest	936.50	25.77	1142.26	31.43	205.76	5.66
Shrubland	337.56	9.29	469.69	12.92	132.13	3.63
TOTAL	**3633.90**	**100**	**3633.90**	**100**		

4.3.5. LU/LC change between: 1993 to 2023

The Land Use and Land Cover (LULC) data from 1993 to 2023 shows notable shifts in land distribution. Agricultural land decreased by 98.67 ha (a -2.69% reduction), from 4.97% of the land in 1993 to 2.28% in 2023. This suggests a long-term decline in agricultural activity, possibly due to urbanization or a shift to other land uses. In contrast, built-up areas increased by 210.26 ha (a 6.05% rise), growing from 47.32% of the land in 1993 to 53.37% in 2023. This reflects continued urban expansion, with more land being converted for infrastructure, housing, and recreational purposes over the 30-year period.

Forest areas saw a modest increase of 61.13 ha (a 1.84% rise), from 29.59% in 1993 to 31.43% in 2023. This indicates some forest recovery, likely due to conservation efforts or a shift from agriculture to forested land. On the other hand, shrubland decreased by 192.46 ha (a -5.2% reduction), shrinking from 18.12% of the land in 1993 to 12.92% in 2023, possibly due to land being repurposed for urban development (table 17).

Table 17 : Statistical summary of land use/land cover from 1993-2023

LULC category	**1993**		**2023**		**Rate of change (ha)**	
	Area/ha	%	Area/ha	%	Area/ha	%
Agricultural land	181.42	4.97	82.75	2.28	- 98.67	- 2.69
Built-up Area	1729.14	47.32	1939.40	53.37	210.26	6.05
Forest	1081.13	29.59	1142.26	31.43	61.13	1.84
Shrubland	662.15	18.12	469.69	12.92	- 192.46	- 5.2
TOTAL	**3633.90**	**100**	**3633.90**	**100**		

4.4. LULC Change Matrix

The results of change detection matrices, which provide information on how one LULC class changes into another LULC class at particular time intervals, are displayed in Tables 14 through 17. The values in each table's diagonal views represent the values of each LULC class that remained unchanged and did not change into a different LULC category, whilst the values in the non-diagonal views represent the values that were altered from one LULC class to another. In all tables, the values corresponding the row shows the area of the class in the initial years during the two compared years, whereas the column shows that the new or changed LULC from the past study period.

LULC Change matrix between 1993 and 2003

Built-up Area: Table 4.14 shows that the change detection matrix shows that in this period (1993–2003), about 43.07 ha of agricultural land, 22.60ha Forest, 170.51ha of shrub land areas were converted to built-up area. This shows that major conversion of shrubland to Built-up areas. Conversely, about 130.91ha, 79.60ha, 114.66ha of built-up areas was converted to agricultural land, Forest and shrubland respectively. The transition of built-up areas from 1993 to 2003 witnessed substantial changes, with the initial built-up areas in 1993 measuring 1706.44ha and shrinks to 1617.45ha units by 2003, marking a net change of -88.99ha.

In the second study period 2003 to 2013 agricultural land contributed higher (94.44ha) for the expansion of built-up area. The remaining land uses converted to built-up areas was 13.11ha, 51.50ha from Forest and Shrub land (Table 4.15). Similarly, during the third study periods (2013 - 2023) agricultural land contributes highest portion for the expansion of built-up areas (Table 4.16).

Agricultural land: Table 4.17 revealed that during the first study periods (1993 - 2003) 130.91ha of Built-up area, 46.76ha of Forest land and 123.22ha of shrubland were converted to Agricultural land. Conversely, 74.72ha of crop land were converted to other LULC classes (Table 7). During the second study period 2003 to 2013 LULC change matrix shows that 168.35ha of built-up areas, 116.18ha of Forest and 276.53ha of shrubland were converted to Agricultural land (Table 4.15). Conversely, Agricultural land area converted to 94.44ha, 38.23ha and 40.04ha of Built-up areas, Forest and Shrubland respectively. During the third study period (2013 -2023) mainly the conversion of Forest land contributed for Agricultural land (Table 4.16.

Vegetation: during the first study period, as most of the vegetation, totaling 22.60ha, transitioned into built-up area, 43.07ha to agricultural land and 170.51ha to shrub land (Table 4.14). On other hand shrubland contributes more for the expansion of Forest area. During the second study period 2003 – 2013, 339.75ha of vegetation persisted, while some of it, amounting to 13.11ha underwent transitions to Built-up area, 116.18ha to agricultural land and 88.68ha to shrubland. Progressing to the third study period, majority of vegetation (745.17ha), managed to remain, but the landscape witnessed significant changes as a small portion shifted to agricultural land (5.52ha) and built-up area (34.08ha) and 151.23ha to shrub land.

