

THE IMPACT OF ADAMA CITY EXPANSION ON WONJI FARM LAND: FROM
FOOD SECURITY AND LAND OPPORTUNITY PERSPECTIVE



Ermiyas Abebayehu Taye

A Thesis Submitted to The Department of Architecture
School of Civil Engineering and Architecture.

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban
Planning and Design

Office of Graduate Studies
Adama Science and Technology University

May, 2024
Adama Ethiopia

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Advisor: Sileshi Azagew (PHD)

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Declaration

I hereby declare that this master's thesis entitled "The Impact of Adama City Expansion on Wonji Farm Land: From Food Security and Land Opportunity Perspective" is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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ACKNOWLEDGMENTS

I give all the Glory to God Almighty since he guided me from the beginning and strengthened me to get to the end of this journey. This work would never have been accomplished without his blessing and his power that would within me praise His Holy Name.

I would first like to extend my heartfelt gratitude to my advisor, DR Sileshi Azagew, for his unwavering guidance, encouragement, and critical review throughout the entire process. From the proposal preparation to the final thesis write-up, his support was indispensable in bringing this thesis to fruition.

Secondly, I am deeply grateful to my wife, Mihiret Solomon, and my friends, their provision of essential materials, ideal support, and constructive advice have been invaluable not only during the preparation and completion of this thesis but also throughout my entire life. Their unwavering support and guidance have helped me stay on track, and for that, I am profoundly thankful. May God bless their future endeavors. Thank you all, again and again.

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LIST OF ABBREVIATIONS

AFDB	African Development Bank
UN	United Nations
GC	Gregorian colander
UN DESA	United Nations Department of Economic and Social Affairs
GDP	Gross Domestic Product
UN DESA	United Nations Department of Economic and Social Affairs
U_Accuracy	User Accuracy
P_Accuracy	Producer Accuracy
SPSS	Statistical Package for the Social Sciences
SDG	Sustainable development goal
MOUDH	Ministry of Urban Development and Housing
NUDSP	National Urban Development Spatial Plan
ECPI	Ethiopian Cities Prosperity Initiative
GIS	Geographic Information Systems
LULC	land use/land cover
FAOUN	Food and Agriculture Organization of the United Nations
IHDP	Integrated Housing Development Program
FAO	Food and Agriculture Organization
OLI	Operational Land Imager
TIRS	Thermal Infrared Sensor
TM	Thematic Mapper
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
MOUDH	Ministry of Urban Development and Housing
NUDSP	National Urban Development Spatial Plan
NO of RE	Number of Respondent

ABSTRACT

Urban expansion's impact on agricultural land, poses a critical challenge globally, affecting food security and rural livelihoods. This study focuses on the repercussions of Adama City's expansion on Wonji farmland, evaluating its effects on food security and land opportunities. The study used geospatial data, government records, field surveys, and statistical methods to comprehensively assess the situation. Remote sensing and GIS were used to track land use and land cover changes, while field surveys and interviews were used to gather perspectives from farmers and stakeholders. The research utilizes the combination of both qualitative and quantitative analysis methods, including land use/land cover (LULC) analysis and farmer surveys, to provide a comprehensive understanding of the spatial and socioeconomic changes. The study reveals that both formal and informal settlements have significantly impacted Wonji farmland. Formal settlements, driven by government projects for infrastructure and residential areas, have led to structured urban expansion. In contrast, informal squatter settlements have caused unplanned sprawl, further straining agricultural land. From 1996 to 2023, farmland in Wonji decreased from 60.1% to 27.1%, while built-up areas increased from 6.9% to 48.1%. This shift has severely affected local livelihoods with 52.3% of respondents reported losing agricultural land, and 26.0% were completely displaced. Urban expansion has also impacted food security, about 45.5% drop in local food production, 31.9% decrease in affordable food options, and 15.3% loss of traditional food sources. These findings highlight the need for comprehensive strategies to balance urban development with food security. Policymakers, urban planners, and agricultural stakeholders must work together to address the challenges posed by urban expansion through better regulation, planning, and infrastructure development. This approach aims to ensure sustainable urban growth while preserving farmland and safeguarding food security for the local community.

Keywords: City expansion, Farmland, Food security, Land opportunity, Adama

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Urban expansion affecting agricultural land is a major challenge globally, impacting food security, environmental sustainability, and socio-economic balance. According to the United Nations, approximately 30% of the world's ice-free land is used for agriculture, and this land often becomes a target for urban sprawl due to population growth and rapid urbanization (UN DESA, 2019). Numerous reports and studies have indicated that the expansion of urban areas continues to encroach upon fertile agricultural land globally, affecting food production capacities (FAO, 2019; FAO, and World Bank, 2021).

In Africa, urban expansion on farmland is a major problem that poses significant challenges to food security, agricultural sustainability, and rural livelihoods. According to the AFDB, rapid urbanization in Africa is leading to the conversion of agricultural land for urban and infrastructure development resulting in the loss of valuable farmland. This impacts the livelihoods of rural communities and has significant implications for food production and supply (African Development Bank, 2018).

Ethiopia's urban expansion is a growing concern, Cities like Addis Ababa were expanding rapidly, leading to the conversion of agricultural land for urban development and infrastructure projects. the AFDB highlighted the pressures faced by farmland due to this urban growth (AfDB, 2018). One prominent issue was the displacement of rural communities and the loss of agricultural land, impacting livelihoods and food production.

Adama City, located in the Oromia region of Ethiopia, has experienced significant population growth in recent years. The city has experienced rapid urbanization mainly due to its strategic location along major transportation routes and economic opportunities. The expansion of manufacturing and services industries has attracted a growing number of people seeking employment and better livelihoods (Seid, 2007). This expansion has resulted in the conversion of agricultural land, including the fertile Wonji farmland, into urban areas. This study examines the impact of Adama city expansion on Wonji farmland from the perspectives of food security and land opportunities and also provides a comprehensive analysis of the situation to understand the challenges and opportunities for sustainable land use in the periphery of Wonji and Adama and ensure food security in the city.

1.2. Background of the study

Urbanization is the process by which an increasing proportion of a population lives in cities and urban areas. It involves the movement of people from rural to urban areas in search of better economic opportunities, improved living standards, access to amenities, and various social and cultural factors. Urbanization has been a global trend for centuries, but it gained significant momentum during the Industrial Revolution in the 18th and 19th centuries. As industries developed, people moved from rural areas to cities in search of better employment opportunities and improved living standards. According to the UN, over half of the world's population lives in urban areas and this number is expected to increase to 68% by 2050. (UN DESA, 2018). The phenomenon of urbanization, or city growth, incorporates both lateral and vertical development of city structures. This can lead to the disappearance of farmlands, natural landscapes, grazing lands, parks, and picturesque views (Melese, 2007). The United Nations' World Urbanization Prospects report states that between 1985 and 2014, the world's population increased from 4.83 billion to 7.24 billion, and it's projected to surpass 9.7 billion by 2060 (UNDESA, 2022).

African cities have experienced substantial growth due to urbanization. This phenomenon has been remarkable, with cities across the continent witnessing rapid increases in population and economic activity (UNDESA, 2014). The report outlines that Africa is undergoing one of the fastest urbanization rates globally. By 2060, it is projected that nearly 60% of Africa's population will reside in urban areas. This rapid urban growth will present significant challenges and opportunities (UNDESA, 2018).

In Ethiopia, uncontrolled urbanization and the resulting expansion of cities have significant negative impacts on farmland, food security, and land opportunities. It encroaches on agricultural land, reducing farm size and displacing households. This loss of farmland diminishes local food production, leading to increased reliance on expensive external food sources. The reduced farming opportunities and income generation worsen the vulnerability to food shortages and higher prices. Urban expansion also converts farmland into non-agricultural areas, further limiting farming possibilities. (Alemineh, 2018)

The rapid expansion of Adama city in Ethiopia has led to significant impacts on the nearby Wonji farmland, both in terms of food security and land opportunities. Urban expansion

drives the conversion of peri-urban agricultural land for development due to rural-urban migration and city growth. People move to cities for better jobs, higher wages, and improved lifestyles (World Bank, 2015). However, this urban expansion has brought about various socio-economic challenges for the communities affected, including reduced land quality and agricultural productivity, soil erosion, deforestation, decreased open spaces, and desertification (Yimam, Ahlam, 2017)

Wonji farmland, located near Adama city, has experienced the negative consequences of this expansion. As Adama City has grown rapidly since 1997 (GC) due to economic activities and government attention, there has been a significant influx of migrants from different parts of the country (CSA, 2018). To accommodate the growing population, the city has expanded horizontally, converting farmland into urban areas. This transformation, particularly evident in the conversion of Wonji farmland into urban spaces in Adama City, has resulted in the loss of agricultural land, grazing areas, and bare land. Consequently, crop productivity has decreased, directly impacting food security in the region. The displacement of agricultural activities and the loss of farmers' livelihoods exacerbate the food security challenges faced by the community (Messay, January 2010).

Furthermore, Adama City has attracted private investments due to its location advantage and accessibility to infrastructure such as roads and electricity. The recent expansion of Adama City has significantly impacted Wonji farmland, presenting challenges related to food security and land use opportunities. The conversion of agricultural land into urban areas has led to a decrease in crop productivity, posing serious challenges to the local farming community's ability to sustain their livelihoods (Bank, 2015). This shift not only reduces the availability of fertile land for farming but also undermines the food security of the region, as agricultural activities are displaced and farmers struggle to adapt to the changing landscape.

1.3. Statement of the Problem

The government's efforts to promote industrialization and urban growth often came at the expense of agricultural land, causing concerns about food security (Amanuel Kussia Guyalo, 2022). Urban expansion is accelerating at an alarming rate in developing countries. This is due to the fastest growth of the world's population and changes in human settlement

preferences. This urbanization process manifests itself through urban physical/horizontal expansion towards their peripheral agricultural lands (Cohen, 2018).

The expansion of cities and urban areas at the expense of farmland is a pervasive and significant problem on a global scale. This trend poses substantial challenges to food security and land opportunities worldwide (Djan, 2023). As urban areas expand, valuable agricultural land is increasingly converted into infrastructure for residential, commercial, and industrial purposes. This conversion reduces the availability of fertile land for food production, further straining the already scarce global arable land resources.

The reduction in agricultural land due to urban expansion directly impacts food production capabilities, resulting in decreased crop yields and livestock productivity. These effects ripple through the local food system, causing disruptions in food production, distribution, and access. Local food systems that depend on nearby farmland are particularly vulnerable, as farmers may be forced to abandon their agricultural practices due to land acquisition or changing land use policies. This disruption negatively affects the availability and affordability of fresh, locally-produced food, impacting both urban and rural populations. Consequently, the decline in local food production necessitates increased reliance on imported goods, driving up food prices and further straining the accessibility of essential food items for vulnerable communities. (Koroso, 2010).

The environmental consequences of urbanization on green space are also profound, as ecosystems and green spaces are converted into built-up areas, resulting in the loss of natural habitats, biodiversity, and ecosystem services. (Sileshi Azagew and Hailu Worku, 2020)

Such urban expansion further affects farmers in peri-urban territories, especially in developing countries and many other countries with agricultural economies such as Ethiopia. The expansion of Adama city into Wonji farmland has raised a series of interrelated issues that require an investigation from the perspective of food security and land opportunities. The expansion of Adama city is leading to the conversion of fertile agricultural zones in Wonji into urban areas, resulting in agricultural land depletion and posing a threat to food security. This transformation raises concerns about the displacement of farmers, potential livelihood losses, and a decline in regional food production (Wakitole Dadi, 2023).

In addition, changes in land use and accessibility have an impact on land ownership, agricultural efficiency, and the overall opportunities for agricultural growth. Also, this rapid expansion poses a multifaceted quantification challenge regarding the extent of farmland encroachment and the actual area of agricultural land affected by the city's expansion. Moreover, the unchecked urban growth triggers significant land use changes in Wonji, leading to uncertainties in agricultural productivity, including fluctuations in crop yields, alterations in soil quality, and potential constraints on water resource availability. (Fekadu, 2015)

Hence, the expansion of the city is becoming fast, irregular, and uncontrolled, it creates displacement in the farming community. There are different problems associated with this expansion and Some research has been done in this city. For instance, (Kassaw, December 2020), (Mulugeta, 2010), and (TIBEBU, 2022) but urban expansion still affects the livelihood of the peripheral farming community.

However, this study did not cover all areas of the city rather it will focus primarily on Adama City and Wonji boundary areas. Adama City, located in Ethiopia, is the specific urban area undergoing expansion, while Wonji represents the farmland that is being impacted by this expansion.

In light of these multifaceted challenges, addressing the expansion of cities at the expense of farmland requires comprehensive strategies that prioritize the preservation of agricultural land and the promotion of sustainable land use practices. Addressing these issues is crucial for effective policy and planning to manage urban growth while preserving agricultural land, ensuring food security, and promoting equitable land utilization within the context of Adama city expansion.

1.4. Objectives

1.4.1. General objective

To assess the effects of Adama city expansion on Wonji farmland in terms of food security and land opportunities, and to provide strategies for sustainable land use and food production in the face of urban growth.

1.4.2. Specific objectives

1. To quantify the extent of Wonji farmland encroachment resulting from the expansion of Adama city from 1996-2023.
2. To analyze the implications of land use changes caused by urban expansion on the agricultural productivity of Wonji farmland.
3. To suggest potential strategies that mitigate the negative impact of Adama city expansion on Wonji farmland.

1.5. Research Questions

1. What is the quantitative extent of Wonji farmland encroachment resulting from the expansion of Adama city from the year 1996 to 2023?
2. How do the changes in land use, attributed to urban expansion, directly and indirectly affect the agricultural productivity of Wonji farmland in terms of crop yield variations?
3. What are the potential sustainable strategies available to mitigate the adverse effects of city expansion on farmland?

1.6. Significance of the study

The outcome of the study can be very important to policymakers and the scientific world. Quantifying the extent of farmland encroachment due to Adama city expansion in Wonji provides valuable data on the scale of land conversion and loss of agricultural productivity. This will be crucial for policymakers, urban planners, and stakeholders to make informed decisions regarding land use planning and resource allocation.

Analyzing the direct and indirect implications of land use changes caused by urban expansion on the agricultural productivity of Wonji farmland helps identify the specific challenges faced by farmers and the factors affecting crop yields. This knowledge can inform

targeted interventions and strategies to mitigate these negative impacts and support sustainable agricultural practices.

Identifying potential strategies to mitigate the negative impact of Adama city expansion on Wonji farmland and exploring opportunities for sustainable land use practices is essential for promoting a balance between urban development and agricultural needs. These strategies can help ensure the preservation of agricultural land, protect farmers' livelihoods, and enhance food security in the region.

Overall, the study's significance lies in providing evidence-based insights into the consequences of urban expansion on farmland, highlighting the importance of sustainable land use practices, and informing policy and planning interventions that promote both urban development and agricultural sustainability.

1.7. Scope of the Study

Thematic scope; This study explores the complex relationship between Adama City's expansion and its impact on Wonji farmland, focusing on the thematic intersections of urbanization and agricultural sustainability. It aimed to comprehensively examine the extent of farmland encroachment caused by the city's growth, assess the resultant changes in agricultural productivity, and clarify potential strategies for harmonizing urban expansion with sustainable land use practices in Wonji.

Spatial Scope; The spatial scope for the study would typically involve the physical boundaries of Wonji and the areas directly affected by the expansion of Adama city into these farmlands. The study was primarily focused on the Wonji area and its surrounding farmlands affected by the expansion of Adama City. Specifically, it encompasses the geographical boundaries of Wonji and the adjacent agricultural lands experiencing changes due to urban expansion. This includes a detailed examination of the land use alterations and their impact on agricultural productivity within this defined geographical area.

1.8. Limitations of the Study

Firstly, the challenge in acquiring Clear and pixelated data on the historical expansion of Adama city, Additionally, the absence of well-organized documented data from the town municipality and reliance on secondary data sources and limited primary data collection,

potentially creating uncertainties and gaps in the study analysis. The study may also struggle to fully account for the complex socioeconomic and environmental factors influencing food security and land use changes in the region, making it methodologically challenging to isolate the specific impact of Adama's expansion from other confounding variables. The political situation in the study area also poses challenges in data collection, presenting significant obstacles for the researcher throughout the study.

Despite the challenges of acquiring clear and comprehensive data, this study investigates the historical expansion of Adama city and its impacts on food security and land use. By employing a mixed-methods approach, integrating GIS analysis, and addressing the political and socioeconomic complexities.

1.9. Operational Definitions of key terms and concepts

Adama City Expansion: This refers to the comprehensive growth of Adama City, including its physical, infrastructural, and demographic aspects. It encompasses the extension of urban boundaries, implementation of development projects, increase in population, and resulting transformations in land use. (Jema Haji, 2009)

Urban expansion; is a common phenomenon in both developed and developing countries. However, in developing countries, urban expansions are known to have a negative effect. The major effects contributing to rapid urban expansion in Ethiopia are higher natural population growth, rural-to-urban migration, and spatial urban development. (Batty, 2018)

Wonji Farmland: Agricultural land located in the vicinity of the Wonji area, specifically designated for cultivation, crop production, and other agricultural activities. This includes both privately owned plots and communal land used by local farmers.

Food security; Refers to the state where all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (FAOUN, FAO, and World Bank, 2021).

Land Opportunity: The perceived or actual potential for utilizing or gaining access to land resources within or adjacent to the areas affected by the expansion of Adama City. Land opportunity also considers factors like land availability, affordability, suitability for intended uses, and legal or regulatory frameworks governing land use.

Impact: The measurable and observable effects, changes, or consequences resulting from the expansion of Adama City on Wonji farmland. This includes alterations in land use patterns, agricultural productivity, livelihoods of farmers, and overall food production.

Farmland; Refers to a piece of land specifically used for agricultural purposes, including cultivation, growing crops, or raising livestock for food production. It's an area of land dedicated to agricultural activities to sustain and produce food and other agricultural products. (FAO, 2019)

1.10. Organization of the Research

This thesis is structured into five main chapters, beginning from the cover page and proceeding through to the internal content. The initial sections include the title page and abstract. The body of the paper is organized as follows:

Chapter One Introduction; This chapter provides the background of the study, outlines the statement of the problem, defines the objectives of the study, and presents the research questions. It also discusses the scope, limitations, and significance of the study.

Chapter Two Literature Review; This chapter reviews the theoretical and Empirical concepts related to urban expansion, providing a comprehensive overview of existing literature on the topic.

Chapter Three Methodology; This chapter offers a brief description of the study area and details the methodology employed in the research.

Chapter Four Results and Discussion; This chapter presents the findings of the study and includes a discussion of the results.

Chapter Five Summary and Conclusion; The final chapter summarizes the study and presents the conclusions and findings drawn from the research.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

In this section, the study examined both theoretical and empirical works related to this study. The expansion of cities has brought about a deep transformation in the landscape, often approaching farmland and agricultural areas. This phenomenon has sparked significant discussions regarding its impact on both food security and land opportunities. Understanding this impact requires digging into various dimensions, from the preservation of agricultural land to the challenges posed by urban sprawl.

2.1.1 The impact of urbanization and urban expansion.

Urbanization refers to the process by which an increasing proportion of a population resides in urban areas, leading to the growth and expansion of cities and towns. This phenomenon is often driven by factors such as industrialization, economic development, rural-to-urban migration, and population growth. As cities expand, they consume surrounding rural land for various purposes, including residential, commercial, and industrial development.

Conversion of Farmland: As urban areas expand, the conversion of agricultural land on their periphery into urban uses such as housing, industrial parks, and infrastructure projects poses significant threats to food security. This land conversion reduces the available land for farming, potentially leading to decreased agricultural productivity and compromising the ability to meet the food demands of urban populations (Bonye, 2021).

Fragmentation of Agricultural Land: Urban sprawl resulting from urban expansion can cause agricultural land to fragment into smaller plots, diminishing the efficiency and economic viability of farming operations. This fragmentation not only disrupts traditional land-use patterns and agricultural practices but also obstacles food production by creating challenges for farmers in managing their land effectively (Beckers, 2020).

Loss of Agricultural Resources: Farmland, which is a crucial component of the agricultural sector, typically harbors valuable natural resources such as fertile soil, water sources, and biodiversity. However, urbanization can lead to the loss or degradation of these resources, posing significant challenges to the long-term sustainability of agriculture and the ability to meet the growing demand for food (Department of Agriculture, 2019).

Pressure on Food Supply Chains: Urbanization significantly impacts food demand and supply chains. As urban populations grow, the total amount of food that agrifood systems must produce, process, and distribute increases substantially. This is driven by rising incomes, changing lifestyles, and increased regulation of agrifood systems in urban areas (Behailu Melesse Digafe and Achamyeleh Gashu Adam, 2022).

Opportunities for Urban Agriculture: Despite its challenges, urbanization also creates opportunities for urban agriculture, including rooftop gardens, community gardens, and hydroponic systems. Integrating agriculture into urban environments can help mitigate the loss of farmland, improve food access for urban populations, and promote local food production (Suresh Babu, 2015).

