Addis Ababa University

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Sustainability and Challenges of Urban Green Infrastructure Development and Management: The case of Adama City, Ethiopia

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This is to certify that the thesis, prepared by Olani Gobena, has been submitted as a partial requirement for the Master of Arts degree in Environment and Sustainable Development. The title of the thesis is "Sustainability and Challenges of Urban Green Infrastructure Development and Management: the case of Adama City, Ethiopia". The thesis fulfills the accepted requirements for originality and quality, and it meets the university's regulations.

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Abstract:

Urban green infrastructure (UGI) plays a crucial role in improving the environmental, economic, and social aspects of cities. However, cities and towns of developing countries, including Ethiopia in general and the study city are not properly making and implementing. In addition, the existing interventions are not supported by metrical evidence-based research. Therefore, this study focused on the sustainability of UGI development and management in Adama City. The study utilized both quantitative and qualitative approach to achieve its objectives. It gathered socio-spatial data from multiple sources and employed various techniques and tools for analysis. The research mapped and calculated the status of UGI (Urban Green Infrastructure) from 1991 to 2021 using city land use data available in ArcMap format. Additionally, socioeconomic data were collected from 372 households through a structured questionnaire, and the data was analyzed using descriptive statistics. The GIS-based analysis result revealed that UGI status over the past three structural plan periods was below the standard set for modern cities, as evidenced by a significant decline (by 63.07%) in UGI and in conversely, built-up areas expanded dramatically (by 574.91%). Green infrastructure coverage found below the national standard that covers only 5.6% of the total area of the city. The existing green infrastructure components per capita were also found to be 8.09 m^2, which is below the standard (15m^2) set for cities. In relation to this, the majority of survey respondents reported a lack of amenities such as playgrounds (87.1%), sports fields (95.2%), or forests (78.2%), where all the survey respondents mentioned the amenities deficit is much below the standards set for modern cities. The key challenges to implementing sustainable urban green infrastructure include a lack of clear implementation strategies, insufficient prioritization and attention from local administration, limited community participation, lack of transparency, poor connectivity and integration among existing urban infrastructure, lack of public awareness, inadequate resources to implement the scanty plan, ineffective long-term management and maintenance plans, poor cooperation among different departments and offices, and difficulties in resource mobilization and policy enforcement. Therefore, to address these issues, decision-makers should take appropriate measures to improve the integration, accessibility, transparency, community involvement, and overall governance of urban green infrastructure development and management so as to ensure the long-term sustainability of greenery in the city.

Keywords: Sustainability, Green infrastructure, Development, Management

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ACRONYMS

CIWEM	Chartered Institution of Water and Environmental Management
FIDIC	International Federation of Consulting Engineers
GI	Green Infrastructure
GIS	Geographic Information System
LULC	The spatial and temporal distribution of land use/cover
OECD	Organization for Economic Co-operation and Development
OLI	Operational Land Imager
RICS	Royal Institution of Chartered Surveyors
SES	Social-Ecological Systems
SUGI	Sustainable Urban Green Infrastructure
SUDs	Sustainable urban drainage systems
TCPAWT	Town & Country Planning Association The Wildlife Trusts
TM	Thematic Mapper
UGI	Urban Green Infrastructure
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WGCFNR	Wando Genet College of Forestry and Natural Resources,
WGS	World Geodetic System
WHO	World Health Organization

CHAPTER ONE

1. INTRODUCTION

1.1. Background

In recent years, cities around the globe have experienced significant growth in their size. According to a report by the United Nations, over half (55%) of the world's population currently resides in urban areas, and this percentage is projected to rise to 68% by 2050 (Zayed, 2022). The rapid growth in population and urbanization has resulted in adverse effects on nearby ecosystems, including heightened air pollution, intensified heat island effects, decreasing urban green spaces, declines in biodiversity, and deterioration of other ecosystem functions. In summary, population growth and expansion of urban areas are placing immense pressure on natural resources, which in turn adverse effect on the quality of life in urban environments (Gelan and Girma, 2021). As more people migrate to urban centers in search of economic opportunities, the demand for housing, commercial development, and other built environments has steadily increased, often at the expense of the natural landscapes that once characterized these metropolitan areas (Nugent, 2019). The loss of these green spaces not only diminishes the aesthetic appeal of cities but also has tangible impacts on public health, environmental sustainability, and climate resilience (Kabisch et al., 2016).

Urban green infrastructure offers sustainable and regenerative solutions to address present and future urban challenges. Through careful planning and adequate funding, UGI can also help cities adapt to the impacts of climate change, enhance resilience to extreme weather events, promote biodiversity and ecosystem services, and improve public health and people well-being (CIWEM, 2010). Moreover, the development of UGI is seen as a suitable approach to mitigate the negative effects of climate change and global warming, primarily caused by industrial expansion and the growth of other urban infrastructure. Additionally, it is anticipated that the UGI sector will generate significant employment opportunities, contributing to poverty reduction strategies for the cities and countries implementing the program (WGCFNR, 2017).

There is no universally accepted definition for Green Infrastructure (OECD, 2023). However, in recent times, it has been described as a strategic and planned network comprising natural, semi-natural, and artificial elements and connections. Within urban areas, green infrastructure networks encompass various features such as parks, woodlands, wetlands, river side’s, private

gardens, street trees, allotments, playing fields, cemeteries in church compound, and new innovations like green roofs and sustainable drainage systems. Considering the different typologies and functions as part of green infrastructure development their design, protection and management should be strategically enhanced (Malki-Epshtein et al., 2018). In line with this, Rouse and Bunster (2013) have determined six guidelines that need to be adhered to when developing and planning green infrastructure. Multi-functionality, connectivity, habitability, resilience, identity, and return on investment are some of these guiding concepts. Resilience in this context refers to the capacity of recovering back from or adjust to shocks and changes (kefale, 2017).

