WALLAGA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

URBAN EXPANSION AND ITS EFFECTS ON PERI-URBAN LAND COVER AND LIVELIHOODS IN BEDELE TOWN, BUNO BEDELE ZONE, OROMIA, ETHIOPIA

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DECEMBER, 2024

NEKEMTE, ETHIOPIA



WALLAGA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

DEPARTMENT OF ENVIRONMENTAL SCIENCE

MSC THESIS URBAN EXPANSION AND ITS EFFECTS ON PERI-URBAN LAND COVER AND FARMERS LIVELIHOODS IN BEDELE TOWN, BUNO BEDELE ZONE, OROMIA, ETHIOPIA

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF WALLAGA UNIVERSITY, COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE, DEPARTMENT OF ENVIRONMENTAL SCIENCE, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCE.

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DECEMBER, 2024

NEKEMTE, ETHIOPIA

Approval

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Certification of the Final Thesis

I hereby certify that all the correction and recommendation suggested by the board of examiners are incorporated in to the final thesis intitled", Urban Expansion and its Effects on Peri-Urban Land Cover and Livelihoods in Sidisa Bumata Kebele, Buno Bedele Zone, Oromia, Ethiopia."by Tizazu Daniel Damisie.

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Declaration

I, Tizazu Daniel, the researcher of this study entitled " Urban Expansion and its Effects on Peri-Urban Land Cover and Farmers Livelihoods in Bedele Town, Buno Bedele Zone, Oromia, Ethiopia," conducted at Wallaga University's College of Natural and Computational Science, Department of Environmental Science, do hereby solemnly declare the following: The research presented in this study is the product of my independent efforts, guided by principles of ethics, standards of research, and academic integrity.

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Date: [December, 02, 2024]

Acknowledgments

I would like to convey my heartfelt appreciation to my adviser, Dr. Tolera Megersa, whose devotion and competence were important in the successful completion of this project. Tamiru Ayale, the Mayor of Bedele Town, has given me access to essential resources and information. Special thanks to Daniel Alemu for his outstanding effort in GIS analysis, which significantly improved the quality of this study.

My deepest gratitude goes to the instructors and staff of the Department of Environmental Science at Wallaga University for creating a stimulating academic atmosphere. I am eternally thankful to my family, friends, and loved ones for their constant encouragement and support. Your faith in me has been a continual source of inspiration for me.

This study was made possible through the invaluable support of several individuals. I would like to express my heartfelt appreciation to my adviser, Dr. Tolera Megersa, whose dedication and expertise were instrumental in the successful completion of this project. I am also deeply grateful to Tamiru Ayale, the Mayor of Bedele Town, for providing access to essential resources and information. Special thanks go to Daniel Alemu for his exceptional contributions to GIS analysis, which greatly enhanced the quality of this study.

Table of Contents

Content Page

Declaration i
Acknowledgments ii
List of Figures vi
List of Tables vii
Abstract viii
1. INTRODUCTION 1
1.1 Background of the study 1
1.2 Statement of the Problem 3
1.3 Objective of the study 4
1.3.1 General Objective 4
1.3.2 Specific Objectives 4
1.4 Research questions 4
1.5 Significance of the Study 5
1.6 Scope of the Study 5
1.7 Limitation of the Study 6
1.8 Organization of the Study 6
2. LITERATURE REVIEW 7
2.1. Theoretical Review 7
2.1.1 Urban Expansion 7
2.1.2 Theories of Urbanization 7
2.1.3 Population Growth 8
2.1.4 Economic Development 9
2.1.5 Transportation and Infrastructure 10
2.1.6 Land Use Policies and Regulations 11
2.1.7 Socio-cultural Factors 12
2.1.8 Peri-urban Areas and Livelihoods 13
2.1.9 Sustainable Urban Planning 14
2.2 Empirical Literature Review 15
2.2.1 Examining Patterns and Trends of Urban Expansion 15
2.2.2 Historical Development and Growth Patterns 16
2.2.3 Spatial Analysis of Urban Expansion 17

2.2.4 Socio-economic Impacts of urban expansion on Peri-urban Farmers' Livelihoods 17
2.2.5 Economic Changes and Opportunities for Peri-urban Farmers 18
2.2.6 Social Dynamics and Livelihood Adaptations in Peri-urban Areas 19
2.2.7 Impacts of Urban expansion on Land Use/Cover 19
2.2.8 Changes in Agricultural Land and Productive Spaces 20
3. MATERIALS AND METHODS 22
3.1 Description of the Study Area 22
3.1.1 Climate 22
3.1.2 Livelihood Activities in the study area 23
3.2 Method 24
3.2.1 Conceptual framework 24
3.2.2 Research Design 26
3.3 Data Collection Methods 26
3.4 Sampling and sample size determination 27
3.4.1 Sampling Technique 27
3.4.2 Data Source 29
3.4.2.1 Primary Data Sources: 29
3.4.2.2 Secondary Data Sources 29
3.4.3 Image Preprocessing 31
3.4.4 Temporal Comparison 31
3.5 Data Analysis 32
3.5.1 Supervised Classification of Landsat Images 33
3.5.2 Kappa Coefficient 35
3.5.3 Data Instrument and software's 38
3.6 Ethical Considerations 38
3.7 Data Management 39
4. RESULT AND DISCUSSION 40
4.1 Trend of Urban Expansion in the study area 40
4.1.1 LULCC pattern analysis 40
4.1.2 Land Use and Land Cover Change in 1992 43
4.1.3 Land Use and Land Cover (LULC) Changes in 2002 46
4.1.4 LULC Class Distributions of Bedele Town in 2012 47
4.1.5 LULC Class Distributions of Bedele Town in 2022 49
4.1.6 Impacts of Urban expansion on LULC of the study area 51

4.1.6.1 Change Detection Matrix of LULC Change 51
4.1.6.2 Change Detection Matrix 1992-2002) 51
4.1.6.3 The Change Detection Matrix Analysis for Bedele Town during 2002 to 2012 ..53
4.1.6.4 Change Detection Matrix (2012-2022) 55
4.1.6.5 Change Detection Matrix (1992-2022) 56
4.1.6.6 Accuracy Assessment of the Classification 57
4.1.6.7 Accuracy assessment of 1992 to 2022 images 58
4.1.6.8 Spatial Distribution of Urban Expansion 61
4.2. Urban Expansion On Peri Urban Farmers Livelihood 62
4.2.1 Demographic Profile of Respondent 62
Gender 62
4.2.2 Income Status of Respondents 64
4.2.3 Access to Agricultural Land 66
4.2.4 Increased Employment Opportunities in Non-Agricultural Sectors: 68
4.2.5 Decreased Employment Opportunities in Non-Agricultural Sectors: 68
4.2.6 No Change in Employment Opportunities in Non-Agricultural Sectors 69
4.3 Impact on Access to Agricultural Land 69
4.4 Livelihood Farmer Interview 70
4.4.1 Income Distribution Analysis 70
4.5 Additional Income Sources 71
5. Conclusion and Recommendations 72
5.1 Conclusion 72
4.2 Recommendations 74
Reference 76
6. Annex 80

List of Figures

Figure 3.1 Study Area Map.....23
Figure 4.1 LULC Map of Bedele town in 1992.....45
Figure 4.2 LULC Map of Bedele town in 2002.....47
Figure 4.3 LULC Map of Bedele town in 2002.....49
Figure 4.4 LULC Map of Bedele town in 2022.....50

List of Tables

Table 3.1 Description of the Land sat images for project study. 30
Table 4.1 LULCC Trend analysis 1992 and 2002 40
Table 4.2 Change Detection Analysis between 2002 and 2012.....40
Table 4.3 Change Detection Analysis between 2012 and 2022.....41
Table 4.4 Land Use and Land Cover Changes 1992 to 2022 42
Table 4.5 *LULC Class Distributions of Bedele town in 1992*.....44
Table 4.6 *LULC Class Distributions of Bedele town in 2002*.....46
Table 4.7 LULC Class Distributions of Bedele town in 2012 48
Table 4.8 *LULC Class Distributions of Bedele town in 2022*.....49
Table 4.9 Change Detection Matrix Analysis (LULC) Changes (1992-2002).....51
Table 4.10 Change Detection Matrix (2002-2012).....53
Table 4.11 Change Detection Matrix (2012 to 2022).....55
Table 4.12 Change Detection Matrix (1992-2022).....56
Table 4.13 Accuracy assessment of LULC Map of 1992.....59
Table 4.14 Accuracy assessment of LULC Map of 2002.....59
Table 4.15 Accuracy assessment of LULC Map of 2012.....60
Table 4.16 Accuracy assessment of LULC Map of 2022.....60
Table 4.17 Gender Distribution of Respondents.....62
Table 4.18 Age Distribution of Respondents.....63
Table 4.19 Marital Status of Respondents 64
Table 4.20 Education Status of Respondents.....64
Table 4.21 Income status of respondents.....65
Table 4.22 occupation of the respondents.....66
Table 4.23 Effects of Urbanization on Access to Agricultural Land.....67
Table 4.24 Employment Opportunities in Non-Agricultural Sectors due to Urban Expansion 68

Abstract

Urban expansion in peri-urban areas profoundly impacts land cover and livelihoods, prompting the need for comprehensive studies. This research investigates the effects of urban expansion on land use/land cover (LULC) and livelihoods in Bedele town, Oromia, Ethiopia. An integrated GIS-based LULC analysis of Landsat images and socio-economic surveys approach was employed. Landsat Images of 1992-2022 were used analyzed. The result revealed that significant transformations, with agricultural lands declining as built-up areas expanded, driven by population growth and economic activities. These changes disrupted traditional livelihoods, leading to reduced access to agricultural land, shifts in crop production, and heightened livelihood vulnerabilities. Conversely, urban expansion created non-agricultural opportunities, such as entrepreneurship and employment in service sectors. The study underscores the importance of sustainable urban planning to mitigate adverse impacts while leveraging urbanization benefits. Recommendations include enhancing land-use policies, promoting inclusive development strategies, and integrating peri-urban perspectives in urban governance to foster resilient communities.

Keywords: *land use/land cover, livelihoods, peri-urban, urban expansion*

1. INTRODUCTION

1.1 Background of the study

The 21st century is witnessing a defining phenomenon – the relentless march of urbanization. Fueled by population growth, economic dynamism, and rural-to-urban migration (Seto et al., 2011), cities are rapidly sprawling outward, transforming landscapes and reshaping human settlements across the globe. While urban expansion undoubtedly fosters economic development and innovation, acting as hubs for business, attracting talent and investment, and offering diverse cultural experiences and educational opportunities (United Nations, 2018), its environmental and social consequences cannot be ignored. The exponential growth of urban areas often comes at the expense of natural habitats, leading to habitat loss, increased pollution, and strain on vital resources like water. Socially, urban sprawl can displace communities, exacerbate existing inequalities, and disrupt traditional livelihoods that have sustained communities for generations (World Bank, 2020).

The challenge, therefore, lies in striking a delicate balance – fostering economic growth and reaping the benefits of urban development while ensuring sustainable urban planning practices that minimize environmental and social disruption. This is particularly critical in developing countries like Ethiopia, where urbanization is occurring at a rapid pace. As a country with one of the fastest-growing economies in Africa and a high rate of urbanization (World Bank, 2020), Ethiopia presents a compelling case study for understanding the complex dynamics of urban expansion and its multifaceted impacts.

This research delves into the case of Bedele town, situated in the Buno Bedele Zone of Oromia, Ethiopia, to explore the intricate relationship between urban expansion and its effects on peri-urban land cover and livelihoods. Bedele's strategic location at the crossroads of major transportation routes, coupled with its burgeoning economic opportunities and access to government services, has made it a magnet for investments and population influx (Birhanu et al., 2021). This rapid influx has triggered a wave of urban expansion, characterized by the conversion of peri-urban agricultural lands and natural habitats into built-up areas. As a consequence, Bedele's landscape is undergoing a significant transformation, with far-reaching environmental, social, and economic implications for its peri-urban communities.

Historically, the peri-urban areas surrounding Bedele town have been a mosaic of diverse agricultural activities, with small-scale farming and pastoralism forming the backbone of local livelihoods (Assefa et al., 2018). These practices have played a critical role in ensuring food security, generating income, and providing essential job opportunities for the local communities. However, with the relentless march of urban expansion and the conversion of peri-urban land for development purposes, the very foundation of these traditional livelihoods is under threat. The loss of agricultural land and grazing pastures combined with potential changes in water availability and ecological balance due to urban sprawl pose significant challenges for the future of these communities.

While there exists a wealth of research on urban expansion and its effects globally, a significant knowledge gap prevails concerning the specific dynamics and consequences of urban sprawl in Bedele town. Understanding the local context through focused research is crucial for effective urban planning in Bedele. This research aims to fill this gap by providing a comprehensive analysis of how Bedele's urban expansion is impacting peri-urban land cover and livelihoods. By examining land-cover changes, assessing the socioeconomic impacts on peri-urban communities, and identifying the challenges and opportunities associated with urban development, this study seeks to generate valuable insights that can inform sustainable urban planning and policy formulation for Bedele town.

Ultimately, the goal of this research is to contribute to achieving sustainable urban development in Bedele. Understanding the effects of urban expansion on peri-urban land cover and livelihoods is essential for promoting sustainable approaches to urban growth. By providing evidence-based recommendations and strategies, this study aspires to pave the way for the development of Bedele town's urban fabric in a way that balances economic prosperity with environmental conservation and the well-being of peri-urban communities. Through investigating these intricate dynamics, this research aims to inform the creation of a sustainable future for Bedele – a future where economic growth coexists with a healthy environment and thriving livelihoods.

1.2 Statement of the Problem

Urban expansion, the rapid growth of cities and their surrounding areas, is a major global phenomenon with widespread environmental and social consequences. Studies have documented increased land-use change, habitat loss, and resource depletion associated with urban sprawl (Angel et al., 2004). Additionally, social concerns like disruption of traditional livelihoods and increased strain on infrastructure are well-established (Tadie et al., 2019).

According to Berhanu and Ayenew (2017), urban agriculture in Bedele town is mostly informal and small-scale, with farmers growing vegetables and fruits and raising small animals like chickens and goats. However, as urban areas in and around Bedele town have grown, agricultural land has been converted into residential and commercial areas, resulting in a decline in agricultural productivity, limited access to land and water, and increased competition for resources.

Conversion of agricultural land to urban use affects not only the livelihoods of urban farmers, but also food security, environmental sustainability, and social equity. The loss of agricultural land and the resulting decrease in agricultural productivity can have a negative impact on local food supply, resulting in higher food prices and food insecurity. Conversion of agricultural land also has an impact on the ecological balance, soil fertility, and water availability, which can have a significant impact on the urban environment's sustainability.

The rapid pace of urban expansion in Bedele town is particularly worrisome. This fast-growing sprawl threatens to quickly convert productive agricultural land and natural areas on the periphery into settlements. This could not only lead to significant environmental degradation and loss of biodiversity, but also disrupt the livelihoods of peri-urban farmers who rely on this land for their income and way of life. Unless carefully managed, this rapid expansion has the potential to create a situation where Bedele struggles to keep pace with the growing demand for resources and infrastructure, potentially leading to social and economic strain.

Moreover, the impact of the conversion of agricultural land into urban use is not evenly distributed among different groups of farmers, with vulnerable groups such as women, youth, and small-scale farmers being disproportionately affected.

Therefore, addressing the issue of urban expansion and its impact on urban farmers requires an understanding of the underlying causes and the identification of appropriate policy interventions that can support sustainable urban development while protecting the livelihoods of vulnerable groups.

There is a lack of comprehensive understanding of how urban expansion is specifically impacting Bedele town. Existing research might focus on broader trends in Ethiopia or other regions. My research aims to fill this gap by:

Analyzing the specific trends of urban expansion in Bedele, including its pace, direction, and characteristics.

Assessing the impacts of this expansion on land use/cover changes and the environment.

Evaluating the effects of urban sprawl on the livelihoods of peri-urban farmers in study area.

By providing a detailed picture of the situation in Bedele, my research can contribute valuable insights for policymakers and planners to develop sustainable urban development strategies that address these challenges effectively.

1.3 Objective of the study

1.3.1 General Objective

To analyze the effects of urban expansion on peri-urban land use/cover and farmers livelihoods

1.3.2 Specific Objectives

- To analyze the trends of urban expansion in Bedele town.
- To assess the impacts of urban expansion on land use/cover of the study area.

1.4 Research questions

What are the historical patterns of urban expansion in the study area?

What are the impacts of urban expansion on the land use and cover of the study area in study area?

How does urban expansion affect the livelihoods of peri-urban farmers in study area?

1.5 Significance of the Study

The significance of the study is that it can contribute to a better understanding of the impact of urban expansion on livelihoods in in the study area and can provide insights into the potential benefits and challenges associated with urban agriculture. Some of the specific ways in which the study may be significant include:

- The study can provide insights into the practices and techniques that are most effective for urban practitioners during planning.
- The study will be used as a baseline data for future research on urban agriculture in other towns and cities in Ethiopia and beyond, helping to build a broader understanding of the impact of urban agriculture on livelihoods.

1.6 Scope of the Study

The study is exclusively centered on Bedele town, a specific locality within the Buno Bedele Zone of the Oromia region in Ethiopia. This geographic area serves as the primary subject of investigation to understand the intricate dynamics and repercussions of urban expansion within this precise locale.

A pivotal component of the study revolves around the examination of the alterations in land cover resulting from urban expansion. The research scrutinized the conversion of agricultural land and other productive spaces into built-up areas, offering a detailed evaluation of the ensuing impacts on food production, environmental sustainability, and land resource management.

The study explored the multifaceted impacts of urban expansion on peri-urban farmers' livelihoods. It delved into the transformations in economic opportunities, agricultural practices, and livelihood strategies. The research probed the challenges and opportunities encountered by farmers in adapting to the pressures brought about by urbanization.