Policy Responses: Recognizing the implications of urbanization for farmland and food security, policymakers may implement various strategies to manage urban expansion sustainably. These may include land-use planning regulations, zoning policies, incentives for agricultural conservation, and support for urban agriculture initiatives (European Commission, 2024).

In General, urbanization is a multi-faceted process with significant implications for farmland, food security, and land opportunities. Understanding the dynamics of urban expansion and its impact on agricultural land use is essential for developing effective policies and interventions to ensure the sustainability of food production and access in rapidly urbanizing regions. (Ayele Assefa, 2020)

2.2 Theoretical literature review

Urban expansion is a multifaceted phenomenon that has been analyzed through various theoretical lenses. Several theories have emerged to explain the causes and consequences of urban expansion. Some of the prominent ones are listed as follows;

Urban Sprawl Theory: This theory focuses on the uncontrolled, low-density spread of cities into surrounding areas. Urban sprawl theory emphasizes the uncontrolled and low-density expansion of cities into surrounding areas, driven primarily by automobile-centric development, cheap land, and inadequate land-use planning. This theory highlights the significant role of these factors in shaping the growth patterns of metropolitan areas, leading

to the characteristic features of sprawl such as low-density residential housing and single-use zoning (Brody, 2013).

Economic Theory of Urban Growth: Originating from the works of economists like Alonso, Muth, and Mills, this theory suggests that urban expansion is a result of market forces. It revolves around the idea that individuals and businesses seek locations that offer the best trade-offs between accessibility, land costs, and proximity to amenities and jobs. The book (O'Sullivan, 2018) provides a comprehensive understanding of these economic principles.

Political Economy Theories: These theories highlight the influence of political decisions, power structures, and policies on urban expansion. Scholars like David Harvey, in works such as argue that urban growth is driven by political and economic elites seeking to maximize their power and wealth through land development and urban infrastructure projects (Shlomo Angel, 2023).

Ecological Theories of Urban Expansion: These theories focus on the ecological impacts of urban growth, considering factors like land degradation, loss of biodiversity, and resource consumption. Authors like (Forman, June 2014): *Science of Cities*" delve into how urban expansion alters ecosystems and affects biodiversity within and beyond city boundaries.

Socio-Cultural Theories: These theories explore how societal norms, cultural values, and lifestyle preferences influence urban expansion. The work of (Sassen, 2001), particularly in *"The Global City; New York, London, Tokyo,"* examines how global economic changes and cultural dynamics shape the spatial organization and growth of cities.

2.2.1 Urbanization and its impact

Urbanization is a product of industrialization in the countries of Europe and North America as of the last update in 2022, the UN DESA provides detailed information, projections, and analyses on urbanization patterns, including statistics on urban population growth, urban-rural migration, and the expansion of cities across different regions of the world (DESA, 2022). Its impact on the world is multifaceted and profound, influencing various aspects of society, economy, and the environment.

Urbanization in Ethiopia, particularly within cities like Adama, has driven multifaceted impacts on surrounding agricultural areas like the Wonji farmlands. According to (Abera,

2019) rapid urban expansion exerts pressure on adjacent agricultural lands, leading to encroachment, fragmentation, and conversion for infrastructural development. This urban expansion, driven by population growth, economic development, and infrastructural improvements, has both direct and indirect impacts on agricultural lands.

Direct Impacts; Land Encroachment: As cities expand, urban boundaries often extend into adjacent agricultural lands. This encroachment reduces the land available for farming, leading to a decrease in agricultural production and affecting food security. (Abera, 2019)

Land Fragmentation: Urban development can cause the division of large, contiguous agricultural plots into smaller, fragmented parcels. This fragmentation can disrupt traditional farming practices, reduce the efficiency of agricultural operations, and complicate land management. (Abera, 2019)

Conversion of Agricultural Land: Farmlands are frequently converted into residential, commercial, or industrial areas to accommodate the growing urban population and economic activities. This conversion not only reduces the area available for agriculture but also impacts the livelihoods of farmers who depend on these lands. (Alemayehu, 2020)

Indirect Impacts; Changes in Land Use Patterns: The demand for non-agricultural land uses increases with urban growth, altering the land use patterns in peri-urban areas. These changes can lead to conflicts over land use priorities and may require regulatory interventions to manage competing interests. (Tadesse G. &, 2018)

Environmental Degradation: Urban expansion often leads to environmental issues such as soil degradation, water pollution, and loss of biodiversity in surrounding agricultural areas. Construction activities and increased human activity can contribute to these environmental challenges, affecting the sustainability of agriculture. (Tsfaye, 2019)

Increased Land Prices: Urbanization tends to drive up land prices, making it more expensive for farmers to purchase or lease land for agricultural purposes. Higher land costs can discourage investment in agriculture and lead to the displacement of farming communities. (Getachew, 2021)

Changes in Labor Dynamics: The urban economy offers diverse employment opportunities, attracting rural labor to urban centers. This migration can result in labor shortages in agricultural areas, impacting farming operations and productivity. (Getachew, 2021)

Socioeconomic Impacts; Livelihood Shifts: Farmers and rural inhabitants may need to transition to non-agricultural livelihoods due to the loss of farmland. This shift can pose challenges as individuals may lack the skills or resources required for urban employment, leading to economic and social disparities (World Bank, 2020).

Infrastructure Development: While urbanization can negatively impact agricultural lands, it can also bring infrastructural benefits to rural areas, such as improved roads, electricity, and access to markets. These improvements can enhance agricultural productivity and rural living standards if managed appropriately (F Shah, 2019).

Policy and Planning Challenges: Effective urban planning and policy-making are crucial to balancing urban growth with agricultural sustainability. Policies need to address land use conflicts, promote sustainable development practices, and ensure the protection of agricultural lands (C Yin, 2021).

In the context of Adama and the Wonji farmlands, urbanization has led to notable changes. The city's expansion has encroached upon these farmlands, causing significant land use changes. As Adama experiences population growth and industrialization, the demand for land intensifies, impacting the once-fertile farmlands (Gebre, 2017). Simultaneously, urbanization presents economic opportunities through increased market access, employment generation, and technological advancements, influencing the agricultural sector's dynamics in complex ways (Alemu, 2020) Balancing urban growth with sustainable land use practices remains a critical challenge, necessitating comprehensive policies and strategies that safeguard agricultural resources while supporting urban development in Ethiopia.

Population

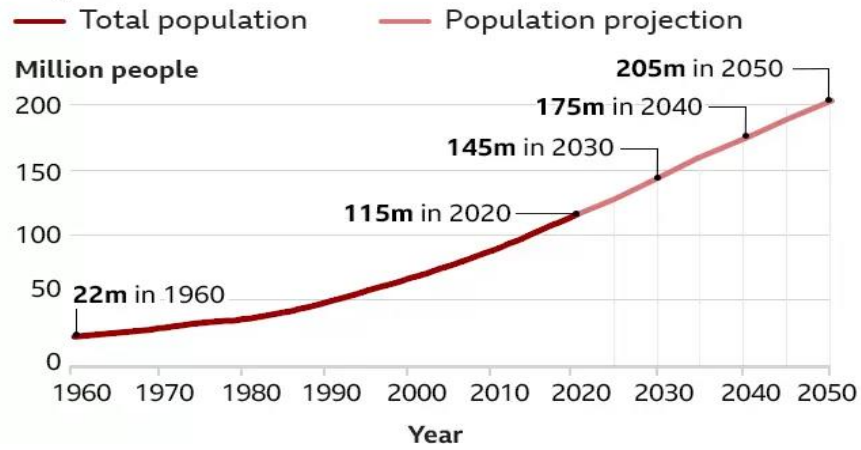
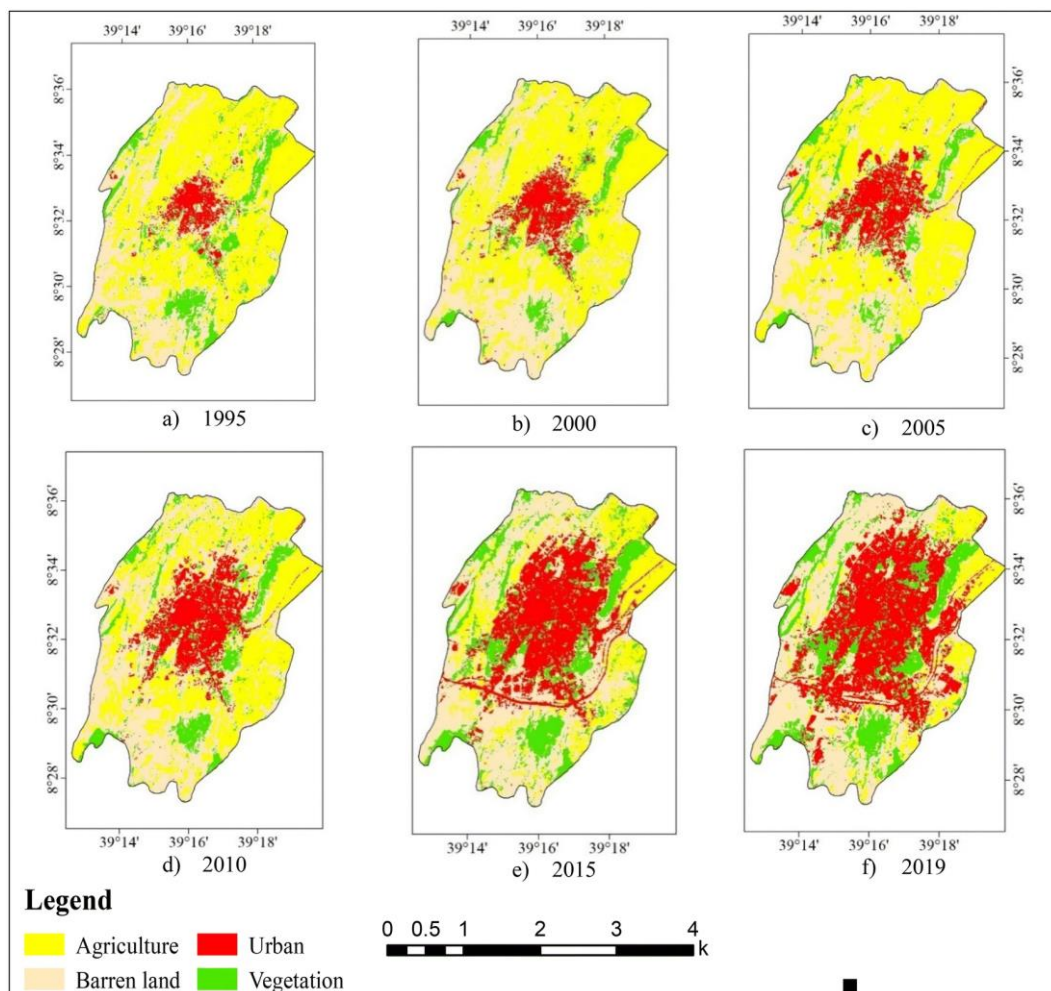


Figure 1 Ethiopia's projected population growth (1960-2050);

Source; UN ESA data (2020)



Figure; 2 LULC change from 1995-2019;

Source; (Dejene Tesema & Berehanu Girma, 2020)

From the above figure 2 Over 24 years from 1995 to 2019, Adama City witnessed substantial Land Use and Land Cover (LULC) changes. Initially, agricultural land held dominance but experienced a consistent decline, largely due to the rapid expansion of urban areas. This urban growth significantly outpaced the annual growth rates of other land use classes, leading to a notable increase in urban land extent (Dejene Tesema & Berehanu Girma, 2020).

2.2.2. The factors and potential effects of urban expansion.

Table 1 provides a simplified overview of factors and potential effects associated with urban expansion. Each factor can have multiple sub-factors and intricacies that contribute to its effects on the environment, society, economy, and governance.

Table 1 Conceptual framework of the impact of urban expansion

Factors	Potential Effects
Land Use Changes	Loss of natural habitats Increased impervious surfaces (pavement, buildings) Fragmentation of ecosystems
Population Growth	Increased demand for housing and infrastructure Pressure on resources like water, energy, and food Changes in social dynamics and community structure
Transportation Systems	Increased traffic congestion Infrastructure development and maintenance challenges
Socioeconomic Impacts	Changes in income distribution and affordability Gentrification and displacement Access to healthcare, education, and social services
Environmental Impacts	Air and water quality degradation Increased waste generation and management challenges
Policy and Governance	Urban planning and zoning regulations Infrastructure investment and management Public participation and community engagement

Source; (United Nations World Urbanization Prospects., 2018)

2.2.3 Impacts of rapid urbanization, the challenges, policy responses, and land use regulations in Ethiopia

Rapid urbanization in Ethiopia has brought about significant impacts on various aspects of society and the economy, presenting challenges.

2.2.3.1 Impacts and Challenges

Urbanization in Ethiopia has accelerated in recent years, driven by factors such as rural-urban migration, natural population growth, and economic development. This rapid urbanization has had significant impacts on various aspects of Ethiopian society and the economy.

Population Growth: Ethiopian cities have experienced substantial population growth as rural residents migrate to urban areas in search of better economic opportunities and improved living conditions. This influx of people has strained urban infrastructure and services, leading to challenges in providing adequate housing, transportation, healthcare, and education. (Behailu M, Achamyeleh G, and Gebeyehu B, 2023 Jun 23)

Infrastructure Development and Housing Demand: Urbanization has spurred investment in infrastructure projects such as roads, water supply systems, sanitation facilities, and electricity networks. While these developments have helped accommodate growing urban populations, infrastructure gaps remain, particularly in informal settlements and peri-urban areas. The rapid pace of urbanization has created a high demand for affordable housing, resulting in the proliferation of informal settlements and slums in many Ethiopian cities. Access to formal housing remains limited for a significant portion of the urban population, exacerbating issues of poverty, overcrowding, and inadequate living conditions (Mezgebo, 2021).

Economic Opportunities and Environmental Impacts: Urbanization has contributed to the growth of Ethiopia's urban economy, with cities serving as centers of commerce, industry, and service provision. Urban areas offer employment opportunities in sectors such as manufacturing, construction, trade, and services, attracting migrants from rural areas seeking livelihoods in non-agricultural activities. The expansion of urban areas has resulted in environmental degradation, including deforestation, soil erosion, air and water pollution, and loss of biodiversity. Unplanned urban growth, inadequate waste management systems, and

industrial activities have contributed to environmental challenges, posing risks to public health and ecosystem integrity (UNDP, 2020).

Social Dynamics: Urbanization has reshaped social structures and cultural dynamics in Ethiopian society. Cities are melting pots of diverse ethnicities, languages, and cultures, fostering social interactions, cultural exchange, and the emergence of new urban identities. However, urbanization has also led to social inequalities, marginalization, and tensions, particularly between long-standing urban residents and rural migrants. (Amha E, Jan Bogaert, and Dagnachew A, 2020)

In general, while urbanization in Ethiopia presents opportunities for economic growth and social development, it also poses significant challenges related to infrastructure provision, housing affordability, environmental sustainability, and social inclusion.

2.2.3.2 Land Use Regulations and Standards

In Ethiopia, land use regulations are primarily governed by the Ethiopian Constitution of 1995 and various laws, proclamations, and regulations enacted by the federal government and regional authorities. **Constitutional Provisions:** The Ethiopian Constitution of 1995 contains provisions related to land ownership, use, and administration. Article 40 of the Constitution states that land is owned by the state and the people of Ethiopia, and the government holds ownership of all land. However, individuals and communities are entitled to the right to use land, including for agricultural, residential, and other purposes, based on leasehold or use rights (Daniel, 2012).

Land Use Planning and Administration Proclamation: The Land Use Planning and Administration Proclamation (No. 145/1998) is a key piece of legislation that governs land use planning and administration in Ethiopia. This proclamation establishes the legal framework for land use planning, land administration, and the allocation of land rights. It provides guidelines for the preparation of land use plans, the establishment of land use planning institutions, and the regulation of land use activities.

Urban Development Regulations: Urban development regulations in Ethiopia are typically governed by municipal bylaws and regulations issued by city administrations. These regulations may address zoning, building codes, land subdivisions, and other aspects of urban development. While there may not be a single proclamation governing urban development nationwide, individual cities may have their urban development regulations based on national guidelines. (IGAD, 2005)

Regional and Local Regulations: Regional governments in Ethiopia may also enact their land use regulations, tailored to the specific needs and circumstances of their respective regions. Additionally, local municipalities and city administrations have the authority to issue zoning ordinances, building permits, and other regulations related to land use and development within their jurisdictions. (laws, 2013)

Standards; there are national standards and guidelines outlined by Ethiopian urban planning policies. According to the Ethiopian MOUDH, specific zones should be designated for urban expansion to minimize encroachment on prime agricultural lands, aligning with the Ethiopian NUDSP. The plan should emphasize infill development and the redevelopment of underutilized urban areas to mitigate urban sprawl, as described in the Urban Planning Proclamation No. 574/2008.

Establishing clear zoning regulations, and designating areas for urban development, agriculture, and conservation, as supported by the Ethiopian Urban Planning Standards. Additionally, creating green belts around urban areas to protect agricultural land from encroachment is advocated in the National Spatial Planning Guidelines.

By adhering to these national standards, the master plan for Adama City can promote sustainable and compact urban development while safeguarding agricultural lands and preventing unplanned urban sprawl. (Digafe, 2022)

The Ethiopian Constitution of 1995 declares that land is owned by the state and the people, with the government holding ownership of all land. The Land Use Planning and Administration Proclamation (Proclamation No. 145/1998) regulates land use planning and administration in Ethiopia.

2.2.3.3 Policy Responses and Urban Development Strategies

To address the challenges posed by rapid urbanization, the Ethiopian government has implemented policy initiatives and urban development strategies aimed at promoting inclusive growth, improving urban governance, enhancing infrastructure provision, and addressing housing affordability issues. Efforts to strengthen land use planning, promote sustainable urban design, and upgrade informal settlements are underway to mitigate the negative impacts of rapid urbanization and create more livable cities for all residents (Commission, 2016).

Integrated Housing Development Program (IHDP) Case Study:

Addis Ababa: The IHDP, launched in 2005, aimed to address the housing shortage in Ethiopian cities by constructing affordable condominium housing units. The program targeted low- and middle-income households, providing them with access to homeownership and reducing the proliferation of informal settlements. As a result, tens of thousands of housing units have been built, contributing to improved living conditions for many urban residents. (Alberto G, Alexander O, 2016)

Urban Land Lease Policy, Case Study:

National Policy: The Urban Land Lease Policy introduced in Ethiopia in 1993 under Proclamation No. 80/1993 aimed to regulate land use and promote planned urban development. By requiring developers to lease land from the government rather than purchase it outright, the policy intended to curb speculative land practices and ensure that land is used for its designated purposes. This approach has helped manage urban growth more effectively and ensure that development aligns with city plans. (Takele, 2018)

Slum Upgrading and Integration, Case Study:

Addis Ababa's "Integrated Development Plan for Slum Areas; This plan focuses on upgrading informal settlements through the provision of basic services (water, sanitation, electricity) and improving housing conditions. The plan also includes initiatives to integrate these areas into the broader urban fabric, enhancing connectivity and access to economic opportunities. Successful projects have seen improved living conditions and greater social inclusion for residents of upgraded slums. (Kebede, 2007)

Urban Governance and Capacity Building, Case Study:

Ethiopian Cities Prosperity Initiative (ECPI): This initiative aims to enhance urban governance by strengthening the capacity of municipal administrations. It includes training programs for local government officials, improvements in urban management practices, and the establishment of more transparent and accountable governance structures. The ECPI has led to better service delivery and more efficient urban management in participating cities.

Green Urban Development, Case Study:

Sheger Park Project in Addis Ababa: As part of efforts to promote sustainable urban design, the Sheger Park project was launched to create green public spaces and enhance the city's environmental quality. The project includes the development of parks, recreational areas,

and riverbank restorations. These green spaces provide urban residents with recreational opportunities and help improve the city's ecological health. (Demsachew Guadie, 2009)

Overall, The Ethiopian government's policy initiatives and urban development strategies demonstrate a comprehensive approach to addressing the challenges of rapid urbanization. By focusing on housing, land use, infrastructure, resilience, and governance, these efforts aim to create more inclusive, sustainable, and livable cities for all residents. Each case study highlights the progress made in specific areas, showcasing the potential for positive change through targeted and well-implemented policies.

2.3. Empirical literature review

2.3.1. The impact of city expansion on farmland from the perspectives of food security and land opportunities.

The international cases are described as follows;

Urbanization and its implications for food and farming

Urbanization has a significant impact on food production and farming practices, leading to the loss of agricultural land, changes in land use, and shifts in farming methods and crop choices. The growing urban population creates a higher demand for agricultural products, while climate change further complicates food production. Meeting urban food demands presents challenges related to land scarcity, water availability, climate change impacts, food safety, transportation, and market access.

To address these challenges, integrated approaches are needed, including investments in research, infrastructure, and policies supporting sustainable agriculture and small-scale farmers, as well as collaboration between urban and rural stakeholders (David S, Gordon McGranahan, and Cecilia T, 2020).