However, currently, the incorporation of ecological knowledge into the design of green infrastructure is limited, and green spaces are typically managed with a focus on amenity outcomes rather than considering other ecosystem service benefits (Wentworth, 2017). In this regard, Herslund et al. (2017) and Girma, (2019) highlighted that the suitable approach of GI planning and implementation can be achieved through effective integration of its plan with the city's planning and governance systems. This has been lacking in most cities of developing countries including Ethiopia cities. In addition, limited research evidence exist that supporting and guiding sustainable UGI developments and management.

1.2. Statement of the Problem

Urban Green Infrastructure (UGI) components play a crucial role in promoting sustainable urban development. However, these components face significant threats due to the negative consequences of unplanned urban growth (Girma, 2019). In its urban land management plans, the Ethiopian Ministry of Urban Development, Housing, and Construction (2014) recommended that 30% of the land has to be set aside for roads and infrastructure, 30% for green spaces and shared public use, and 40% for building construction. However, the recommendations have not been effectively implemented in practice. Despite its significance at all level ranging from regional, national, and international levels, the development of UGI components has not met expectations that fall much far below the required standards . Numerous socio-cultural, environmental, and structural challenges have hindered the proper development and management of UGIs. One major challenge is the lack of attention and support from the government regarding UGI development and management (WGCFNR, 2017).

Moreover, various factors impact the progress of green infrastructure development, such as a lack of political support, societal perceptions of landscape values, and weak promotion of an ecological systems approach for sustainability (Faisal et al., 2022). Another key challenge is the lack of comprehensive urban planning and policy frameworks that prioritize the integration of green infrastructure into urban development. Many developing countries often lack the institutional capacity, technical expertise, and financial resources to effectively plan, implement, and maintain urban green infrastructure projects. This can lead to ad-hoc and fragmented approaches, which undermines the long-term sustainability of these initiatives (Gómez-Baggethun & Barton, 2013). Furthermore, the unequal distribution of urban green spaces across socioeconomic lines can exacerbate issues of environmental justice, with marginalized communities often having less access to the benefits provided by these natural resources (Schüle et al., 2019).

For instance, Kefale (2017) explored the issues surrounding particular UGI elements, like inner sub-city cobblestone roads, street-side and median trees, and recreational parks. Gashu and Gebre-Egziabher (2018) stated that urban development has a significant impact on green spaces Azagew (2021) underlined that Ethiopian cities lack planning and management of accessible Urban Green Infrastructure, while Bekele (2021) found that urban green spaces are challenged by lack of proper planning and policy implementation. Those studies primarily aimed to investigate the impact of urban development on green spaces, the accessibility of UGI, and the challenges specific to UGI components.

Similarly, studies conducted to explore the development and management of urban Green Infrastructure (GI) in the Oromia Special Zone surrounding Finfinne Emerging Towns have also fallen short of offering a thorough comprehension of sustainability concerns (Girma, 2019). Furthermore, a few studies have addressed specific issues and difficulties related to Adama City's UGI, such as environmental injustice linked to air pollution (Erin et al., 2021). Informal sources suggest that the development and management of urban green infrastructure in Adama face numerous obstacles that hinder its widespread implementation and effectiveness (Esmo, 2017). However studies have not comprehensively analyzed the green infrastructure development and management sustainability indictors in the Adama city. Therefore, this study is aimed to analyze the sustainability of green infrastructure development and management of Adama city, Oromia region, Ethiopia.

1.3. Objective of the Study

1.3.1. General Objectives

The general objective of the study is to analyze the sustainability and challenges of green infrastructure development and management in Adama City of Ethiopia

1.3.2. Specific Objectives

The specific objectives tried to:

- Assess the patterns and trends of green infrastructure of Adama City
- Identify the key challenges of green infrastructure development and management of Adama City
- Analyze the sustainability of green infrastructure development and management of Adama City

1.4. Research Questions

In line with the stated objectives, the research questions addressed include the following:

- What are the patterns and trends of the green infrastructure in Adama City?
- What are the key challenges in the development and management of green infrastructure in Adama City?
- Analyze the sustainability of green infrastructure Development and Management in Adama City?

1.5. Significance of the Study

The little that is currently understood about the difficulties and long-term viability of developing and managing urban green infrastructure will be expanded upon by this study. As a result, policymakers can use the study's findings to inform their planning and design of urban green infrastructure. The study also outlines the difficulties in advancing the development and management of green infrastructure and makes insightful recommendations for the research field. Additionally, this study might establish baseline data for subsequent research that aims to carry out in-depth investigations on the topic and in the study region. Furthermore, this study may serve as a reference for future research on the contribution of developed green infrastructure to urban environments.

1.6. Scope of the Study

The scope of this study focuses on evaluating the sustainability and challenges associated with the development and management of green infrastructure in Adama City, Ethiopia. The study takes a comprehensive approach, examining various components of urban green infrastructure, choosing a period of 30 years (1991-2021) for analysis in Adama City researchers to examine the long-term patterns and changes in the development, management, and sustainability of green infrastructure. The study is confined to Adama City, specifically targeting six woredas (administrative districts) within the city: Goro, Oda, Caffe, Migira, Hangatu, and Melka Adama. By focusing on these specific areas, the researchers aim to provide a detailed and context-specific analysis of the green infrastructure challenges and sustainability in Adama City. and also the study employs a multifaceted approach, integrating both quantitative and qualitative methods. This may include, but is not limited to, field surveys, remote sensing data analysis, interviews with stakeholders, and policy and document reviews. The researchers aim to gather comprehensive data to understand the current state of green infrastructure, the challenges faced in its development and management, and the opportunities for enhancing sustainability.