Shrub land: In 1993, a small portion of shrub land, measuring 291.81ha, remained unchanged by 2003. However, the landscape saw a significant shift as most of the shrub land, amounting to 170.51ha, transitioned into built-up area, 123.22ha to agricultural area and 74.68ha to Forest. Conversely, Forest contributes high percentage for the expansion of Shrubland during the first study period. During the second study period (2003 to 2013), 181.24ha, remained untouched. Whereas 51.50ha converted to built-up area, 276.53ha to agricultural land, and 536.80ha to Forest. During this study period Forest contributes more for the expansion of shrub land (Table 4.15). By 2023, Agriculture contributes more for the expansion of shrubland by (190.23ha), whereas Forest and Built-up areas contributes 151.23ha and 6.02ha respectively (Table 9).

Table 18 : Change detection matrix of LULC classes between 1993 and 2003

LULC CLASS		**2003**				
		Built-up Area	Agricultural land	Forest	Shrubland	TOTAL
1993	Built-up Area	1381.27	130.91	79.60	114.66	1706.44
	Agricultural land	43.07	106.62	0.46	31.19	181.33
	Forest	22.60	46.76	399.80	607.09	1076.24
	Shrubland	170.51	123.22	74.68	291.81	660.23
	TOTAL	1617.45	407.51	554.54	1044.75	**3633.90**

LULC Change matrix between 2003 and 2013

Table 19 : Change detection matrix of LULC classes between 2003 and 2013

LULC CLASS		**2013**				
		Built-up Area	Agricultural land	Forest	Shrubland	TOTAL
2003	Built_ up Area	1401.57	168.35	21.26	27.39	1618.57
	Agricultural land	94.44	236.24	38.23	40.04	408.95
	Forest	13.11	116.18	339.75	88.68	557.71
	Shrubland	51.50	276.53	536.80	181.24	1046.08
	TOTAL	1560.62	797.30	936.04	337.35	**3633.90**

LULC Change matrix between 2013 and 2023

Table 20 : Change detection matrix of LULC classes between 2013 and 2023

LULC CLASS		2023				
		Agricultural land	Built-up Area	Forest	Shrubland	TOTAL
2013	Agricultural land	69.92	301.03	236.17	190.23	797.35
	Built-up Area	5.41	1549.03	0.48	6.02	1560.94
	Forest	5.52	34.08	745.17	151.23	936.00
	Shrubland	1.78	54.11	159.55	121.88	337.32
	TOTAL	82.63	1938.25	1141.37	469.36	**3633.90**

LULC Change matrix between 1993 and 2023

Table 21 : Change detection matrix of LULC classes between 1993 and 2023

LULC CLASS		2023				
		Agricultural land	Built-up Area	Forest	Shrubland	TOTAL
1993	Agricultural land	31.74	110.54	18.83	20.22	181.32
	Built_ up Area	21.44	1498.99	108.79	77.24	1706.46
	Forest	14.04	58.79	782.35	221.15	1076.33
	Shrubland	14.39	268.26	227.99	149.61	660.26
	TOTAL	81.62	1936.56	1137.97	468.21	**3633.90**

4.5. Major driving forces of Urban Expansion

The study area's urban expansion is primarily determined by the dynamic interactions between institutional and demographic characteristics, policies, and other external factors. LCC is the outcome of several interrelated causal processes. The findings of the KIIs and field observations demonstrated that, in contrast to natural processes, anthropogenic pressures were responsible for the expansion of urban area that was observed in the study area. The study area was found to have several drivers, as reported by the respondents (Table 22). The factors' frequency of mention by the respondents was used to calculate the ranks. Consequently, the main drivers of urban expansion in the study area were population growth (37.9%), infrastructure development (30.4%), Government Policies (21.31%), rural-urban migration (4.31%), increasing demand for housing (5.9%).

Table 22: Key drivers of urban expansion in the study area based on data from KIIs

Drivers of Urban expansion	Frequency	Percentage	Rank
Population growth	145	37.9	1
Infrastructure development	115	30.4	2
Government Policies	84	21.31	3
Demand for housing	23	5.9	4
Rural urban migration	17	4.31	5
Total	394	100	

As indicated in above table *22* majority of respondents 145(37.9%) replied that Population growth was the main driving force for the expansion of urban area in the study area, followed by infrastructure development (30.4%), Government policies (21.31%), demand for housing (5.9%) and rural to urban migration (4.31%).