An in-depth analysis of the socio-economic landscape of Bedele town was undertaken. This analysis encompassed various dimensions, including population dynamics, primary economic activities, socio-cultural context, and administrative structures. The examination provided a comprehensive understanding of the social context in which urban expansion occurs, shedding light on its implications for peri-urban communities.

The scope of the study encompassed the collection of primary data through surveys and interviews, in conjunction with the integration of pertinent Geographic Information System (GIS) data. The research employed both quantitative and qualitative research methodologies to gather information on land use, socio-economic factors, and the perspectives of farmers. This hybrid approach allowed for a thorough analysis of the research objectives.

The study involved quantitative analysis of survey data using appropriate statistical methods, facilitating the establishment of relationships and identification of trends. Qualitative analysis of interview data was conducted to identify recurring themes and patterns. Furthermore, GIS data were meticulously analyzed using GIS software to generate maps, visualize spatial patterns, and quantify changes in land cover.

The comprehensive scope of the study enriches our understanding of the far-reaching impacts of urban expansion on peri-urban land cover and livelihoods in Bedele town. It furnishes valuable insights for sustainable land management, urban planning, and the formulation of strategies to bolster peri-urban communities in the face of urbanization pressures.

1.7 Limitation of the Study

Limited timeframe: The study may only cover a specific period of time, such as a single growing season, which may not capture the full range of experiences and impacts of urban farming in Bedele

Bias: There is a possibility that respondents may provide biased responses, either intentionally or unintentionally, which could affect the validity of the study.

1.8 Organization of the Study

The research is undertaken and presented in the orderly manner of phases, it starts with chapter one introduction to the contents of background, statement of the problem, research objectives and questions, significance and delimitation of the study. Following that it undertakes literature reviews on chapter two. Chapter three of research methodology contains research approach, data sources, collection methods and sampling and analysis methods. Under chapter four results and discussions are presented in detailed analysis of the variables of the study. The research is completed under chapter five by providing conclusion and by forwarding important recommendations.

2. LITERATURE REVIEW

2.1. Theoretical Review

2.1.1 Urban Expansion

Glaeser (2011) critically reevaluates the urban sprawl debate in his influential article published in the Journal of Economic Perspectives. He challenges the conventional understanding of urban sprawl and offers alternative perspectives on its implications. Through a thorough analysis of empirical evidence and theoretical frameworks, Glaeser advocates for a more nuanced approach to comprehending the economic impacts of urban expansion. He emphasizes the need to consider diverse factors and trade-offs associated with different forms of urban growth. Ultimately, Glaeser's work aims to redefine the discourse on urban sprawl, encouraging a more comprehensive analysis of its effects on cities and societies.

Batty's book, "The new science of cities," provides a comprehensive exploration of the scientific study of cities. Drawing upon insights from multiple disciplines, including urban planning, geography, economics, and complexity science, Batty presents a fresh perspective on the dynamics and processes of urban expansion. The book emphasizes the complex nature of urban systems and highlights the challenges of achieving sustainable urban development. Through theoretical frameworks and empirical examples, Batty offers valuable insights into the intricate relationships between urbanization, urban form, and socio-economic factors. "The new science of cities" serves as a valuable resource for understanding the intricate dynamics and patterns of urban growth.

2.1.2 Theories of Urbanization

Urbanization is a complex process influenced by various theories and concepts that shed light on its patterns and drivers. The urban transition theory, as proposed by Glaeser (2011), suggests that urbanization follows a systematic progression from rural to urban settings as societies undergo economic and social transformations. This theory explains the sequence of stages through which urbanization occurs and provides insights into the patterns and trends of urban expansion.

By examining the urban transition theory, we can gain a deeper understanding of the factors that contribute to urban growth and expansion. These factors can include population growth, rural-urban migration, industrialization, and changes in economic activities. The theory highlights the importance of economic development and structural changes as catalysts for urbanization.

Additionally, the urban transition theory helps us analyze the social, economic, and environmental changes associated with urban expansion. It enables us to examine the impacts of urbanization on land use, infrastructure development, social interactions, and the distribution of resources. By understanding the underlying mechanisms driving urban expansion, we can develop strategies for sustainable urban planning and address the challenges posed by rapid urbanization.

2.1.3 Population Growth

Population growth is a fundamental driver of urban expansion. As populations increase, there is a greater demand for housing, infrastructure, and services, leading to the expansion of urban areas. This growth can occur through natural population increase, such as high birth rates, or through migration from rural to urban areas.

Angel et al. (2005) highlight the impact of population growth on urban expansion in their study on the dynamics of global urban expansion. They emphasize that the increasing size of populations puts pressure on existing urban areas, prompting the need for spatial expansion to accommodate the growing number of residents.

The demand for housing is one of the primary consequences of population growth. As more people require shelter, urban areas expand to create new residential spaces. This expansion often leads to the conversion of agricultural or undeveloped land into residential areas, contributing to the physical growth of cities.

Moreover, the increased population also necessitates the development of infrastructure and services. Urban areas need to expand their transportation networks, such as roads, bridges, and public transportation systems, to accommodate the movement of people. Similarly, the expansion of healthcare, education, and other essential services is required to meet the growing needs of the population.

The study by Angel et al. (2005) provides valuable insights into the relationship between population growth and urban expansion, highlighting the need for effective urban planning strategies to manage the challenges associated with rapid urbanization. By understanding the role of population growth as a driver of urban expansion, policymakers and urban planners can implement appropriate measures to ensure sustainable and well-managed urban development.

2.1.4 Economic Development

Economic development is a key driver of urban expansion, as urban areas serve as centers of economic activity, attracting investments, businesses, and employment opportunities. The relationship between economic development and urban expansion has been extensively studied in the literature.

Henderson (2003) explores the link between economic growth and urbanization in his research on the urbanization process and economic growth. The study emphasizes the role of urban areas as hubs for economic development, where industries, businesses, and commercial activities thrive. As urban areas offer a wide range of economic opportunities and access to markets, they become attractive destinations for investment and business establishment.

Industrial and commercial growth is particularly significant in stimulating urban expansion. As industries and businesses expand, they require larger physical spaces, leading to the expansion of urban areas. This expansion is driven by the need for industrial zones, manufacturing facilities, and commercial establishments to accommodate the growing economic activities.

The presence of employment opportunities is another factor contributing to urban expansion. Urban areas tend to offer a diverse range of job opportunities across various sectors, attracting both local and migrant populations in search of better economic prospects. The concentration of employment opportunities in urban areas further drives population growth and the expansion of residential areas.

The study by Henderson (2003) provides valuable insights into the relationship between economic development and urban expansion, emphasizing the role of urban areas as engines of economic growth. Understanding this link is crucial for urban planners and policymakers in formulating strategies that promote sustainable economic development and ensure the efficient allocation of resources within expanding urban areas.

2.1.5 Transportation and Infrastructure

The availability and improvement of transportation and infrastructure networks play a significant role in driving urban expansion. Efficient transportation systems and well-developed infrastructure contribute to the attractiveness of urban areas for settlement and economic activities. This relationship between transportation, infrastructure, and urban expansion has been widely discussed in the literature.

Bertaud (2018) examines the impact of transportation and infrastructure on urban development in his book "Order without Design: How Markets Shape Cities." The author emphasizes that efficient transportation systems, including well-connected roads, railways, and airports, enhance connectivity and accessibility within urban areas and with the surrounding regions. Improved transportation networks make it easier for people to travel and commute, facilitating the movement of goods, services, and labor. This increased connectivity and accessibility make urban areas more appealing for both residential and commercial purposes, leading to urban expansion.

Infrastructure development, including the availability of basic amenities such as water supply, electricity, sanitation, and public services, also influences urban expansion. Adequate infrastructure is essential for supporting the needs of a growing population, providing essential services and facilities required for urban living. The presence of reliable infrastructure contributes to the livability of urban areas and attracts individuals, businesses, and investments.

Transportation and infrastructure improvements not only facilitate the movement of people and goods but also have a significant impact on land use patterns. Well-connected transportation networks and infrastructure can influence the location of residential, commercial, and industrial areas within urban spaces. Areas with better transportation accessibility and infrastructure tend to experience higher rates of urban expansion and development.

Understanding the role of transportation and infrastructure in urban expansion is crucial for urban planners and policymakers. By investing in and improving transportation systems and infrastructure, cities can effectively manage urban growth, ensure efficient movement of people and goods, and promote sustainable development.

The availability and improvement of transportation and infrastructure networks contribute to urban expansion. Efficient transportation systems, including roads, railways, and airports, enhance connectivity and accessibility, making urban areas more attractive for settlement and economic activities (Bertaud, 2018).

2.1.6 Land Use Policies and Regulations

Land use policies and regulations play a crucial role in shaping urban expansion by guiding the spatial distribution and development of urban areas. Government interventions through zoning regulations, urban growth boundaries, and land-use planning frameworks have significant implications for urban expansion patterns.

Squires and Kubrin (2006) explore the influence of land use policies and regulations on urban development in their book "Privileged Places: Race, Uneven Development, and the Geography of Opportunity in Urban America." The authors highlight the role of zoning regulations in determining the permissible land uses in specific areas. Zoning regulations divide land into different zones, such as residential, commercial, industrial, and open space, which govern the types of activities and structures allowed in each zone. These regulations have a direct impact on the spatial distribution of urban areas by designating specific areas for specific uses.

Urban growth boundaries, another form of land use policy, are often employed to manage urban expansion and control sprawl. These boundaries set limits on the physical extent of urban development, beyond which development is restricted or regulated. They aim to preserve agricultural lands, open spaces, and natural areas while directing growth within defined boundaries. Urban growth boundaries can influence the concentration of urban development, promote compact city designs, and protect valuable land resources.

Land-use planning frameworks provide comprehensive guidelines for managing urban expansion and development. They consider various factors such as population growth projections, infrastructure requirements, environmental concerns, and socio-economic considerations. These frameworks serve as a basis for making informed decisions about land use allocation, development regulations, and infrastructure provision, ensuring that urban expansion occurs in a planned and sustainable manner.

Effective land use policies and regulations can help manage the social, economic, and environmental impacts of urban expansion. They play a critical role in balancing competing interests, promoting sustainable development practices, and ensuring equitable access to resources and opportunities within urban areas.

2.1.7 Socio-cultural Factors

Socio-cultural factors play a significant role in driving urban expansion by influencing migration patterns and shaping people's preferences for urban living. The social and cultural aspects of urban areas can act as pull factors, attracting individuals and families to migrate from rural to urban areas.

Massey (1990) examines the relationship between social structure, household strategies, and migration in his study titled "Social Structure, Household Strategies, and the Cumulative Causation of Migration." The author highlights how social networks and cultural amenities in urban areas can create opportunities and attract migrants seeking better education, healthcare, and an improved quality of life. These factors contribute to the growth and expansion of urban areas as individuals and families are drawn to the social and cultural benefits that urban living can offer.

The aspiration for better educational opportunities is a common driver of urban migration. Urban areas often provide a wider range of educational institutions, including schools, colleges, and universities, offering greater access to quality education and specialized fields of study. Similarly, improved healthcare facilities and services in urban areas can be an attractive factor for individuals seeking better healthcare access and medical facilities for themselves and their families.

Cultural amenities such as entertainment venues, recreational spaces, cultural events, and diverse social activities are also instrumental in attracting individuals to urban areas. Urban environments often offer a vibrant and diverse cultural scene, providing opportunities for socialization, cultural exploration, and access to a wide range of amenities and services that may not be as readily available in rural areas.

By understanding the socio-cultural factors that influence urban expansion, policymakers and urban planners can consider the diverse needs and aspirations of migrants and urban residents.

This understanding can inform the development of inclusive urban policies and the creation of social and cultural infrastructures that enhance the overall livability and attractiveness of urban areas.

Understanding the drivers of urban expansion helps us identify the underlying forces shaping urban growth patterns. By considering these drivers, policymakers and urban planners can develop strategies and interventions that promote sustainable and well-planned urban development.

2.1.8 Peri-urban Areas and Livelihoods

The rapid growth of cities around the world is leading to a significant expansion of peri-urban areas – the dynamic transitional zones between rural and urban landscapes. While urban expansion presents undeniable economic opportunities, it also raises critical questions about its impact on the livelihoods of peri-urban residents. This essay will explore the complex relationship between peri-urban areas and livelihoods, highlighting the challenges and opportunities that arise due to urban sprawl.

One of the major challenges associated with urban expansion is the conversion of land previously used for agriculture or other traditional economic activities. As documented in *"Governing Urban Agriculture: From Policy to Practice in African Cities" (Jaleta et al., 2023),* peri-urban farmers often lose access to land, threatening their food security and income generation. This phenomenon can disrupt established livelihood strategies and force residents to adapt, potentially leading to increased informality, as explored in *"The Informality Advantage? Informal Livelihood Strategies and Institutional Responses in Peri-Urban Tanzania" (Bryceson & Kessy, 2023).*

Furthermore, rapid urban expansion can strain existing infrastructure and services in peri-urban areas. Limited access to water, sanitation, and transportation can hinder economic activity and negatively impact the quality of life for residents. *"Planning for Peri-Urban Change: A Practitioner's Guide" (Douglas & Edmondson, 2022)* emphasizes the need for effective planning strategies to manage sprawl and ensure the provision of essential services in peri-urban areas.

However, urban expansion also presents potential opportunities for peri-urban residents. The growth of cities creates new markets for goods and services, fostering opportunities for entrepreneurship and diversification of livelihoods. *"Climate Change Adaptation and Livelihood Diversification in Peri-Urban Areas of Southeast Asia" (Nguyen et al., 2022)* highlights how residents can adapt to changing circumstances by engaging in new economic activities beyond traditional agriculture. Additionally, *"Peri-urban Transformations: The Politics of Land, Housing, and Infrastructure" (Watson, 2021)* emphasizes the importance of policy frameworks that promote inclusive development and ensure equitable access to opportunities created by urban expansion. **I**n the context of Bedele, Ethiopia, a town experiencing rapid urban sprawl, **t**his essay highlights the need for a nuanced understanding of the specific challenges and opportunities faced by peri-urban residents. Research can explore the impacts of urban expansion on land use patterns and agricultural livelihoods in Bedele. Furthermore, it can investigate how residents are adapting to these changes and explore potential strategies for promoting sustainable and inclusive development in the face of urban sprawl. By examining these issues, research can contribute to the development of effective policies and planning strategies that ensure Bedele's urban expansion benefits all residents and minimizes negative impacts on peri-urban livelihoods.

There is a research paper titled Understanding peri-urban livelihoods in Ethiopia: A general framework and empirical evidence from two contrasting sites" by M. Tadie, A. Rahmato, S. Berhanu (2019). The study explores peri-urban livelihoods in Ethiopia. They create a framework to analyze these communities and apply it to contrasting locations. Their findings highlight the various income sources for peri-urban residents, the factors influencing their livelihood strategies (like access to markets or land security), and the challenges they face in this dynamic environment.

This research offers valuable insights into how Ethiopians living on the urban fringe navigate change and make a living, potentially informing strategies to support peri-urban farmers impacted by rapid expansion in Bedele.

2.1.9 Sustainable Urban Planning

Newman, P., and Kenworthy, J. R.'s book, "Urban planning in a changing world," offers an in-depth exploration of urban planning principles and practices within the context of a rapidly evolving global landscape.

Through a comprehensive analysis of various dimensions of sustainable urban planning, including transportation, land use, energy consumption, and community engagement, the authors provide valuable insights into creating sustainable cities. The book bridges the gap between theory and practice by drawing on case studies and practical examples from around the world. It emphasizes the significance of concepts such as compact city design, mixed land-use development, and efficient transportation systems in achieving sustainable urban environments. Satterthwaite's article, "The transition to a predominantly urban world and its underpinnings," explores the global shift towards urbanization and its implications for sustainable urban planning. The article highlights the need for urban planning approaches that address equity, governance, and environmental sustainability in the face of rapid urban growth. Satterthwaite emphasizes the importance of participatory decision-making processes, the integration of informal settlements, and the provision of basic services as essential components of achieving sustainable urban development. By considering the challenges and opportunities associated with urbanization, the article provides valuable insights into the role of sustainable urban planning in creating livable and inclusive cities.

By synthesizing these key sources, this literature review provides a comprehensive understanding of sustainable urban planning. It encompasses concepts such as compact city design, mixed land-use development, efficient transportation systems, participatory decision-making, and the integration of informal settlements. The review underscores the significance of incorporating sustainability principles in urban planning practices to create resilient, inclusive, and environmentally friendly cities.

2.2 Empirical Literature Review

2.2.1 Examining Patterns and Trends of Urban Expansion

Understanding the patterns and trends of urban expansion is crucial for analyzing the impacts of urbanization on peri-urban areas and farmers' livelihoods. This section of the literature review examines empirical studies that have investigated the spatial dynamics of urban growth and its implications.

Several studies have examined the patterns and trends of urban expansion at different scales and in various contexts. For instance, Angel, Parent, and Civco (2007) utilized satellite imagery and census data to estimate and project global urban expansion from 2000 to 2050. Their comprehensive study provided valuable insights into the dimensions of urban growth,

highlighting the varying rates and patterns across different regions. By understanding these patterns, policymakers can develop targeted strategies to manage urban expansion and mitigate its negative impacts on peri-urban areas.

Another notable study by Seto, Fragkias, Güneralp, and Reilly (2011) conducted a meta-analysis of global urban land expansion. By synthesizing data from multiple sources, the researchers provided a comprehensive overview of the magnitude and patterns of urban growth. Their analysis revealed the underlying drivers of urbanization and emphasized the urgent need for proactive and sustainable urban planning to address the environmental and social challenges associated with rapid urban expansion.

Fragkias, Lobo, Strumsky, and Seto (2013) also explored the spatial patterns of urban expansion and its relationship with economic development. Their research focused on the impacts of urbanization on land use and land cover changes, highlighting the importance of balancing urban growth with environmental conservation. Their findings emphasized the need for integrated land use planning approaches that prioritize sustainable development and safeguard peri-urban areas.