Urbanization, food security and agricultural systems in developing countries

Urban sprawl has significantly impacted food systems in developing countries, emphasizing the importance of addressing urban food security. The study identifies Policies aiming to ensure food security in developing countries must consider the interlinkages within urban food systems and adopt a holistic approach. Additionally, external stressors such as socioeconomic, demographic, natural resource, environmental, and other factors influence urban food systems, underscoring the complex challenges faced.

To address the disconnects and fragmentation, potential solutions include promoting interoperability, adopting a holistic approach, implementing integrated governance, and conducting inclusive research (Assem, Maria E, and Carl-Johan Lagerkvist, 2019).

2.3.2. The impact of city expansion on farmland from the perspectives of food security and land opportunity.

The local cases are described as follows;

An assessment of livelihood and food security of farmers displaced due to urban expansion.

Urban expansion has profoundly impacted farmers, forcing them away from traditional agriculture to alternative income sources, resulting in decreased productivity and altered livelihoods. The shift has sparked a growth in an informal economy. It suggests diversifying income sources, implementing strategic programs, and engaging partner organizations like NGOs to support livelihood assets and ensure food security for displaced farmers. It emphasizes the role of local government in providing assistance, fair compensation, and rehabilitation measures, including alternative agricultural land (Belay, 2014).

Exploring the Future of rural-urban connections in sub-Saharan Africa

This paper discusses the burgeoning urban expansion of Addis Ababa and its neighboring towns, encroaching upon peri-urban regions and significantly impacting food production for the city's inhabitants. Using an urban spatial scenario design model, it examines settlement growth patterns and their consequences on peri-urban agriculture.

Two population density scenarios within a proposed master plan are assessed, revealing substantial differences in land usage. By 2038, the low-density scenario would occupy 29% of the total area, while the high-density scenario would limit it to 19%, requiring only a third of the agricultural land for settlement (Hany Abo, Kumelachew Y, and Stephan P, 2016).

Livelihood Changes, and Related Effects of Urban Expansion on Urban Peripheral Communities

The expansion of Gondar City adversely impacted farmers and small business owners in its peri-urban areas, causing a decline in crop production and livelihoods. To address these challenges, policy recommendations were put forth. Firstly, the city administration was advised to prioritize vertical urban development to minimize future land acquisition that affects farming communities and the agricultural contribution to the economy. Secondly, the

study recommended fair compensation for affected households to match the loss of assets and livelihoods. Lastly, it proposed involving impacted communities in the planning and execution of urban expansion programs to safeguard their interests (Alemineh Yeshiwas, 2018).

The impact of urbanization expansion on agricultural land in Ethiopia

The study highlights the main drivers of urban expansion, including population growth, rural-urban migration, and economic development. The conversion of agricultural land into built-up areas has significant implications for rural livelihoods and the economy, including a loss of fertile land, reduced agricultural productivity, and increased food insecurity. The study also discusses the potential environmental degradation resulting from the conversion of agricultural land and also highlights the need for sustainable solutions and policies to mitigate the negative effects of urbanization expansion, such as promoting sustainable land use practices and improving land tenure security (Assefa Ayele, and Kassa Tarekegn, 2020).

Impact of urban expansion on the livelihoods of peripheral farming communities

The study on Adama City's peripheral farming communities revealed profound challenges stemming from urban expansion. Displacement, inadequate compensation, and reduced agricultural land threaten livelihoods and food security, causing socioeconomic and environmental upheavals. Policy recommendations emphasize stakeholder involvement in compensation decisions, improved planning, and interventions to mitigate impacts. It highlights the complexity of issues and urges comprehensive, inclusive approaches to address the repercussions faced by these communities (HAILEMARIAM, 2022).

Impacts of urban expansion on the livelihoods of local farming communities

The study found significant eviction rates among farming households due to this expansion, prompting coping strategies among those affected. These strategies included transitioning to animal rearing, diversifying income sources, intensifying agricultural practices for quicker market access, engaging in non-agricultural activities, and household member migration in search of urban jobs. These adaptations were responses to the challenges posed by urban expansion and the loss of agricultural land, showcasing the multifaceted impacts on livelihoods in the affected community (Abebe Ta, and Wubshet B, 2022).

2.4. Research Gaps from the reviewed literature

Theoretical Research Gaps:

Several gaps were identified during the literature review one of them is the lack of detailed theoretical models that explain how sustainable land use practices can be harmonized with urban development goals. There is a need for theoretical advancements that bridge the gap between sustainability and urbanization.

Empirical Research Gaps:

The researcher identified several gaps during the literature review. The primary gap observed is that there's a lack of examination regarding livelihood diversification among affected households and well as couldn't observe its impact from the food security concern. Understanding the rate of agricultural land conversion for urban development and its implications for overall productivity remains unexplored. Additionally, those study lacks a comprehensive approach to understanding the interactions between urbanization stresses, resource use, agricultural production, and food security. There's also a notable absence of strategies detailing collaborative mechanisms for local governments and organizations to assist affected communities. Policy recommendations aimed at minimizing farmland loss are missing, and the study doesn't delve deeply into the impact of urbanization on farmers' sustainable employment, assets, and social networks, presenting critical gaps in current research.

CHAPTER THREE

MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Study Location

The study area is located in the East Shewa District in the Oromia Region of Ethiopia. It covers the Adama City and the Wonji farmland, which called one woreda named Nannawa Adama (Adama Zuria) and also which are separated by the Awash River. The Adama City is a large urban center that hosts many governmental and non-governmental conferences. Wonji has Farmland for farmers' irrigation around the Awash River and also has a large sugarcane plantation established in 1954 which irrigates about 8,000 hectares of land. Geographically Wonji is situated 8.4500° N, 39.2833° E. and covers an approximate area of 70.5km². The topography of the region includes flat plains, rolling hills, and rivers. The altitude ranges from an elevation of about 1588 meters above sea level, influencing the climate and agricultural practices.

The altitude in the study area ranges from around 1,588 meters above sea level. This elevation impacts the local climate, creating conditions conducive to diverse agricultural activities. The topography, which includes expansive flat plains and gently rolling hills, supports a variety of crops and farming practices. The presence of rivers, especially the Awash River, is pivotal for irrigation, ensuring the viability of both small-scale and large-scale farming operations.

Both Adama City and the Wonji farmland play crucial roles in the socio-economic fabric of the East Shewa District. Adama City, with its bustling urban environment, acts as an economic engine, providing employment opportunities and serving as a center for commerce and services. In contrast, Wonji's agricultural sector underpins the local economy, providing livelihoods for numerous farmers and contributing significantly to Ethiopia's agricultural output. In general, the study area combines the urban vibrancy of Adama City with the rich agricultural heritage of the Wonji farmland, underpinned by the vital waters of the Awash River. The diverse topography and favorable climate conditions make it a unique and significant area, both economically and environmentally.

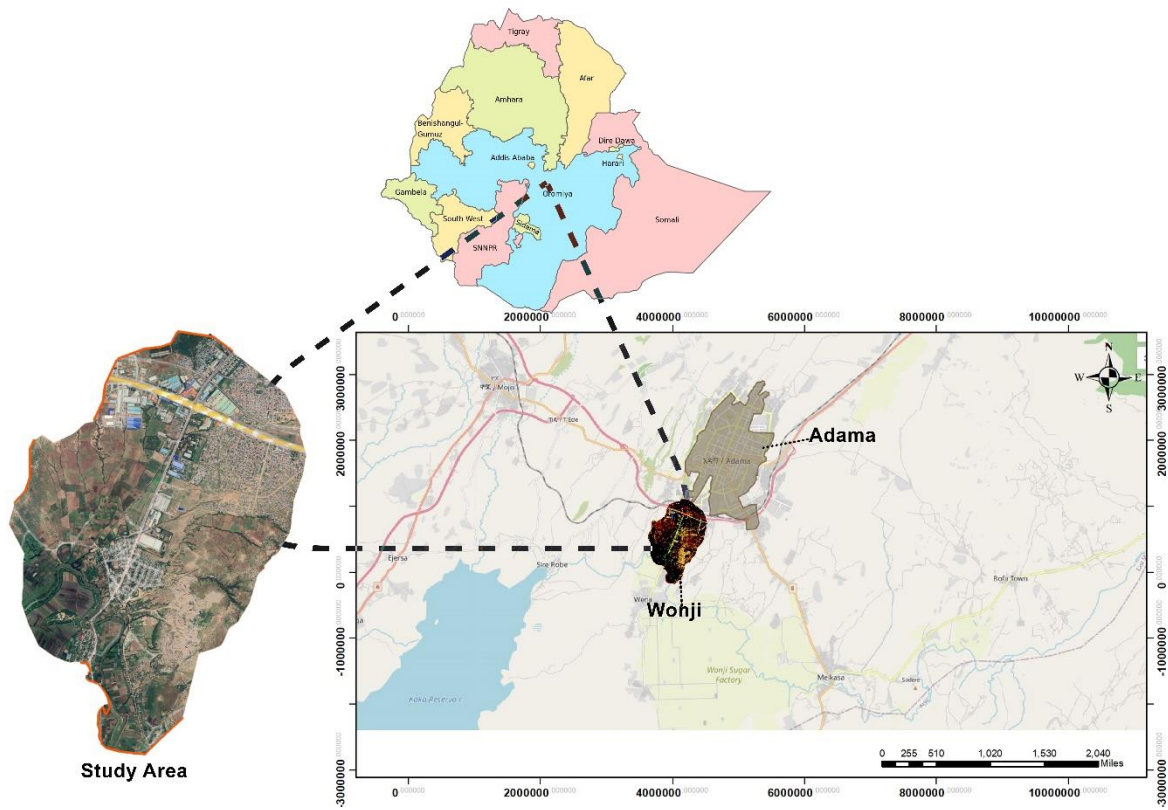


Figure 3 Map of the study area

Source: - Transformed from Google map

3.1.2. Study Population

According to the CSA 2020 report, the total population of Adama city was 400,477 of which 199,500 were males and 200,977 were females. As its population increases, the size of the city becomes enlarged and expands to peripheral farming lands. (Ethiopia, 2007) (Statistical, 2014)

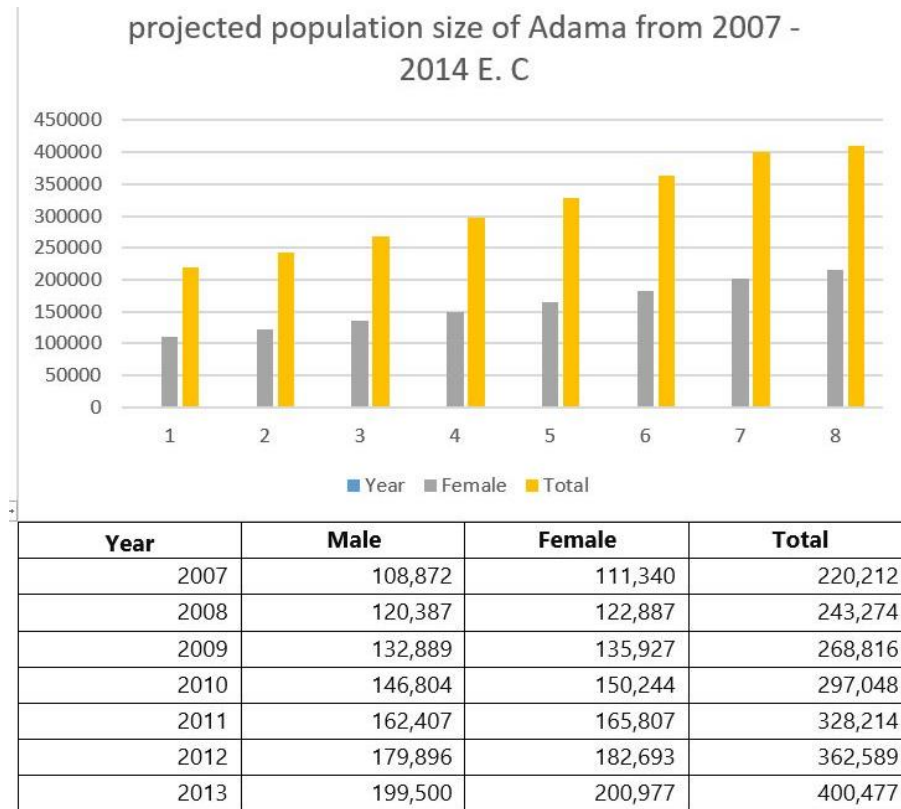


Figure 4 illustrates the projected population size of Adama from 2007 - 2014 E. C

Source: - CSA and projected population

3.2. Study design

This study uses a mixed methods approach; which is the combined of qualitative methods and quantitative methods. To evaluate the extent of farmland encroachment due to the expansion of Adama City into Wonji, remote sensing and GIS analysis are employed. Historical images have been acquired to establish a baseline, while current images are used to assess recent changes. Following data collection, the next step involves image processing using the software ArcGIS and QGIS. This process includes classifying land use types, identifying urban areas, and delineating farmland. Subsequently, change detection techniques were applied to quantify the extent of farmland lost to urban expansion over the study period. This involves comparing land use maps from different years and calculating the area of farmland converted to urban use.

Following data collection, data analysis can be performed using statistical methods. This analysis includes comparing crop yields before and after the expansion and identifying trends in agricultural productivity. To describe potential strategies to mitigate the negative impacts of urban expansion on farmland, a literature review and interviews with stakeholders have

been conducted. The qualitative analysis uses thematic analysis to identify key themes and insights from the interviews. The findings summarized to propose feasible and context-specific mitigation strategies, integrating both empirical evidence and stakeholder perspectives to address the challenges posed by urban expansion.

Table 2 Summary of the study design

Specific Objective	Study Design
Evaluate the extent of farmland encroachment due to Adama city expansion in Wonji	Remote Sensing and Geographic Information System (GIS) Analysis: Utilize satellite imagery and GIS technology to quantify the extent of land use changes over a specified period. This involves analyzing historical and current land use maps to identify patterns and trends in farmland encroachment.
Analyze the direct and indirect implications of land use changes on agricultural productivity	Field Surveys: Conduct surveys in the affected areas to collect data on crop yields and other agricultural productivity indicators. This includes direct measurements of crop yields, and interviews with local farmers to gather insights on changes in agricultural practices and productivity.
Describe potential strategies to mitigate negative impacts	Literature Review: Examine existing literature to identify successful case studies and mitigation strategies implemented in other regions facing similar challenges. - Interviews with Stakeholders: Conduct semi-structured interviews with key stakeholders, including local government officials, agricultural experts, and community leaders, to gather qualitative data on potential mitigation strategies and their feasibility.

3.3 Study approaches

The following study approaches are implemented in the study:

Table 3 outlines potential study approaches for each objective of the study

Specific Objective	Study Approaches
Evaluate the extent of farmland encroachment due to Adama city expansion in Wonji, quantifying the affected area	1. Remote Sensing Analysis: Utilize satellite imagery to assess land cover changes over time.
	2. GIS Mapping: Employ Geographic Information Systems to precisely delineate urban expansion boundaries.
	3. Field Surveys: Conduct ground-level surveys to validate remote sensing data and assess land use changes.
Analyze direct and indirect implications of land use changes on agricultural productivity in Wonji	1. Agricultural Surveys: Assess crop yield variations and changes in farming practices.
	2. Soil Sampling and Analysis: Study soil quality changes due to urbanization.
	3. Hydrological Studies: Investigate water resource availability and its impact on agricultural activities.
Identify potential strategies to mitigate the negative impacts of city expansion on Wonji farmland	1. Stakeholder Interviews: Engage farmers, urban planners, and policymakers for input on mitigation plans.
	2. Comparative Case Studies: Analyze successful models from other regions facing similar challenges.
	3. Sustainability Assessment: Evaluate the feasibility of various land use practices for urban-agricultural balance.

3.4 Data Type and Sources

As described in the Study design the study needs a combination of quantitative and qualitative data.

3.4.1 Quantitative Data

Geographic Information System (GIS) data stands as a pivotal resource, enabling insights into the transformation of land use, urban expansion patterns, and changes in agricultural areas across time. For the land use/land cover (LULC) change detection study, five classes of built-up areas, water bodies, farmland, vegetation, and bare land were selected for analysis based on their relevance to urban expansion and overall landscape transformation. **Built-up Areas:** This class includes residential, commercial, and industrial structures. Tracking the expansion of built-up areas is crucial for understanding urban growth and its impact on the environment. **Water Bodies:** Monitoring changes in water bodies helps assess the effects of urbanization on water resources, including potential reduction or pollution of lakes, rivers, and other water features. **Farmland:** Farmland is often converted into urban areas as cities expand. Analyzing changes in farmland can provide insights into food security, agricultural practices, and rural-to-urban land transitions. **Vegetation:** Vegetation, including forests and green spaces, is vital for maintaining ecological balance. Urban expansion often leads to a reduction in vegetation, impacting biodiversity and ecosystem services.

Bare Land: This category includes areas devoid of significant vegetation, such as barren land or newly cleared land for development. Changes in bare land can indicate construction activities and land preparation for future urban use. Using these five classes allows for a comprehensive assessment of urban expansion and its environmental impacts over time.

Government reports, including municipal records, city planning documents, and agricultural reports, offer crucial details outlining urban expansion plans and the utilization of agricultural land.

The inclusion of statistical data, encompassing crop yields, land productivity metrics, population growth data, and food consumption patterns sourced from government agencies or agricultural organizations, supplements the study's depth. Additionally, conducting surveys and questionnaires among farmers, residents, and stakeholders stands as a vital method to obtain quantitative insights into shifting land use, agricultural methodologies, and perceptions regarding food security within the studied areas.

3.4.2 Qualitative Data

Interviews and focus group discussions are valuable tools, engaging farmers, residents, city planners, and policymakers to pick their viewpoints on how Adama City expansion affects farmland and food security. Supplementing this approach, case studies offer an in-depth exploration of specific areas impacted by the city's expansion, shedding light on the lived experiences of affected individuals.

Table 4 Data Type and Sources for each objective of the study

Specific Objective	Data Type	Sources
Evaluate the extent of farmland encroachment due to Adama city expansion in Wonji, quantifying the area of agricultural land affected by urbanization.	Geographic Information System (GIS) data, Satellite Imagery, Land Survey Records	National Land Administration, Adama City Planning Department, Agricultural Extension Offices, Remote
Analyze the direct and indirect implications of land use changes caused by urban expansion on agricultural productivity in Wonji, considering crop yield variations	Agricultural Production Records, Crop Yield Data	Wonji Farmers' Cooperative, Ministry of Agriculture, Research Institutions
Identify potential strategies to mitigate the negative impact of Adama city expansion on Wonji farmland, exploring opportunities for sustainable land use practices that balance urban development with agricultural needs.	Case Studies on Urban-rural Integration, Best Practices in Land Use Management, Interviews with Local Stakeholders	Urban Development Authorities, Academic Studies, Local NGOs, Interviews with Farmers and Community Leaders

3.5. Instruments of data collection

The following instruments are considered:

3.5.1. Questionnaire

This instrument is used to collect demographic data like age, educational status of the household, family size, social status of the household, marital status of the household, reaction of the displaced household, annual Income (financial capital) of households, etc. The data collection is made and led by the researcher, and participating enumerators. The researcher introduced and trained enumerators to minimize errors in data collection to ensure the questionnaire was well structured. The questionnaire was used to fill the gap and support the representative sample to address as many individuals as possible and to get relevant firsthand information. The questionnaires were composed of closed-ended and open-ended questions. The questionnaires have been prepared in English and translated into Amharic and Oromic for the household for fear of misunderstanding and to obtain deep and reach data. The questionnaires were distributed to the respondent who had given enough time to read each item carefully and fill in their genuine response appropriately.

3.5.2 Interview

In this study, the researcher used a semi-structured interview because of its flexibility and to make clear any time when there is ambiguity. Interviews were held with key informants who were purposively selected from the community and also from different responsibility levels (municipal workers, kebele administrators) and some elder residents to generate relevant information regarding the current status of the adverse impact of urban expansion on farmland land and the scarcity of land opportunity of on livelihoods in the study area.

Accordingly, informants were selected for interviews to collect qualitative data. It was conducted in a face-to-face approach. Key informant interviews include elder residents, municipal experts, and kebele administrators.

3.5.3 Focus Group Discussion (FGD)

The focus Group Discussion (FGD) was conducted on selected individuals. The participant's longtime residents and in the (FGD) the participants discussed two times. A checklist of questions was used to guide the discussions which availed information that could not be picked by using primary data sources such information included interesting questions to capture the historical trends over time with regards to land cover dynamics including vegetation cover change, buildup lands, settlement patterns, and infrastructure expansions.

It also intended to obtain information on institutional arrangements regulating land use, population dynamics, and community awareness about land use. Focus group discussions were carried out to collect qualitative information from the selected parts of the study area purposely selected participants of which were elderly farmers, they are known to have better knowledge of the present and the past socio-economic status of the study areas.