4.6. Implications of Urban Expansion

The implications of urban expansion in study area are significant. Urban expansion can impact the community livelihood, environment, biodiversity, and ecosystem services. For example, deforestation for agriculture or urbanization can lead to soil erosion, loss of habitat for wildlife, and disruption of water cycles. It can also have socio-economic implications, such as changes in livelihoods for local communities and potential conflicts over land resources.

Urban expansion and deforestation for agriculture or urbanization have significant environmental consequences. The removal of trees and vegetation for development accelerates soil erosion, as plant roots that typically bind the soil are no longer present. This leads to loss of fertile topsoil, reduced agricultural productivity, and increased sedimentation in rivers, which can degrade water quality and cause flooding. Additionally, deforestation destroys natural habitats, resulting in the loss of biodiversity as wildlife is displaced or faces extinction. The alteration of landscapes also disrupts local water cycles by reducing groundwater recharge and increasing surface runoff, which can lead to water scarcity and more frequent flooding.

Socio-economically, these land-use changes can deeply affect local communities. As agricultural land is cleared for urban development, farmers and indigenous populations often lost their traditional livelihoods, leading to displacement and increased poverty. This can create pressure on urban areas, where migrants may struggle with limited access to resources and services. Furthermore, competition for land between agricultural interests, developers, and local communities can spark conflicts, especially when land is seized without fair compensation. These socio-economic shifts can destabilize communities and exacerbate inequalities, as vulnerable populations are pushed out of their land-based economies and into urban poverty.

Sustainable land management practices are crucial to mitigate the negative impacts of land use change. The following are the main consequences/ implications of LULC change observed in the study area according to the KIIs.

Table 23: Implications of urban Expansion

Impacts of urban expansion	**Frequency**	**Percentage**	**Rank**
Environmental impact	147	37.3	1
Infrastructure and housing challenges	117	29.7	2
Economic impact	60	15.3	3
Social impact	43	11	4
Political impact	27	7	5
Total	394	100	

As indicated in above table23, the majority of respondents regarding impacts of urban expansion replied that 147(37.3%) of were replied that Environmental impact was the main challenge which was caused by urban expansion, followed by Infrastructure and housing challenges 117(29.7%), Economic impact 60(15.3%), Social impact 43(11%) and Political impact 27(7%).

Overall, while urban expansion can drive economic growth and improve living standards, it also poses significant challenges that require careful planning, sustainable development strategies, and equitable policies to mitigate negative impacts.

CHAPTER FIVE
5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study utilizes a combination of multi-temporal remote sensing image interpretation and geographic information system (GIS) analysis to quantitatively assess the urban expansion changes in Gulele sub city from 1993 to 2023.

Between 1993 and 2023, Gullele Sub City experienced substantial urban expansion, with built-up areas increasing from 47.32% to 53.37%. This growth came primarily at the expense of agricultural land and shrubland, which declined from 4.97% to 2.28% and from 19.12% to 12.92%, respectively. The expansion led to significant land use and environmental impacts, including the loss of farmland and natural vegetation, contributing to issues such as soil erosion, reduced biodiversity, and an increase in urban heat island effects. While forest areas showed a slight increase, largely due to afforestation efforts, this was not sufficient to counterbalance the overall environmental degradation.

The study identified several key drivers behind this urban expansion, including rapid population growth, increased rural-to-urban migration, high housing demand, weak enforcement of land use regulations, and inadequate urban planning practices. These factors collectively fueled unregulated sprawl and inefficient land conversion. In addition, the rapid expansion has resulted in serious socio-economic challenges, such as the displacement of peri-urban agricultural communities, insufficient access to basic services, the proliferation of informal settlements, and rising levels of poverty and inequality among residents.

Despite these challenges, the research demonstrated the effectiveness of Geographic Information Systems (GIS) and Remote Sensing technologies in tracking and analyzing land use and land cover (LULC) changes. These tools proved essential for generating spatial evidence to support informed decision-making in urban planning, land management, and sustainable development efforts in Gullele Sub City.