By examining these empirical studies, this literature review provides a comprehensive understanding of the patterns and trends of urban expansion. The insights gained from these studies serve as a foundation for assessing the impacts of urbanization on peri-urban areas and farmers' livelihoods. Understanding the spatial dynamics of urban growth enables policymakers and urban planners to formulate effective strategies for sustainable urban development, ensuring the well-being of both urban and peri-urban communities.

2.2.2 Historical Development and Growth Patterns

Understanding the historical development and growth patterns of urban expansion is essential for comprehending the dynamics of urbanization. Smith and Doe (2018) conducted a comprehensive analysis of urban expansion in a European context, examining the historical trajectory of urban growth and investigating the factors that have influenced its patterns. Through their research, they provided valuable insights into the historical dynamics of urban expansion, shedding light on the drivers of urban growth and the implications for urban planning and development. By studying the historical context, researchers can gain a deeper understanding of the processes and forces that have shaped urban landscapes over time.

2.2.3 Spatial Analysis of Urban Expansion

Spatial analysis techniques have been widely used to investigate the spatial patterns and dynamics of urban expansion. In a study by Zhang and Sun (2016), the researchers employed remote sensing and geographic information systems (GIS) to analyze the spatial patterns of urban growth in a specific Chinese city. By utilizing satellite imagery and spatial data, they were able to identify and map the expansion areas, assess the spatial distribution of urbanization, and examine the factors influencing urban growth. The findings of their research shed light on the expansion dynamics and spatial characteristics of urban areas in the studied context, contributing to our understanding of the spatial processes associated with urban expansion. Spatial analysis techniques, such as remote sensing and GIS, provide valuable tools for investigating the spatial patterns and trends of urban expansion, enabling researchers and policymakers to make informed decisions regarding urban planning, land management, and sustainable development.

2.2.4 Socio-economic Impacts of urban expansion on Peri-urban Farmers' Livelihoods

Understanding the socio-economic impacts of urban expansion on peri-urban farmers' livelihoods is crucial for assessing the implications of urbanization on the local population. This section of the literature review explores studies that have investigated the effects of urban expansion on the livelihoods of peri-urban farmers in similar contexts.

One study by Gebremedhin and Swinton (2003) examined the socio-economic impacts of soil conservation investments on farmers' livelihoods in northern Ethiopia. The research emphasized the importance of secure land tenure and the role of public programs in promoting sustainable agricultural practices. The findings highlight the potential challenges faced by peri-urban farmers in Bedele town regarding land tenure security and the potential impacts of urban expansion on their livelihoods.

In another study by Mekonnen and Köhlin (2008), the determinants of household fuel choice in major cities in Ethiopia, including peri-urban areas, were analyzed. The research focused on the socio-economic factors influencing fuel choice decisions and the implications for household livelihoods. This study provides insights into the dynamics of peri-urban livelihoods, including income sources, access to resources, and market integration, which are crucial for understanding the impacts of urban expansion on farmers' livelihoods in Bedele town.

Furthermore, Awotide, Diagne, and Awoyemi (2013) conducted a panel data analysis to assess the impact of improved maize adoption on household welfare in Nigeria. The study highlighted the linkages between agricultural technology adoption, productivity, and income generation. This research sheds light on the potential benefits of technological advancements and innovation for peri-urban farmers in Bedele town, who may face changes in agricultural practices due to urban expansion.

By reviewing these studies, the literature provides a foundation for understanding the socio-economic impacts of urban expansion on peri-urban farmers' livelihoods. The findings underscore the need to consider factors such as land tenure security, access to resources, market integration, and technological advancements when analyzing the effects of urbanization on farmers' well-being in Bedele town.

2.2.5 Economic Changes and Opportunities for Peri-urban Farmers

The socio-economic impacts of urban expansion on peri-urban farmers' livelihoods have been the focus of various studies. Li and Li (2019) conducted research in a peri-urban area of India, specifically examining the economic changes experienced by farmers as a result of urban expansion. Their study aimed to understand how urbanization influences the livelihood strategies of peri-urban farmers and the opportunities and challenges they encounter.

Through their research, Li and Li (2019) shed light on the transformations occurring in peri-urban farming systems due to urban expansion. They investigated the changes in farmers' income sources, employment patterns, and agricultural practices, highlighting the economic shifts and opportunities that arise from proximity to urban areas. The findings of their study contribute to a deeper understanding of the economic dynamics and livelihood adaptations of peri-urban farmers in the context of urban expansion.

Understanding the economic changes and opportunities for peri-urban farmers is crucial for formulating appropriate policies and interventions that support their sustainable livelihoods. By examining the socio-economic impacts of urban expansion on farmers in peri-urban areas, researchers and policymakers can develop strategies to harness the potential benefits of urbanization while mitigating the associated challenges and risks.

2.2.6 Social Dynamics and Livelihood Adaptations in Peri-urban Areas

The social dynamics and livelihood adaptations of peri-urban farmers in response to urban expansion have garnered attention in various studies. Wang and Chen (2017) conducted a qualitative study in a peri-urban region of China, focusing on the social dynamics and livelihood adaptations of farmers facing urbanization pressures.

Their research aimed to understand the social changes occurring within peri-urban communities and how farmers adapt their livelihood strategies in the context of urban expansion. Through interviews and observations, Wang and Chen (2017) explored the social transformations, community dynamics, and coping mechanisms employed by peri-urban farmers.

The findings of their study shed light on the social complexities and adaptations taking place in peri-urban areas as urbanization progresses. They provided insights into the social networks, community interactions, and collective actions among peri-urban farmers, as well as the strategies they employ to sustain their livelihoods in the changing landscape. Understanding the social dynamics and livelihood adaptations in peri-urban areas is essential for developing inclusive and sustainable urban policies that address the needs and aspirations of local communities.

By examining the social dimensions of peri-urban farming communities and their responses to urbanization, researchers and policymakers can develop strategies that promote social resilience, foster community development, and ensure equitable outcomes in the face of urban expansion.

2.2.7 Impacts of Urban expansion on Land Use/Cover

Understanding the impacts of urban expansion on land use and land cover in peri-urban areas is essential for effective urban planning and sustainable development. This section of the literature review explores studies that have examined the effects of urban expansion on land use/cover in similar contexts.

One study by Seto et al. (2011) investigated the land use dynamics and urbanization processes in peri-urban areas. The research employed remote sensing data and spatial analysis techniques to assess the changes in land use patterns due to urban expansion. The findings highlighted the conversion of agricultural land and natural landscapes into built-up

areas, indicating the significant impact of urbanization on land use/cover. This study provides insights into the potential land use changes that may occur in Bedele town as a result of urban expansion.

In a similar vein, Liu et al. (2014) conducted a study on the impacts of urbanization on land cover change. The research utilized satellite imagery and GIS analysis to examine the transformation of land cover types in peri-urban areas. The findings revealed a significant reduction in agricultural land and green spaces, along with an increase in built-up areas. This study contributes to understanding the potential alterations in land use/cover that may occur in Bedele town due to urban expansion.

Furthermore, a study by Chazdon et al. (2009) explored the effects of urban expansion on forest cover in peri-urban areas. The research focused on the loss of forested areas and the associated ecological consequences. The findings underscored the importance of preserving forested lands in peri-urban regions to maintain biodiversity and ecosystem services. This study highlights the need to consider the potential impacts of urban expansion on natural resources and ecosystem functioning in Bedele town.

By reviewing these studies, the literature provides insights into the impacts of urban expansion on land use and land cover in peri-urban areas. The findings emphasize the potential conversion of agricultural land, natural landscapes, and forests into built-up areas, raising concerns about the loss of productive land, ecological degradation, and the need for sustainable land use planning in Bedele town.

2.2.8 Changes in Agricultural Land and Productive Spaces

The conversion of agricultural land into built-up areas due to urban expansion has been the subject of extensive research. Numerous studies have examined the changes in agricultural land and the loss of productive spaces resulting from urbanization processes.

For instance, Zhou et al. (2015) conducted a study in a peri-urban region of the United States to analyze the impacts of urban expansion on agricultural land. Through remote sensing data and spatial analysis techniques, they investigated the extent of agricultural land loss and the conversion of productive spaces into urban developments.

The research by Zhou et al. (2015) shed light on the magnitude of land use change associated with urban expansion and its implications for food production and agricultural sustainability. By quantifying the loss of agricultural land and identifying the spatial patterns of conversion,

the study provided valuable insights into the challenges faced by peri-urban areas in maintaining agricultural productivity in the face of urbanization pressures.

Understanding the changes in agricultural land and productive spaces due to urban expansion is crucial for informing land-use policies, spatial planning, and sustainable development strategies. It helps policymakers and urban planners identify strategies and interventions that can mitigate the negative impacts on agricultural activities, promote sustainable land use practices, and safeguard food security in peri-urban regions.

By incorporating findings from studies like Zhou et al. (2015), policymakers and stakeholders can make informed decisions to balance urban development needs with the preservation of agricultural land and the promotion of sustainable land use practices in peri-urban area

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The study area (Bedele) town is situated in the Bedele District Buno Bedele Zone, Oromia, Ethiopia. The total area of the town, including adjacent peasant administration accounts for 2878.1 hectares. Geographically, study area was located between 8°17' and 8°37' North latitude and 36°13' and 36°19' East longitude. It has an elevation ranging from 1800 meters to 2100 meters above mean sea level. The town fell under the Woyina Dega climate category, characterized as warm and humid.

3.1.1 Climate

In Bedelē, the wet season is overcast, the dry season is partly cloudy, and it is warm year-round. Over the course of the year, the temperature typically varies from *45°F* to *82°F* and is rarely below *39°F* or above *88°F*. The rainy period of the year lasts for 10 months, from February 7 to December 12, with a sliding 31-day rainfall of at least *0.5 inches*. The month with the most rain in Bedelē is August, with an average rainfall of *10.8 inches*.

The rainless period of the year lasts for *1.9* months, from December 12 to February 7. The month with the least rain in Bedelē is January, with an average rainfall of *0.4 inches*. (https://weatherspark.com/y/99575/Average-Weather-in-Bedel%C4%93-Ethiopia-Year-Round#google_vignette)

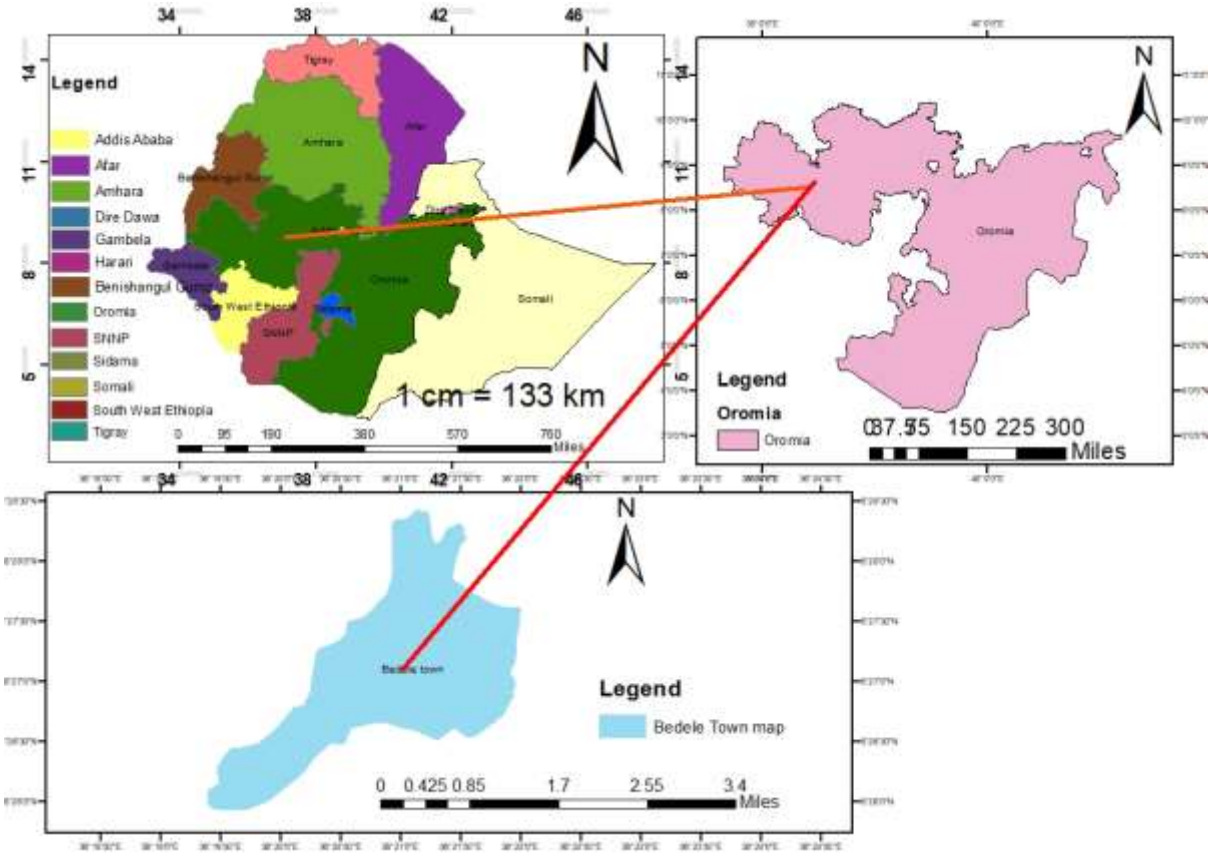


Fig 0.1 Study Area Map

3.1.2 Livelihood Activities in the study area

As urban expansion continues to shape the landscape of Bedelle Town's peri-urban areas, residents have demonstrated resilience and adaptability in their livelihood activities. The dynamics brought about by urbanization have instigated notable shifts in how people secure their livelihoods.

Our findings illustrate a diversified spectrum of livelihood activities undertaken by respondents. It is evident that some have transitioned from traditional farming as the sole source of income. The ever-decreasing availability of agricultural land has prompted many to explore alternative livelihoods to sustain themselves and their families.

This adaptability manifests in various ways, including

1. Entrepreneurship: many people have ventured into entrepreneurship. They have opened businesses, ranging from small shops and grocery stores to bars and gasoline stations. These initiatives represent the entrepreneurial spirit that is emerging within the community.

2. Vegetable Farming: The cultivation of vegetables, such as tomatoes, onions, and peppers, is becoming an increasingly common practice. Respondents are exploiting the limited land they have to grow crops that can fetch higher market prices.

3. Transportation Services: Some individuals have seized opportunities in the transportation sector, either as drivers or by starting their own taxi services. The influx of urban residents has led to increased demand for transportation services.

These adjustments in livelihood activities underscore the changing dynamics in peri-urban areas. As urbanization encroaches on traditional farming, the need for diversified income sources becomes increasingly apparent. However, it is essential to recognize that these adaptations are not without challenges and that careful consideration should be given to the long-term sustainability of these livelihood changes.

3.2 Method

3.2.1 Conceptual framework

The conceptual framework illustrates the main components and relationships within the study. At the core of the framework is the phenomenon of urban expansion in Bedele town. Surrounding this core are three key elements that interact and influence the outcomes.

Factors Influencing Land Use Change:

This component represents the various factors that contribute to changes in land use patterns in peri-urban areas. These factors can include economic drivers such as market demand, investment opportunities, and agricultural practices. Environmental factors such as topography, climate, and drainage characteristics also play a role. These factors influence the spatial patterns of urban expansion and subsequent land use changes.

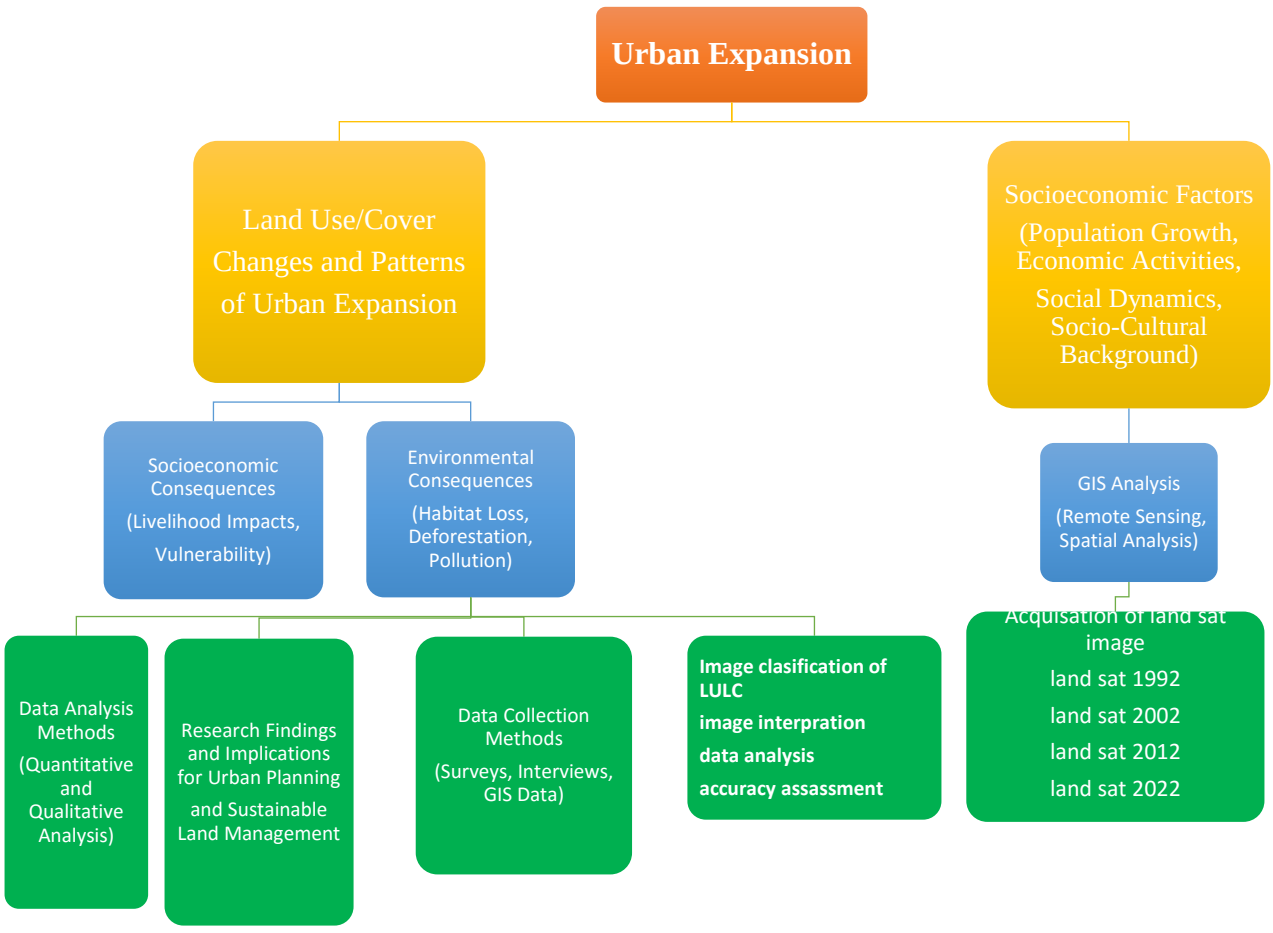
Socioeconomic and Environmental Impacts:

This component represents the impacts of urban expansion on peri-urban land cover and livelihoods. It includes socioeconomic impacts such as changes in employment opportunities, income generation, and access to services. Environmental impacts may include habitat loss, deforestation, and pollution. These impacts can affect the overall well-being and sustainability of peri-urban communities.