3.5.4 Field Observation

The purpose of observation was to get recent information and to gather accurate information about the data and what is going on in the actual setting. The observation acted as a cross-checking mechanism from the extent of the field observation in the study area. The researcher observed the extent of settlement and build-up expansion and infrastructure construction towards the agricultural and forest lands. The researcher used a checklist during field observation. The visual information with the help of a photo camera from the existence of horizontal urban expansion and it collected for not less than three consecutive days in the selected areas. This was conducted through permission and cooperation of the municipal authorities of the town with the concerned body.

Table 5 Summary of potential study instruments or data collection tools

Data Collection Tool	Purpose	Description
Surveys/Questionnaires	Assessing Farmer's perspectives on land use changes	Structured questionnaires to gather opinions, concerns, and experiences of farmers affected by the city expansion
Interviews	In-depth understanding of farmer perspectives	Semi-structured interviews with key stakeholders, farmers, and local authorities
Remote Sensing	Mapping land use changes	Satellite imagery analysis to identify and quantify changes in farmland, urban expansion, and land usage
Geographic Information System (GIS)	Spatial analysis of land use changes	GIS software to analyze spatial patterns, and land cover changes, and identify areas impacted by urbanization

Field Observations	Ground truthing and validation of data	On-site observations to validate satellite data, assess agricultural productivity, and document changes firsthand
Secondary Data Sources	Historical land use data	Accessing governmental records, land surveys
Economic Analysis	Assessing the economic impact on food security	Annual income and crop data analysis, to evaluate changes in food production and prices

3.6. Sampling techniques

For this specific study, both probability and non-probability sampling techniques are used. In the probability sampling technique, simple random sampling was used because the research demands participant from the study areas who are performing their normal daily activity. In the non-probability sampling technique, purposeful sampling was used. Purposeful sampling is selecting strategically and purposefully the portion that has a higher degree of information (Ethiopia, 2007). From those agencies; Adama City Authorities, Agricultural Experts, Food Security Agencies, Environmentalists, and Economic Analysts agency workers. In this research, expertise is listed and filtered out as in Table 6 by considering the expert for the specific information needed.

Table 6 The sample size of expert respondents.

Agency	Expert Respondent	Number of Experts	Respondents
Adama City Authorities	Urban Planners	3	City Planners, Zoning Officials,
Agricultural Experts	Agronomists	2	Agronomists, Soil Scientists, Crop Specialists
Economic Analysts agency	Economic Researchers	1	Economists, Development Economists, Agricultural Economists

Hence These Experts can represent a diverse range of roles and specializations within their respective agencies.

3.6.1. Study Population

Table 7 Potential groups that study population is considered

Study Population	No of population	Description
Farmers	105	Those actively engaged in farming within Wonji farmland
Landowners	95	Individuals or entities who own land in the study area
Local Residents	35	People living in the vicinity affected by the expansion
Adama City Authorities	6	Government officials, and urban planners, involved in city expansion
Agricultural Experts	2	Professionals with knowledge of agricultural practices
Food Security Agencies	2	Organizations working on ensuring food security

3.6.2. Sample size determination

In the sample sizing process, first, the study determines the target population size. There are two groups of populations in this study Area, farmers who live in Wonji and residents of Adama city. For the Farmers and residents in the study area, the sample sizing process has determined using Cochran's formula because the population size exceeds 10000. The population that lives in Adama City is estimated to be around 320,000 to 370,000 people and that of Wonji is around 23,000 (Agency, 2022).

Cochran's formula is commonly used to determine sample size when the population is large and the expected proportion of the population that possesses the attribute being measured is unknown.

$$n_0 = \frac{z^2 pq}{e^2}$$

Where:

n = sample size

Z = Z-score corresponding to the desired confidence level

p = estimated proportion of the population with the attribute (in this case, residents willing to participate in the study)

E = margin of error

Calculate the sample sizes for both Adama City and Wonji (Study Area) using the correct Z-values:

Population estimate: 370,000 to 400,000

By taking the midpoint, from 370,000 to 400,000 which is 385,000.

Z-value for 90% confidence level ≈ 1.645

The margin of error = 5% or 0.05

Using these values in Cochran's formula:

$$\begin{aligned} n_{Adama} &= \frac{1.645^2 * 0.5 * (1 - 0.5)}{0.05^2} \\ &= \frac{2.706025 * 0.25}{0.0025} \\ &= \frac{0.676506250}{0.0025} \\ n_{Adama} &= 270.6 \end{aligned}$$

The sample size of residents is 270 individuals.

Hence; The number of questionnaires, participants for interviews, and focus group discussions are identified based on the above Sample size determinations.

For surveys/questionnaires; Typically, the number of questionnaires distributed is more than the sample size to account for potential non-responses. Distribute around 10% more, so 300 questionnaires are distributed.

Interviews; For in-depth interviews, approximately 10-20% of the sample size are engaged in interviews. Considering 15%, around 40 individuals participated in the interviews.

Focus Group Discussions; Aiming for diverse perspectives, around 5-10% of the sample size can be involved in focus group discussions. Taking 7.5%, roughly 20 participants are part of these discussions.

3.6.3. Sampling methods

Both probability and non-probability sampling techniques were employed.

Simple random sampling is used to select participants from the study areas who are engaged in their normal daily activities.

Purposeful sampling is utilized to strategically select individuals from relevant agencies, ensuring that those with a high degree of information are included.

3.7. Data analysis and interpretation

Three data analysis techniques were used in this study; statistical analysis, thematic analysis, and comparative analysis. Statistical analysis was used to assess changes in agricultural productivity, land use patterns, and food security indicators through quantitative data. Thematic analysis involved qualitative data coding to extract themes and patterns from interviews and focus groups, focusing on the impact on livelihoods and opportunities. Comparative analysis compared pre-expansion and post-expansion data to identify trends, shifts in agricultural practices, and changes in food security parameters. Raw data from questionnaires, interviews, and focus group discussions (FGDs) were processed and cleaned, with a coding system prepared concurrently with the questionnaire. Valid questionnaires were then inputted into SPSS for coherent formatting. Both qualitative and quantitative approaches were used in data analysis; qualitative data was organized and summarized thematically, while quantitative data was interpreted using statistical techniques percentages and other inferential statistics. The results were presented through tables, figures, graphs, and reports.

Table 8 Table outline of the three distinct approaches for data analysis

Data Analysis Approach	Description	Methodology	Data Sources
Statistical Analysis	Quantitative assessment of changes in agricultural productivity, land use, and food security indicators.	Utilizes statistical methods (e.g., regression, ANOVA) on numerical data.	Agricultural yield records, land use surveys, food security indices.

Thematic Analysis	Qualitative extraction of themes and patterns from interviews/focus groups on livelihood impacts and opportunities.	Coding and categorization of qualitative data to identify recurring themes.	Interview transcripts, focus group discussions, and qualitative surveys.
Comparative Analysis	Examination of pre- and post-expansion data to uncover trends, shifts in agricultural practices, and food changes.	Contrasting data before and after expansion to analyze changes.	Pre-expansion surveys/records, post-expansion data, comparative studies.

3.7.1. Satellite Imagery Analysis (Image Categorization)

To evaluate urban expansion in the study area, cloud-free Landsat images from 1996, 2010, and 2023 were obtained for path 168 and row 52 through the USGS Earth Explorer website. These images were referenced in the Universal Transverse Mercator (UTM) projection zone 37N. The datasets were utilized to develop historical land use and land cover maps, facilitating the analysis of urban expansion over time. For the 2023 image, acquired using the Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS), ground truth points were employed to define training sites for classification purposes. For the older images, captured using the Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+), training sites were established using ancillary data from Google Earth and the spectral values from the recent image. Image processing and the final map preparation are completed with ArcMap version 10.7.1.

Table 9 Satellite Imagery (Satellite data)

Data set type	Acquisition Date	Spatial Resolution (m)/Scale	Path/Row	Path/Row
Land Sat TM LT05_L1TP	1996-01-09	30m	Very High	USGS
Land Sat TM LT05_L2SP	2010-01-09	30m	High	USGS
Land Sat OLI/TIRS LC08_L1TP	2023-01-09	30m	Low	USGS

Source: USGS Earth Explorer Landsat TM

Table 10 organized data analysis Tools (techniques), their applications, functions, outputs, and how they are effectively used.

Data Analysis Tools	Application	Function	Output	How to Use
GIS	Mapping	used for spatial analysis, mapping, and visualization.	Maps, spatial data analysis, and visualization.	Import spatial data, perform reprocessing, create maps, and analyze spatial relationships.
Google Earth	Mapping	Satellite imagery and aerial photography for mapping	Detailed satellite images, 3D maps	Access satellite imagery, view maps, measure distances
AutoCAD	Mapping	Computer-aided design software for creating precise 2D and 3D drawings.	Detailed architectural or engineering drawings.	edit designs, and generate 2D/3D models.
Microsoft Excel	Data Analysis	for data organization, analysis, and visualization.	Tables, charts, graphs	Input and manipulate data, perform calculations, and create charts/graphs
Microsoft Word	Presentation	Word processing software for creating documents	Written reports, documents	Write and format reports
Microsoft PowerPoint	Presentation	Presentation software for creating slideshows	Slide-based presentations	Create slides to present findings visually.
Adobe Photoshop	Presentation	for manipulating and enhancing images.	Edited and enhanced images,	enhance graphics for presentations.

3.8. Validity and Reliability of the Data

To ensure the validity and reliability of the knowledge gathered, the questionnaires were not completed by the respondents themselves, but rather by the researcher and two additional data collectors. This method facilitated the consistency and accuracy of the data collected. The study incorporated diverse perspectives obtained through interviews and field observations.

Table 11 Validity and justification of the data

Validity	Justification
Content Validity	The questionnaires were carefully designed based on an extensive literature review and expert consultation. The inclusion of interviews and field observations enriched the content, ensuring comprehensive coverage of all relevant aspects of urbanization in the study area.
Construct Validity	The diverse data collection methods, including interviews and field observations, provided triangulation, strengthening the construct validity.
Criterion Validity	By correlating the questionnaire results with data from field observations and interviews, the researcher ensured that the findings were consistent with other measures of urbanization in the area.
Face Validity	The instruments were reviewed by experts in urban studies, who confirmed that they appeared to measure the intended concepts. Feedback from these experts was incorporated to enhance the clarity and relevance of the questions.

Table 12 Validity and justification of the data

Reliability	Justification
Inter-Rater Reliability	To ensure consistency in data collection, the researcher and the two additional data collectors were trained thoroughly. This training focused on standardizing the way questions were asked and responses recorded, minimizing variations between data collectors.
Internal Consistency	Cronbach's alpha was calculated for the questionnaire items to assess internal consistency.

Test-Retest Reliability	test-retest reliability was considered by repeating certain key questions at different times during the study period. The consistency of responses over time demonstrated the stability of the data.
Triangulation	Combining multiple data collection methods (questionnaires, interviews, and field observations) ensured a comprehensive understanding of urbanization in the study area. This methodological triangulation reinforced the reliability and validity of the findings.

This comprehensive approach ensures that the findings accurately represent the unique urban expansion dynamics within the study. Consequently, the results of this study are both valid and reliable.

3.9. Ethical Consideration

The research upholds a comprehensive framework of ethical considerations crucial for its integrity and impact. Acknowledging the property rights of farmers affected by urban expansion, ensuring their rights are respected and honored throughout the study. Before data collection and interviews, value their autonomy and participation.

One of the primary considerations of the investigator during the research was to ensure the protection and respect of respondents, safeguarding them from any potential harm arising from their participation in the study. To this end, the investigator took several measures to prioritize the well-being and privacy of the participants involved in Key Informant Interviews (KII) and Focus Group Discussions (FGD).

At the outset, the investigator informed all participants about the objectives of the study and assured them that their identities would remain confidential and would not be disclosed to any third parties, apart from the investigator. This commitment to confidentiality was paramount to fostering an environment of trust and openness.

During the interviews, the investigator made concerted efforts to accommodate the needs and schedules of the participants. Interviews were scheduled at times convenient for the respondents, ensuring they were free from work or other obligations, thereby promoting a comfortable and stress-free environment for the discussion.

The objectives of the study were clearly and comprehensively explained to the participants at the beginning of the data collection process. This transparency helped respondents understand the purpose of the research and the importance of their contributions, facilitating a more meaningful and engaged participation.

Throughout the research process, the investigator maintained a positive and respectful approach towards all respondents. This included seeking explicit permission from the selected samples before commencing any interviews or discussions. The emphasis was on voluntary participation, ensuring that respondents provided information willingly and without any force.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter focuses on the discussion and interpretation of the findings. Data were collected using various instruments and then tabulated, presented, and analyzed by dividing them into different sections, including demographic and socio-economic information of the respondents, and land use land cover detection results obtained from GIS and remote sensing software. The chapter is structured according to the objectives and research questions, with methods and approaches designed to achieve the specific goals outlined in previous chapters. It provides an overview of the chosen site and its current conditions. The experiences of farmers, residents, and professionals were examined and analyzed through questionnaires and interviews, as well as direct site observations, which are also discussed in this chapter.

4.1. Land use /land cover Change Detection

Land use/land cover (LULC) change detection of the study area in quantity and thematic maps, which are obtained from the 1996, 2010, and 2023 satellite images, are presented in this section hence five land use/land cover classes have been taken for the study. These are built-up, Water bodies, Farmland, Vegetation, and Bare land.

4.1.1. Land use / Land cover in 1996

Table 13, provides a detailed breakdown of land use/land cover (LULC) for the study area in 1996, highlighting the distribution of various classes across the total area of 1696.133 hectares.

The classification includes five categories: Water Bodies: Covering 96.824 hectares, which accounts for 5.7% of the total area. Built-up Areas; Encompassing 116.435 hectares, representing 6.9% of the total area. Farmland; Dominating the landscape with 1020.054 hectares, making up 60.1% of the total area. Vegetation; Occupying 115.149 hectares, equivalent to 6.8% of the total area. Bare Land; Spanning 347.671 hectares, constituting 20.5% of the total area. The total area covered by these classifications sums to 1696.133 hectares, providing a comprehensive view of land use distribution in the study area for the year 1996.

Table 13 Land use land cover of the Study Area in 1996

LU/ LC Type Class_1996	Area of 1996 in ha	Area in %
Water Body	96.824	5.7%
Built-up	116.435	6.9%
Farmland	1020.054	60.1%
Vegetation	115.149	6.8%
Bare land	347.671	20.5%
Total	1696.133	100.0%

Source: Owen Landsat TM Image Analysis 2024

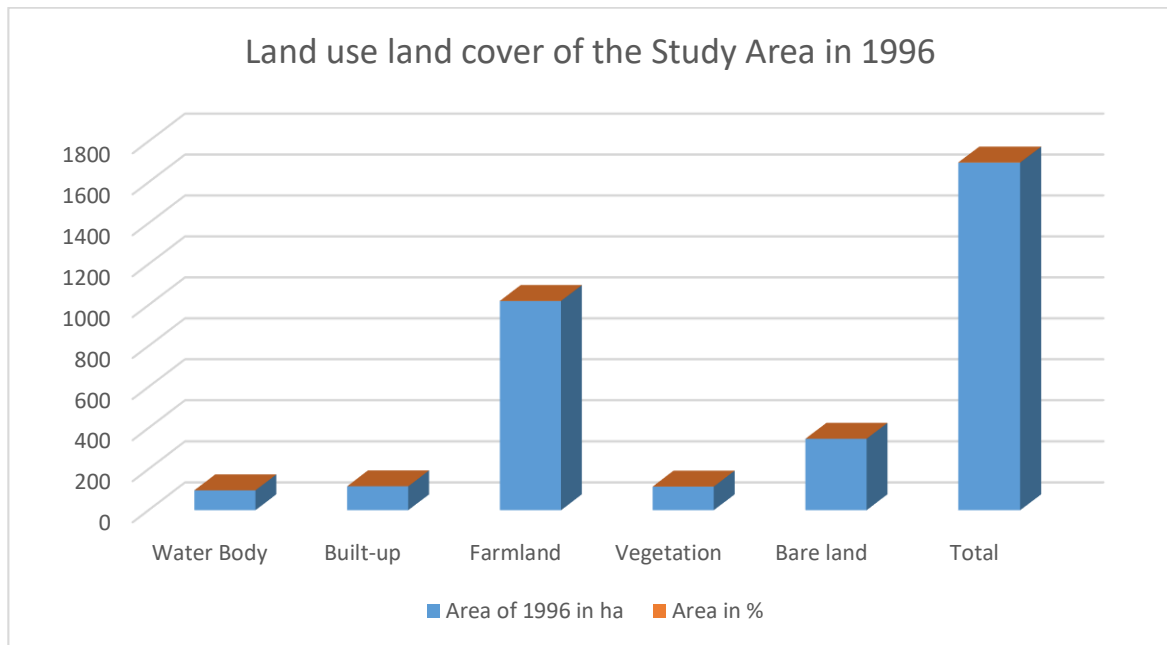


Figure 5 LULC of the Study Area in 1996

Source: Owen's interpretation, 2024

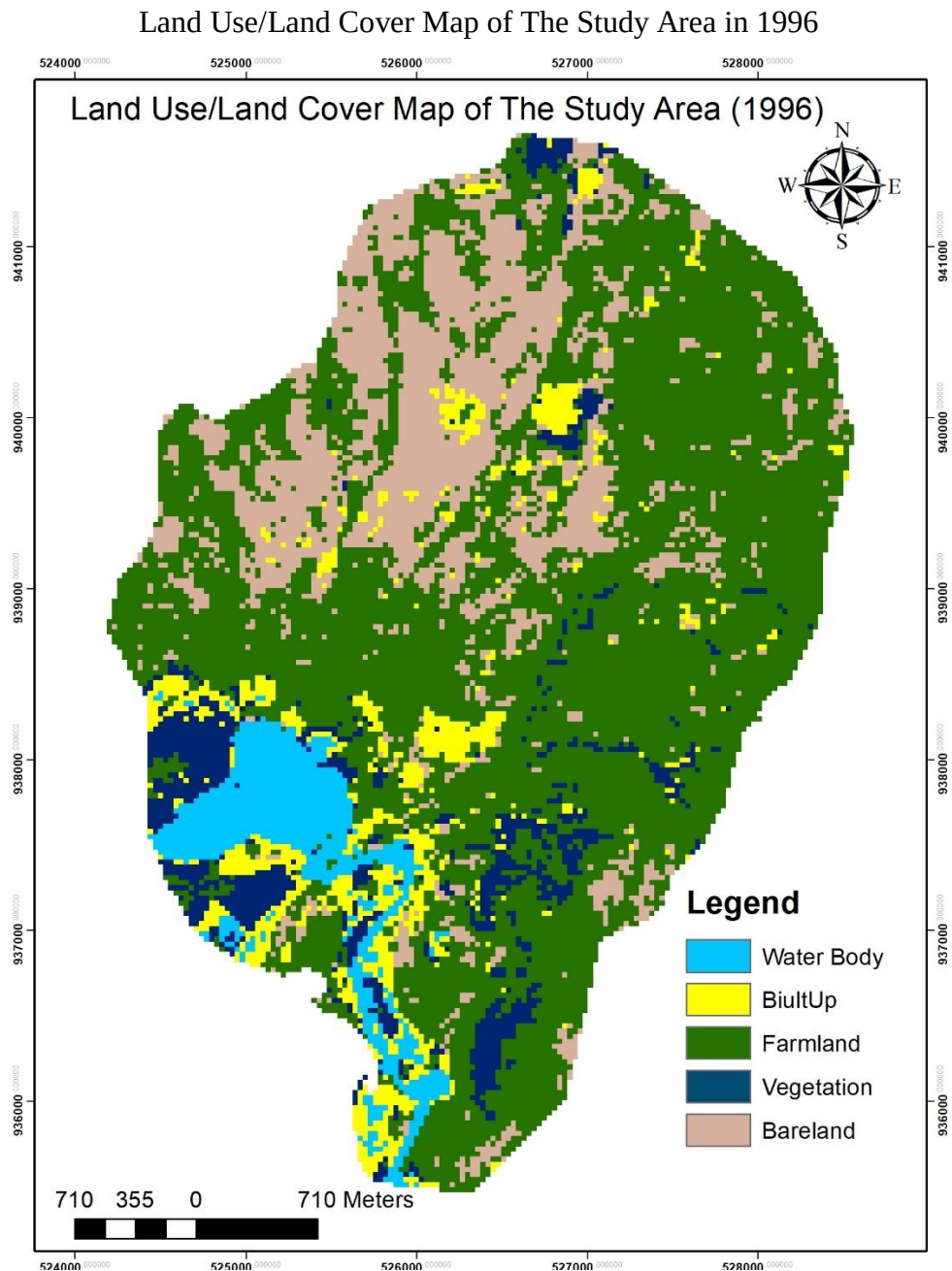


Figure 6 Land use/land cover map of the study area (1996)

Source: Owen's Landsat TM Image Analysis 2024

4.1.2 Land use / Land cover in 2010

Table 14 provides land use and land cover (LU/LC) types for the year 2010, expressed both in hectares (ha) and as a percentage of the total area. The total surveyed area amounts to 1696.133 hectares. Among the different categories, farmland occupies the largest portion, with 594.198 hectares, constituting 35.0% of the total area. Bare land follows, covering 443.255 hectares, which represents 26.1%. Vegetation covers 325.927 hectares, making up

19.2% of the area. Built-up areas account for 293.208 hectares or 17.3%, indicating significant development. Finally, water bodies occupy the smallest portion, with 39.546 hectares, equivalent to 2.3% of the total area. This table effectively illustrates the distribution and extent of different land use and cover types within the study area in 2010.