1.7. Limitation of the Study

Difficulties of acquiring extensive and up-to-date data related to the distribution of green spaces, types of vegetation, land use patterns, and management practices were among major limitation to conduct the study. This could have an impact on the thoroughness and accuracy of the study result. Furthermore, engaging with various stakeholders involved in urban green infrastructure, such as government agencies, city planners, and community organizations, may pose challenges in terms of access and obtaining their cooperation also the other operational challenge of the study. This could potentially hinder ability to gather primary data through interviews, surveys, or site visits. These limitations may consequently impact the breadth and depth of the study.

1.8. Organization of the thesis

This thesis is organized into five chapters. The first chapter provides an introduction, which includes the background information, problem statement, objectives (both general and specific), research questions, significance and scope of the study, limitations, and the organization of the thesis. The second chapter provided review of relevant literature that focus on context of previous studies. The third chapter discusses the materials and methods which subdivided into study area description, research methodology including data capturing and processing, and

analysis methods. The fourth chapter focuses on analyzing, presenting and discussing the results. Finally, the fifth chapter presents conclusions and recommendations of the major finding.

1.9. Definitions of Key terms

Urban green infrastructure refers to a carefully designed and interconnected system of natural and semi-natural areas, structures, and components within urban environments. It encompasses various elements such as parks, green roofs, street trees, wetlands, green corridors, and other green spaces. The purpose of urban green infrastructure is to offer numerous environmental, social, and economic advantages to urban communities (Ahern, 2013).

Urban green space refers to areas within an urban environment that are specifically designed, developed, or preserved to provide recreational, aesthetic, ecological, and social benefits to urban residents (World Health Organization, 2016).

Sustainability is "the enduring integration of environmental, social, and economic aspects in the planning, design, construction, operation, and maintenance of green infrastructure to meet the needs of the present without compromising the ability of future generations to meet their own needs" (FIDIC, 2020). It involves adopting practices that balance the needs of the present with the ability of future generations to meet their own needs, while enhancing the overall resilience, livability, and ecological health of urban areas (Colding et al., 2006).

CHAPTER TWO

2. REVIEW LITERATURE

This chapter provides a comprehensive review of the academic literature pertaining to the development and management of urban green infrastructure. The review serves as the theoretical basis for this study and begins by examining the fundamental concepts of urban green infrastructure, including definitions and theories related to sustainability. It also explores the challenges that arise in implementing green infrastructure initiatives in urban areas. The review further investigates different typologies and classifications of urban green infrastructure, as well as the environmental, social, and economic benefits associated with these assets. Additionally, the literature review delves into research on public perceptions, attitudes, and engagement with urban green infrastructure. Furthermore, this chapter conducts an empirical review of existing research, examining various scholarly works that have identified key barriers and challenges to the successful development and long-term management of green infrastructure, both globally and in Africa.

2.1. The Concept and Definition of Urban Green Infrastructure

Urban green infrastructure (UGI) refers to the strategically planned and managed network of natural and semi-natural areas, features, and green spaces within urban and peri-urban environments (Tzoulas et al., 2007). This includes a diverse array of elements such as parks, gardens, green roofs, street trees, urban forests, wetlands, and other natural or nature-based components that are intentionally integrated into the built environment. The fundamental premise behind the concept of UGI is that these natural systems can provide cost-effective, multifunctional solutions to address a wide range of urban challenges, from stormwater management to urban heat island mitigation (Gómez-Baggethun & Barton, 2013).

The origins of the UGI concept can be traced back to the 1990s, when urban planners and policymakers began to recognize the limitations of traditional, single-purpose "gray" infrastructure and the potential benefits of incorporating natural elements into urban design and development (Mell, 2013). This shift in perspective was driven by growing concerns about the environmental, social, and economic impacts of rapid urbanization, as well as the increasing awareness of the ecosystem services that natural systems can provide to support community resilience and human well-being (Hansen & Pauleit, 2014).

The European Commission (2013) defines urban green infrastructure as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services." This broad definition highlights the multi-functionality of UGI, which is a key aspect of the concept. Rather than serving a single purpose, urban green spaces and features can simultaneously provide a diverse array of regulating services (e.g., air purification, microclimate regulation, stormwater management), supporting services (e.g., habitat provision, nutrient cycling), and cultural services (e.g., recreation, aesthetic value, sense of place) (Demuzere et al., 2014).

The multifunctional nature of UGI contrasts with the traditional, siloed approach to urban planning and design, which has often prioritized single-purpose, gray infrastructure solutions over more integrated, nature-based alternatives. By embracing the concept of UGI, urban planners and policymakers can shift towards a more holistic, systems-based perspective that recognizes the value of natural capital and the importance of maintaining and enhancing the delivery of ecosystem services within the built environment (Rolf et al., 2019).

As per the Ethiopia National Urban Green Infrastructure Standard (2015), the development and management of urban green infrastructure involve several concepts. One of these concepts is the definition of public green open spaces, which includes various types of areas. These areas encompass parks and gardens designed for recreational, botanical, and zoological purposes. They also comprise other kinds of green spaces, such as wetlands, grasslands, both natural and semi-natural land, and urban forests, in addition to amenity green open spaces. Public green open spaces include areas that are accessible to the public, such as school and kindergarten grounds. Furthermore, public cemeteries—even those with limited access because of a lack of recreational opportunities—are regarded as a component of the urban green infrastructure. Publicly accessible in the outdoors sports areas and amenities are also included. Furthermore, publically accessible private gardens, open-air farms, and private compounds are acknowledged as elements of urban green infrastructure.