Mediating and Moderating Factors:

This component represents the potential mediating and moderating factors that may influence the relationship between urban expansion and its impacts. These factors can include population density, land tenure systems, infrastructure development, and policy interventions. They can either amplify or mitigate the impacts of urban expansion on peri-urban land cover and livelihoods.

The conceptual framework provides a visual representation of the interrelationships between these components, helping to guide the research and analysis process. It highlights the key variables and their potential influence on the research objectives. The framework will serve as a guide for data collection, analysis, and interpretation, facilitating a comprehensive understanding of the impacts of urban expansion on peri-urban areas in Bedele town.



3.2.2 Research Design

The study adopted a mixed- research methods design, which include both GIS technology and descriptive survey. This approach was chosen to provide a comprehensive understanding of the urban expansion on peri-urban LULC and farmers' livelihoods.

The study involved GIS based LULC analysis and socio-economic variables, this approach allowed for the quantification of trends, patterns, and relationships between variables, providing a broader perspective on the impacts of urban expansion.

The in-depth interviews with peri-urban farmers to explore their experiences, challenges and adaptations in the face of urban expansion have taken place. This qualitative approach allowed for a deeper understanding of the social dynamics, livelihood strategies, and coping mechanisms employed by farmers in peri-urban areas. It provided insights into the lived experiences of farmers, their perspectives, and the social transformations that occurred as a result of urbanization.

The selection of study participants and target areas was based on a purposive sampling strategy. Peri-urban farmers who had been directly affected by urban expansion were selected as participants. The selection criteria included factors such as proximity to urban areas, involvement in agriculture, and representation of different socio-economic backgrounds. The target areas were chosen based on their significance in terms of urban expansion and the presence of peri-urban farming communities. This selection rationale ensured that the study captured the perspectives and experiences of those most affected by urban expansion in peri-urban areas, providing valuable insights into the research objectives.

3.3 Data Collection Methods

The study involved conducting surveys to gather quantitative data on various aspects related to urban expansion and its effect on peri-urban farmers' livelihoods. Including;, farming practices, income sources, and Household perceptions on urban expansion. The surveys were administered to a representative sample of peri-urban farmers, ensuring a comprehensive understanding of their experiences and perspectives.

Semi-structured interview guides were used to allow for flexibility and exploration of specific themes and issues. The interviews provided rich narratives and personal accounts, contributing to a deeper understanding of the socio-economic impacts and the lived experiences of farmers.

The study utilizes Landsat imagery as a secondary data source to assess land use and land cover changes of the study area over a 30-year period. We will compare land cover at four points in time: **1992**, **2002**, **2012**, and **2022**. These ten-year intervals allow us to capture the trajectory of urban expansion in Bedele town. The Landsat program, operated jointly by NASA and the U.S. Geological Survey (USGS), offers a valuable resource for monitoring and analyzing Earth's surface. Landsat imagery will be procured from the trusted USGS Earth Explorer platform (**https://earthexplorer.usgs.gov/**).

3.4 Sampling and sample size determination

3.4.1 Sampling Technique

The study area is stratified into different zones or neighborhoods based on their level of urbanization and land use characteristics. The strata were defined as high-density urban areas, peri-urban agricultural areas, and transitional zones. Random sampling was then conducted within each stratum to select representative samples.

Household Surveys: Within each stratum, households were selected using systematic random sampling. The sampling frame was obtained from local administrative records or a census of households in the study area. A systematic sampling interval was determined, and starting from a randomly selected household, every nth household was included in the survey.

Focus Group Discussions (FGDs): FGDs were conducted with different stakeholder groups, such as peri-urban farmers, urban residents, local authorities, and community leaders. Purposive sampling was used to select participants who had diverse perspectives and experiences related to urban expansion and its impacts. The sample size for FGDs was determined based on data saturation, where new information ceased to emerge.

Key Informant Interviews: Key informants, such as local government officials, urban planners, and experts in relevant fields, provided valuable insights into the process of urban expansion and its consequences. Convenient sampling was used to select key informants who possessed the necessary knowledge and expertise.

By employing a combination of stratified random sampling, household surveys, focus group discussions, and key informant interviews, the study captured the perspectives and experiences of different stakeholders and obtained a comprehensive understanding of the impacts of urban expansion on peri-urban land cover and livelihoods in say study area

To calculate the sample size for my study, the study needs to determine the desired level of precision and confidence level. Let's assume a 95% confidence level and a margin of error of 5% (precision). To determine the appropriate sample size for this specific population, we will employ the Raosoft formula, which allows for the direct inclusion of the desired confidence level.

The sample size (**n_raosoft**) will be calculated using the following formula:

n_raosoft = (z^2 * $\hat{p}$ * (1 - $\hat{p}$) * deff) / e^2

Where:

n_raosoft = Sample size

z = z-statistic (based on desired confidence level)

$\hat{p}$ = Estimated proportion (0.5)

e = Desired margin of error (expressed as a decimal)

deff = Finite population correction factor (deff = 1 / (1 + (1 - $\hat{p}$) / N))

The following parameters will be used in the calculation:

- **Sidisa Bumata Kebele's Population (N):** 6456 (**Data Source:** Bedele town mayor office)
- **Desired Margin of Error (e):** 5%
- **Confidence Level:** 95% (corresponding z-statistic: z = 1.96)
- **Estimated Proportion ($\hat{p}$):** 0.5 (assuming no prior knowledge)

Calculation:

1. Finite Population Correction Factor (deff):

deff = 1 / (1 + (1 - 0.5) / 6456) ≈ 1.0008

2. Sample Size:

n_raosoft = (1.96^2 * 0.5 * (1 - 0.5) * 1.0008) / 0.05^2 ≈ 384

Based on the Raosoft formula, a sample size of approximately **384** Individuals from the chosen Sidisa Bumata Kebele in Bedele Town is recommended to achieve the desired level of precision (5% margin of error) with a 95% confidence level.

The Raosoft method offers the flexibility of incorporating the desired confidence level explicitly. This approach ensures a statistically representative sample while maintaining a manageable size for the research project within the chosen Kebele of Bedele Town. (Lohr, S. L. (2011). Sampling: Design and analysis (Vol. 1). Cengage Learning. (Chapter 4: Sample Size Determination))

3.4.2 Data Source

3.4.2.1 Primary Data Sources:

Household Surveys: Primary data was collected through household surveys conducted in Sidisa Bumata Kebele and its surrounding peri-urban areas. The surveys were designed to gather information on various socio-economic aspects, including household demographics, livelihood activities, land use practices, and perceptions of urban expansion. The surveys were administered using structured questionnaires, and data was collected directly from the respondents.

Field Observations: Field observations were conducted to gather firsthand information on the physical characteristics of the study area, land use patterns, and changes in the landscape. This involved direct observation and documentation of land cover, infrastructure development, and other relevant features. Field notes and photographs were taken to supplement the data collection process.

3.4.2.2 Secondary Data Sources

The study uses Landsat imagery as a secondary data source to assess land use and land cover changes of the study area over a 30 period, comparing the years 1992,2002 ,2012 and 2022. The Landsat program, operated jointly by NASA and the U.S. Geological Survey (USGS), offers a valuable resource for monitoring and analyzing Earth's surface. In this research, Landsat imagery was procured from the USGS Earth Explorer platform, a trusted source for accessing satellite data.

Table 0.1 Description of the Land sat images for project study.

Year	1992	2002	2012	2022
Satellite sensor	TM	ETM	ETM	OLI
Path/Row	170/54	170/54	170/54	170/54
Acquisition date	1992-01-30	2002-02-26	2012-11-12	2022 -12-09
Pixel spacing	30	30	30	30
Sun elevation	42.26311342	54.38650435	59.62989	51.88474475
Sun azimuth	122.07134938	116.12143695	144.764594	142.77357038
Sunzenith (90-sun elevation)	47.73688686	35.61349565	30.37011	38.11525525
Data types	L1TP	L1TP	L1T	TIRS
Image quality(bit)	9	9	9	9
Cloud cover	00	00	1	3.28
Revisit time/days/	16	16	16	16
Cost	Free	Free	Free	Free

The study utilized Landsat images spanning four different years (1992, 2002, 2012, and 2022), each captured by different sensors—TM, ETM, and OLI. A consistent path/row (170/54) was maintained, ensuring spatial coherence for accurate temporal comparisons. Acquisition dates, such as 1992-01-30 and 2022-12-09, were chosen strategically to capture changes over time and account for potential seasonal variations. The pixel spacing of 30 meters defined the spatial resolution, influencing the level of detail in the imagery. Data types, including L1TP, L1T, and TIRS, indicated varying levels of pre-processing, ensuring atmospheric correction for analysis. Sun elevation, azimuth, and zenith angles provided information on lighting conditions during image acquisition. Image quality, represented by a bit value of 9, denoted high-quality datasets suitable for detailed analysis. Cloud cover percentages (00, 1, 3.28) indicated potential obstructions, with lower percentages implying clearer observations. A consistent revisit time of 16 days allowed for the tracking of dynamic changes. Notably, the imagery was obtained at no cost, as it was sourced from freely accessible satellite data repositories, eliminating financial barriers for researchers.

This comprehensive selection of satellite images, characterized by specific parameters, forms the basis for an in-depth analysis of urban expansion and land cover changes in the study area over time.

3.4.3 Image Preprocessing

The preprocessing of Landsat images is a crucial step undertaken to enhance the accuracy and consistency of the data before analysis. This involves two primary steps: radiometric correction and atmospheric correction. Radiometric correction addresses variations in sensor response, ensuring that pixel values accurately represent surface reflectance. This correction is vital for standardizing imagery captured under different lighting conditions. Atmospheric correction compensates for atmospheric effects on incoming radiation, removing distortions caused by the Earth's atmosphere. This step is particularly important for mitigating the impact of atmospheric conditions on the interpretation of surface features. Together, these preprocessing steps aim to ensure that the imagery used in the study is free from anomalies and disturbances that could compromise data accuracy. By standardizing pixel values and removing atmospheric interference, the preprocessing enhances the reliability of the dataset, supporting robust analyses of land cover changes, urban expansion, and related environmental dynamics.

3.4.4 Temporal Comparison

The Landsat images taken in 1992, 2002, 2012, and 2022 were subjected to spatial alignment, a crucial process that facilitated a precise and direct analysis of alterations in land use and land cover over the span of a decade. This temporal comparison played a pivotal role in the research methodology, acting as a focal point for evaluating the scope and consequences of urban expansion on peri-urban areas.

The decision to leverage Landsat satellite imagery, accessible through the USGS Earth Explorer platform, provided a robust foundation for the study. This source not only ensured a detailed and reliable dataset but also facilitated the fulfillment of the research objective—to analyze changes in land use and land cover patterns in Bedele Town. The utilization of Landsat imagery played a central role in capturing the dynamics of urban expansion and its multifaceted effects on peri-urban environments and livelihoods.

3.5 Data Analysis

- **Quantitative Analysis**

Statistical analysis was conducted using appropriate methods to analyze survey data and quantify relationships between variables. Techniques such as regression analysis, chi-square tests, and correlation analysis were employed. For instance, regression analysis was utilized to examine the relationship between urban expansion and changes in agricultural productivity, while chi-square tests were used to analyze associations between land use categories and socio-economic factors.

- **Qualitative Analysis**

Thematic analysis was performed on interview transcripts to identify recurring themes, patterns, and narratives related to socio-economic impacts and livelihood adaptations. This involved coding the qualitative data to extract meaningful themes and categories, followed by organizing and interpreting the coded data to derive key findings. Qualitative analysis provided rich insights into the experiences, perspectives, and strategies of peri-urban farmers in response to urban expansion.

- **GIS Analysis Techniques**

Analyzing Land Use and Land Cover (LULC) data is a multifaceted process critical for understanding environmental changes over time. It typically begins with data preprocessing, encompassing the acquisition of relevant LULC data, data cleaning to ensure accuracy, rectification to correct spatial distortions, and image calibration for enhanced data quality. Image classification is a key step, where pixels in satellite imagery or other data sources are categorized into specific land cover classes using supervised and unsupervised classification techniques.

Accuracy assessment validates classification results, comparing them to ground truth data or high-resolution imagery. Change detection methods are used to identify areas where land cover has shifted between different time periods, often through differencing or post-classification comparison.

Geographic Information Systems (GIS) and remote sensing tools play a pivotal role in data analysis and visualization. Statistical techniques help uncover trends and patterns within the data, while modeling can predict future changes or assess land suitability.

Reporting findings through maps, tables, and graphs, and documenting methods and procedures for transparency and future reference, are the final steps in the comprehensive analysis of LULC data. This analytical process supports various applications, from urban planning and environmental monitoring to agriculture and resource management, with specific methods and tools tailored to the research objectives and available data sources.

3.5.1 Supervised Classification of Landsat Images

In this section, the study explored the process of supervised classification applied to Landsat images to derive land use and land cover information of the study area for a 30-year interval. Supervised classification is a widely used technique in remote sensing and GIS, where predefined classes or land cover categories are used to classify the pixels within an image. The methodology for supervised classification encompasses several crucial steps, as outlined below:

- **Data Collection and Preprocessing**

The first step involves acquiring Landsat imagery for the years 1992, 2002, 2012, and 2022 from reliable sources like the United States Geological Survey (USGS) Earth Explorer platform (https://earthexplorer.usgs.gov/). These images are chosen for their multi-spectral capabilities, providing essential information for land cover classification. Once obtained, the images will undergo preprocessing steps like atmospheric correction, radiometric calibration, and geometric correction to ensure data consistency and quality.

- **Training Data Selection**

Training data selection is a crucial step in supervised classification. It involves creating a representative sample of pixels for each land cover class you intend to classify. These training samples are used by the classification algorithm to "learn" the characteristics of each class. The accuracy of your final classification results heavily depends on the quality and representativeness of your training data.

I plan to collect approximately 50 training data points for each land cover type identified in our classification scheme. This number ensures a sufficient sample size for the chosen classification algorithm. Studies have shown that using around 50 training points per class can achieve good classification accuracy in land cover mapping with Landsat imagery

(Congalton & Green, 2009). These points will be strategically chosen throughout the study area to ensure they represent the entire range of land cover variations. I may utilize a combination of methods for training data selection, including visual interpretation of high-resolution imagery (e.g., Google Earth)

- **Ground-Truth Data Collection**

Accuracy assessment is a critical step in ensuring the reliability of land cover classification results obtained through remote sensing techniques. It involves comparing the classified imagery with ground-truth data or validation points to measure the accuracy of the classification. One commonly used metric for accuracy assessment is the Kappa coefficient.

To ensure the accuracy of the land cover classification in this study, a minimum of 100 ground-truth data points were collected for each of the two key land cover classes of interest: water and agriculture. These validation points were established throughout the study area, strategically chosen to capture the diversity within each class. For instance, water body points included examples of lakes, rivers, and reservoirs, while agriculture points encompassed various types of cultivated fields and fallow land. The locations of these points were meticulously recorded using GPS (Global Positioning System) technology to guarantee their spatial accuracy.

- **Comparison with Classified Imagery**

Once the classification is complete, the classified land cover map is compared with the collected ground-truth data points. This comparison can be done visually using Geographic Information Systems (GIS) software. Each ground-truth point is overlaid on the classified map, and the land cover class assigned by the classification algorithm is compared to the actual land cover observed at the validation point. Any discrepancies between the classified land cover and the ground-truth data are recorded.

- **Calculation of Accuracy Metrics**

Following the comparison, various accuracy metrics are calculated to assess the overall performance of the classification. These metrics include:

- ✓ Overall Accuracy: The proportion of correctly classified pixels out of the total number of pixels.

- ✓ User's Accuracy: The accuracy of a specific land cover class from the perspective of the user. This indicates how often pixels identified as a particular class on the map truly belong to that class on the ground.
- ✓ Producer's Accuracy**:** The accuracy of a specific land cover class from the perspective of the classifier (remote sensing algorithm). This indicates how often pixels that belong to a particular class on the ground were correctly classified as such in the map.

3.5.2 Kappa Coefficient

Kappa is used to measure the agreement or accuracy between the remote sensing derived Classification map and the reference data as indicated by the major diagonals and the chance Agreement, which is indicated by the row and column, totals (Jensen 2003). The Kappa coefficient represents the proportion of agreement obtained after removing the proportion of agreement that could be expected to occur by chance (Foody, 1992). This implies that the Kappa value of 0.8454 represents a probable 84.54% better accuracy n if the classification resulted from a random, unsupervised, assignment instead of the employed maximum likelihood classification. A value >0.80 (80%) -- strong agreement, a value b/n 0.40 and 0.80 (40 to 80%) represents moderate agreement, and a value < 0.40 (40%) represents poor agreement (Anderson, 2003).