Table 14 Land use land cover of the Study Area in 2010

LU/ LC Type Class_2010	Area of 2010 in ha	Area in %
Water Body	39.546	2.3%
Built-up	293.208	17.3%
Farmland	594.198	35.0%
Vegetation	325.927	19.2%
Bare land	443.255	26.1%
Total	1696.133	100.0%

Source: Owen Landsat TM Image Analysis 2024

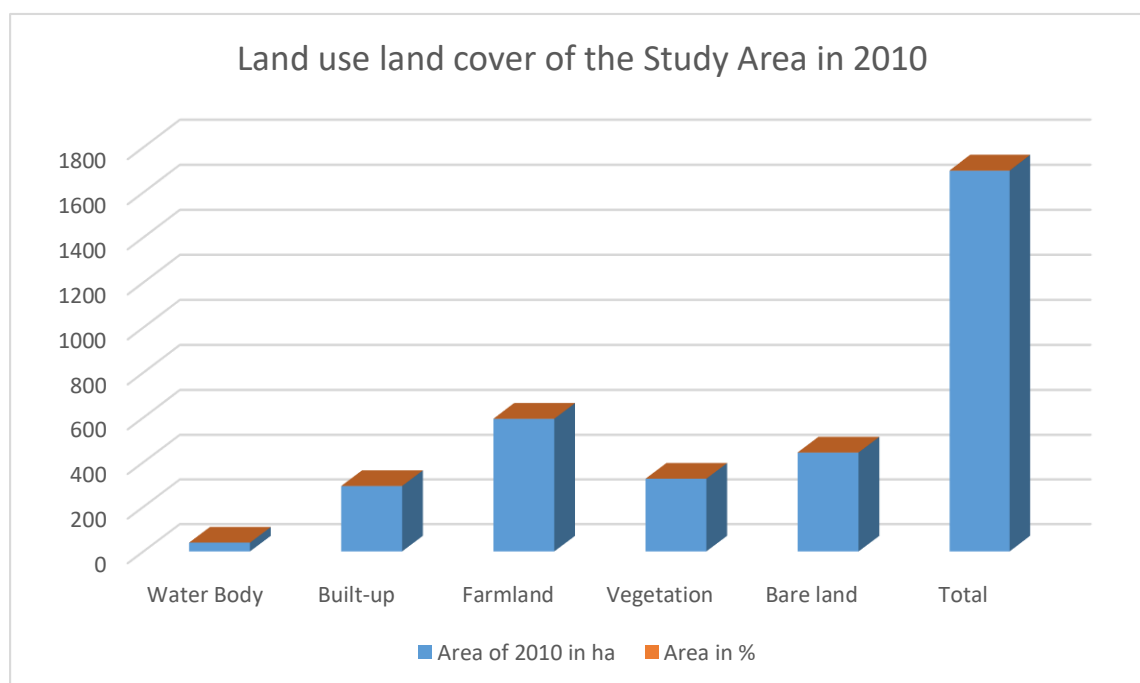


Figure 7 LULC of the Study Area in 2010

Source: Owen's interpretation, 2024

Land Use/Land Cover Map of the Study Area in 2010

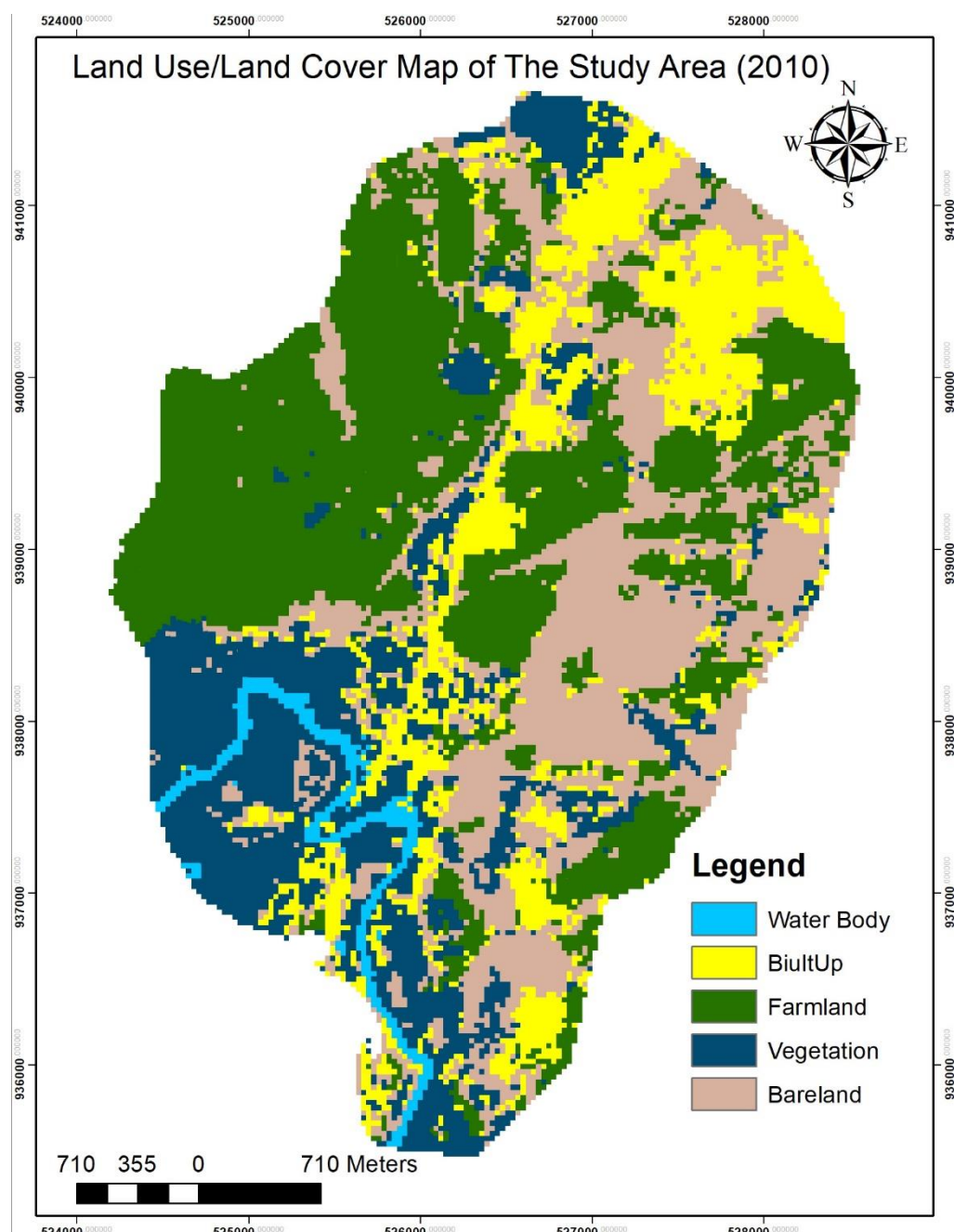


Figure 8 Land use/land cover map of the study area (2010)

Source: Owen's Landsat TM Image Analysis 2024

4.1.3. Land use / Land cover in 2023

Table 15 provides a detailed breakdown of land use and land cover (LU/LC) types for the year 2023, illustrating the distribution of various categories within a total surveyed area of 1696.133 hectares. Water Body: This category covers 151.895 hectares, which constitutes 9.0% of the total area. Built-up: The largest category, built-up areas, encompasses 816.072

hectares or 48.1% of the total area. Farmland: Agricultural land occupies 459.270 hectares, accounting for 27.1% of the area. Vegetation: This category, which includes forests, grasslands, and other areas with natural vegetation, covers 35.779 hectares or 2.1% of the total area. Bare Land: Representing 13.7% of the total area, bare land accounts for 233.117 hectares. the table highlights a predominance of built-up areas, followed by significant portions of farmland and bare land, with smaller areas dedicated to water bodies and vegetation.

Table 15 Land use land cover of the Study Area in 2023

LU/ LC Type Class_2023	Area of 2023 in ha	Area in %
Water Body	151.895	9.0%
Built-up	816.072	48.1%
Farmland	459.270	27.1%
Vegetation	35.779	2.1%
Bare land	233.117	13.7%
Total	1696.133	100.0%

Source: Owen Landsat TM Image Analysis 2024

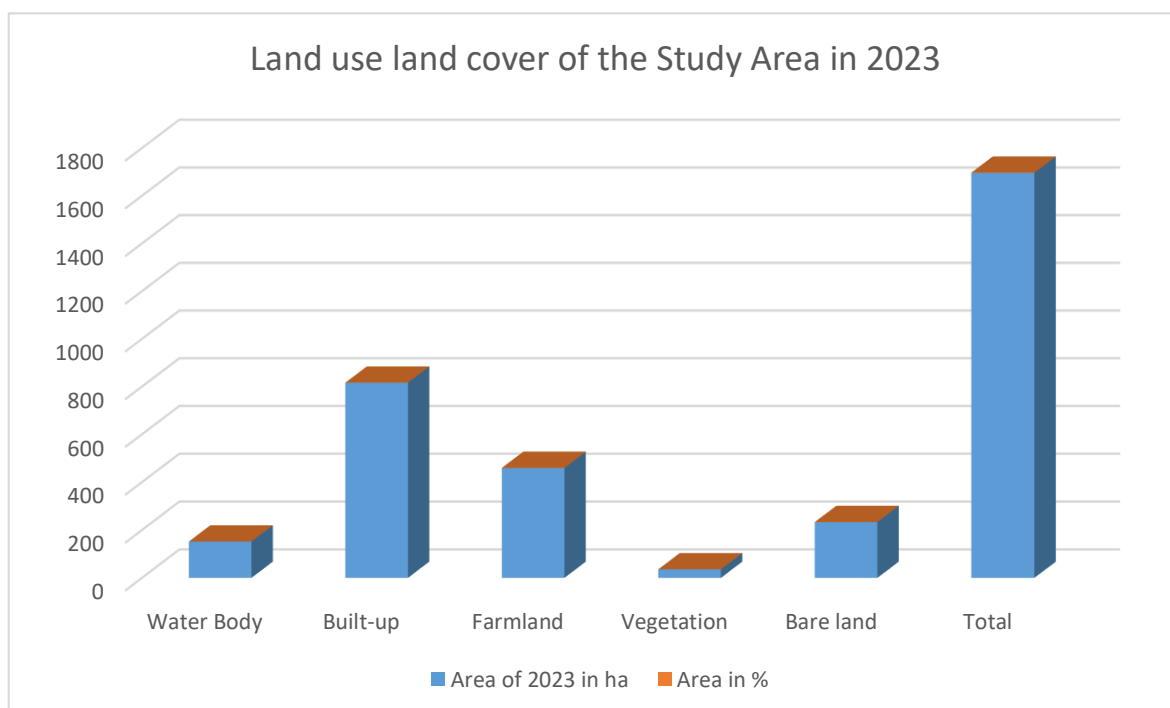


Figure 9 LULC of the Study Area in 2023

Land Use/Land Cover Map of the Study Area in 2023

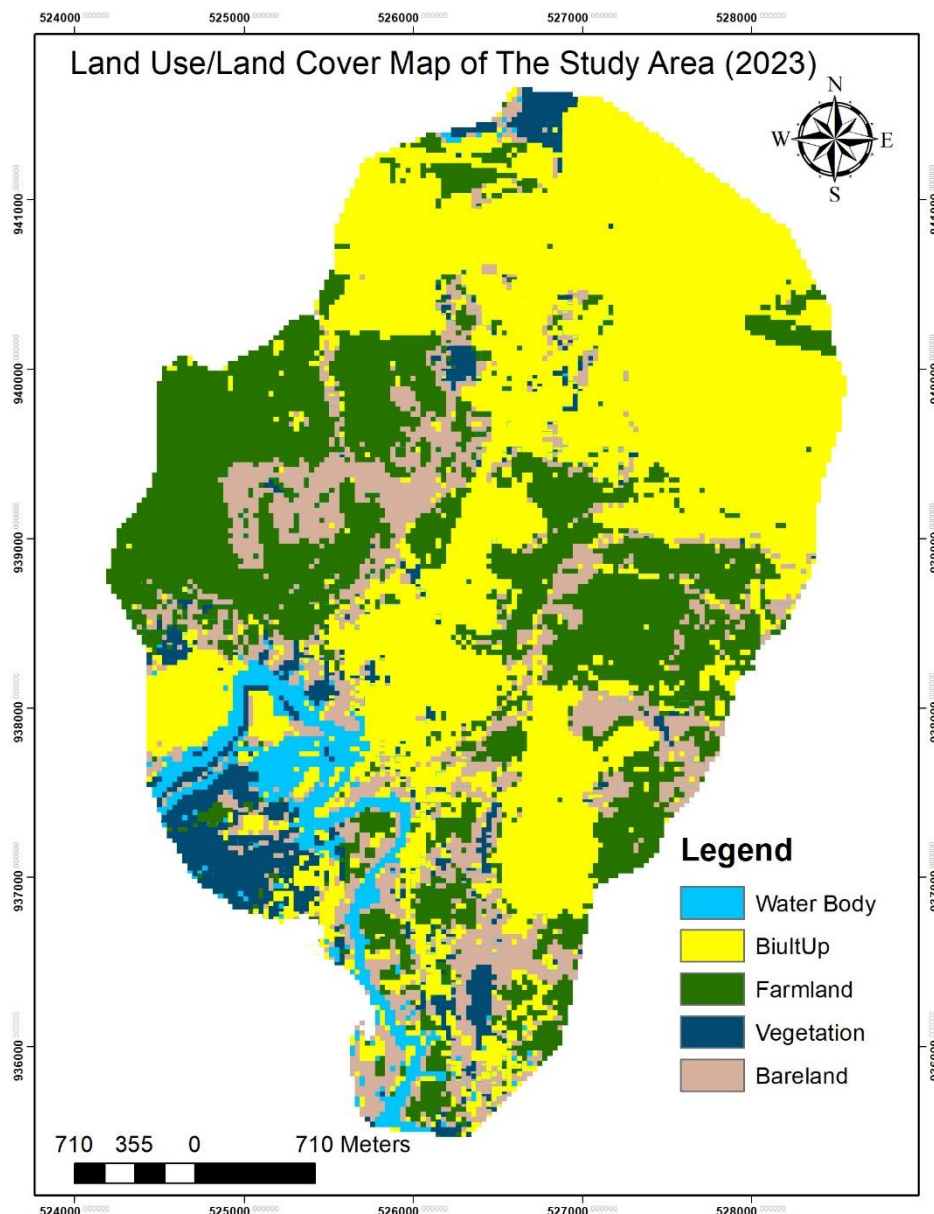


Figure 10 Land use/land cover map of the study area (2023)

Source: Owen Landsat TM Image Analysis 2024

4.1.4. Land Use Land Cover Change from 1996 – 2010, 2010 – 2023, and 1996-2023

The main objective of generating a classification map from images of Five different times was to determine how past and present human activities have been changing land. These thematic maps were further used as inputs in changing into other land cover/land use classes. As indicated in Table 16 the changes in land use and land cover (LU/LC) in the study area over three distinct periods: 1996-2010, 2010-2023, and the overall span from 1996 to 2023. The categories analyzed include Water Body, Built-up areas, Farmland, Vegetation, and

Bare land. These changes are quantified both in hectares (ha) and percentage terms, providing a comprehensive overview of how the landscape has evolved over the given periods.

From 1996 to 2010, the area designated as Water Body decreased by 57.27 hectares, which is a reduction of 3.4%. However, in the following period from 2010 to 2023, there was a significant increase of 112.34 hectares, representing a 6.7% rise. Overall, between 1996 and 2023, the Water Body area increased by 55.71 hectares, which accounts for a 3.3% net growth. This suggests that despite the initial reduction, there has been a substantial recovery and expansion of water bodies in the latter period.

Built-up areas, which typically include urban and infrastructure development, experienced a substantial increase across all periods. From 1996 to 2010, the Built-up area expanded by 176.77 hectares, or 10.4%. This growth accelerated from 2010 to 2023, with an increase of 522.86 hectares, or 30.8%. Cumulatively, from 1996 to 2023, the Built-up area surged by 699.63 hectares, amounting to a significant 41.2% increase. This trend indicates a strong and continuous urbanization and infrastructure development within the study area.

Conversely, Farmland experienced a notable decline throughout the entire period. Between 1996 and 2010, Farmland decreased by 425.85 hectares, equating to a 25.1% reduction. The decline continued from 2010 to 2023, although at a slower rate, with a decrease of 134.92 hectares or 7.9%. Overall, from 1996 to 2023, Farmland decreased by 560.78 hectares, representing a total reduction of 33.0%. This decline highlights a significant shift away from agricultural land, likely due to urban expansion.

The area covered by Vegetation saw mixed changes over the periods. From 1996 to 2010, there was an increase of 210.77 hectares, or 12.4%. However, from 2010 to 2023, this was reversed with a decrease of 290.14 hectares, amounting to a 17.1% reduction. Overall, the net change from 1996 to 2023 shows a slight decrease of 79.37 hectares or 4.7%. This fluctuation suggests varying factors influencing vegetation cover, including possible reforestation efforts in the early period followed by deforestation or land clearing in the later period.

Lastly, Bare land, which can include areas without significant vegetation or development, increased by 95.58 hectares (5.6%) from 1996 to 2010. However, it decreased by 210.13 hectares (12.4%) from 2010 to 2023. The net change over the entire period was a reduction of 114.55 hectares or 6.8%. This indicates that while there was initially an increase in bare

land, likely due to land clearing or degradation, later efforts or natural processes may have led to a reduction and possible reclamation or repurposing of these areas.

In summary, the study area has undergone significant changes in land use and land cover from 1996 to 2023. The trends indicate urban expansion at the expense of farmland, fluctuating vegetation cover, and dynamic changes in water bodies and bare land.

Table 16 land use land cover change in ha and percentage from 1996- 2023

LU/ LC Type	Change in 1996-2010		Change in 2010-2023		Change in 1996-2023	
	Area in ha	Area in %	Area in ha	Area in %	Area in ha	Area in %
Water Body	-57.27 ha	-3.4%	112.34 ha,	6.7%	55.071 ha	3.3%
Built-up	176.77 ha	10.4%	522.86 ha,	30.8%	699.63 ha	41.2%
Farmland	-425.85 ha	-25.1%	-134.92 ha,	-7.9%	-560.78 ha	-33.0%
Vegetation	210.77ha	12.4%	-290.14 ha,	-17.1%	79.37 ha,	-4.7%
Bare land	95.58 ha	5.6%	-210.13 ha,	-12.4%	-114.55 ha	-6.8%

Source: computed based on data extracted from Owen's image analysis 2024

The observed changes in land use and land cover (LU/LC) within the study area can be evaluated by comparing them to both international standards and local expectations.

On an international level, sustainable land management practices emphasize the preservation of natural resources, biodiversity conservation, and the minimization of land degradation. (Tadesse T. , Jul 2023) In this context, the reduction in farmland and vegetation cover raises concerns, as it can indicate unsustainable agricultural practices.

Conversely, the increase in built-up areas suggests urban sprawl, which can lead to habitat fragmentation and loss of ecosystem services. International standards typically advocate for balanced land use planning that promotes conservation, sustainable agriculture, and resilient urban development (Kenneth John Button, 2007).

Locally, land use policies and standards may be influenced by regional priorities, economic considerations, and societal needs. The significant increase in built-up areas may align with local development goals aimed at boosting economic growth and meeting housing demands. However, the decline in farmland could pose challenges for food security and rural livelihoods, especially if not accompanied by measures to enhance agricultural productivity or support alternative livelihoods.

The analysis of land use and land cover (LULC) change between 1996, 2010, and 2023 in the study area reveals significant trends that reflect broader patterns of human activity and environmental management. Hence the Analysis of LULC Changes mainly shows the fluctuation between two land cover classes which are Built-up and farmland so The continuous and substantial increase in built-up areas reflects significant urbanization and infrastructure development. This trend is consistent with global urbanization patterns, especially in developing regions where urban growth is rapid. However, such expansion should be managed to minimize adverse effects on the environment, ensure sustainable urban planning, and align with SDG 11 (Sustainable Cities and Communities).

The reduction in farmland highlights a shift from agricultural land to urban and other uses. This trend may pose risks to food security and rural livelihoods if not managed properly. (Abebe, 2024) Sustainable agriculture practices and land use planning are essential to balance urban growth and agricultural needs, aligning with SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production). (Mollier Ludovic, 2017), (Russell, January 2018)) Overall; In the study area the substantial increase in built-up areas indicates rapid urbanization, which is a global trend and also The significant reduction in farmland raises concerns about food security and rural economies When agricultural land is lost, it can negatively impact food production, farmer livelihoods, and the overall economic viability.