2.2. The Planning of Urban Green Infrastructure

In the face of growing urbanization and the pressing need to address environmental challenges, the concept of urban green infrastructure planning has gained significant momentum in recent years (Tzoulas et al., 2007). Green infrastructure (GI) has become an important approach for

achieving sustainable urban development. It serves as a planning concept and tool to promote sustainability in various areas such as green and open space planning, development control, and biodiversity protection (Wang, 2020). Urban green infrastructure planning is a holistic approach that seeks to integrate these natural elements into the built environment, creating a more sustainable and livable urban landscape. This approach recognizes the essential role that green spaces play in regulating temperature, reducing air and water pollution, mitigating the effects of climate change, and providing recreational opportunities for residents (Mell, 2013).

One of the core principles of urban green infrastructure planning is the idea of multi-functionality. Green spaces are designed to serve multiple purposes, such as storm-water management, biodiversity conservation, and social and cultural engagement. By adopting a multifunctional approach, urban planners can maximize the benefits of green infrastructure and ensure that it is strategically integrated into the overall urban development plan (Rolf & Pauleit, 2019). Another key aspect of urban green infrastructure planning is the emphasis on connectivity. The goal is to create a well-connected network of green spaces, allowing for the movement of people, wildlife, and ecosystem services across the urban landscape. This connectivity can be achieved through the use of green corridors, greenways, and other linkages that facilitate the flow of resources and interactions between different green spaces (Lennon & Scott, 2014).

Successful implementation of urban green infrastructure planning requires a collaborative and multidisciplinary approach. Urban planners, landscape architects, ecologists, and community stakeholders must work together to identify the most appropriate green infrastructure strategies for a given urban context, taking into account local environmental conditions, socio-economic factors, and the needs and preferences of the local community (European Commission, 2013). Comprehensive GI planning involves identifying priority areas for conservation, restoration, and strategic placement of new green assets to maximize these benefits (Meerow & Newell, 2017).

A common framework for UGI planning involves first conducting a thorough inventory and assessment of existing green spaces, natural features, and ecosystem services within the urban region (Hansen & Pauleit, 2014). This provides a baseline understanding of the current GI network. Planners can then model future scenarios and growth patterns to determine where new GI elements should be integrated to address projected needs, such as storm-water management or

urban heat island mitigation (Gill et al., 2007).Stakeholder engagement is also critical, as the planning process should incorporate the values, needs, and local knowledge of residents, community organizations, and other parties impacted by GI decisions (Connop et al., 2016).

2.3. Benefits of Urban Green Infrastructure

Many research studies have shown that urban green infrastructure is essential for promoting sustainability in cities, as it provides significant benefits in social, economic, and environmental aspects (Girma, 2019). To strengthen the theoretical basis of this study on urban green infrastructure in urban areas, a thorough review of its importance in these three areas is presented here. In recent times, there is growing recognition of the numerous advantages provided by urban green infrastructure (Gashu and Gebre Egziabher, 2019). Urban green spaces are essential elements of urban environments, providing a diverse array of social, economic, and ecological advantages. Essentially, these green spaces have a positive impact on social, economic, and ecological aspects, helping to alleviate the negative effects of urban living (Harasimowicz, 2018).

Extensive research conducted worldwide demonstrates that UGI has the potential to address key challenges associated with urbanization, such as social and cultural decline, climate change, air pollution, landscape fragmentation, and ultimately enhances the overall quality of life for urban dwellers (Xu and Zhao, 2021).

Urban green infrastructure has been found to have numerous positive effects on the environment and climate change adaptation. These components help reduce heat-related mortality and mitigate the heat island effect in urban areas by providing cooling effects and lowering air temperatures. They also aid in decreasing flood risk, improving water quality, enhancing air circulation, and providing habitat for various species. Sustainable urban drainage systems, a part of green infrastructure, help mitigate runoff, flash flooding, and erosion risks. Overall, green infrastructure contributes to creating more sustainable and resilient environments in both urban and rural settings (Carlsson, 2021).

One of the economic benefits of urban green infrastructure that can be directly measured and compared is its impact on property value, particularly in relation to proximity to green infrastructure components. A study conducted in eight towns in the Netherlands found that houses located near green infrastructure elements such as parks and playgrounds experienced an

increase in their property value by approximately 28% (Jabir, 2021). Urban green areas have economic benefits that contribute to local economic regeneration. These benefits include job creation, the establishment of new businesses, and an increase in land values. By improving the aesthetics of the local landscape, green areas enhance people's enjoyment of the surroundings. This, in turn, attracts businesses to invest in the area, leading to further economic growth (Carlsson, 2021.

Research from various nations has demonstrated that urban dwellers regularly make use of green infrastructure components for strolling, exploring, seeing wildlife, and participating in leisure activities. In nations like the UK, Finland, and Mexico, playground and park facilities are especially important resources for leisure activities (Girma, 2019).

Urban green infrastructure has social benefits that include improvements in physical activity levels, psychological health, and mental wellbeing. Engaging in exercise activities such as walking, running, and participating in green gym programs not only promotes healthier lifestyles but also reduces healthcare costs and alleviates traffic congestion. A study conducted in nine Swedish cities revealed that individuals who frequently visit green parks experience fewer stress-related illnesses and urban green infrastructure components fulfill the recreational needs of communities, offering spaces for various leisure activities, including play, sports, events, and relaxation (Carlsson, 2021).