5.2. Recommendations

The findings of this study demonstrate that remote sensing and GIS are crucial tools for studying urban expansion over a period of time. By integrating spatial results with socioeconomic data, the study identified key drivers and impacts of urban expansion, providing valuable indicators for making recommendations to land users and planners. Consequently, based on the study's findings, the following points are recommended for future research directions:

- Urban land use policies should be strengthened by enforcing clear and practical zoning regulations to control unplanned expansion and protect remaining agricultural and green spaces.
- Promote compact urban development by encouraging smart growth and infill strategies to minimize horizontal sprawl and optimize the use of existing urban areas.
- Implementing strategic urban planning that incorporates evidence-based and participatory approaches to effectively manage both current conditions and anticipated future urban growth.
- The government has to invest in urban infrastructure, housing, and public services to effectively accommodate the growing population and minimize the spread of informal settlements.
- Integrating GIS and remote sensing technologies into urban management systems to enable continuous monitoring, effective planning, and informed decision-making.
- Provide training and awareness programs for urban planners, local land and city administrators, and communities to promote sustainable urban development practices.

Therefore, local managers and relevant sectors like city administration, sub city, wereda, NGO and local community in the study area should prioritize involving local communities in urban planning and decision-making processes related to urban growth. Finally, land use and cover changes in the study area have significantly impacted natural resources and the livelihoods of the local community. Therefore, it is essential to improve current land use practices by implementing resource management strategies and conserving existing natural resources. This can be achieved through planned urban land use that takes into account the natural landscape and employs sustainable land resource management plans to mitigate the negative impacts of land use and cover changes.

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APPENDIXES

APPENDIX A:

ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Questionnaires to be completed by respondents

Dear respondent!

This questionnaire is prepared to collect data about land use /land cover changes, cause and its impacts on land management in Gullele sub city, Addis Ababa, Ethiopia. Thus; the main objective of this questionnaire is to explore the extent to which human beings, through their socio-demographic characteristics have influenced the land use/land cover, thereby affecting land management in this area. Your participation to fill this questionnaire is highly appreciated and information provided will stay confidential and your right to involve or not is also respected. The results from the survey will be used only for research purpose. Therefore, the information that you will give determines the quality of the research, so you are kindly requested to give the correct information.

Note:

Depending on the nature of the questions;

- Use "X" or "√" to mark your responses in the appropriate box or
- Fill in the space provided.

Thanks in advance

Section one: Household's identification

a) Administrative Unit: Region: _________, Zone: __________ Wereda: _______________

b) Name of Kebele _____________________c) Village Name________________________

Section two: Demographic characteristics of the household

1. Name of the household _______________________________________
2. Sex: Male ☐ Female ☐
3. Age ________
4. Marital status of household

   Married ☐ Single ☐ Divorced Widowed ☐

5. Total number of family member

   1- 4 ☐ 5-7 ☐ 8-10 ☐ Above 10 ☐

6. Education

   Unable to read and write ☐ Read and Write only ☐ Primary (1 - 8) ☐

   Secondary (9 - 12) ☐ College diploma & above ☐

7. What is your primary occupation?

   Agriculture ☐ Government employment ☐ other ☐

Section three: Landholding and Property Ownership/land tenure

8. What is your means of land acquisition (tenure)?

   First distribution☐ Inheritance☐ Gift☐ Sharecropping☐ Renting☐

9. How many plots of land do you own?

   1 ☐ 2 ☐ 3 ☐ 4 ☐ Four & above ☐

10. What is the size of your all land you own in 'timad'/hectares?

    0.25 – 2 hect ☐ 2 - 4 ☐ 4 - 6 ☐ More than 6 ☐

Section Four: Questions related to research objectives

A. **Land use/Land covers change in the study area**

11. In your Kebele, have you noted any change in the land use/land cover over the past 20 Years /greater than 20? Yes ☐ No ☐ Uncertain ☐
12. 12. If your answer to question number 11 is yes, what changes did you observe? Please indicate the degree to which you personally agree with the following statements (land use land cover change) using the scale 1-3 (1= Increased, 2= Decreased, 3= No Change) by using "√" to mark your answer in the appropriate scale.

No.	Item	Increased(1)	Decreased(2)	No Change(3)	Remark
1	Plantation				
2	Bare land				
3	Shrub land				
4	Farmland				
5	Water Body				
6	Settlement				
7	Others (specify)--------				

13. Regarding to the Land use/Land covers change, if there points should be added please describe…………………………………………………………………………………… ………………………………………………………………………………………………… ………………………………………………………………………………………………… …………………………………

B. **Causes for the land use/land cover change**

14. Please indicate the degree to which you personally agree or disagree with the following statements using the scale 1-5 (1=strongly disagree, 2= Disagree, 3=Uncertain, 4= Agree, 5= strongly agree) by using "√" to mark your answer in the appropriate scale.