4.1.5. The Rate of Change of Land Use and Land Cover in The Study Area

The analysis of Land Use and Land Cover (LU/LC) changes over the years 1996, 2010, and 2023 reveals significant transformations in the study area. By examining the changes in hectares and calculating the annual rate of change, between 1996 and 2010, notable shifts occurred in various land cover categories: The area of water bodies decreased by 57.278 hectares, with an annual reduction rate of 4.091 hectares per year. This decline corresponds to a percentage decrease of 3.4%. There was a substantial increase of 176.773 hectares in built-up areas, growing at a rate of 12.627 hectares per year. This category saw a percentage rise of 10.4%. Farmland experienced a significant reduction of 425.856 hectares, translating to an annual loss of 30.418 hectares per year, and a percentage decrease of 25.1%. The vegetation cover expanded by 210.778 hectares, with an annual increase of 15.056 hectares per year. This reflects a percentage growth of 12.4%. Bare land increased by 95.584 hectares, at a rate of 6.827 hectares per year, representing a 5.6% increase.

From 2010 to 2023, the trends in land cover changes showed different patterns: The area of water bodies saw an increase of 112.349 hectares, at an annual rate of 8.642 hectares per year. This represents a percentage increase of 6.7%. Built-up areas continued to grow significantly, increasing by 522.864 hectares at a rate of 40.220 hectares per year, with a percentage rise of 30.8%. Farmland continued to decrease, losing 134.928 hectares at an annual rate of 10.379 hectares per year, showing a 7.9% decrease. Vegetation cover decreased dramatically by 290.148 hectares, at an annual loss of 22.319 hectares per year, reflecting a percentage reduction of 17.1%. Bare land also saw a reduction of 210.138 hectares, at an annual rate of 16.164 hectares per year, with a percentage decrease of 12.4%. Over the longer period from 1996 to 2023, the changes are; There was a net increase of 55.071 hectares in water bodies, with an annual increase of 2.040 hectares per year, and a percentage rise of 3.3%. Built-up areas experienced a dramatic increase of 699.637 hectares, growing at a rate of 25.909 hectares per year, showing a significant percentage increase of 41.2%. Farmland saw a large reduction of 560.784 hectares, translating to an annual loss of 20.766 hectares per year, and a percentage decrease of 33.0%. Vegetation cover decreased by 79.370 hectares, with an annual reduction of 2.940 hectares per year, reflecting a percentage decrease of 4.7%. Bare land decreased by 114.554 hectares, at an annual rate of 4.243 hectares per year, representing a 6.8% reduction.

Table 17 The rate of change in land use land cover between the year 1996- 2023

LU/ LC Type	1996-2010	2010-2023	1996-2023
	Rate in ha/year	Rate in ha/year	Rate in ha/year
Water Body	-4.091 ha/year	8.642 ha/year	2.040 ha/year
Built-up	12.627 ha/year	40.220 ha/year	25.909 ha/year
Farmland	-30.418 ha/year	-10.379 ha/year	-20.766 ha/year
Vegetation	15.056 ha/year	-22.319 ha/year	-2.940 ha/year
Bare land	6.827 ha/year	-16.164 ha/year	-4.243 ha/year

Source: computed based on data extracted from own image analysis 2024

4.1.6. Accuracy Assessment

Error matrix was produced for all images in this study. An error matrix is a square array of rows and columns and presents the relationship between the classes in the classified and reference data. The reference data used for accuracy assessment were obtained from GPS

points during fieldwork and from high-resolution images of Google Earth. High-resolution images of Google Earth were used to generate reference data for older images of TM and ETM+ and are acquired as close as the acquisition dates of the older Land sat images. Based on the error matrix, overall accuracy and kappa statistics were used to illustrate the classification accuracy. Therefore, an overall accuracy of 88%, 89%, and 91% was achieved for the Land sat TM of 1996, Land sat ETM+ of 2010 and Land sat OLI/TIRS of 2023 respectively

4.1.6.1. Accuracy Assessment and Confusion Matrix for Land Use Land Cover Map of 1993

Table 18, presents the results of a classification accuracy assessment for various land cover types in a given area. It shows the number of correctly and incorrectly classified instances for five different land cover classes: Water Body, Built-up, Farmland, Vegetation, and Bare Land. The data includes both the confusion matrix and the calculation of user accuracy (U Accuracy) and producer accuracy (P Accuracy) for each class. The confusion matrix is a 5x5 table where: Rows represent the actual land cover classes. Columns represent the predicted land cover classes. Each cell in the matrix indicates the number of instances where a particular land cover type was classified. For example, the cell at the intersection of "Water Body" in the rows and "Water Body" in the columns has a value of 5, meaning 5 instances of actual Water Body were correctly classified as Water Body. Breakdown of the Confusion Matrix; Water Body: Out of 6 actual instances of Water Body, 5 were correctly classified, and 1 was misclassified as Farmland, Built-up: All 5 instances of Built-up were correctly classified with no misclassifications, Farmland: Out of 50 actual instances, 47 were correctly classified, and 3 were misclassified as Bare Land, Vegetation: Out of 11 actual instances, only 5 were correctly classified. The remaining 6 were misclassified as Farmland. Bare Land: Out of 28 actual instances, 26 were correctly classified. There were 2 misclassifications (1 as Built-up and 1 as Farmland).

User accuracy indicates the likelihood that a given class on the map is present on the ground (i.e., the reliability of the classification from the user's perspective): Water Body: 83% (5 out of 6 instances are correct), Built-up: 100% (All instances are correct), Farmland: 94% (47 out of 50 instances are correct), Vegetation: 45% (5 out of 11 instances are correct), Bare Land: 93% (26 out of 28 instances are correct)

Producer accuracy indicates the likelihood that a given class on the ground is correctly classified on the map (i.e., the completeness of the classification from the producer's

perspective): Water Body: 100% (All actual Water Body instances were correctly classified), Built-up: 83% (5 out of 6 actual instances were correctly classified), Farmland: 85% (47 out of 55 actual instances were correctly classified), Vegetation: 100% (All actual Vegetation instances were correctly classified), Bare Land: 90% (26 out of 29 actual instances were correctly classified)

The overall accuracy of the classification is calculated by dividing the total number of correctly classified instances by the total number of instances:

$$\{\text{Overall Accuracy}\} = \{5 + 5 + 47 + 5 + 26\} \{100\} = 0.88$$

Thus, the overall accuracy of the classification is 88%.

Overall, Kappa Statistics = 0.81

Table 18 Confusion Matrix for Land Cover Maps of 1996

Class Name	Water Body	Built-up	Farmland	Vegetation	Bare land	Total	U Accuracy
Water Body	5	0	1	0	0	6	0.83
Built-up	0	5	0	0	0	5	1
Farmland	0	0	47	0	3	50	0.94
Vegetation	0	0	6	5	0	11	0.45
Bare land	0	1	1	0	26	28	0.93
Total	5	6	55	5	29	100	0
P Accuracy	1	0.83	0.85	1	0.90	0	0.88

Source: computed based on data extracted from own image analysis 2024

4.1.6.2. Accuracy Assessment and Confusion Matrix for Land Use Land Cover Map of 2010

Table 19, presents a confusion matrix along with the associated user (U Accuracy) and producer (P Accuracy) accuracies for a classification task involving five different land cover classes: Water Body, Built-up, Farmland, Vegetation, and Bare Land. The confusion matrix shows the actual versus predicted classifications for 100 samples. Here's a detailed description:

User accuracy is the proportion of correctly predicted instances out of the total instances predicted for each class. Water Body: 100%, Built-up: 100%, Farmland: 83%, Vegetation: 100%, Bare Land: 89%. Producer accuracy is the proportion of correctly predicted instances

out of the total actual instances for each class. Water Body: 100%, Built-up: 68%, Farmland: 100%, Vegetation: 89%, Bare Land: 89%.

The classification system performs exceptionally well for Water Body, Farmland, and Vegetation, with both user and producer accuracies being very high. Built-up areas show high user accuracy but a relatively lower producer accuracy, indicating some misclassification in predicting Built-up instances. Bare Land has slightly lower user and producer accuracies compared to the other classes, suggesting a bit more confusion in distinguishing Bare Land from other categories. Overall classification Accuracy = 89%, Overall, Kappa Statistics = 0.85

Table 19 Confusion Matrix for Land Cover Maps of 2010

Class Name	Water Body	Built-up	Farmland	Vegetation	Bare land	Total	U Accuracy
Water Body	1	0	0	0	0	1	1
Built-up	0	13	0	0	0	13	1
Farmland	0	4	34	0	3	41	0.83
Vegetation	0	0	0	17	0	17	1
Bare land	0	2	0	2	24	28	0.86
Total	1	19	34	19	27	100	0
P Accuracy	1	0.68	1	0.89	0.89	0	0.89

Source: computed based on data extracted from own image analysis 2024

4.1.6.3. Accuracy Assessment and Confusion Matrix for Land Use Land Cover Map of 2023

Table 20, provided represents a confusion matrix along with the producer's accuracy (P_Accuracy), user's accuracy (U_Accuracy), and kappa statistics for different land cover classes. Each row represents the actual class, and each column represents the predicted class. The diagonal elements indicate the number of correctly classified instances for each class, while the off-diagonal elements represent misclassifications. Out of 10 actual Water Body instances, 8 were correctly classified as Water Body, and 2 were misclassified as Built-up. Out of 43 actual Built-up instances, 42 were correctly classified, 1 was misclassified as Farmland, 1 as Bare land, and 2 Water Body instances were wrongly classified as Built-up. Out of 28 actual Farmland instances, 26 were correctly classified, 1 was misclassified as Built-up, and 2 as Bare land. Out of 2 actual Vegetation instances, all 2 were correctly

classified. Out of 17 actual Bare Land instances, 13 were correctly classified, 1 was misclassified as Farmland, and 3 Vegetation instances were wrongly classified as Bare land.

User's Accuracy (U_Accuracy): This metric indicates the probability that a pixel classified into a given category represents that category on the ground. Water Body: 1.00 (100% accurate), Built-up: 0.91 (91% accurate), Farmland: 0.90 (90% accurate), Vegetation: 0.67 (67% accurate), Bare land: 0.93 (93% accurate)

Producer's Accuracy (P_Accuracy): This metric indicates the probability that a pixel on the ground is correctly classified. Water Body: 0.80 (80% accurate), Built-up: 0.98 (98% accurate), Farmland: 0.93 (93% accurate), Vegetation: 1.00 (100% accurate), Bare land: 0.76 (76% accurate)

Kappa Statistics: The Kappa statistic measures the agreement between the classification and the ground truth, corrected for the chance agreement. The overall kappa value is 0.87, indicating a high level of agreement beyond chance. High U_Accuracy and P_Accuracy values suggest that the model is generally reliable for most classes, except for Vegetation, which has a lower User's Accuracy (0.67). The Kappa statistic of 0.87 indicates strong agreement between the classification results and the ground truth data.

Table 20 Confusion Matrix for Land Cover Maps of 2023

Class Name	Water Body	Built-up	Farmland	Vegetation	Bare land	Total	U Accuracy
Water Body	8	0	0	0	0	8	1
Built-up	2	42	1	0	1	46	0.91
Farmland	0	1	26	0	2	29	0.90
Vegetation	0	0	0	2	1	3	0.67
Bare land	0	0	1	0	13	14	0.93
Total	10	43	28	2	17	100	0
P Accuracy	0.8	0.98	0.93	1	0.76	0	0.91

Source: computed based on data extracted from own image analysis 2024

4.2. The major Cause for the city Expansion in the Study Area

Urbanization has a significant impact on farmland, and understanding the major causes behind this phenomenon is crucial. So in this portion, the study focuses on the impact of urbanization on Wonji farmland by examining the roles of formal and informal (squatter) settlements in the study area. These categories reflect varying levels of regulation, planning, and infrastructure availability, and understanding them is key to addressing the challenges posed by urban expansion.

According to field observation and interviews conducted with urban planners from the Adama city municipality land Authorities office, different factors contribute to formal and informal settlements. Formal settlements encompass government projects such as road constructions, industrial developments, warehouses, and residential developments that adhere to urban planning regulations and receive official permissions. These projects initiated between 2010 and 2022, have significantly contributed to the structured expansion of the city. Conversely, informal settlements in the study area primarily consist of squatter residential developments. These settlements arise without government approval or regulation, often leading to unplanned urban sprawl. The lack of official oversight and infrastructure in these areas exacerbates the strain on agricultural land, as these settlements encroach upon farmland without following any strategic urban planning.

The maps (Figures 11, 12, and 13) presented in the study highlight the growth of both formal and informal settlements. They illustrate how government-sanctioned developments have expanded over the years, showing a clear pattern of regulated urban growth. However, they also reveal the presence of squatter settlements, which the government is often unaware of until they have already significantly impacted the farmland.

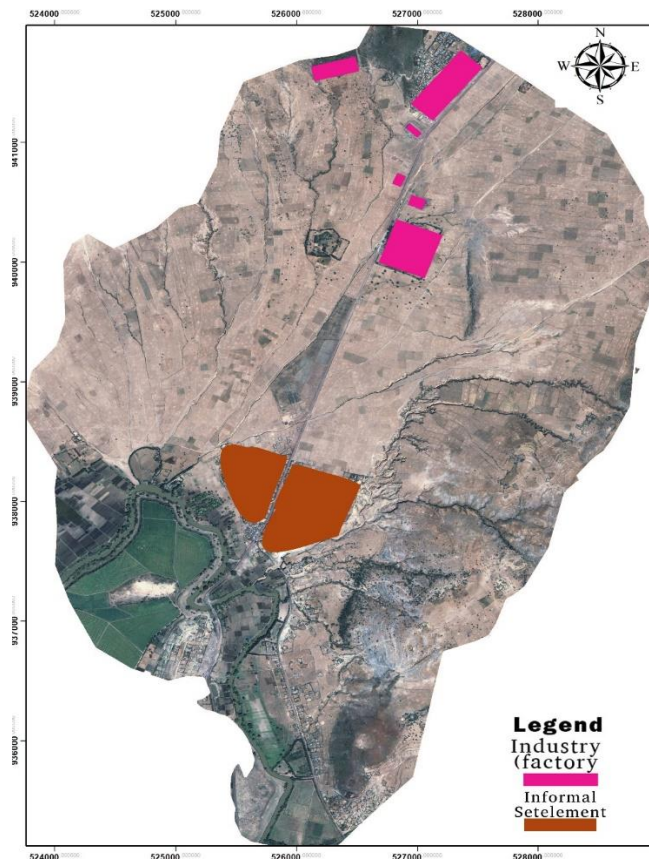


Figure 11 Transformed Actual Google Earth Image 2007

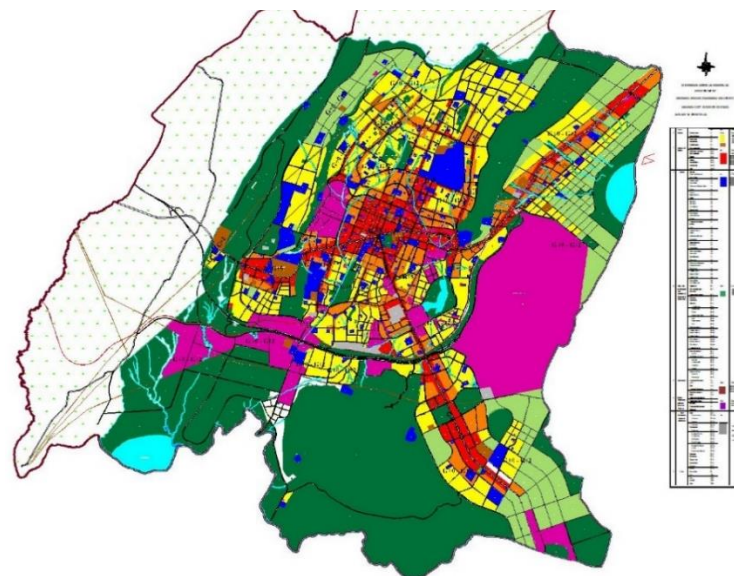


Figure 12 Adama City Final Structure Plan

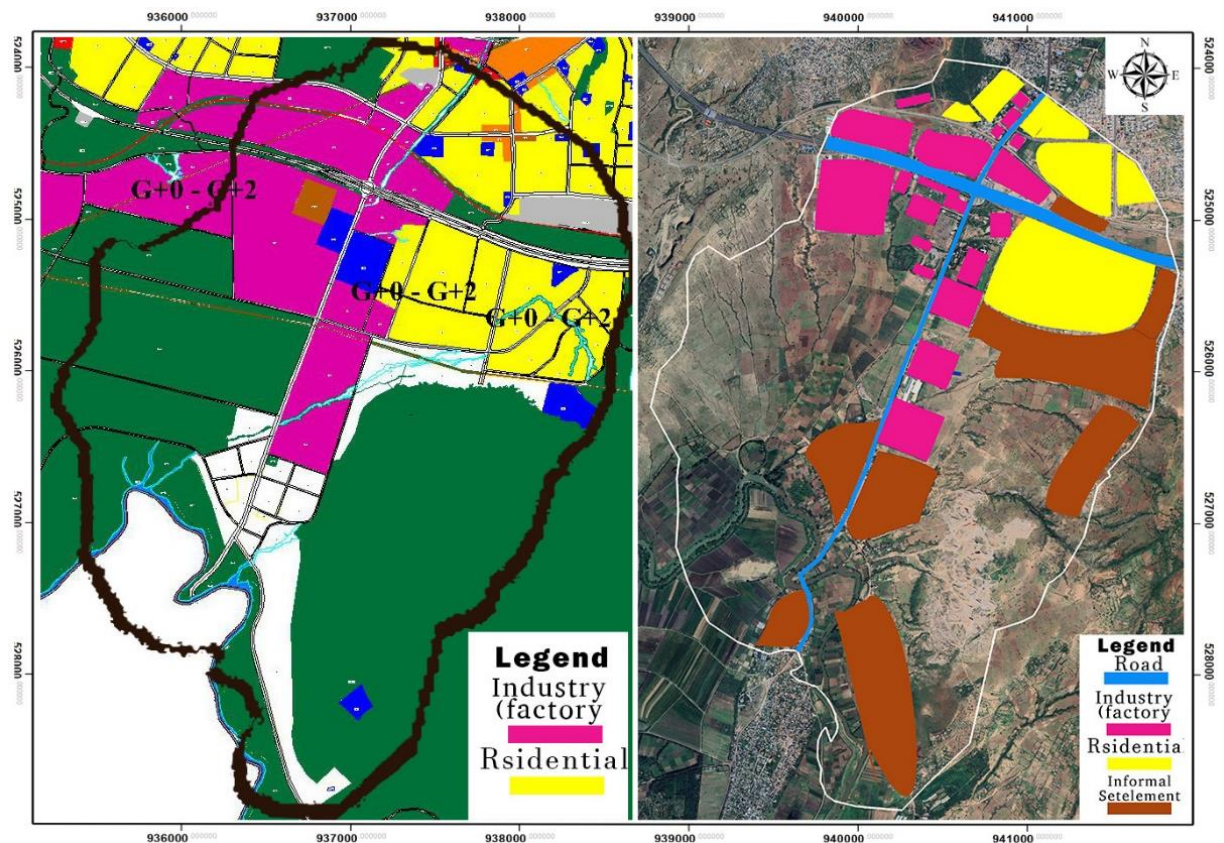


Figure 13 Adama City Final Structural Plan and Transformed Actual Google Earth Image 2024.

From the above information, the expansion of Adama City into Wonji farmland is driven by both formal and informal settlement activities. Government-approved projects contribute to organized urban growth, whereas squatter settlements lead to uncontrolled sprawl. Addressing the challenges posed by informal settlements through better regulation, planning, and infrastructure development is essential to mitigate the adverse effects of urbanization on farmland.

4.3. Implications of Land Use Changes Caused by Urban Expansion On the Agricultural Productivity of Wonji Farmland

4.3.1. Background of the Respondents

Gender

Based on the data collected from the study area, among the total sampled households (comprising both farmers and residents), 83.3% were male-headed households, while the remaining 16.7% were female-headed households, as shown in Table 21. The gender composition of households is a crucial factor influencing participation and decision-making processes, which, in turn, affects the overall livelihood of the community.

Table 21 Gender distribution

The gender of the household's	Frequency of NO of RE	Percent
Male	190	80.9%
Female	45	19.1%
Total	235	100.0%

Source: Own Field Survey data, 2024

Age of the household

The household survey conducted in the study area revealed the age distribution among the total sampled households. The findings are detailed as of Age Group 18-30; There were 72 households in this age group, representing 30.6% of the total sampled households, Age Group 31-43; This was the largest age group, with 110 households, accounting for 46.8% of the total, Age Group 44-56; There were 46 households in this category, making up 19.6% of the total, Age Group 57 and above; The smallest group, with 7 households, comprised 3% of the total sampled households. This age distribution provides insight into the demographic structure of the households in the study area, which can be critical for understanding participation rates, decision-making processes, and the overall impact on community livelihood.