According to Gebremedihin (2008) the development of urban green infrastructure aims to create a healthy and sustainable living environment that offers essential services to all individuals. One of these fundamental services is the establishment of a robust and multi-functional urban green structure (Jabir, 2021).

Green infrastructure plays a crucial role in achieving urban sustainability by aligning with the broader objectives of creating livable, equitable, and environmentally responsible cities. It encompasses strategies that aim to minimize negative environmental impacts while promoting economic prosperity and social well-being (Olawe et al., 2024). Green infrastructure contributes to the ecological sustainability of cities by improving biodiversity, mitigating the urban heat island effect, and facilitating sustainable water management. This integration addresses the environmental aspect of sustainability (Beatley and Newman. 2013).

Green infrastructure is vital for ensuring social sustainability and promoting the overall well-being of urban communities. By establishing easily accessible green spaces, it fosters social cohesion, enhances physical health, and contributes to mental well-being. The integration of green spaces into urban environments is a key aspect of sustainable development, as it significantly improves the quality of life for residents (Wan et al., 2021). Furthermore, green infrastructure contributes to economic sustainability through various benefits. The establishment and upkeep of green spaces generate employment, attract tourism, and increase property values, reinforcing economic growth and serving as a catalyst for sustainable urban development (Jennings & Bamkole, 2019).

2.4. Challenges of UGI Development and Management

2.4.1. Challenges of Developing and Managing of UGI In The World

According to Portsmouth City Council (2021), a well-managed network of green infrastructure can play a crucial role in addressing the decline in biodiversity. However, as explained by Wright and Nebel (2002), many cities face obstacles in developing and managing their green spaces. Urbanization and development have put significant pressure on urban green areas, leading to the loss of natural landscapes and ecosystems (Mpofu, 2013). Cities face numerous sustainability challenges, such as social inequality, community cohesion, public health, climate change, and biodiversity loss. To address these issues, Urban Green Infrastructure (UGI) is being recognized as a vital element in urban planning and management. UGI plays a crucial role in advancing towards a more sustainable society (Buffam et al., 2022).

As cities grapple with growing populations, the demand for housing has led some residents to illegally occupy environmentally sensitive areas meant for urban green spaces, such as swamps, riverbanks, and steep slopes. Furthermore, there are numerous challenges that hinder the development and upkeep of green areas. These challenges include a lack of political commitment, reduced budgets, insufficient skilled personnel, increased maintenance responsibilities, limited information and knowledge about green spaces, and encroachment by other activities (Mpofu, 2013).

Recent literature on urban ecology has emphasized the importance of incorporating urban green spaces into the management of cities, considering their social, cultural, economic, and environmental aspects, in order to achieve sustainable urban development (Breuste, 2015).

Consequently, it is suggested that the development of green infrastructure should align with other policy drivers and initiatives to maximize its potential (TCPAWT, 2012).

However, Kimme et al. (2013) reported several barriers hinder the implementation of urban green infrastructure. These barriers include limited public knowledge and perception, landowner preferences, conflicts with development plans, resistance to change, and a lack of political commitment and leadership. Financial constraints in planning, designing, implementing, and maintaining UGI pose significant challenges globally. Legal frameworks also play a crucial role, as regulations at various government levels can impede the development and sustainability of UGI in urban areas (Gelan and Girma, 2021). Furthermore, governance gaps, structural pressures, and insufficient ecological knowledge and vision contribute to UGI implementation challenges. The most prevalent barriers involve governance and management, such as the absence of political support, competing funding priorities, and inadequate communication and coordination among municipal agencies and the public (Buffam et al., 2022).

Green Infrastructure implementation faces hurdles in institutional, technological, and perceptual realms. Institutional challenges encompass political backing, staff turnover, coordination issues, and ecosystem service boundary discrepancies. Technological barriers involve maintenance, data gaps, knowledge deficits, resistance to change, and irrigation issues. Perceptual obstacles include cost worries, limited understanding, budget constraints, and resistance from older generations, social acceptance issues, and educational shortcomings (Staddon et al., 2017).

2.4.2. Challenges of Developing and Managing UGI- In African Cities

Sustainable Development Goal 11 aims to create inclusive, safe, resilient, and sustainable cities. Policymakers worldwide are addressing urbanization challenges, but in some developing countries, urban planning implementation is hindered by ambitious plans that exceed administrative capacity (Buffam et al., 2022). Green spaces are often overlooked in policymaking, particularly in African urban regions. Weak legal frameworks in Sub-Saharan Africa lead to inadequate development and management of urban green spaces (Mpofu, 2013). In Ethiopia, although policy documents exist, there is a lack of quantitative guidelines and standards. Legislation, guidelines, and standards are crucial for shaping green space initiatives in planning and execution (Eshetu et al., 2021).

In their study, Zakka et al. (2017) investigated urban green infrastructure components in African cities and found that inadequate policy, legal, and regulatory frameworks are the root cause of ad hoc provision, poor management, and insufficiency. Furthermore, as noted by Kendal et al. (2012), local municipalities oversee UGI and other publicly managed recreational areas, so urban planning policies serve as a guide for management decisions and practices. Green space laws and policies may also have an impact on how accessible green spaces are. n a similar vein, Bedimo-Rung et al. (2005) discovered that policies pertaining to parks cover elements like park layout, administration techniques, and financial protocols. Informal policies may exist within some park organizations that favor the creation and upkeep of facilities easily accessible to their target user base, while less accessible areas of the park may receive less attention (Azagew, 2021).