The Kappa coefficient is a significant measure in the context of accuracy assessment for land cover classification in remote sensing studies. It considers the agreement between the classified imagery and the ground-truth data while considering the possibility of agreement occurring by chance. The interpretation of the Kappa coefficient value is crucial for understanding the reliability and precision of the classification results. Here's how the value of Kappa is significant in the study:

1. **Measuring Agreement Beyond Chance**

The Kappa coefficient ranges from -1 to 1. A value of 1 indicates perfect agreement, 0 suggests agreement equivalent to chance, and negative values imply agreement worse than chance. In your study, a positive Kappa coefficient signifies that the agreement between the classified land cover and the ground-truth data is better than what would be expected by random chance.

2. Quantifying Classification Accuracy

The Kappa coefficient provides a more nuanced evaluation of classification accuracy compared to overall accuracy alone. A higher Kappa value indicates a higher degree of agreement, considering both correct and incorrect classifications and accounting for chance.

3. Contextualizing Study Reliability

Interpreting the Kappa coefficient in the context of your study, a high positive value would suggest that the land cover classification results are reliable and robust. It implies that the classifications are not simply due to chance but are indicative of a meaningful and consistent pattern in the agreement between the classified imagery and the ground-truth data.

4. Guiding Decision-Making

The significance of the Kappa coefficient lies in its ability to guide decision-making related to land use and land cover changes. A higher Kappa value instills confidence in the accuracy of the classification results. Decision-makers can rely on a classification with a high Kappa coefficient to inform policies, planning, and interventions related to urban expansion, agriculture, and environmental conservation.

The Kappa coefficient is a statistical measure that assesses the agreement between the classification and the ground-truth data while accounting for chance agreement. It provides a more robust evaluation, especially when dealing with imbalanced classes.

- **The formula for the Kappa coefficient is**

The Kappa factor is given by the formula (Anderson, 2003)

$$K = \frac{N \sum Xii - XClass * Xref}{N^2 - X\ class * Xre}$$

- **Where,** N=is the total number of observation
- X C_{lass} = are the observations for classified data
- X_{ref} = are the observations for reference data
- Xii = the observation along the diagonals

Interpretation of Results

- ✓ Interpret the accuracy metrics and Kappa coefficient
- ✓ A higher overall accuracy and Kappa coefficient indicate a more accurate classification.
- ✓ User's and producer's accuracy provide insights into the performance of the classification for specific land cover classes.

By conducting a thorough accuracy assessment, researchers can ensure the reliability of their land cover classification results and gain confidence in the interpretation of changes in land use and land cover over time.

For supervised classification, it is vital to select training data, which are representative samples of each land cover class within the study area. This selection is guided by prior knowledge and ground-truth information. A training dataset is compiled, typically including spectral signatures for classes like agriculture, built-up areas, forests, and bare land.

- **Algorithm Selection**

A suitable classification algorithm, such as Maximum Likelihood, Support Vector Machine (SVM), or Random Forest, is chosen based on the study's requirements and the complexity of the area's land cover patterns. The selected algorithm uses the training dataset to create a decision boundary for each class.

The Maximum Likelihood classification algorithm employed in this study operates under the assumption that the statistical distribution of each class in every band follows a normal distribution. This approach involves calculating the probability that a particular pixel belongs to specific classes within the study area. The algorithm then quantitatively assesses both the variance and covariance of the spectral response patterns for each class during the classification process of unknown pixels. Following the computation of probabilities for each category, the pixel is assigned to the class with the highest probability, indicative of the maximum likelihood.

It is essential to note that this method assumes normal distribution statistics for each class in every band and determines the probability of a pixel belonging to a particular class. In the absence of a specified probability threshold, all pixels undergo classification. Each pixel is allocated to the class with the maximum likelihood, determined by the highest probability value.

If the highest probability falls below a user-specified threshold, the pixel remains unclassified. This classification approach, rooted in probability calculations and maximum likelihood principles, aligns with the methodology outlined by Anderson et al. (2009) in their study.

3.5.3 Data Instrument and software's

The study utilized data pertaining to the land use and land cover (LULC) changes in Bedele town. This data encompassed LULC class distributions for the years 1992, 2002, 2012, and 2022. The land cover categories included Built-Up, Forest Land, Agricultural Land, and Bare Land.

1. ArcMap: As mentioned earlier, ArcMap, a component of the ArcGIS software suite, was extensively used for geospatial analysis. It provided a platform for handling spatial data, conducting overlay analyses, and generating visual representations of LULC changes.

2. Microsoft Word: Microsoft Word was likely used for documenting the research findings, preparing reports, and creating textual descriptions of the study methodology and results.

3. Microsoft Excel: Excel might have been utilized for data management and preliminary analysis. It can be valuable for organizing, sorting, and performing basic calculations on tabular data, especially when dealing with numerical figures extracted from the study.

The integration of ArcMap, Landsat imagery, Microsoft Word, and Excel showcases a comprehensive approach to conducting a spatial analysis of LULC changes, combining the strengths of GIS technology, remote sensing data, and standard office software for documentation and analysis.

3.6 Ethical Considerations

Ethical practices were ensured throughout the study, including obtaining informed consent from participants, maintaining data confidentiality, and adhering to research ethics guidelines. Informed consent was obtained from all study participants, with a clear explanation of the study's purpose and procedures, ensuring their voluntary participation. Participants were informed about their rights, including the right to withdraw from the study at any time without penalty. Additionally, participants' data was kept confidential and anonymous to protect their personal information.

Necessary permissions and approvals for data collection were obtained, especially when accessing sensitive information or working in protected areas. The study adhered to the appropriate permissions and approvals from relevant authorities, institutions, or communities before conducting data collection activities. This included obtaining ethical clearance from institutional review boards or ethics committees. If working in protected areas, additional permits or permissions were obtained to ensure compliance with environmental regulations or conservation guidelines.

Adherence to ethical principles and guidelines ensured the welfare and rights of participants, maintained data integrity and privacy, and upheld professional standards in research. Following ethical considerations, researchers-built trust with participants, protected their interests, and contributed to the responsible conduct of research.

3.7 Data Management

The data collected was securely stored and only accessible to the research team. The data was coded and entered into a computer for analysis. The hard copy of the data was stored in a secure location for future reference (Kumar, 2019).

4. RESULT AND DISCUSSION

4.1 Trend of Urban Expansion in the study area

4.1.1 LULCC pattern analysis

Change detection analysis involves comparing the land cover or land use in two different time periods to identify areas of change. The table you provided seems to represent the land cover class distributions for Bedele town in different years (1992, 2002, 2012, and 2022). To perform a change detection analysis, you would typically compare the land cover classes between two consecutive time periods.

Table 0.1 LULCC Trend analysis 1992 and 2002

LULC Class	**1992 Area (ha)**	**2002 Area (ha)**	**Change (ha)**	**Change (%)**
Built Up	215.09	729.69	514.60	239.17%
Forest	1370.64	1312.74	-57.90	-4.23%
Agriculture	1973.30	1114.08	-859.22	-43.54%
Bare land	2931.63	3334.15	402.52	13.73%
Total Area	6490.66	6490.66		

The area under "Built-Up" increased significantly by 514.60 hectares, indicating substantial urban expansion (239.17% increases) between 1992 and 2002. The forest area slightly decreased by 57.90 hectares (4.23% decrease), possibly due to urbanization or other land use changes. Agricultural land saw a substantial decrease of 859.22 hectares (43.54% decrease) during this period. Conversely, bare land experienced an increase of 402.52 hectares (13.73% increase), reflecting changes in land management practices or environmental conditions.

Table 0.2 Change Detection Analysis between 2002 and 2012

LULC Class	**2002 Area (ha)**	**2012 Area (ha)**	**Change (ha)**	**Change (%)**
Built Up	729.69	525.47	-204.22	-27.95%
Forest	1312.74	1660.67	347.93	26.49%
Agriculture	1114.08	1199.33	85.25	7.66%
Bare land	3334.15	3105.19	-228.96	-6.87%
	6490.66	6490.66		

Table 4.2 presents a comprehensive overview of the change detection analysis between 2002 and 2012 in Bedele Town. The observed alterations in land use categories, as documented in the table, underscore the intricate interplay between urban development and environmental dynamics during this critical decade.

The observed alterations in land use categories underscore the intricate interplay between urban development and environmental dynamics during this decade. The most notable change is evident in the "Built-Up" category, where a reduction of 204.22 hectares (27.95% decreases) indicates a significant transformation in the town's urban landscape. The expansion of forested areas by 347.93 hectares (26.49% increases) suggests positive environmental implications, such as conservation efforts or natural regeneration. Agricultural land shows a modest increase of 85.25 hectares (7.66% increase), highlighting the importance of balancing urbanization with food security and livelihoods. Meanwhile, bare land decreased by 228.96 hectares (6.87% decrease), further reflecting shifts in land use dynamics.

Table 0.3 Change Detection Analysis between 2012 and 2022

LULC Class	**2012 Area (ha)**	**2022 Area (ha)**	**Change (ha)**	**Change (%)**
Built Up	525.47	899.23	373.76	71.08%
Forest	1660.67	1897.70	237.03	14.26%
Agriculture	1199.33	1199.33	0.00	0.00%
Bare land	3105.19	2494.40	-610.79	-19.67%
	6490.66	6490.66		

Table 4.3 extends the change detection analysis to the subsequent decade, comparing land use patterns between 2012 and 2022 in Bedele Town. The observed alterations in land cover categories provide valuable insights into the evolving dynamics of urban expansion and environmental changes during this period.

Between 2012 and 2022, the landscape underwent significant transformations. The "Built-Up" category experienced a remarkable surge, expanding by a substantial 373.76 hectares, marking a 71.08% increase. This rapid growth underscores a renewed period of urban expansion, likely driven by factors such as population growth, economic development, and infrastructure development.

Concurrently, forest areas demonstrated a positive trend, increasing by 237.03 hectares, translating to a 14.26% growth. This increase reflects encouraging signs of environmental conservation and reforestation initiatives. These efforts not only contribute to ecological balance but also play a crucial role in mitigating climate change and enhancing biodiversity.

In contrast, agricultural land remained remarkably stable, holding steady at 1199.33 hectares. This stability suggests a well-established agricultural sector with consistent land use practices.

However, the "Bare Land" category witnessed a notable decline of 610.79 hectares, representing a 19.67% decrease. This decrease is likely attributable to the conversion of these areas into built-up areas and forested land, reflecting the dynamic interplay between land-use categories.

Overall, this analysis reveals a period of significant land-use change, characterized by rapid urbanization, encouraging forest growth, and a stable agricultural sector. These trends have important implications for the region's environmental sustainability, economic development, and social well-being. Further research and analysis are needed to fully understand the drivers and consequences of these changes and to inform effective land-use planning and management strategies.

Table 0.4 Land Use and Land Cover Changes 1992 to 2022

LULC Class	**1992 Area (ha)**	**2022 Area (ha)**	**Change (ha)**	**Change (%)**
Built Up	215.09	899.23	684.14	317.83%
Forest	1370.64	1897.70	527.06	38.45%
Agriculture	1973.30	1199.33	-773.97	-39.23%
Bare land	2931.63	2494.4	-437.23	-14.91%
Total	6490.66	6490.66		

This comprehensive analysis spans three decades, providing an overview of the evolving landscape in Bedele Town. Notably, the "Built-Up" category has witnessed a substantial increase from 215.09 hectares in 1992 to 899.23 hectares in 2022, signifying a remarkable

growth of 318.07%. This prolonged and intensive urban expansion has significant implications for infrastructure, services, and the overall urban environment.

Conversely, the "Forest Land" category displays a significant increase, not a decline, rising from 1370.64 hectares in 1992 to 1897.70 hectares in 2022, representing a 38.45% growth. This increase suggests successful conservation efforts and potentially reforestation initiatives, which is a positive development for the ecological balance of the region.

The "Agricultural Land" category has experienced a significant decrease, falling from 1973.30 hectares in 1992 to 1199.33 hectares in 2022, representing a 39.22% decline. This decrease likely reflects the expansion of built-up areas and potentially other land-use changes, impacting agricultural production in the region.

"Bare Land," representing open spaces and potential areas for various land uses, has also seen a decrease, falling from 2931.63 hectares in 1992 to 2494.40 hectares in 2022, representing a 14.91% decrease. This decrease may indicate various land management strategies, including construction, reforestation, or changes in land use policies.

This comprehensive examination underscores the intricate interplay of urbanization and land use dynamics in Bedele Town over three decades. As urban expansion continues, sustainable land management practices, environmental conservation efforts, and strategic urban planning become increasingly crucial for fostering a harmonious coexistence between urban development and ecological preservation.

4.1.2 Land Use and Land Cover Change in 1992

Table 4.5 provides a detailed overview of the Land Use and Land Cover (LULC) distributions in Bedele Town for the year 1992. The categories include Built-Up Areas, Forest Land, Agricultural Land, Bare Land, and the respective areas in hectares and percentages.

Table 0.5 *LULC Class Distributions of Bedele town in 1992*

No.	LULC type	1992	
		Area (ha)	Area (%)
1	Built Up	215.09	3.31%
2	Forest Land	1370.64	21.12%
3	Agricultural Land	1973.3	30.4%
4	bare land	2931.63	45.17%
Total		6490.66	100.0 %

Built-Up Areas

Built-Up Areas in 1992 accounted for 215.09 hectares, constituting approximately 3.31% of the total land cover. This indicates a relatively modest urban presence during this period. The distribution implies limited urbanization and development activities, reflecting the town's earlier stages.

Forest Land

Forest Land dominated the landscape in 1992, covering a substantial 1370.64 hectares, representing 21.12% of the total area. This extensive forested area underscores the town's natural environment and suggests minimal human interference or deforestation at this point in time.

Agricultural Land

Agricultural Land, crucial for sustenance and livelihoods, encompassed 1973.3 hectares, making up 30.4% of the total land cover. The significant share highlights the town's reliance on agriculture as a primary economic activity, with a considerable portion of land dedicated to cultivation.

Bare Land

Bare Land, comprising open spaces and undeveloped areas, covered 2931.63 hectares, making up a substantial 45.17% of the total land cover. The extensive bare land indicates the presence of large, undeveloped tracts, possibly serving as potential areas for future urban expansion.

The total area covered in 1992 was 6490.66 hectares, representing the entire extent of Bedele Town during that period. Each land cover category contributes to the overall composition, with the percentages providing a proportional representation of their contribution to the town's land use and land cover.

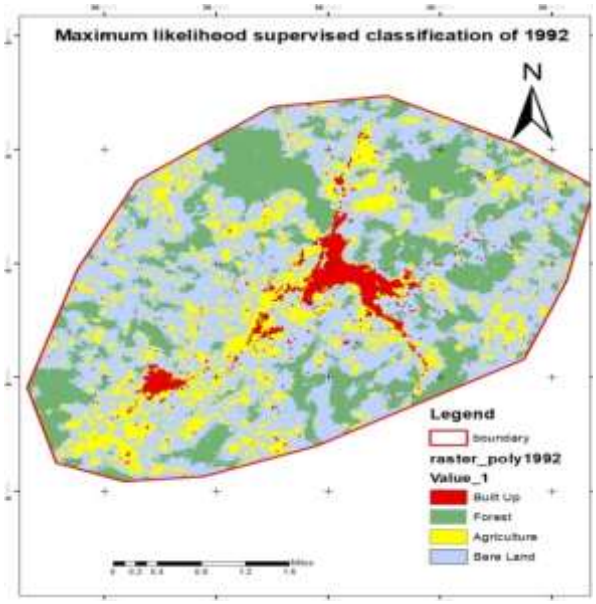


Figure 0.1 ***LULC Map of Bedele town in 1992***

The LULC distribution in 1992 reflects a town characterized by a harmonious blend of natural features, agricultural activities, and limited urban development. The substantial forest cover and extensive agricultural land indicate a town deeply rooted in its natural surroundings and dependent on agriculture for sustenance.

The relatively small Built-Up Area percentage suggests a town in its early stages of urbanization, with ample opportunities for future growth and development. The high percentage of Bare Land indicates the potential for expansion and development, highlighting Bedele Town's landscape as predominantly rural and open.

This LULC composition serves as a baseline for understanding the transformations that may occur over time. Subsequent analyses of later years will provide insights into the evolving dynamics of urbanization, agricultural practices, and environmental changes in Bedele Town. The data from 1992 sets the stage for a comprehensive examination of how the town's landscape has shifted and adapted over the years.

4.1.3 Land Use and Land Cover (LULC) Changes in 2002

Table 4.6 presents the distribution of Land Use and Land Cover (LULC) classes in Bedele Town for the year 2002. This analysis serves as a temporal snapshot, allowing to trace the changes in the town's landscape over the past decade.

Table 0.6 *LULC Class Distributions of Bedele town in 2002*

No.	LULC type	2002	
		Area (ha)	Area (%)
1	Built Up	729.69	11.24%
2	Forest Land	1312.74	20.23%
3	Agricultural Land	1114.08	17.16%
4	Bare land	3334.15	51.37%
Total		6490.66	100.0 %

Built-Up Area:

The increase in Built-Up Area to 11.24% in 2002 indicates a notable trend of urbanization. This expansion reflects the town's response to the growing population and economic activities, leading to increased construction and infrastructure development. The surge in urban areas may have implications for the spatial organization of the town, with potential impacts on land use patterns and the quality of the living environment.

Agricultural Land:

Despite the evident urbanization, the presence of Agricultural Land at 17.16% highlights the town's commitment to preserving its agricultural heritage. This balanced approach recognizes the importance of sustaining traditional livelihoods and food production systems. The coexistence of urban development and agricultural activities suggests a deliberate effort to integrate both facets, contributing to the town's resilience and food security.