Table 22 Age of household

Age	Frequency of NO of RE	Percent
18-30	72	30.6%
31--43	110	46.8%
44-56	46	19.6%
>_ 57	7	3.0%
Total	235	100%

Source: Own Field Survey data, 2024

Education

Concerning educational background there is significant variation as is noticed in the table below. The data presented in Table 23, revealed that 18(7.7%), cannot read and write. 95(40.4%) can read and write (Also there are only by attending adult education). 45(19.1%) are in grades 1-8 primary school, 37(15.7%) are in Secondary school grade completed, 24(10.2%) in Vocational/technical school, and 16(6.8%) in Tertiary (college and university) This implies that most of the peripheral farming communities whose land has been displaced and those whose livelihood has been affected by urban expansion have no educational qualification.

Table 23 Level of education

Education	Frequency of NO of RE	Percent
Cannot read and write	18	7.7%
Read and write	95	40.4%
Primary school	45	19.1%
Secondary school	37	15.7%
Vocational/technical school	24	10.2%
Tertiary (college and university)	16	6.8%
Total	235	100%

Source: Own Field Survey data, 2024

Marital Status

Marital status is a critical factor influencing fertility behavior, as the majority of births occur within marital unions. Changes in the distribution of marital status, therefore, significantly impact the size and structure of families and households. With the urban expansion, these dynamics can become even more pronounced. Table 24, presents data on the marital status of respondents, which is crucial for understanding the social dynamics within the context of urban expansion. Out of the total 235 respondents, the majority, 136 individuals (57.9%), are married. This suggests that a substantial portion of the population has established family units, which can be an important factor when considering the impact of urban expansion on housing needs and community services. The second-largest group comprises single

individuals, with 68 respondents (28.9%). This demographic is likely to be more mobile and may have different housing and employment needs compared to married respondents. Divorced respondents make up 9.8% of the total, with 23 individuals. Lastly, 8 respondents (3.4%) are widowed. Overall, the data indicates that the majority of the population is married, with significant proportions of single and divorced individuals.

Table 24 Marital Status of Respondents

Marital status	Frequency of NO of RE	Percent
Single	68	28.9%
Married	136	57.9%
Divorced	23	9.8%
Widowed	8	3.4%
Total	235	100%

Source: Own Field Survey data, 2024

4.3.2. Current Land Ownership Distribution Among Respondents in the Study Area.

Table 25, provides an overview of the land ownership status among the respondents based on a field survey conducted in 2024. The table categorizes respondents into two groups: those who own land and those who do not. Out of a total of 235 respondents, a significant majority, 191 individuals, representing 81.3%, reported owning land. In contrast, 44 respondents, which constitute 18.7%, indicated that they do not own any land.

The data suggests that land ownership is common among the respondents, with over four-fifths of the individuals surveyed holding land. This information could be useful for understanding the socio-economic conditions and potential agricultural or development activities within the surveyed area.

Table 25 Status of land ownership of respondents

Response	Frequency of NO of RE	Percent
Yes	191	81.3%
No	44	18.7%
Total	235	100.0%

Source: Field survey conducted in, 2024

4.3.2.1. Respondents Land Size in Hectare

Table 26, provided the distribution of land holdings among 191 respondents, categorized by the size of their land in hectares. 3 hectares and above; This category represents the smallest group of respondents, with only 8 individuals owning land holdings of 3 hectares or more. This group makes up a minor 4.2% of the total respondents, indicating that large land holdings are relatively uncommon among the surveyed population. 2 to 3 hectares; In this category, 37 respondents own land between 2 and 3 hectares. This group constitutes 19.4% of the total, representing a significant portion of the respondents who have moderately sized land holdings. 1 to 2 hectares; The majority of respondents fall into this category, with 102 individuals owning land holdings between 1 and 2 hectares. This group forms the largest segment, making up 53.4% of the total. It indicates that the most common land-holding size among the respondents is between 1 and 2 hectares. Below 1 hectare; This category includes respondents with land holdings of less than 1 hectare. With 44 individuals, it represents 23.0% of the total respondents. This significant percentage shows that a considerable number of respondents have relatively small land holdings.

From the data, it is clear that the majority of respondents (53.4%) own land in the range of 1 to 2 hectares, indicating that this is the most common landholding size among the surveyed population.

Understanding the distribution of land holdings is crucial for developing policies and programs aimed at land use management, agricultural productivity, and rural development. (Daniel Weldegebriel AMBAYE, May 2012) Hence, the high percentage of respondents with land holdings between 1 and 2 hectares indicates a need for targeted support to optimize the use of these lands for agricultural purposes.

Table 26 Respondents' Land Holdings in Hectares

Land Holding Group in hectares	Frequency of NO of RE	Percent
3 ha and above	8	4.2%
2-3 ha	37	19.4%
1-2 ha	102	53.4%
Below 1 ha	44	23.0%
Total	191	100%

Source: Own Field Survey data, 2024

4.3.2.2. Respondents' Land Allotment Purposes

As per Table 27, Cropland is the most popular land use type among respondents. Nearly 41% of the participants use their land primarily for growing crops. This indicates the farmer's significant focus on agricultural production in the study area. Grazing land is the least common land use type, with only 2.1% of respondents using their land primarily for grazing livestock. This suggests a limited emphasis on livestock farming compared to other types of land use. A notable proportion of respondents, 17%, utilize their land for cultivating fruits and other types of vegetation. This reflects a substantial interest in horticulture and possibly small-scale agricultural diversification.

Some respondents (14.9%) have a mixed-use approach, employing their land for both crop production and livestock grazing. This dual usage indicates a strategy to maximize land productivity and diversify agricultural activities. A significant portion of respondents, 18.7%, do not own any land. This could include individuals who live in urban areas, those without access to land, or they do engage in agricultural activities by contracting the land from farmers.

A small group, 6.4%, use their land for all purposes mentioned (cropland, grazing, and fruits and vegetation). This indicates a highly versatile farmland exists in the study area. Generally, this highlights the diverse ways in which respondents use their land, with cropland being the predominant type, followed by fruits and vegetation, mixed-use of cropland and grazing, and a notable percentage of respondents not using any land at all. The smallest groups are those using land only for grazing and those utilizing their land for all purposes.

Table 27 Respondents' current land allotment

Land use type	Frequency of NO of RE	Percent (%)
Cropland	96	40.9%
Grazing land	5	2.1%
Fruits and vegetation	40	17.0%
Cropland and grazing land	35	14.9%
No land	44	18.7%
All purposes	15	6.4%
Total	235	100%

Source: Own Field Survey data, 2024

4.3.3. Scarcity of Land Opportunities and the displacement of farmland holders Due to Urban Expansion

As indicated in Table 28, urban expansion has significantly impacted respondents' displacement from their land. A majority of respondents (66.4%) reported losing their secondary land, highlighting substantial disruptions in their ability to maintain additional agricultural plots. Additionally, 26.0% of respondents experienced total displacement, indicating a severe impact on their primary living conditions and livelihood. A smaller proportion, 7.7%, reported no loss of land, suggesting some level of resilience or alternative arrangements but they may be in big scarcity of losing their lands due to the expansion.

Table 28 Land Displacement Status of Affected Landowners

Displaced from their land	Frequency of NO of RE	Percent (%)
Displaced	61	26.0%
loss of the second land	156	66.4%
Reduction of lands(subtracted)	18	7.7%
Total	235	100%

Source: Own Field Survey data, 2024

4.3.3.1. Type of Land Lost Due to Urban Expansion

As indicated in Table 29; the significant impact of urban expansion on various types of land owned by respondents. A majority of respondents (52.3%) reported the loss of agricultural land, highlighting a substantial impact on farming activities and potentially their primary source of income. Additionally, 28.9% of respondents experienced the loss of all types of land (agricultural, residential, and grasslands), indicating a severe disruption to their livelihoods and living conditions. Loss of residential land was reported by 8.5% of respondents, while 10.2% lost grassland, which may affect livestock grazing and related agricultural practices. Hence there are different causes for losing their land Overall, these figures underscore the broad and multifaceted impacts of urban expansion on the respondents' land holdings.

Table 29 Type of land lost due to urban expansion

Type of land lose	Frequency of NO of RE	Percent (%)
Agricultural land	123	52.3%
Residential land	20	8.5%
Grassland	24	10.2%
All types of land (agricultural, residential, and grasslands)	68	28.9%
Total	235	100%

Source: Own Field Survey data, 2024

4.3.3.2. Farmland Expropriation in the Wonji Area Due to Urban Expansion

Table 30, presents data on the expropriation of land in the Wonji farmland area due to urban expansion, categorizing the reasons and frequency of land loss among respondents. A total of 235 surveyed respondents.

For road expansion; This category reflects the significant impact of infrastructure development, For Factories, this indicates the growth of industrial areas where agricultural land is converted for industrial use. The largest category shows the conversion of agricultural land into residential areas. Unsuitable for farming this includes land that has been deemed unsuitable for farming, due to the flooding of the awash river.

The data indicates a significant transformation in the use of farmland in the Wonji area, primarily driven by urban expansion and infrastructure development. Residential use tops the list, with nearly 37.45% of respondents reporting land loss for this purpose, indicating the pressure of housing demands. Road expansion follows, accounting for 31.91%, due to the increasing infrastructural developments in the area. Industrialization, as evidenced by land appropriated for factories (15.32%) and warehouses (5.96%), also plays a crucial role in this transformation. Additionally, a smaller but notable proportion of land (9.36%) has been lost due to its unsuitability for farming. Overall, these trends reflect the dynamic changes and development pressures reshaping the agricultural landscape of Wonji farmland.

Table 30 Respondents Purposeful Land lose Reasons and Frequency

Types of cases (reasons)	Frequency of NO of RE	Percent (%)
For road Expansion (construction)	75	31.91%
For factories (Industries)	36	15.32%
For Warehouse	14	5.96%
For residential use	88	37.45%
Unsuitable for farming	22	9.36%
Total	235	100.00%

Source: Own Field Survey data, 2024

4.3.4. The Impact of Urban Expansion on Farmers Annual Income

According to Table 31, the sample households of respondents 6 (2.6%), 19 (8.1%), 39 (16.6%), 65 (27.7%), and 106 (45.1%) reported that these households used to earn a total annual income of above 45 quintals, 36-45 quintal, 26-35 quintal, 16-25 quintal and below 15 quintals, respectively, before urban expansion. After urban expansion, they reported that they had earned 0 (0%), 7 (3%), 24 (10.2%), 41 (17.4%), and 163 (69.4%) for above 45 quintals, 36-45 quintal, 26-35 quintal, 16-25 quintal and below 15 quintals, respectively. This indicates that annual production/income decreased after urban expansion in the study area. This can be seen from the following table that the number of respondents who produced above 45 quintals decreased from 2.6 % to 0%, 36-45 quintals from 8.1% to 3%, 26-35 quintals from 16.6% to 10.2 %, and 16-25 quintal from 27.7% to 17.4%. However, the number of respondents who produced less than 15 quintals increased their income from 45.1% to 69.4%. This means that the majority of the population produces fewer quintals after urban expansion. Therefore, the survey results indicate that annual production/ incomes decreased after urban expansion. This implies the majority of the population's produce declined after urban expansion in the study area.

Table 31 Respondents' Annual incomes before and after urban expansion between 2006 to 2022

Before urban expansion			After urban expansion		
Quintal	Frequency of NO of RE	Percent (%)	Quintal	Frequency of NO of RE	Percent (%)
Below 15	106	45.1%	Below 15	163	69.4%
From 16-25	65	27.7%	From 16-25	41	17.4%
From 26-35	39	16.6%	From 26-35	24	10.2%
From 36-45	19	8.1%	From 36-45	7	3.0%
Above 45	6	2.6%	Above 45	0	0.0%
Total	235	100.%		235	100.%

Source: Own survey, 2024

4.3.5. Scarcity of Food Security Due to Urban Expansion

The major crops produced in the study area for local food consumption are Teff, Wheat, and Corn. These crops constitute the primary agricultural output annually, surpassing other types of crops in terms of production volume. The table illustrates the types and frequencies of crops produced by farmers before and after urban expansion, highlighting significant changes in agricultural patterns.

Before urban expansion, Teff was the predominant crop, accounting for 48.5% of production with a frequency of 114. Wheat followed with 26% (61 instances), and Corn was produced at a frequency of 20, making up 8.5% of the total. Other crop types collectively represented 17% with a frequency of 40.

After urban expansion, the production shifted noticeably. Wheat became the most commonly produced crop, increasing to 41.7% with a frequency of 98. Teff production decreased significantly to 21.3% (50 instances). Corn production saw a modest rise to 12.8%, corresponding to 30 instances. Other crop types increased their share to 24.3%, with a frequency of 57. This shift indicates a diversification in crop production and a notable increase in the prevalence of Wheat in post-expansion.

Table 32 The major types of crops that farmers produced before and after the expansion between (2004-2010) & (2012-2022) GC

Before urban expansion			After urban expansion		
Crop type	Frequency of NO of RE	Percent (%)	Crop type	Frequency of NO of RE	Percent (%)
Teff	114	48.5%	Teff	50	21.3%
Wheat	61	26%	Wheat	98	41.7%
Corn	20	8.5%	Corn	30	12.8%
Other types	40	17%	Other types	57	24.3%
Total	235	100%		235	100%

Source: Own Field Survey data, 2024

4.3.6 The Number of Major Crops Produced in The Study Area Before and After Expansion (2004-2022) GC

Table 33 presented data on the yield variations of three major crops Teff, Wheat, and Maize measured in quintals per hectare for the years 2004, 2014, and 2023. The following is a detailed analysis of the trends observed for each crop over these periods. Teff; In 2004: The yield was 16 quintals per hectare, In 2014; The yield slightly decreased to 15.5 quintals per hectare, In 2023: The yield further declined to 14.6 quintals per hectare. Hence Teff shows a consistent decrease in yield over the 19 years. From 2004 to 2014, the yield dropped by 0.5 quintals per hectare (approximately 3.1%). The decline continued from 2014 to 2023, with a reduction of 0.9 quintals per hectare (about 5.8%). Overall, the yield of Teff decreased by 1.4 quintals per hectare (8.75%) from 2004 to 2023, indicating a negative trend.

Wheat; In 2004; The yield was 49 quintals per hectare., In 2014: The yield decreased significantly to 40.2 quintals per hectare., In 2023; The yield remained almost stable, slightly reducing to 40 quintals per hectare. Hence Wheat exhibits a substantial decline between 2004 and 2014, with a yield reduction of 8.8 quintals per hectare (approximately 17.96%). However, from 2014 to 2023, the yield shows relative stability, with only a minor decrease of 0.2 quintals per hectare (about 0.5%). The overall reduction from 2004 to 2023 is 9 quintals per hectare (approximately 18.37%). Maize; In 2004; The yield was 50.1 quintals per hectare., In 2014; The yield slightly decreased to 50 quintals per hectare., In 2023; The yield further decreased to 48.5 quintals per hectare. Hence Maize yields show a relatively

minor decline over the years compared to Teff and Wheat. From 2004 to 2014, the yield decreased by just 0.1 quintals per hectare (about 0.2%). Between 2014 and 2023, there was a further reduction of 1.5 quintals per hectare (3%). Overall, the decline from 2004 to 2023 is 1.6 quintals per hectare (3.19%).

Overall Rating Stability; Maize shows the highest stability in yield, with only a minor overall reduction of 3.19%. This makes it the most consistently performing crop in terms of yield. Wheat: Despite a significant initial drop, wheat yields have stabilized in recent years, placing it second in terms of performance. Teff: Teff has experienced the most consistent decline, with an overall reduction of 8.75%, indicating it faces the most challenges among the three crops.

Thus The data indicates that all three crops have experienced declines in yield over the 19 years, though to varying degrees. Maize has been the most stable, followed by wheat, which has seen efforts to stabilize yields after an initial sharp decline. Teff, on the other hand, has shown a continual decrease in yield, suggesting it may require targeted interventions to address underlying issues affecting its productivity. This analysis shows the need for continuous monitoring and adaptive strategies to improve and sustain crop yields in the face of changing agricultural conditions.

Table 33 Major crop yield variations (quintals/hectare) for the years 2004, 2014, and 2024

Crop type	2004 (quintals/hectare)	2014 (quintals/hectare)	2023 (quintals/hectare)
Teff	16	15.5	14.6
Wheat	49	40.2	40
maize	50.1	50	48.5

Source: data, from East Shewa Zone Agriculture Office, Central Statistical Agency (CSA) (2024)

4.3.7. The Loss in The Local Food or Crop Production in The Past and Post-Expansion Periods

As indicated in Table 34, urban expansion has significantly impacted various aspects of food security among respondents. A majority of respondents (45.7%) reported there is a decrease in local food (crop) production capacity, highlighting the substantial impact on the availability of fresh and locally grown food. This loss is particularly concerning as it affects

the primary source of food for many families and communities. Additionally, 32.1% of respondents experienced a loss (decrease) of affordable food options due to an increase in market prices, making it difficult for many to maintain a balanced and nutritious diet. This trend indicates that urban expansion can lead to economic pressures that exacerbate food insecurity. The loss of traditional food sources, reported by 15.3% of respondents, indicates a significant disruption in the availability of culturally significant and diverse food items. Moreover, 6.8% of respondents noted a loss of access to food due to increased competition for limited resources. This increase in competition can lead to social tensions and inequities in food distribution, further threatening food security.

Table 34 Respondents Scarcity on Food Security

Type of land loss	Frequency of NO of RE	Percent (%)
Loss of local food production capacity	107	45.5%
Loss of affordable food options	75	31.9%
Loss of traditional and culturally significant food sources	36	15.3%
Loss of access to food due to increased competition	17	7.2%
Total	235	100%

Source: Own’s Field Survey data, 2024

4.3.8. Household Awareness of Urban Expansion

As indicated in Table 35, A majority of respondents 197 households (83.83%) reported being aware of the urban expansion program. This awareness was facilitated through orientations, seminars, and information provided by the city administration. Meanwhile, 38 households (16.17%) indicated that they were not directly informed by the government but were aware of the expansion due to its direct impact on their lives.

On the other hand, key informants mentioned that the community had been informed through various channels over different periods that the land would be used for various development purposes.

Table 35 Community awareness of urban expansion

Awareness about the urban expansion	Frequency of NO of RE	Percent
Yes	197	83.83%
No	38	16.17%
Total	235	100.00%

Source: Own Field Survey data, 2024

4.3.8.1. Methods of Households' Awareness of Urban Expansion

Table 36, illustrates the different means through which respondents gained awareness of urban expansion. Among the 235 respondents surveyed, 69 individuals, representing 29.36% of the total, reported acquiring awareness through public orientation sessions. Additionally, 92 respondents, constituting 39.15%, indicated that they became aware through official meetings and training sessions organized by relevant authorities. A further 36 respondents (15.32%) acknowledged gaining awareness through both public orientation and official meeting training. Conversely, 38 respondents (16.17%) stated that they did not receive awareness through either public orientation or official meetings. Overall, the table reflects the diverse channels through which individuals in the surveyed population attained knowledge about urban expansion initiatives.

Table 36 Means of Awareness of Urban Expansion

Means of awareness	Frequency of NO of RE	Percent (%)
Through public orientation	69	29.36%
Through official meeting training	92	39.15%
Both (public orientation and official meeting training)	36	15.32%
Neither public orientation nor official meeting	38	16.17%
Total	235	100.00%

Source: Own Field Survey data, 2024

4.3.8.2. Social Relations Before and After Displaced from the Original Land

As indicated in Table 37, Before the urban expansion, the majority of individuals had a very high or high status in terms of social relations, with 45.5% classified as very high and 51.1%

as high. Only a small proportion, 3.4%, had low social status, while none were classified as having a very low status. After urban expansion, the distribution of social statuses shifted significantly. While no individuals maintained a very high status, 12.3% retained a high status. Conversely, there was a notable increase in individuals with low social status, comprising 62.1% of the population post-expansion. Additionally, 25.5% of individuals fell into the very low-status category. This indicates a clear change in the social status following urban expansion, with a reduction in higher social statuses and a corresponding increase in lower statuses.

Table 37 Social relationship before and after relocation

Before urban expansion			After urban expansion		
Status	Frequency of NO of RE	Percent (%)	Status	Frequency of NO of RE	Percent(%)
Very High	107	45.5%	Very High	--	--
High	120	51.1%	High	29	12.3%
Low	8	3.4%	Low	146	62.1%
Very Low	--	--	Very Low	60	25.5%
Total	235	100.0%		235	100.0%

Source: Own's Field Survey data, 2024

The data result clearly illustrates the adverse effects of urban expansion and subsequent displacement on social relations. Before displacement, the community exhibited strong social cohesion with the majority high or very high social relations. However, after the displacement, the complete absence of individuals in the very high social relation category and the heavy reduction in those with high status suggest a heavy breakdown in social networks.