African leaders demonstrate a lack of strong political will when it comes to initiating green space initiatives. In numerous cities across Sub-Saharan Africa, there is a noticeable absence of enthusiasm for implementing measures that promote the development and management of green spaces. A study by Amoako and Adom-Asamoah (2017) revealed instances in which political actors in Kumasi, Ghana, instead of preserving green spaces, opted to make changes to them. The unwillingness of politicians in Sub-Saharan Africa to take decisive action and work towards protecting and preserving public parks is a significant contributing factor to the decline and disappearance of these parks (Appiah-Opoku et al., 2023).

Several research studies have highlighted the main factors contributing to the inadequate development and management of urban green infrastructure components in African cities. These factors include rapid urbanization, unplanned urban growth, limited institutional capacity, a lack of political will, corruption, insufficient financial resources, and a lack of skilled expertise. Furthermore, there is limited awareness and understanding of the benefits offered by UGI components among both communities and decision-makers, which further contributes to the inadequate provision of high-quality UGI components (Gelan and Girma, 2021).

2.4.3. Challenges of Developing and Managing UGI in Ethiopia cities

Ethiopian urban centers struggle to meet the WHO's (2016) minimum standard for green space per capita. Cities like Adama, Shashemene, Dese, Jijiga, Dire Dawa, and Bahir Dar have only 2.1, 1.0, 3.1, 3.8, 5.6, and 8.2 square meters of urban green infrastructure components per person, respectively, which is far below the recommended level. Moreover, the existing UGI

components face challenges such as limited accessibility, lack of safety measures, underdevelopment, and the absence of basic facilities, discouraging residents from utilizing them. Inadequate enforcement of planning regulations, a weak legal framework, and a shortage of qualified professionals, insufficient financial support, limited participation, and poor collaboration among institutions contribute to the inadequate development and management of UGI components in Ethiopian urban areas (Gelan and Girma, 2021).

In many cities in Ethiopia, the implementation of master plans aimed at safeguarding, expanding, or establishing new green areas within urban landscapes has fallen short of expectations. This failure can be attributed to various factors, including inadequate enforcement of development plans, the rapid expansion of built-up areas due to population pressures, a lack of emphasis on prioritizing urban green spaces, financial limitations, a shortage of professional expertise, and limited public participation (Girma et al., 2019). However, there seems to be a growing recognition of the positive advantages associated with urban vegetation and green spaces (Herslund et al., 2018).

Addis Ababa is undergoing rapid urban growth and development, leading to a significant decrease in green spaces by 32% over the past decade, primarily due to the conversion of agricultural land for residential and industrial purposes. The city has also seen a 32% increase in bare land as a result of an urban renewal program that involved demolishing slums in central business areas for future redevelopment. The challenges in establishing and maintaining urban green infrastructure in Addis Ababa stem from inadequate planning, ineffective legal enforcement, and frequent institutional restructuring (Yeshitela, 2019).

The availability of green spaces, such as urban forests and urban agriculture, in Addis Ababa has experienced a significant decline. Residents now have access to only 0.37 square meters of park space per capita. A study conducted by Worku et al. (2021) in Addis Ababa revealed a reduction in overall vegetation cover and a 16% increase in built-up areas between 1985 and 2015. This transformation is believed to have contributed to a rise in land surface temperature in the city by 3 to 8 degrees Celsius during the same period (Flanagan et al., 2021).

2.5. Sustainable UGI Development and Management

To achieve sustainable development and management of urban green infrastructure, an integrated planning approach is essential, encompassing various disciplines such as open space, landscape

and urban planning, nature conservation, water resource management, mobility, energy supply, real estate, and social institutions. This interdisciplinary planning requires the involvement of a wide range of stakeholders beyond government officials. Effective communication and awareness among stakeholders are crucial, as well as collaboration between institutions responsible for urban green infrastructure (Gelan and Girma, 2019). The effective implementation of green infrastructure requires a comprehensive and integrated approach that considers ecological, social, and economic factors in urban planning and development (Foster et al., 2011).

The creation of Green Infrastructure should be in line with the main objective of building sustainable communities. This means focusing on improving people's lives by addressing different aspects of livability, such as social inclusion, community unity, and economic revitalization (Carlsson, 2021). Effective management of urban green infrastructure requires a comprehensive understanding of its extent and accessibility throughout the urban area. This involves considering factors such as coverage, condition, age, and interconnectivity of these infrastructures (Jennings & Bamkole, 2019). The management of urban green spaces should also take into account natural features, seasonal changes, physical characteristics, wildlife needs, current and potential land use, local community preferences, and strategic placement within the local network of open spaces. It is important to allocate resources for the management, restoration, or development of all types of urban green infrastructure (Jabir, 2021).

2.5.1. Holistic Planning and Design

Enhancing green infrastructure in urban planning involves initiatives such as improving pedestrian accessibility, providing essential amenities, addressing safety concerns, adding aesthetic enhancements, emphasizing proximity to well-maintained GI for economic benefits, promoting green transportation, and ensuring interconnectedness through pedestrian and cycling routes, safety measures, and aesthetic improvements. These efforts enhance urban livability, contributing to the overall health, safety, and economic prosperity of urban communities (Hagos, 2023).

The key strategies for successful green infrastructure development include holistic planning and design, biodiversity planning, and the incorporation of green roofs and vertical greening. Holistic planning involves understanding the interconnectedness of urban ecosystems and integrating natural systems into the urban fabric. Biodiversity planning focuses on protecting critical

habitats, promoting native plantings, and creating green corridors to support species movement. Energy efficiency, biodiversity, and the reduction of the urban heat island effect are all aided by green roofs and vertical greening. Encouraging real estate developers to incorporate green infrastructure components into building plans promotes a resilient and sustainable urban landscape(Olawe, et al. 2024).