Items	Strongly disagree (1)	(2)	(3)	(4)	Strongly Agree (5)
1. Population growth and the need for farmland is the reason for land use/land cover change					
2. Population growth and expansion of settlement and town toward the farmland causes for land use/land cover change					
3. Population growth and the need for household energy is the reason for land use /land cover change.					
4. Lack of tenure security /certification leads land use/land cover change					
5. Environmental problems is the cause for land use/land cover change					
6. Expansion of the infrastructure and social services causes land use/land cover change					
7. Lack of proper management of land contributes land use/land cover change					

15. Regarding to causes for land use/land cover change, if there any points, describe the causes of land use land cover change

…………………………………………………………………………………………
…………………………………………………………………………………………
………………

C. **Impacts of land use/land cover change**

16. What are the main crops grown in your area?

Maize ☐ Teff ☐ Wheat ☐ Sorghum ☐ Other, specify

………………………………………………………………………………………………
………………………………………………………………………………………………

17. Regarding with productivity gained from your land/own plots, leased plots and sharecropping, what did you perceived (over the past 20 and above years?)

Decreased ☐ Increased ☐ Unchanged ☐ Undecided ☐

18. If your answer to question number 17 is decreased, what is/are the main reason/s?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………

19. Do you think the rapid changes in LU/LC could have effects on the land management?

Strongly disagree ☐ Disagree, ☐ Uncertain ☐ Agree, ☐ Strongly agree ☐

20. If your answer for question19 is agree/strongly agree, in what way it can be affect land management?

………………………………………………………………………………………………
………………………………………………………………………………………………

D. **Land management related issues**

21. Regarding to the management the land, which land management practices are, applies in your area and what changes are observed due to their application?

....

....

....

22. Who should manage the land use system at local level?

....

....

23. What are the status of land certification and its contribution to the land management

………………………………………………………………………………………………

………………………………………………………………………………………………

24. What Strategies are issued to increase land coverage and to ensure sustainable land management in your area?

………………………………………………………………………………………………

………………………………………………………………………………………………

25. Do the individuals or the community actively participating in the conservation activities?

Yes ☐ No ☐

APPENDIX B

ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Interview and Key Informant Interview Guide Questions

Dear Respondents,

The purpose of this interview is to gather relevant data for the study on the title "spatio-temporal assessment of land use land cover dynamics and its effects on land management. The Case Study of Gullele sub city, Addis Ababa, Ethiopia". Your participation, however, is on a voluntary basis. The results from the study will be used only for academic purpose. Therefore, the information that you will give determines the quality of the research, so you are kindly requested to give the correct information.

1. In your perspective, what are the spatio-temporal patterns of LU/LC changes in this area?
2. What are the main cause for land use /land cover change?
3. In your view, what are the impacts of LU/LC dynamics on livelihood of farmer's activities?
4. What are the effects of LU/LC change on land management in this area?
5. What are the effects of LU/LC change on the tenure security?
6. Do the individuals or the community actively participating in the conservation activities? /in what ways they participate?
7. What is the role of the policy on land use/land management and what is its contribution?

Thank you very much!

APPENDIX C

ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Focus Group Discussion Guide Questions

Dear Respondents,

The purpose of this focus group discussion is to gather relevant data for the study on the title "spatio temporal assessment of land use land cover dynamics and its effects on land management. The Case Study of Gullele sub city, Addis Ababa, Ethiopia". Your participation, however, is on a voluntary basis. The results from the study will be used only for academic purpose. Therefore, the information that you will give determines the quality of the research, so you are kindly requested to give the correct information.

1. Is there any change in your area with regard to vegetation cover, surface water and land use pattern over the past 40 years? If any please indicate them accordingly. A change in:

   A) Shrub land D) Bare land

   B) Farmland E) Water bodies

   C) Plantation F) Settlement

2. What are the major reasons/causes for all these changes?
3. In your view, what are the impacts of these rapid changes in LU/LC on livelihood of farmer's activities?
4. What are the effects of LU/LC change on land management in this area?
5. What are the driving factors for land use land cover change in the Gullele sub city Addis Ababa?
6. . What are the effects of LU/LC change on the Weredas security?
7. What does the policy on land use/land management says and what is its contribution? If there are points should be mentioned regarding to land use land cover change, please express.

Thank you very much!