The overall shift towards lower social statuses indicates that the majority of the population experienced a decline in their social relations, likely due to the loss of established social networks and community structures.

4.4. Potential Strategies to Mitigate the Negative Impact of Adama City Expansion on Wonji Farmland

To mitigate the negative impact of Adama city's expansion on Wonji farmland and explore opportunities for sustainable land use practices, several strategies should be implemented.

These strategies aim to balance urban development with the preservation of agricultural land, ensuring food security and sustainable growth. potential strategies to mitigate the negative impacts of Adama city expansion on Wonji farmland and promote sustainable land use practices.

4.4.1. Implement Comprehensive Land Use Planning and Urban Planning

The existing structure plan has encouraged horizontal expansion, leading to inefficient land use, and increased commuting distances (Figure 13). Hence it is needed to Develop a master plan for Adama City that prioritizes sustainable and compact urban development, this plan should emphasize infill development and the redevelopment of underutilized urban areas to mitigate urban sprawl. Establishing clear zoning regulations is crucial, designating specific areas for urban development, agriculture, and conservation, which will help prevent the unplanned sprawl of informal settlements. Additionally, creating green belts around urban areas will serve as buffers to protect Wonji farmland from encroachment, fostering a balanced and sustainable growth strategy for Adama City.

4.4.2. Strengthen Land Use Regulations and Enforcement

To safeguard agricultural land from unauthorized urban conversion, it is essential to enhance enforcement mechanisms rigorously. This can be achieved by implementing strict development permit requirements and thorough review processes to ensure that land use decisions are sustainable and aligned with long-term planning goals. Additionally, establishing a comprehensive land registration system will secure land tenure for Wonji farmers, significantly reducing the risk of displacement caused by urban expansion. To further protect these farmers, providing them with legal assistance will be crucial in defending their land rights against unauthorized land grabs, thereby fostering a more equitable and stable land use environment.

4.4.3. Encourage Vertical Growth

To sustainably manage urban growth while preserving valuable land resources, promoting high-density, mixed-use developments is paramount. By incentivizing the construction of multi-story buildings and the redevelopment of underutilized land parcels, cities can efficiently accommodate population increases without expanding their footprint. Supporting this vertical growth requires robust infrastructure and services to ensure accessibility and sustainability. Embracing these strategies fosters vibrant urban environments that optimize

space usage and enhance the quality of life for residents while minimizing environmental impact.

4.4.4. Establish Land Banking and Farmland Preservation Programs

To ensure the preservation of critical agricultural lands in Wonji, comprehensive strategies should be implemented. Firstly, priority agricultural lands should be identified and designated for long-term preservation through innovative land banking initiatives. Additionally, programs for land acquisition, leasing, or transfer of development rights should be executed to safeguard Wonji's farmland from encroachment. Financial incentives, including tax credits and subsidies, should be offered to landowners who commit to maintaining their land for agricultural purposes, incentivizing long-term preservation. Moreover, initiatives are underway to encourage sustainable practices on agricultural land through various incentives such as tax breaks and subsidies. Alongside these proactive measures, robust regulatory frameworks are being established to control urban expansion rigorously and enforce land use policies effectively, ensuring the sustainable development of Wonji while safeguarding its agricultural heritage.

4.4.5. Promoting Urban Agriculture

Encourage urban farming projects within the city to reduce the pressure on rural farmland. This can include rooftop gardens, community gardens, and vertical farming. Develop agricultural neighborhoods where farming is integrated into residential areas, providing local food production and green space.

4.4.6. Foster Stakeholder Engagement and Collaborative Governance

Engage with Wonji farmers, community members, and local authorities to understand their needs and concerns. Establish multi-stakeholder platforms and forums to facilitate dialogue, knowledge sharing, and joint decision-making. Empower local communities to participate in the planning and implementation of urban development and agricultural conservation initiatives. Conduct awareness campaigns to educate the public on the importance of preserving agricultural land and sustainable urban development.

By implementing a combination of these strategies, Adama City can work towards balancing its urban expansion with the preservation of Wonji farmland, ensuring food security, livelihood opportunities, and sustainable land use practices in the long term.

CHAPTER FIVE

SUMMARY AND CONCLUSION

5.1 Summary

This study has been conducted to investigate the impacts of urban expansion on agricultural lands in the case of Adama city, in the Oromia national regional state of Ethiopia. Urban expansion is the process in which agricultural-based rural societies predominantly are shifted to nonagricultural economic bases in integration with socio-economic (cultural) and special reorganizations of the area's surrounding cities/towns.

The expansion of Adama City into Wonji farmland has brought significant changes to land use patterns and agricultural practices, impacting both food security and land availability. The research delineates the dual impact of formal and informal urban settlements on agricultural land, highlighting the challenges of unchecked urban sprawl and its strain on farmland. Formal settlements, driven by government initiatives, have led to structured urban expansion with regulated growth in areas such as road construction, industrial development, and residential zones. However, informal squatter settlements have emerged without government approval, contributing to unplanned sprawl and aggravating pressure on agricultural land.

The study underscores the direct consequences of urban expansion on farmers' livelihoods, with a notable portion experiencing land loss and a subsequent decline in annual income. Crop production patterns have also shifted, with changes in dominant crops and a general decline in yields over time, particularly for Teff.

Furthermore, the transformation of land use and land cover over the years reflects the intensifying urbanization and decreasing agricultural land in the study area. The analysis reveals a significant increase in built-up areas at the expense of farmland, highlighting the urgent need for sustainable land management strategies to balance urban growth with agricultural preservation.

From a food security perspective, the expansion of Adama City has disrupted local food production capacity, leading to decreased access to fresh, locally grown food and a rise in market prices. This has implications for the nutritional well-being of communities, with some experiencing a loss of access to traditional food sources and increased competition for limited resources.

Overall, the research underscores the complex interplay between urban expansion, land use dynamics, and food security in the study area. It emphasizes the importance of holistic

approaches to urban planning, regulation, and infrastructure development to mitigate adverse effects on farmland while ensuring sustainable urban growth and food security for local communities.

5.2. Conclusion

Urban expansion is viewed from various perspectives, but it generally involves the transformation of rural, agricultural-based societies into urban, non-agricultural economic bases. Historically, the growth and formation of urban areas have paralleled agricultural innovation and development, integrating socio-cultural and spatial reorganization of the surrounding areas. However, in recent times, particularly in developing countries, rapid urban expansion into fertile agricultural land has imposed serious impacts on these areas, despite contributing to national development through expanded private investment and economic transformation.

In Ethiopia, including cities like Adama, rapid economic growth has led to significant urban expansion, which has endangered the agricultural activities of areas such as Wonji. Long-established agricultural communities are particularly affected. The impacts of this urban expansion include the loss of agricultural land and products, displacement of landholder farmers, and the creation of unsustainable livelihoods. Survey results indicate that the average farmland holding size and agricultural production have significantly decreased following urban expansion.

The research findings present a comprehensive analysis of the impact of Adama City's expansion into Wonji farmland, shedding light on the multifaceted challenges posed by urbanization from both food security and land opportunity perspectives. The dual impact of formal and informal urban settlements has been delineated, showcasing the structured growth driven by government projects alongside the unplanned sprawl of informal settlements. This has led to significant land loss for farmers, resulting in a decline in agricultural productivity and income. The shift in crop production patterns and declining yields further underscores the profound effects of urban expansion on agricultural practices. Moreover, the transformation of land use and land cover over the years reflects the escalating urbanization trend, with built-up areas expanding at the expense of agricultural land. This poses serious implications for sustainable land management and necessitates urgent action to balance urban growth with agricultural preservation. From a food security standpoint, the expansion of Adama City has disrupted local food production, leading to decreased access

to fresh, locally grown food and rising market prices. This threatens the nutritional well-being of communities and highlights the importance of safeguarding agricultural land to ensure food security for all. Generally, the research emphasizes the critical need for comprehensive strategies to address the challenges posed by urban expansion.

5.2.1 Recommendations

Based on the findings outlined, the following recommendations are proposed:

- **Integrated Urban Planning:** Develop and implement integrated urban planning frameworks that consider the preservation of agricultural land as a priority alongside urban expansion. This involves coordinating various sectors such as housing, transportation, and agriculture to ensure sustainable land use practices.
- Establish clear land use zoning regulations that designate areas for urban development, agricultural activities, and conservation purposes. This ensures that agricultural lands are protected from indiscriminate conversion to built-up areas and provides a framework for sustainable land management.
- Strengthen monitoring and enforcement mechanisms to prevent illegal land conversion and unauthorized developments on agricultural land. This involves regular inspections, satellite monitoring, and community engagement to identify and address land use violations effectively.
- Provide training, capacity building, and knowledge-sharing initiatives for farmers, local authorities, and stakeholders on sustainable land management practices, land use planning, and urban-rural integration strategies. This empowers communities to participate effectively in decision-making processes and adapt to changing land use dynamics.
- The government should situate factories and warehouses in outer areas characterized by low annual rainfall and high temperatures, rather than in fertile agricultural areas. This approach preserves valuable arable land for food production, ensures the efficient use of resources, and minimizes the environmental impact on crucial agricultural zones.
- Introduce incentives and support mechanisms for farmers to maintain agricultural productivity and preserve farmland. This may include financial assistance, technical

support, and land use subsidies aimed at promoting sustainable farming practices and land conservation.

- Enhance land use policies and zoning regulations in Adama city to protect designated agricultural zones of Wonji and Adama from conversion to non-agricultural uses.
- Enhance and modernize land tenure systems to guarantee secure and clear land rights for farmers in the study area, thereby encouraging long-term investments in agricultural development and sustainable land management.
- Most importantly, the city administration should focus on Regularly monitoring and Establishing a comprehensive land use/land cover monitoring system to track changes over time and inform evidence-based policymaking by Conducting periodic evaluations of the effectiveness of implemented strategies and adaptation of approaches.

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APPENDICES.

Appendix-I

Adama Science and Technology University
Office of Graduate Studies
School of Civil Engineering and Architecture
The Department of Architecture.

Dear respondent: -

The main aim of this questionnaire is to collect data as input for the study titled The Impact of Adama City Expansion On Wonji Farmland:

Dear respondents, you are expected to provide genuine, accurate, and balanced information concerning the urban expansion and displacement process. Your accurate information is highly valuable as it determines the success of this study. Therefore, the researcher is very much grateful for the sacrifice you paid to this end, and the information gathered will be highly confidential and will be only for this research.

Please note that:

There is no need to write your name.

Each section has its own instructions to follow.

Thank you!

Section 1: Demographic and Background Information

1. Gender;

- a. Male
- b. female

2. Age;

- a. Under b, 18-25 c,26-35 d, 36-45 e,46-55 f, 56 and above

3. Occupation:

- | | |
|---------------|-------------------|
| a. Farmer | d. Private Sector |
| b. Student | Employee |
| c. Government | e. Other (please |
| Employee | specify) |

4. Education level:

- | | | |
|--------------------------------|----------------------|-----------|
| a. Primary school | d. Bachelor's degree | g. -Other |
| b. Secondary school | e. Master's degree | (_____) |
| c. Vocational/technical school | f. Doctorate | |

5. Marital status

- | | |
|------------|-------------|
| a. Single | c. Divorced |
| b. Married | d. Widowed |

Section 2: Awareness of Adama City Expansion

6. Are you aware of the expansion of Adama City into the Wonji area?

- | | |
|--------|-------|
| a. Yes | b. No |
|--------|-------|

7. If yes, how did you become aware of it? (Check all that apply)

- | | |
|--------------------------------|------------------|
| a. News media | c. Government |
| b. Local community information | announcements |
| | d. Other (_____) |

8. How long have you been residing in Adama City?

- | | |
|---------------------|-----------------------|
| a. Less than 1 year | c. 5-10 years |
| b. 1-5 years | d. More than 10 years |

9. Do you believe that the Adama City expansion has impacted the availability of farmland in the Wonji area?

- | | | |
|-------------------|-------------|-------------|
| a. Strongly Agree | c. Neutral | e. Strongly |
| b. Agree | d. Disagree | Disagree |

10. How has the expansion of Adama City affected land prices in the Wonji area?

- | | |
|--------------|----------------------|
| a. Increased | c. Remained the same |
| b. Decreased | d. Not sure |

Section 3: Impact on Farmland

11. How familiar are you with Wonji farmland?

- | | |
|----------------------|------------------------|
| a. Very familiar | c. Not familiar at all |
| b. Somewhat familiar | |

12. Have you observed any changes in agricultural practices in the Wonji area due to urban expansion?

- b. No

13. In your opinion, how has the expansion of Adama City affected the availability of farmland in Wonji?

- c. No change

14. Do you own farmland in the Wonji area? Or Are you currently involved in any agricultural activities in Wonji?

- b. No

15. If yes, how has the expansion of Adama City affected your farmland? (Select all that apply)

- e. Other (_____)

16. For what purposes have you been using your land?

- d. all

17. Have you or your community experienced any changes in access to agricultural land due to Adama City expansion?

- b. No

18. Have you observed any changes in agricultural practices in Wonji as a result of the city expansion?

- b. No

19. If yes, please describe the changes you have observed.

20. Have you experienced any challenges related to farmland ownership or cultivation due to Adama City expansion?

Section 4: Impact on Food Production

21. How would you rate the access to markets for agricultural products in Wonji before and after the expansion of Adama City?

- | | | |
|---------------------------|----------------------|---------------------------|
| a. Significantly improved | c. No change | e. Significantly worsened |
| b. Slightly improved | d. Slightly worsened | |

22. How do you perceive the impact of Adama City expansion on food production in the Wonji area?

- | | | |
|--------------------|--------------------|--------------|
| a. Positive Impact | b. Negative Impact | c. No Impact |
|--------------------|--------------------|--------------|

23. Have you experienced any challenges related to food security since the expansion of Adama City? Between 1988 to 2016 EC.

- | | |
|--------|-------|
| a. Yes | b. No |
|--------|-------|

23. If yes, please specify the challenges you have faced.

24. How would you rate the current food security situation in the Wonji area?

- | | |
|----------------|------------------|
| a. Very Secure | c. Insecure |
| b. Secure | d. Very Insecure |

25. Have you noticed any changes in the demand for agricultural products from Wonji as a result of Adama City's expansion?

- | | |
|--------|-------|
| a. Yes | b. No |
|--------|-------|

26. If yes, please describe the changes you have noticed.

Section 5: Land Opportunity Perspective

27. From a land opportunity perspective, do you believe the expansion of Adama City has provided new opportunities for farmers in Wonji?

- | | |
|-------------------|----------------------|
| a. Strongly agree | d. Disagree |
| b. Agree | e. Strongly disagree |
| c. Neutral | |

28. Have you observed any changes in land prices in Wonji following the Adama City expansion?

a. Yes

b. No

29. Have you witnessed any displacement of farmers or communities due to Adama City expansion?

a. Yes

b. No

30. If yes, please describe the changes you have noticed.

Section 6: Perception of Government Policies

31. Do you think the government has adequately addressed the concerns of farmers affected by Adama City expansion?

a. Yes

b. No

c. Not sure

32. Do you think there is a need for better coordination between urban planning authorities and agricultural stakeholders in Adama City expansion projects?

a. Strongly Agree

d. Disagree

b. Agree

e. Strongly Disagree

c. Neutral

33. Have you noticed any Consultation between local communities and city planners regarding Adama City expansion projects?

a. Yes

b. no

34. If yes How would you rate the level of consultation between local communities and city planners regarding Adama City expansion projects?

a. Excellent

c. Fair

b. Good

d. Poor

35. Have you witnessed any conflicts arising from the allocation of land for urban development in the Wonji area?

a. Yes

b. No

36. Do you think there should be stricter regulations governing land use change from agricultural to urban purposes?

a. Yes

b. No

c. Not sure

37. What measures do you think the government should take to mitigate the impact of city expansion on farmland?

38. Are you aware of any efforts made to mitigate the impact of Adama City expansion on Wonji farmland?

- a. Yes b. No

39. If yes, please describe the efforts made to mitigate the impact.

40. Are there any governmental policies or initiatives aimed at mitigating the impact of Adama City expansion on farmland in the Wonji area?

- a. Yes
- b. No
- c. Not aware of any

41. How would you rate the level of awareness among farmers in Wonji regarding their rights and responsibilities in the context of land acquisition and use?

- a. Highly aware c. Slightly aware
b. Moderately aware d. Not aware at all

42. How would you rate the level of cooperation and coordination between Adama City authorities and the stakeholders in Wonji (e.g., farmers, and community leaders) regarding the impact of urban expansion?

- a. Very high c. Very low
- b. Moderate

Section 7: Conclusion

43. Have you witnessed any conflicts or disputes arising between farmers and other stakeholders (e.g., developers, and government agencies) due to the expansion of Adama City?

- a. Yes b. No

44. If yes, please describe the nature of the conflicts or disputes.

45. Do you think the expansion of Adama City has led to increased employment opportunities in the Wonji area?

a. Yes

b. No

46. How would you describe the overall impact of Adama City expansion on the quality of life in the Wonji area?

a. Positive Impact

c. No Impact

b. Negative Impact

47. Do you believe there is a need for greater collaboration and coordination between different stakeholders (e.g., farmers, government, developers) to address the challenges posed by Adama City expansion on Wonji farmland?

a. Strongly
agree

c. Neutral
d. Disagree

e. Strongly
disagree

b. Agree

48. Are you aware of any alternative livelihood opportunities that have been created for farmers in Wonji as a result of the expansion of Adama City?

a. Yes

b. No

49. If yes, please describe the alternative livelihood opportunities.

50. Any additional comments or information you would like to share regarding the impact of Adama City expansion on Wonji farmland?

Appendix-II

Adama Science and Technology University
Office of Graduate Studies
School of Civil Engineering and Architecture
The Department of Architecture.

Interview Questions for Farmers and Residents in The Study Area.

Part I: Background of Respondent

1. Address _____
2. Kebele _____
3. Sex _____
4. Age _____
5. Level of education _____

Part II: Open-ended Interview Questions

1. How long have you been a resident of Adama City, and how do you perceive the recent expansion of the city?
2. Have you noticed any changes in access to food or agricultural products since the city's expansion into neighboring farmland?
3. How do you view the importance of preserving agricultural land in the surrounding areas for food security?
4. Could you please specify whether you own farmland, and if so, what is the size of your landholding in hectares?
5. What type is your land? Cropland, Grazing land, Fruits and vegetation, Cropland and grazing land.
6. What Type of Land do you Lost Due to Urban Expansion? Agricultural land, Residential land, Grassland, All types of land (agricultural, residential, and grasslands)
7. Can you describe your experience as a farmer in Wonji and how long you've been cultivating land here?
8. How has the expansion of Adama City affected your farmland and agricultural activities?
9. Have you noticed any changes in crop yields or soil quality due to urbanization?
10. What challenges have you faced in maintaining your farming practices amidst the city's expansion?

11. How has the increasing demand for urban development impacted your access to water resources for irrigation?
12. Have any changes in land ownership or tenure rights have affected your ability to farm?
13. Are there any alternative livelihood strategies you've explored due to the changing landscape of Wonji?
14. How do you perceive the long-term implications of urban expansion on food security in the region?
15. Have there been any government interventions or support programs to mitigate the impacts of urbanization on agriculture in Wonji?
16. In your opinion, what measures could be taken to balance urban growth with the preservation of farmland and food security in the area?
17. How do you think the expansion of Adama City has affected employment opportunities for residents in both urban and rural areas?
18. What measures, if any, do you think could be taken to mitigate any negative impacts on farmland in Wonji while accommodating the expansion of Adam

Appendix-III

**Adama Science and Technology University
Office of Graduate Studies
School of Civil Engineering and Architecture
The Department of Architecture.**

questions asking Adama City authorities (For Expert respondents)

Part I: Background of Respondent

1. Address _____
2. Kebele _____
3. Sex _____
4. Age _____
5. Level of education _____
6. Occupation _____
7. Your position in this organization _____
8. Year of services in this organization _____

Part II: - Interviews about Adama City expansion

1. How does the current urban development plan account for the preservation of agricultural land in areas like Wonji to ensure food security for both current and future residents?
2. How has the expansion of Adama City affected the availability and accessibility of farmland in the Wonji area?
3. What changes have occurred in land use patterns and agricultural productivity in Wonji following the expansion of Adama City?
4. What are the economic implications of converting farmland in Wonji to urban use? How has this affected local food production and supply?
5. Can you provide insights into the projected rate of urban expansion in Adama City over the next decade and how it might affect the availability of farmland in Wonji?
6. What is your view about the positive impacts of urban expansion on the social and economic?
7. What strategies or policies are in place to balance the need for urban development with the preservation of agricultural land in Adama's surrounding areas?

Are there any specific measures being taken to support farmers in Wonji who may be affected by urban expansion, such as providing alternative land or livelihood opportunities?

8. Are there alternative land management strategies that could be implemented to mitigate the negative effects of urban expansion on Wonji farmland?

Thank you for participating in this survey. Your input is greatly appreciated