2.5.2. Community Engagement and Participation

Active community engagement is vital for the successful development and management of green infrastructure. It is important to involve local residents in the planning, design, and maintenance of green spaces to ensure that projects meet their specific needs and preferences. This can be achieved by establishing community gardens, organizing educational programs, and creating opportunities for citizens to actively participate in improving their neighborhoods (Ghose & Pettygrove, 2014).

To promote community engagement in green infrastructure development, it is essential to organize participatory design workshops and implement green education programs. Participatory design workshops bring together community members, urban planners, and environmental experts to exchange ideas and ensure that projects align with the local community's aspirations and cultural context. By fostering a sense of ownership, communities become stewards of their green spaces. Green education programs play a crucial role in raising awareness about the significance of green infrastructure (Hagos, 2023). These programs can include topics such as sustainable living, biodiversity conservation, and the benefits of green spaces for mental and physical well-being. By building an informed and environmentally conscious community, the social fabric and resilience of urban areas are strengthened (Olawe et al., 2024).

2.5.3. Integration of Existing Infrastructure

To optimize the impact of green initiatives, it is essential to integrate them seamlessly with the existing infrastructure. This includes incorporating green infrastructure elements into transportation systems, storm water management, and urban development projects. By doing so, green spaces can be connected, forming a network that improves ecological functioning and accessibility for people. This integration promotes a holistic and unified approach to urban sustainability (Olawe et al., 2024).

To promote urban sustainability, it is crucial to implement green streets and sustainable transportation solutions. This entails designing streets that prioritize pedestrians and cyclists and incorporating green infrastructure elements such as street trees, bioswales, and permeable pavements. Furthermore, adopting water-sensitive urban design principles is essential for effective storm water management and water conservation. By incorporating features like rain gardens, green roofs, and constructed wetlands, rainwater can be captured and treated, reducing the likelihood of flooding and enhancing groundwater recharge and water resilience (Patil, 2021).

2.5.4. Policy and Governance Support

The success of green infrastructure development and management relies on supportive policies and effective governance. This can be achieved by implementing zoning regulations that prioritize green spaces, providing incentives for green building practices, and establishing conservation easements to protect ecologically important areas. Collaboration between governmental bodies, NGOs, and the private sector is crucial to ensure a coordinated and sustained effort. Incentive programs, such as tax breaks, grants, or density bonuses, can encourage property developers and homeowners to integrate green infrastructure elements (Olawe et al., 2024). Developing and enforcing green infrastructure standards, including guidelines for plant selection, maintenance practices, and monitoring protocols, ensures the quality and long-term impact of green projects (Naumann et al., 2011).

2.5.4. Long-term Maintenance and Monitoring

To ensure the long-term success of green infrastructure, it is essential to develop comprehensive maintenance plans that involve collaboration between local communities, public agencies, and private stakeholders. Implementing monitoring programs is crucial to assess the performance of green infrastructure in terms of biodiversity conservation, storm water management, and community well-being. Citizen science initiatives can engage citizens in monitoring and data collection, empowering them to actively participate in the stewardship of green spaces (Patil, 2021). This sense of responsibility enhances the long-term sustainability and resilience of green infrastructure (Staddon et al., 2018). Additionally, adaptive management strategies should be implemented to allow for flexibility in responding to changing environmental conditions and community needs. Regular assessments and adjustments to management practices ensure that green infrastructure remains effective and resilient in the face of evolving challenges (Olawe et al., 2024).

2.5.5. Qualities of Urban Green Infrastructure

Stephen (1992) highlights that successful green infrastructures possess various qualities that contributes to their appeal and effectiveness. These qualities include sustainability, connectivity, accessibility, inclusiveness, and biodiversity, which are key factors in ensuring the overall success of green infrastructure projects (Jabir, 2021). The effectiveness of green infrastructure is determined by its capacity to meet the environmental, health, social, and economic needs of users. Research indicates that GI is widely utilized by older populations, especially when it is located in close proximity to residential areas Stessens et al. (2020). Sustainable GI developments contribute to the overall appeal of a city, as evidenced by the vitality of neighborhood activities, the presence of cafes along main roads, and the availability of specialized parks (Patil, 2021). Experts suggest that the quality of GI can be best assessed based on its suitability for intended purposes, including factors such as accessibility, inclusivity, maintenance, and functionality (Hagos, 2023).

2.5.5.1. Environmental Sustainability

Green infrastructure (GI) plays a crucial role in modifying climate and micro-climate conditions through sun radiation control, temperature reduction, and wind speed minimization. It promotes energy efficiency with natural shading, green roofs, and walls. GI regulates hydrological processes with bio-swales, permeable pavements, and retention ponds, while also supporting waste decomposition, biodiversity, and recreation (Trica et al., 2019). Urban surfaces impact micro-climates, but street corridors, public areas, and GI elements help regulate climate in cities. Green GIs lower wind speed and cool walls, roofs, and surroundings (Firmansyah et al., 2018). Evergreen plants in colder regions moderate wind flow. GI influences the water cycle, enabling water percolation, reducing erosion, and supporting waste decomposition. Waste separation techniques are incorporated, reducing reliance on treatment plants (Pan et al., 2019).

2.5.5.2. Social Sustainability

Green infrastructure enhances social relationships by promoting social interaction, integration, and cohesion. Regular encounters in green spaces facilitate the formation of lasting friendships and a strong sense of community. Physical spaces within GI, designed for various activities like sports and leisure, play a crucial role in nurturing social bonds and attracting tourists (Olawe et al., 2024). The design, multi-functionality, accessibility, and consideration of user characteristics in GI contribute to its appeal as a destination for tourism and social engagement (Hagos, 2023).