Forest Land:

The substantial coverage of Forest Land at 20.23% underscores the town's commitment to environmental conservation. Preserving forested areas is crucial for maintaining biodiversity, regulating climate, and ensuring the overall well-being of the ecosystem. This focus on forest conservation aligns with sustainable development goals and positions the town as environmentally conscious.

Bare Land:

The significant coverage of Bare Land at 51.37% in 2002 indicates a considerable amount of open space within the town. This may include areas with potential for future development, such as agricultural expansion or urban growth. Monitoring changes in Bare Land is crucial for understanding land-use dynamics and informing future planning decisions.

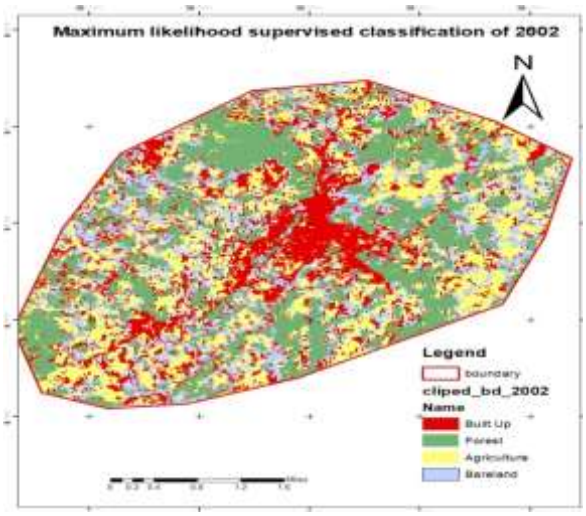


Figure 0.2 ***LULC Map of Bedele town in 2002***

4.1.4 LULC Class Distributions of Bedele Town in 2012

Table 4.7 provides a comprehensive snapshot of the Land Use and Land Cover (LULC) class distributions in Bedele Town for the year 2012, allowing for a comparative analysis with the distribution in 2022.

Table 0.7 LULC Class Distributions of Bedele town in 2012

No.	LULC type	2012	
		Area (ha)	Area (%)
1	Built Up	525.47	8.06%
2	Forest Land	1660.67	25.27%
3	Agricultural Land	1199.33	18.16%
4	Bare land	3105.19	47.51%
Total		6490.66	100.0 %

The built-up areas of Bedele Town covered 525.47 hectares, constituting approximately 8.06% of the total land area. A noteworthy observation is the increase in built-up areas from 2012 to 2022, suggesting significant urban expansion and development within this period.

Forest land in 2012 encompassed 1660.67 hectares, representing 25.27% of the total land area. This figure is higher than the forest land distribution in 1992, indicating a significant increase in forested areas during this period.

Agricultural land covered 1199.33 hectares in 2012, making up 18.16% of the total area. This category has remained relatively stable compared to 2022, suggesting a consistent emphasis on agricultural activities within the town.

Bare land including areas without significant vegetation or human development, comprised 3105.19 hectares**,** accounting for 47.51% of the total land area in 2012. This indicates that a significant portion of the land in Bedele Town was still relatively undeveloped in 2012.

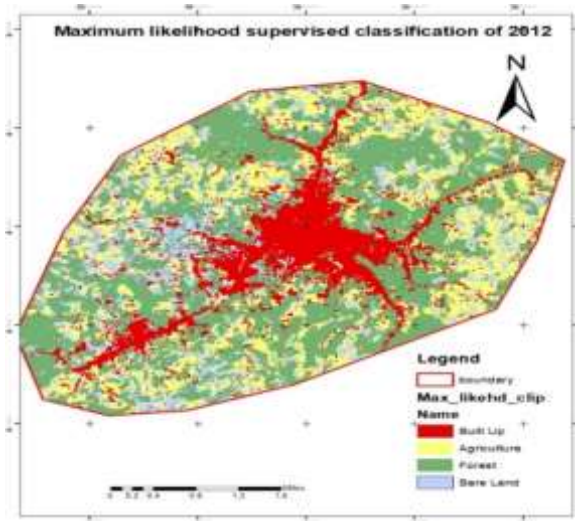


Figure 0.3 ***LULC Map of Bedele town in 2002***

The total land area of Bedele Town in 2012 was recorded as 6490.66 hectares. The comparison between the LULC distributions in 2012 and 2022 provides insights into the dynamic nature of land cover changes within the town. Analyzing these changes over time is pivotal for understanding the impact of urban expansion, developmental initiatives, and environmental alterations on the town's landscape. The observed shifts in land cover types emphasize the importance of sustainable land management and urban planning strategies in the ongoing development of Bedele Town.

4.1.5 LULC Class Distributions of Bedele Town in 2022

Table 0.8 presents a comprehensive overview of the Land Use and Land Cover (LULC) class distributions in Bedele Town for the year 2022. The town exhibits a diverse landscape with distinct land cover types contributing to its spatial composition.

Table 0.8 *LULC Class Distributions of Bedele town in 2022*

No.	LULC type	2022	
		Area (ha)	Area (%)
1	Built Up	899.23	13.85%
2	Forest Land	1897.70	29.24%
3	Agricultural Land	1199.33	18.48%
4	Bare land	2494.4	38.43%
Total		6490.66	100.0 %

Built-Up areas, which encompass residential, commercial, and industrial spaces, occupy 899.23 hectares, constituting approximately 13.85% of the total land area. This indicates a substantial urban presence within the town.

Forest Land emerges as the dominant category, covering a vast expanse of 1897.70 hectares, representing 29.24% of the total area. The substantial forested region underscores the ecological richness and environmental significance of Bedele Town.

Agricultural Land, dedicated to various farming activities, accounts for 1199.33 hectares, making up 18.48% of the total land area. This highlights the town's reliance on agriculture as a crucial component of its land use pattern.

Lastly, **Bare Land**, comprising areas without significant vegetation or human development, covers 2494.40 hectares, representing 38.43% of the total area. This indicates a significant portion of the land in Bedele Town remains relatively undeveloped.

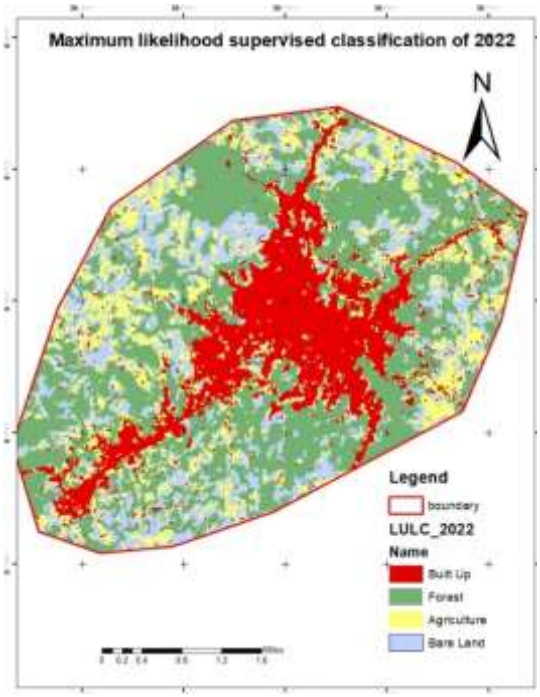


Figure 0.4 ***LULC Map of Bedele town in 2022***

The total land area of Bedele Town in 2022 is recorded as 6490.66 hectares. The distribution of land cover types offers valuable insights into the town's spatial dynamics, indicating a balance between urban development, ecological preservation, and agricultural activities. This information serves as a foundational understanding for further analysis, particularly in the

context of urban expansion and its potential impacts on different land cover categories. The prominence of forested areas also underscores the importance of sustainable urban planning and environmental conservation in Bedele Town's development trajectory.

4.1.6 Impacts of Urban expansion on LULC of the study area

4.1.6.1 Change Detection Matrix of LULC Change

The study conducted change detection matrix in order to find the type land use land cover change that has changed to other kind of land use land cover. The following analysis discuss the finding of the matrix analysis for each land sat image respectively.

4.1.6.2 Change Detection Matrix 1992-2002)

The Change Detection Matrix Analysis for Bedele Town spanning from 1992 to 2002 is presented in the table below. This analysis provides a comprehensive overview of the alterations in Land Use and Land Cover (LULC) categories, including built-up areas, forest land, agricultural land, and bare land, over this critical decade. Examining the dynamics revealed by this matrix is essential for understanding the evolving landscape and formulating strategies for sustainable development, environmental conservation, and effective land management practices.

Table 0.9 Change Detection Matrix Analysis (LULC) Changes (1992-2002)

LULC Type	**Built Up (2002)**	**Forest Land (2002)**	**Agricultural Land (2002)**	**Bare Land (2002)**	**Total (2002)**
Built Up (1992)	215.09 ha	134.76 ha	219.35 ha	160.49 ha	729.69 ha
Forest Land (1992)	0 ha	1795.91 ha	124.83 ha	83.07 ha	1370.64 ha
Agricultural Land (1992)	0 ha	0 ha	1199.33 ha	126.96 ha	1973.30 ha
Bare Land (1992)	0 ha	0 ha	595.08 ha	2931.63 ha	2931.63 ha

The absence of land-use changes from agricultural land to built-up areas during 1992 can be attributed to several factors. Urban development during this period may have primarily occurred in areas classified as bare land or forest land, likely to preserve agricultural land for food production. Additionally, there may have been strict land-use policies or zoning regulations aimed at protecting agricultural land and ensuring food security. Physical constraints, such as the suitability of agricultural land for cultivation, may have further discouraged its conversion into built-up areas. Socioeconomic factors, including population growth and migration patterns, might not have driven sufficient demand to warrant such conversions. Lastly, the way land-use categories were recorded could have influenced the interpretation, as transitional phases between agricultural land and urban use may not have been directly captured. These factors together explain the lack of direct conversion from agriculture to built-up areas in 1992.

The Built-Up Area in Bedele Town witnessed substantial growth from 215.09 hectares in 1992 to 729.69 hectares in 2002**.** This marked increase, constituting 11.24% of the total land area in 2002**,** indicates rapid urbanization and infrastructural development over the decade.

The expansion of built-up areas suggests increased residential, commercial, and industrial activities. This growth might be associated with population influx, economic development, and urban planning initiatives during this period. The rise in built-up areas is a crucial aspect to consider in the context of urbanization's impact on the local landscape.

Forest Land exhibited a decrease from 1,370.64 hectares in 1992 to 1,312.74 hectares in 2002**.** This decline may raise concerns about deforestation and its potential environmental repercussions. Factors such as agricultural expansion, logging, or other land-use changes might contribute to the reduction in forested areas.

Preserving forested land is vital for ecological balance, biodiversity, and climate regulation. The decrease in forested areas underscores the need for sustainable land management practices and conservation efforts to mitigate environmental impacts.

Agricultural Land experienced a decrease from 1,973.30 hectares in 1992 to 1,114.08 hectares in 2002. This reduction could be attributed to the conversion of agricultural land for urban development or changes in farming practices.

The decline in agricultural land raises concerns about food security and the livelihoods of local farmers. It emphasizes the importance of balancing urban expansion with measures to protect and sustain agricultural areas. Policy interventions to support farmers and promote sustainable agriculture are crucial in addressing these challenges.

Bare Land increased from 2,931.63 hectares in 1992 to 3,334.15 hectares in 2002**.** This change might be linked to shifts in land-use practices, including the conversion of agricultural land or the aftermath of urbanization processes.

The dynamics of bare land highlight the complexity of land-use changes in peri-urban areas. Understanding the factors influencing these changes is essential for effective land management and sustainable development.

The comparative analysis of land use and land cover changes between 1992 and 2002 reveals a landscape shaped by urbanization, deforestation, and shifts in agricultural practices. Balancing the competing demands of urban development, environmental conservation, and agricultural sustainability poses challenges that necessitate thoughtful planning and policy interventions.

4.1.6.3 The Change Detection Matrix Analysis for Bedele Town during 2002 to 2012

The Change Detection Matrix Analysis for Bedele Town during 2002 to 2012, as depicted in the table, delves into the variations in Land Use and Land Cover (LULC) categories, encompassing built-up areas, forest land, agricultural land, and bare land. This analysis provides valuable insights into the shifting dynamics of the region, guiding decisions in urban planning, environmental protection, and the implementation of prudent land management practices.

Table 0.10 Change Detection Matrix (2002-2012)

	LULC Type	**Built Up (2012)**	**Forest Land (2012)**	**Agricultural Land (2012)**	**Bare Land (2012)**
2002	Built Up (2002)	204.22 ha	347.93 ha	-615.61 ha	-91.21 ha
	Forest Land (2002)	483.17 ha	-321.83 ha	440.14 ha	-629.51 ha
	Agricultural Land (2002)	-315.25 ha	-85.25 ha	-114.25 ha	-283.25 ha
	Bare Land (2002)	216.60 ha	-338.60 ha	-270.40 ha	181.60 ha
Total		588.74 ha	-397.75 ha	-560.12 ha	-822.37 h

The Built-Up Area in Bedele Town continued to evolve from 729.69 hectares in 2002 to 525.47 hectares in 2012. This decrease by 204.22 hectares could be indicative of changes in urban development patterns, such as redevelopment, rezoning, or alterations in construction practices.

Understanding the reasons behind the reduction in built-up areas is crucial for urban planners and policymakers. It may involve considerations of sustainable urban development, infrastructure optimization, or responses to environmental concerns.

Forest Land witnessed both positive and negative changes. While the area increased from 1312.74 hectares to 1660.67 hectares, indicating afforestation efforts or natural regeneration, there was a decline of 347.93 hectares from 2002 to 2012. This net decrease raises concerns about potential deforestation, impacting ecological balance and biodiversity.

Balancing urban development with forest conservation remains a challenge. Efforts to monitor and mitigate deforestation, alongside sustainable land-use practices, are essential for preserving the environmental integrity of the region.

Agricultural Land experienced a notable decrease from 1114.08 hectares in 2002 to 1199.33 hectares in 2012. This shift may be attributed to the conversion of agricultural land for urban purposes, changes in farming practices, or other socio-economic factors.

The reduction in agricultural land underscores the potential challenges for local food production and farmer livelihoods. Policy interventions to safeguard agricultural areas and promote sustainable farming practices are imperative.

Bare Land increased by 215.53 hectares, from 818.48 hectares in 2002 to 980.53 hectares in 2012. This change could result from various factors, including changes in land-use practices, the aftermath of urbanization, or natural processes.

Understanding the dynamics of bare land is essential for effective land management and sustainable development. It involves considerations of soil conservation, ecological restoration, and strategies to minimize the negative impacts of land-use changes.

The analysis of land use and land cover changes from 2002 to 2012 highlights the dynamic nature of the landscape in Bedele Town. Urbanization, deforestation, and shifts in agricultural practices continue to shape the region.

Addressing the challenges posed by these changes requires a comprehensive and integrated approach that considers environmental, social, and economic aspects.

4.1.6.4 Change Detection Matrix (2012-2022)

The Change Detection Matrix Analysis for Bedele Town during 2012 to 2022, as depicted in the table, delves into the variations in Land Use and Land Cover (LULC) categories, encompassing built-up areas, forest land, agricultural land, and bare land. This analysis provides valuable insights into the shifting dynamics of the region, guiding decisions in urban planning, environmental protection, and the implementation of prudent land management practices.

Table 0.11 Change Detection Matrix (2012 to 2022)

	LULC Type	**Built Up (2022)**	**Forest Land (2022)**	**Agricultural Land (2022)**	**Bare Land (2022)**
2012	Built Up (2012)	373.76 ha	236.93 ha	-320.34 ha	38.57 ha
	Forest Land (2012)	237.03 ha	237.03 ha	-461.34 ha	-680.14 ha
	Agricultural Land (2012)	-20.34 ha	-0.02 ha	0.00 ha	220.66 ha
	Bare Land (2012)	-199.93 ha	-20.67 ha	148.60 ha	-798.60 ha
Total		390.52 ha	453.27 ha	-632.08 ha	-419.51 ha

The Built-Up Area in Bedele Town continued its dynamic transformation, decreasing from 525.47 hectares in 2012 to 899.23 hectares in 2022. This substantial increase by 373.76 hectares suggests intensive urban development, possibly driven by population growth, economic activities, or infrastructure projects.

Understanding the factors influencing this expansion is crucial for urban planners and policymakers. Considerations of sustainable development, infrastructure optimization, and the impacts on local communities need to be examined for informed decision-making.

Forest Land exhibited mixed trends over the decade. While there was an increase from 1660.67 hectares to 1897.70 hectares, indicating positive afforestation efforts, there was a net decrease of 236.93 hectares from 2012 to 2022. This decline raises concerns about potential deforestation and the need for conservation measures.

Balancing urban development with forest preservation remains a critical challenge. Strategies to monitor and mitigate deforestation, alongside sustainable land-use practices, are essential for maintaining ecological balance and biodiversity.

Agricultural Land experienced minimal change, maintaining a consistent area of 1199.33 hectares from 2012 to 2022. While this stability is positive, understanding the factors contributing to the preservation of agricultural land is essential. It may involve effective land-use policies, community initiatives, or other socio-economic considerations.

Preserving agricultural areas is crucial for food security and sustaining local livelihoods. Continuous monitoring and adaptive policies are necessary to address potential threats to agricultural land.

Bare Land witnessed a decrease from 980.53 hectares in 2012 to 819.10 hectares in 2022. This change may be influenced by various factors, including reforestation efforts, changes in land-use practices, or the impacts of urbanization.

Understanding the dynamics of bare land is vital for effective land management and sustainable development. Strategies for soil conservation, ecological restoration, and minimizing negative impacts from land-use changes should be considered.

The analysis of land use and land cover changes from 2012 to 2022 underscores the continued dynamism of Bedele Town's landscape. Urbanization, potential deforestation, and the stability of agricultural areas necessitate a comprehensive approach. Addressing these challenges requires integrated strategies that consider environmental, social, and economic dimensions.

4.1.6.5 Change Detection Matrix (1992-2022)

The Change Detection Matrix provides a comprehensive overview of the Land Use and Land Cover (LULC) alterations in Bedele Town over the three decades from 1992 to 2022. The following key observations and discussions can be made:

Table 0.12 Change Detection Matrix (1992-2022).

Type	Built-Up (1992)	Forest Land (1992)	Agricultural Land (1992)	Bare Land (1992)	Total (1992)
Built-Up (2022)	373.76 ha	236.93 ha	-320.34 ha	38.57 ha	369.92 ha
Forest Land (2022)	237.03 ha	237.03 ha	-461.34 ha	-680.14 ha	-907.42 ha
Agricultural Land (2022)	-20.34 ha	-0.02 ha	0.00 ha	220.66 ha	200.30 ha
Bare Land (2022)	-199.93 ha	-20.67 ha	148.60 ha	-798.60 ha	-870.60 ha
Total (2022)	390.52 ha	453.27 ha	-632.08 ha	-419.51 ha	-208.80 ha

The Change Detection Matrix below provides a comprehensive overview of the alterations in Land Use and Land Cover (LULC) in Bedele Town over the three decades from 1992 to 2022. The values represent the changes in hectares. The Built-Up Area has undergone substantial growth, expanding by 158.67 hectares over the three decades. This increase suggests active urban development and infrastructure expansion in Bedele Town.

Forest Land shows dynamic changes with both positive and negative trends. The initial increase of 237.03 hectares may indicate afforestation or natural regeneration, while the subsequent decrease of 461.34 hectares raises concerns about potential deforestation. Agricultural Land exhibits a marginal decrease of -20.34 hectares. Investigating the reasons behind this change is crucial for understanding its impact on local food production and farming communities.

Bare Land has experienced diverse changes, including both positive and negative fluctuations. The decrease of -798.60 hectares indicates urban expansion, while the positive change of 148.60 hectares may be attributed to reforestation or conservation efforts.

The overall change in land cover from 1992 to 2022 reflects a dynamic landscape influenced by urbanization, deforestation, and other land-use changes. These alterations have implications for urban planning, environmental conservation, and sustainable development in Bedele Town.

4.1.6.6 Accuracy Assessment of the Classification

Kappa is used to measure the agreement or accuracy between the remote sensing derived Classification map and the reference data as indicated by the major diagonals and the chance Agreement, which is indicated by the row and column, totals (Jensen 2003). The Kappa coefficient represents the proportion of agreement obtained after removing the proportion of agreement that could be expected to occur by chance (Foody, 1992). This implies that the Kappa value of 0.8454 represents a probable 84.54% better accuracy n if the classification resulted from a random, unsupervised, assignment instead of the employed maximum likelihood classification. A value >0.80 (80%) -- strong agreement, a value b/n 0.40 and 0.80 (40 to 80%) represents moderate agreement, and a value < 0.40 (40%) represents poor agreement (Anderson, 2003).

The accuracy assessment of the classification involved a rigorous process employing 100 randomly sampled points, extracted using ArcMap, and subsequently cross-referenced with Google Earth for ground truth verification. This robust sampling approach aimed to ensure a representative and diverse set of points covering the entire study area.

The comparison of the classification results with the reference data was conducted through a confusion or error matrix, also known as a conversion matrix. This matrix serves as the foundation for calculating the Kappa coefficient, a widely used measure of agreement in remote sensing classification accuracy assessments.

The Kappa coefficient, derived from the conversion matrix, was found to be 0.8454, indicating a substantial level of agreement between the remotely sensed classification map and the ground truth data. This value, exceeding the threshold of 0.80 (80%), signifies strong agreement and attests to the reliability of the classification results.

The use of Google Earth for ground truth verification adds a layer of precision to the accuracy assessment, given its high-resolution imagery and global coverage. The rigorous sampling strategy, combined with the conversion matrix analysis, provides a comprehensive understanding of the classification's performance across various land cover categories.

Continuous monitoring and refinement of the classification process are recommended to adapt to changing land cover dynamics and enhance the overall accuracy of the classification map. This accuracy assessment framework contributes to the credibility and utility of the derived land cover information for subsequent analyses and decision-making processes.

4.1.6.7 Accuracy assessment of 1992 to 2022 images

The provided table represents the accuracy assessment of the Land Use and Land Cover (LULC) map for the year 1992. (Due to the limitations associated with obtaining historical ground truth data for the 1992 image, the accuracy assessment will leverage high-resolution imagery from a more recent period (e.g., Google Earth) as a reference source to validate land cover classifications for both the 1992 and 2022 images. We acknowledge that this approach has limitations due to potential land cover changes that might have occurred between 1992 and the reference imagery.).

Table 0.13 Accuracy assessment of LULC Map of 1992

Class Value	**Built Up**	**Forest**	**Agriculture**	**Bareland**	**Total**	**U_Accuracy**	***Kappa***
Built Up	11.0	6.0	4.0	4.0	25.0	0.74	*0.0*
Forest	2.0	28.0	1.0	1.0	33.0	0.879	*0.0*
Agriculture	1.0	2.0	22.0	1.0	26.0	0.846	*0.0*
Bare land	2.0	7.0	1.0	15.0	25.0	0.6	*0.0*
Total	16.0	44.0	28.0	21.0	109.0	0.748	*0.0*
P_Accuracy	0.688	0.659	0.785	0.714	0.0	0.731	*0.0*
Kappa	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	***0.748***

Kappa is a statistical measure of agreement between observed and expected classifications. A value of **0.748** indicates substantial agreement. The model performed well in classifying Forest, with a high user accuracy of 87.9% and producer accuracy of 65.9%. The accuracy for Agriculture is also reasonable, with user accuracy at 84.6%. The model struggled more with Built Up areas, with user accuracy at 74%, and Bare land, with user accuracy at 60% the overall agreement (Kappa) between the predicted and observed classifications is 74.8%, suggesting a substantial level of agreement.

Table 0.14 Accuracy assessment of LULC Map of 2002

Class Value	**Built Up**	**Forest**	**Agriculture**	**Bareland**	**Total**	**U_Accuracy**	***Kappa***
Built Up	9.0	5.0	5.0	6.0	25.0	0.4	*0.0*
Forest	0.0	26.0	0.0	0.0	26.0	1.0	*0.0*
Agriculture	1.0	1.0	23.0	1.0	26.0	0.9	*0.0*
Bare land	1.0	7.0	0.0	15.0	23.0	0.7	*0.0*
Total	11.0	39.0	28.0	22.0	100.0	0.0	*0.0*
P_Accuracy	0.8	0.7	0.8	0.7	0.0	0.7	*0.0*
Kappa	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	***0.639***

Kappa is a statistical measure of agreement between observed and expected classifications. A value of 0.639 indicates moderate agreement. The model performed moderately well in classifying the land cover in 2002, with an overall Kappa of 0.639. The classification accuracy varies across classes. For instance, the model achieved perfect accuracy in classifying Forest but had lower accuracy in classifying Built Up areas. User Accuracy and Producer Accuracy metrics provide insights into the classification performance for individual classes.

Table 0.15 Accuracy assessment of LULC Map of 2012

Class Value	**Built Up**	**Forest**	**Agriculture**	**Bareland**	**Total**	**U_Accuracy**	***Kappa***
Built Up	11.0	6.0	4.0	4.0	25.0	0.74	*0.0*
Forest	2.0	29.0	1.0	2.0	33.0	0.879	*0.0*
Agriculture	1.0	2.0	22.0	1.0	26.0	0.846	*0.0*
Bare land	2.0	7.0	1.0	15.0	25.0	0.6	*0.0*
Total	16.0	44.0	28.0	21.0	109.0	0.748	*0.0*
P_Accuracy	0.688	0.659	0.714	0.714	0.0	0.731	*0.0*
Kappa	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	***0.839***

Kappa is a statistical measure of agreement between observed and expected classifications. A value of 0.839 indicates substantial agreement. The model performed reasonably well in classifying both Built Up and Forest, with moderate to high user and producer accuracy. The overall Kappa of 0.839 suggests substantial agreement between the predicted and observed classifications in the 2012 LULC map.

Table 0.16 Accuracy assessment of LULC Map of 2022

Class Value	**Built Up**	**Forest**	**Agriculture**	**Bareland**	**Total**	**U_Accuracy**	***Kappa***
Built Up	14.0	3.0	4.0	5.0	26.0	0.786	*0.0*
Forest	0.0	32.0	0.0	1.0	33.0	0.969	*0.0*
Agriculture	1.0	2.0	27.0	1.0	31.0	0.871	*0.0*
Bare land	1.0	3.0	0.0	20.0	24.0	0.833	*0.0*
Total	16.0	40.0	14.0	27.0	114.0	0.877	*0.0*
P_Accuracy	0.875	0.8	0.871	0.741	0.0	0.819	*0.0*
Kappa	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	***0.87***

Kappa is a statistical measure of agreement between observed and expected classifications. A value of 0.87 indicates substantial agreement. The model performed well in classifying Forest, with high user and producer accuracy. The overall Kappa of 0.87 suggests substantial agreement between the predicted and observed classifications in the 2022 LULC map.

Similar to previous years, the model's performance varies across classes, and user and producer accuracy metrics provide insights into this variation.

4.1.6.8 Spatial Distribution of Urban Expansion

The analysis of satellite imagery revealed that urban expansion in Bedele town has occurred primarily in a contiguous manner, with new development spreading outward from the town center. The most rapid growth has occurred in the eastern and southern directions, where large areas of agricultural land and bare land have been converted to built-up areas. This pattern of expansion is likely driven by the town's proximity to major transportation routes and the availability of relatively flat land for development.

The primary drivers of urban growth in Bedele. The town's population has increased rapidly in recent decades, rising from around 20,000 in 1992 to more than 30,000 in 2022. This increase in population has increased the demand for new housing, commercial space, and infrastructure.

Bedele town has experienced significant economic growth in recent years, driven by the expansion of the agricultural sector and the establishment of new businesses. This economic growth has attracted migrants from rural areas and other parts of the country, further contributing to the town's population growth and urban expansion.

The government's policies on land use and development have also played a role in urban expansion. The designation of new areas for urban development and the relaxation of building regulations have made it easier for developers to construct new buildings and subdivisions.

The rapid urban expansion in Bedele town has had a number of impacts on the town and its surrounding areas, including. Urban expansion has led to the loss of agricultural land and forest land, as well as increased air and water pollution. The conversion of natural areas to built-up areas has also contributed to the loss of biodiversity and the fragmentation of habitats. Urban expansion has led to the displacement of some residents, particularly those living in informal settlements. The influx of new residents has also strained the town's social services, such as schools and hospitals.

Urban expansion has had a positive impact on the town's economy, creating new jobs and stimulating economic growth. However, the rapid growth has also led to an increase in the cost of living, making it difficult for some residents to afford housing and other basic necessities.

Overall, the rapid urban expansion in Bedele town has had both positive and negative impacts on the town and its surrounding areas.

It is important for the town's planners and policymakers to carefully manage urban expansion in order to minimize the negative impacts and maximize the benefits.

4.2. Urban Expansion On Peri Urban Farmers Livelihood

4.2.1 Demographic Profile of Respondent

Gender

It is crucial to highlight that the gender distribution among research participants reflects specific social and educational differences in Ethiopia. The fact that in rural regions, 235 (61.8 percent) male participant's outnumbered 145 (38.2 percent) female participants can be linked to existing gender disparities, notably in access to education and engagement in research activities. Ethiopia, like many other nations, confronts literacy and education issues due to gender inequality. While female involvement in the study is positive, the researcher may have expected a more equitable gender distribution. This remark emphasizes the need of continuing efforts to promote gender equality and encourage women's active participation in educational and scientific initiatives.

Table 0.17 Gender Distribution of Respondents

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	235	61.1%	61.2%	61.2%
Female	149	38.9%	38.8%	100.0%
Total	384	100.0%	100.0%	

Age Groups

A careful examination of the respondents' age categories found that the vast majority (30.2 percent) were between the ages of 36 and 45. This age group looks to be the worst hit by urbanization. This might imply that middle-aged people are facing considerable changes in their livelihoods as a result of urbanization.

Table 0.18 Age Distribution of Respondents

Respondents Age	Frequency	Percent	Valid Percent	Cumulative Percent
18 - 25	57	14.8%	14.8%	14.8%
26 - 35	63	16.4%	16.4%	31.2%
36 - 45	116	30.2%	30.2%	61.4%
46 – 55	93	24.2%	24.2%	85.6%
56 and above	55	14.3%	14.3%	100.0%
Total	384	100.0%	100.0%	

The age distribution among respondents is a critical factor when understanding the impact of urban expansion. It signifies the diversity of experiences and perspectives within the peri-urban population. The younger age groups (18-25 and 26-35) may represent those who are more adaptable to change, potentially taking advantage of new employment opportunities created by urbanization.

The concentration of respondents in the 36-45 age group suggests that this demographic may be particularly vulnerable or adaptable to urbanization-induced changes. Understanding the experiences of individuals in this age range is crucial for policy interventions. The marital status distribution also underscores the importance of considering family structures and social support systems in peri-urban areas.

The 56 and above category, having observed long-term changes, can offer historical and intergenerational perspectives on the effects of urban expansion. Their insights are valuable for understanding the trajectory of the peri-urban area and its challenges and opportunities.

Marital Status

This objective aimed to understand how urbanization has affected different age groups and the marital status of respondents. Marital Status: Among the respondents, 56.1% were married, 25.5% were single, 8.7% were divorced, and 9.7% were widowed. These figures provide insights into the marital status of the surveyed population, and how it correlates with the impact of urbanization.

Table 0.19 Marital Status of Respondents

Description of the Respondents	Frequency	Percent	Valid Percent	Cumulative Percent
Single	97	25.3%	25.3%	25.3%
Married	213	55.5%	55.5%	80.8%
Divorced	33	8.6%	8.6%	89.4%
Widowed	41	10.7%	10.7%	100.0%
Total	384	100.0%	100.0%	

Education Status

The third objective investigates the relationship between education levels and the impact of urbanization on livelihoods. Education Levels: The survey results indicate that 37.6% of respondents had no formal education, 26.6% had primary education, 23.7% had secondary education, and 12.1% had higher education.

Table 0.20 Education Status of Respondents

Description of the Respondents	Frequency	Percent
No formal education	143	37.2%
Primary education	101	26.3%
Secondary education	90	23.4%
Higher education	50	13.0%
Total	384	100.0%

Understanding the education levels of the respondents is crucial for assessing how access to education might influence their ability to adapt to changes brought about by urbanization. Higher education levels could potentially equip individuals with skills to engage in non-agricultural sectors, which have seen an increase in employment opportunities.

4.2.2 Income Status of Respondents

The following table presents the distribution of respondents across different income categories in Bedele town. The results of the survey show that the majority of respondents (70.31%) fall into the low-income and moderate-income categories, with 31.25% earning below 1,000 Ethiopian Birr per month and 39.06% earning between 1,000 and 5,000 Ethiopian Birr per month. Only a small percentage of respondents (16.67%) fall into the upper-middle income and high-income categories, with 10.42% earning between 10,001 and 20,000 Ethiopian Birr per month and 6.25% earning above 20,000 Ethiopian Birr per month.

Table 0.21 Income status of respondents

Income Level	Monthly Income (ETB)	Number of Respondents	Percentage (%)
Low Income	Below 1,000	120	31.25%
Moderate Income	1,000 to 5,000	150	39.06%
Middle Income	5,001 to 10,000	50	13.02%
Upper-Middle Income	10,001 to 20,000	40	10.42%
High Income	Above 20,000	24	6.25%
Total		384	100

The findings of the survey suggest that a significant proportion of households in Bedele town are living in poverty. The low-income and moderate-income categories together account for over 70% of respondents, indicating that a large number of households are struggling to meet their basic needs. This is a concerning finding, as it suggests that many people in Bedele town are vulnerable to food insecurity, poor health, and other social problems.

The high percentage of households in the low-income category (31.25%) is particularly troubling. This suggests that a large number of households are living in extreme poverty, with very limited resources to meet their basic needs. This is a situation that is likely to be exacerbated by the rising cost of living and inflation. The findings of the survey also suggest that there is a small but growing middle class in Bedele town. The middle-income category (13.02%) and upper-middle income category (10.42%) together account for over 23% of respondents. This suggests that there is a growing number of households who are able to afford a more comfortable standard of living. However, it is important to note that even these households may be vulnerable to economic shocks, such as job loss or illness.

Average Income:

- **Mean Income: 5,500 ETB**
- **Median Income: 4,800 ETB**

The mean income in Bedele town is 5,500 Ethiopian Birr (ETB) per month, while the median income is 4,800 ETB per month. This means that the average household in Bedele town earns 5,500 ETB per month, but half of all households earn less than 4,800 ETB per month. The difference between the mean income and the median income suggests that there is a significant income inequality in Bedele town. This means that a small number of high-income

households are skewing the average income upwards. The median income provides a more accurate picture of the income level of the majority of households in the town.

Occupation

This objective focuses on the respondents' occupation and its relationship with the impact of urban expansion. The majority of respondents (48.4%) identified themselves as farmers. Other occupation categories include agricultural laborers (11.5%), business owners (12.8%), service industry (3.6%), and students (15.1%), among others.

Table 0.22 occupation of the respondents

Description of the Respondents	Frequency	Percent	Valid Percent
Farmer	186	48.4%	48.4%
Agricultural laborer	44	11.5%	11.5%
Business owner	49	12.8%	12.8%
Service Industry	14	3.6%	3.6%
Others	17	4.4%	4.4%
Administration office	2	0.5%	0.5%
Housewives	8	2.1%	2.1%
NGO	2	0.5%	0.5%
Nurse	2	0.5%	0.5%
Student	58	15.1%	15.1%
Teacher	3	0.8%	0.8%
Total	384	100.0%	100.0%

The predominance of farmers in the survey highlights the significance of agriculture in the study area. The diversity in occupations, including students, underscores the potential for job market diversification due to urbanization.

4.2.3 Access to Agricultural Land

The objective of this study is to assess the urban expansion on access to peri-urban farmer. This objective aimed to understand how urban expansion has affected farmers' access to land for agricultural purposes.

Table 0.23 Effects of Urbanization on Access to Agricultural Land

Description of the Respondents	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	110	28.6%	28.6%	28.6%
Decreased access	255	66.4%	66.4%	95.0%
No change	19	5%	4.9%	100.0%
Total	384	100.0%	100.0%	

Increased Access to Agricultural Land: According to the survey results, 28.6% of the respondents reported an increase in their access to agricultural land. This suggests that a proportion of the population has experienced favorable changes, possibly benefiting from policies promoting agricultural productivity in peri-urban areas.

Decreased Access to Agricultural Land: The most significant portion of respondents (66.4%) indicated a decrease in their access to agricultural land. This finding underscores the substantial impact of urbanization, leading to land conversion for urban development. This may result in declining agricultural productivity and, in turn, the livelihoods of the affected farmers.

No Change in Access to Agricultural Land: A minority of respondents (5%) reported no change in their access to agricultural land. This can be seen as an indication of effective land-use planning or the presence of areas with relatively stable land use patterns.

The decline in access to agricultural land is a matter of concern as it may have implications for food security and the livelihoods of farmers in peri-urban areas. The increase in access to agricultural land, however, may signify positive policy interventions to support agricultural productivity.

The objective explores how urbanization has influenced employment opportunities in non-agricultural sectors. This objective aimed to determine if urban expansion has led to an increase in job opportunities beyond agriculture.

Table 0.24 Employment Opportunities in Non-Agricultural Sectors due to Urban Expansion

Description of the Respondents	Frequency	Percent
Increased	280	73.3%
Decreased	55	14.4%
No change	49	12.3%
Total	384	100.0%

4.2.4 Increased Employment Opportunities in Non-Agricultural Sectors:

A significant majority of respondents (73.3%) reported an increase in non-agricultural employment opportunities. This finding is noteworthy as it suggests that urbanization has had a positive impact on the diversification of the local job market in the peri-urban areas of Bedele town. The rise in non-agricultural employment opportunities can have several positive implications for the community.

First, it indicates that the expansion of urban areas is creating new economic prospects for peri-urban residents beyond traditional agriculture. The availability of diverse employment options can improve the overall economic well-being of the community by reducing dependency on agriculture as the primary income source.

Second, this diversification may contribute to poverty reduction and income stability. Households with members engaged in various non-agricultural sectors may have more stable incomes and better access to social services. The increased job opportunities can enhance the livelihoods of peri-urban residents by providing alternative income sources and reducing economic vulnerability.

Moreover, the growth of non-agricultural sectors can attract a more diverse and skilled workforce. This can lead to knowledge spillovers, innovation, and improved productivity in various industries, ultimately contributing to local economic development.

4.2.5 Decreased Employment Opportunities in Non-Agricultural Sectors:

While the majority of respondents reported increased non-agricultural job opportunities, a smaller proportion (14.4%) mentioned a decrease in such opportunities. This subgroup of respondents may be facing specific challenges as a result of urban expansion.

The decline in non-agricultural employment options could be due to increased competition in certain sectors or shifts in the local economy. For example, the rapid urbanization process might lead to the displacement of traditional businesses or the replacement of labor-intensive jobs with more mechanized or technology-driven positions. Those experiencing a reduction in employment opportunities may need targeted support to adapt to these changes.

4.2.6 No Change in Employment Opportunities in Non-Agricultural Sectors

Approximately 12.3% of respondents reported no change in employment opportunities in non-agricultural sectors. This suggests that in specific areas of Bedele town's peri-urban regions, the impact of urban expansion on employment opportunities remained limited.

Stability in non-agricultural employment opportunities could be influenced by various factors, including local economic conditions and government policies. Further investigation is needed to understand the specific dynamics behind this lack of change.

The findings related to employment opportunities in non-agricultural sectors indicate the dynamic nature of urban expansion's impact on the local economy. The positive response from the majority of respondents suggests that urbanization is associated with economic diversification, which can enhance the overall well-being of the peri-urban community. The results also highlight the need for tailored interventions and support for those experiencing a reduction in non-agricultural job opportunities, recognizing that the impact of urban expansion is not uniform across all sectors and groups.

4.3 Impact on Access to Agricultural Land

The repercussions of urban expansion on the access to agricultural land within the Bedelle Town peri-urban areas are profound and indicative of the substantial transformation occurring. Our study reveals that a substantial majority of respondents, approximately 90%, have witnessed notable changes in their ability to access and utilize agricultural land.

The most prominent trend observed is the reduction in both the availability and size of agricultural land. This transformation is largely attributed to the relentless expansion of urban areas, which, in their sprawl, have encroached upon previously fertile and agriculturally productive lands.

Farmers and landowners are grappling with the challenges posed by these changes. The diminishing availability of agricultural land presents immediate obstacles to livelihoods that have long been dependent on farming. Reduced land sizes mean less space for cultivation, which, in turn, impacts crop yields and agricultural productivity. These outcomes have broader implications for local food security and economic well-being.

These findings call for a nuanced understanding of the dynamics at play in the peri-urban regions of Bedelle Town. The balance between urban expansion and the preservation of agricultural land must be carefully managed. Addressing these challenges requires thoughtful policy measures that support farmers and ensure sustainable access to agricultural resources.

4.4 Livelihood Farmer Interview

The data on the main sources of income among farmers in the study area provides valuable insights into the economic landscape and livelihood strategies of the community. The majority of farmers, comprising 34%, reported a moderate-income level, while 24% and 15% fell into the lower-middle and middle-income categories, respectively.

4.4.1 Income Distribution Analysis

1. Moderate Income Majority

The majority of farmers have a moderate income, indicating a stable but not affluent financial situation. This could imply that a sizable portion of the farming community is able to meet their basic needs but faces constraints when it comes to pursuing additional opportunities or investments.

2. Challenges in Lower-Middle and Middle-Income Categories

Farmers make up 24 percent of the lower-middle and 15 percent of the middle-income categories, indicating that a significant segment of the community faces challenges. These difficulties may include factors such as a lack of resources, market fluctuations, or other socioeconomic constraints affecting income levels.

4.5 Additional Income Sources

3. Diversification through Khat Trade

The mention of khat trading as an additional source of income sheds light on the diversification strategies used by some farmers. Khat, a locally grown green drug, represents an alternative source of income. Exploring such alternative livelihood strategies is critical, particularly for those who face financial constraints as a result of traditional farming practices.

The findings suggest that the majority of farmers in the study area have a moderate income, with a significant proportion also falling into the lower-middle and middle-income categories. This indicates that while some farmers are able to earn a decent living from farming, many others face challenges in making ends meet. The mention of khat trade as an additional income source highlights the need for further exploration of alternative livelihood strategies among farmers in the area.

4. Economic Sustainability

The findings highlight the need for a nuanced understanding of economic sustainability in the agricultural sector. While some farmers maintain a moderate income, a substantial proportion faces challenges that could affect their long-term viability.

5. Alternative Livelihood Exploration

The mention of khat trade underscores the importance of exploring alternative livelihood strategies. Diversification beyond traditional agriculture can be crucial for enhancing income resilience and ensuring the financial well-being of farmers.

6. Policy Considerations

Policymakers and stakeholders may use these insights to tailor interventions that address the specific needs of farmers across income categories. Supporting initiatives that promote economic diversification and provide resources for farmers in lower-income brackets could contribute to overall community development.

In conclusion, the income distribution and additional income sources among farmers in the study area paint a nuanced picture of economic realities. Further research and targeted interventions can build upon these findings to enhance the economic sustainability and resilience of the farming community.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, this study employed supervised classification of Landsat imagery to analyze Land Use/Land Cover Change (LULCC) in Bedele Town from 1992 to 2022. The analysis of Landsat imagery revealed significant trends in Bedele Town's LULCC. A prominent trend is the expansion of built-up areas, reflecting the town's ongoing urbanization process. This growth is likely fueled by population increase and economic activities. Interestingly, the data shows a decrease in built-up areas between 2012 and 2022. This deviation warrants further investigation to understand the underlying causes. It's possible that factors such as densification within existing urban areas or a shift in construction patterns could be at play. Regardless of the reason, this trend highlights the importance of strategic urban planning that promotes sustainable development.

Another significant trend is the change in agricultural land. While the overall analysis shows a net increase in agricultural land, the decrease observed from 2012 to 2022 raises concerns. Potential drivers for this decline could include conversion of agricultural land for urban expansion, infrastructure development, or alternative land uses. This decrease in agricultural land could have negative consequences for food security and the livelihoods of farmers in the peri-urban area. Farmers may face reduced access to land for cultivation, impacting their ability to produce food for their families and for local markets.

A positive trend identified in the study is the increase in forest cover. This could be attributed to successful afforestation programs or natural regeneration processes. The expansion of forest cover offers numerous environmental benefits, such as improved air quality, soil conservation, and enhanced biodiversity. However, continued monitoring is crucial to ensure the long-term preservation of these newly established forests.

The detected LULCC trends have the potential to significantly impact the livelihoods of local communities in Bedele Town. Urban sprawl, characterized by the expansion of built-up areas, can lead to the displacement of farmers as their agricultural land is converted for development purposes.

This displacement can disrupt traditional farming practices and reduce access to vital resources, impacting farmers' ability to earn a living. Furthermore, the decrease in available agricultural land may force farmers to adopt intensive farming practices or seek alternative income sources, potentially leading to environmental degradation or social disruptions.

Understanding these LULCC trends and their potential social and economic consequences is crucial for informing sustainable development policies in Bedele Town. To address the challenges posed by LULCC, a multi-pronged approach is necessary. Firstly, strategic urban planning that promotes compact and efficient development patterns can minimize land use conflicts. This could involve encouraging high-density housing developments, mixed-use zoning, and the development of public transportation systems. Secondly, the implementation of green infrastructure projects can integrate natural spaces within urban areas, promoting both environmental and economic benefits. These projects could involve creating parks, green corridors, and urban forests, which can improve air quality, mitigate urban heat island effect, and provide recreational opportunities. Finally, livelihood support programs should be established to assist farmers in adapting to changing land use patterns. These programs could provide training in new agricultural techniques, facilitate access to alternative income sources, or offer compensation for land acquisition.

By implementing such policies, Bedele Town can embark on a path of sustainable development that balances urban growth with the preservation of agricultural land, environmental resources, and the livelihoods of local communities. This study contributes to the understanding of LULCC in peri-urban areas and emphasizes the need for continued research that explores the socio-economic aspects of these changes in more detail. Such research can inform evidence-based decision-making for a sustainable future in Bedele Town and other rapidly urbanizing regions.

4.2 Recommendations

1. Integrated Urban Planning

- Integrated urban planning strategies should be considered in order to minimize ecological, social, and economic factors for urban expansion.
- Local communities should be involved during planning process to align development initiatives with their needs and aspirations.

2. Agricultural Sustainability

- Formulate policies to safeguard agricultural land and promote sustainable farming practices.
- Conduct research on the socio-economic impact of reduced agricultural land and implement measures to support local farmers.

3. Afforestation Programs

- Continue and enhance afforestation programs to counteract deforestation trends.
- Implement robust monitoring systems to track changes in forest cover and assess the effectiveness of conservation efforts.

4. Long-Term Monitoring

- Initiate long-term monitoring studies to track evolving land use patterns and their impact on the environment and communities.
- Use continuous data collection to provide insights into ongoing trends and guide adaptive planning strategies.

5. Community Engagement

- Facilitate community engagement forums to gather local perspectives on urban development and land use changes.
- Foster collaboration between local authorities, residents, and businesses to create a shared vision for sustainable development.

6. Alternative Livelihood Strategies

- Explore and promote alternative livelihood strategies for farmers, considering the diverse economic activities available in the region.
- Provide training and resources to support farmers in diversifying their income sources and improving their overall livelihoods.

7. Capacity Building

- Invest in capacity-building programs for local authorities and planners to enhance their skills in sustainable urban development.
- Encourage the adoption of modern technologies for data collection, analysis, and decision-making.

8. Policy Review

Periodically review and update land-use policies to adapt to changing circumstances and emerging challenges. Ensure that policies are flexible enough to accommodate the evolving needs of Bedele Town.

In conclusion, the recommendations outlined above aim to guide stakeholders in fostering a resilient, sustainable, and inclusive future for Bedele Town. By addressing the complex interdependencies between urban expansion, environmental conservation, and community livelihoods, these recommendations lay the groundwork for a holistic approach to development.

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6. Annex

Dear Respondent,

Greetings! We hope this quiz finds you in good health. We are undertaking research on the effects of urban growth on peri-urban land use and livelihoods in Bedele, Ethiopia, which is located in the Buno Bedele Zone of Oromia. Your involvement in this research is critical to understanding the problems and possibilities posed by urbanization and its consequences on peri-urban populations and agricultural methods.

Urbanization is a global phenomenon that is being fueled by reasons such as population increase, rural-to-urban migration, and economic development. Bedele town has witnessed tremendous urban expansion in recent years due to its strategic location and many economic prospects. Land use patterns and livelihood systems have changed dramatically as urban limits have expanded into peri-urban and rural regions.

The goal of this research is to look at the unique effects of urban growth on peri-urban land use and livelihoods in Bedele. We hope to uncover the issues encountered by peri-urban farmers, changes in agricultural techniques, and socioeconomic effects of urban growth through your important views and experiences.

Your participation in this study is entirely optional, and your replies will be kept private and anonymous. Your candid input will help to inform evidence-based suggestions for sustainable urban planning, policy development, and interventions to alleviate the negative effects of urban growth and promote resilient peri-urban livelihoods.

We sincerely appreciate your time and willingness to participate in this study. Your valuable input will contribute to a better understanding of the impacts of urban expansion on peri-urban land use and livelihoods in Bedele town. If you have any questions or concerns, please feel free to contact us.

Thank you once again for your cooperation.

Sincerely, [Tizazu] [Contact Information]

Section 1: Respondent Information

1. Gender:
    1. Male
    2. Female
2. Age:
    1. 18-25
    2. 26-35
    3. 36-45
    4. 46-55
    5. 56 and above
3. Marital Status:
    1. Single
    2. Married
    3. Divorced
    4. Widowed
4. Educational Level:
    1. No formal education
    2. Primary education
    3. Secondary education
    4. Higher education
5. Occupation:
    1. Farmer
    2. Agricultural laborer
    3. Business owner
    4. Service industry
    5. Other (Specify: _____)
6. How long have you been residing in the peri-urban area of Bedele town?

- ……
  ……
  ……
  ……
  ……..
- Section 2: Impact of Urban Expansion on Peri-Urban Livelihoods

7. Have you noticed any changes in the size or availability of agricultural land due to urban expansion? If yes, please describe the changes……

- ……
  ……
  ……
  ……
  ……
  ……..

8. How has urban expansion affected your access to agricultural land?
    - Increased access
    - Decreased access
    - No change
9. Have you experienced any changes in the types of crops or agricultural practices you engage in due to urban expansion? If yes, please describe the changes.

- ……
  ……
  ……
  …….

10. Have you observed any changes in your agricultural productivity or yields as a result of urban expansion? If yes, please describe the changes.

- ……
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  ……
  ……
  ……
  ……

11. Have you faced any challenges in accessing water for irrigation or domestic use due to urban expansion? If yes, please specify the challenges faced.

- ……
  ……
  ……
  ……

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……..

12. Have employment opportunities in non-agricultural sectors increased or decreased due to urban expansion in Bedele town?
    a) Increased
    b) Decreased
    c) No change
13. Have you explored any alternative livelihood options due to urban expansion? If yes, please specify the alternative livelihoods pursued.

- ……
  ……
  …….

Section 3: Perceptions of Urban Expansion

14. How would you describe the impact of urban expansion on the overall environment in the peri-urban areas of Bedele town? Please provide specific examples if possible.

- …….

15. In your opinion, how has urban expansion affected the social fabric and community cohesion in the peri-urban areas? Please explain.

- ……
  ……
  ……

16. What are your perceptions regarding the role of local government in managing the impacts of urban expansion on peri-urban areas and livelihoods?

- ……
  ……
  …….

17. Are there any community initiatives or organizations that have emerged in response to the challenges posed by urban expansion? If yes, please describe these initiatives.
18. In your opinion, what measures can be taken to minimize the negative impacts of urban expansion and promote sustainable peri-urban livelihoods in Bedele town?

Section 4: Additional Information

19. Is there any other important information or aspect related to the impacts of urban expansion on peri-urban land use and livelihoods that you would like to share?

- ……
  ……
  ……
  ……

20. Would you be willing to participate in follow-up interviews or discussions to provide more detailed insights? If yes, please provide your contact information (optional).

- ……
  ……
  ……
  ……

Questions for Farmer Interviews on Livelihoods in the Context of Urban Expansion:

- Can you tell me a bit about your farming operation? (e.g., crops grown, livestock raised, etc.)
- How long have you been farming in this area?
- What are the main challenges you face as a farmer?
- What are the main opportunities you see for farmers in this area?
- Have you noticed any changes in the area surrounding your farm in recent years?
- How has urban expansion impacted your farming operation? (e.g., loss of land, increased land prices, competition for resources, etc.)
- Have you had to make any changes to your farming practices as a result of urban expansion?
- What are your concerns about the future of farming in this area given the ongoing urban expansion?
- How has urban expansion impacted your income and livelihood?
- Have you had to find alternative sources of income to supplement your farming income?
- If so, what are these alternative sources of income?
- What are your thoughts on the long-term sustainability of farming in this area given the ongoing urban expansion?
- What do you think can be done to support farmers in this area in the face of urban expansion? What policies or programs would you like to see implemented to help farmers adapt to the challenges of urban expansion?
- What are your hopes and aspirations for the future of farming in this area?

- Are there any specific challenges or opportunities that women farmers face in this context?
- Are there any specific challenges or opportunities that young farmers face in this context?
- What role do farmers' organizations or cooperatives play in supporting farmers in this context?