2.5.5.3. *Economic Sustainability*

Sustainable spaces within green infrastructure (GI) have a positive impact on the economic status of neighboring areas. They contribute to an increase in property values and stimulate local economic activity by attracting both local and non-local visitors, as well as street vendors (Firmansyah et al., 2018). These unique features and amenities generate higher demand for the location, leading to an upward trend in housing prices. GI promotes outdoor activities, such as strolling along street corridors and enjoying street cafes, which in turn attract retailers, entrepreneurs, and tourists (Olawe et al., 2024). The transformation of landscapes and the improvement in GI quality make these areas appealing to a diverse range of people, including locals, visitors from outside the neighborhood, and international tourists (Zhu et al., 2019).

2.6. Global Provision of Green Infrastructure

According to Krekel et al. (2016), earlier studies have confirmed the importance of having a sufficient number of urban green infrastructure elements in order to enhance living conditions and foster a sustainable environment in urban areas (Girma, 2019). The study of Hatami et al. (2013) emphasized the necessity of determining the quantity and standards of urban green infrastructure space per person prior to any planning. The standards for urban green space take into account factors such as population size, total green space area, and green space availability per individual. As a result, these standards can vary among different cities (Jabir, 2021).

Various organizations have put forward suggested standards for green infrastructure space per capita. The United Nations (2014) recommends an allocation of 30 square meters per person, while the National Institute of the US suggests a slightly lower standard of 14 square meters. The public health bureau and the ministry of housing (2023) in the US propose a standard of 18 square meters, and the ministry of Housing and Urban Development of Tehran (2012) suggests a slightly smaller allocation of 12 square meters. The World Health Organization (WHO, 2016) suggests a minimum standard of 9 square meters per person. These recommendations highlight the importance of providing adequate green space to support the well-being and quality of life in urban areas (Hassen and Hooman, 2012).

In Ethiopia, the expansion of industrial, commercial, residential, and infrastructure developments, along with the emergence of spontaneous and illegal settlements on mountain slopes, river valleys, and other open spaces, has led to the degradation of urban green infrastructure (Mpofu, 2013). Ethiopia has put in place a number of legislative measures to aid in

the local implementation of Agenda 21 in spite of these obstacles. Article 44 of the nation's 1995 Constitution is one such measure that acknowledges Ethiopians' right to a healthy environment (Eshetu et al., 2021). The National Urban Green Infrastructure standard of Ethiopia, (2016) sets guidelines for providing 15 square meters of public green open spaces per capita within city boundaries.

2.7. People's Perception and Involvement in Development and Management of UGI

Urbanization has significant negative effects on ecosystems, reducing their ability to provide necessary services and support biodiversity. Urban green infrastructure depletion, caused by this transformation, poses risks to the physical and mental well-being of urban residents (Herslund et al., 2018). Challenges include increased heat stress, noise pollution, and the loss of spaces that enhance mental health. To address this issue, understanding people's perceptions and usage of urban green infrastructure is crucial. This knowledge is vital for effective planning, design, and management of green spaces. Tailoring initiatives based on community needs and preferences promotes well-being, active community engagement, and a sense of ownership among residents (Breuste et al., 2015). The successful execution of green infrastructure projects relies on the collaboration and participation of various stakeholders (John et al., 2019).

Multi-stakeholder participation is crucial in GI planning and implementation. It involves collaboration between planners and local stakeholders. Governments collect data, adhere to standards, secure funding, and manage operations, while NGOs conduct surveys, advocate for projects, and enhance stakeholder capacity. Scientific experts provide advisory support, research institutes evaluate projects, and private companies contribute through donations or sponsorships (Rohilla et al., 2017).

The analysis and comprehension of urban green policies are examined from the perspective of participation, as participation plays a vital role in the long-term sustainability of Green Infrastructure projects. According to Zuniga-Terana et al. (2020), political will and community participation are crucial factors for the successful implementation of green infrastructure. Involving various stakeholders through participatory processes, such as collaborative planning, co-construction workshops, and participatory budget schemes, is essential for ensuring long-term success in GI projects (Bozzi, 2020).

Examining urban green policies with a participation perspective is crucial for the long-term sustainability of Green Infrastructure projects. Two key factors, political will and community participation, are emphasized as essential for successful and enduring GI implementation (Zuniga-Terana et al., 2020). Active engagement from diverse stakeholders necessitates the utilization of participatory methods like collaborative planning, co-construction workshops, and participatory budget schemes. Hence, participatory processes are indispensable for achieving long-term success in any GI project (Domitilla, 2020). Hence, Active community involvement is crucial for the development and management of Urban Green Infrastructure (UGI). It fosters tailored initiatives, promotes responsibility and unity, enhances awareness and knowledge, incorporates diverse perspectives and ideas, and ensures the long-term success of UGI projects. Engaging the community as active collaborators leads to mutually beneficial outcomes for both the community and the green spaces they encompass (Breuste et al., 2015).

2.8. Theories of Sustainable UGI Development and Management

The planning, design, and management of urban green infrastructure (UGI) have been informed by several influential theoretical frameworks. These theories provide a conceptual foundation for understanding the complex interactions between the social, ecological, and physical components of urban green spaces, and offer guidance for the development of more sustainable and resilient urban environments. Two prominent theories in this domain are the Landscape Ecology Theory and the Social-Ecological Systems (SES) Theory, which collectively emphasize the importance of spatial relationships, ecosystem processes, and stakeholder engagement in the context of urban green infrastructure.

Landscape Ecology Theory: The Landscape Ecology Theory is a valuable framework for analyzing the complex interplay between urban green spaces and the built environment. Developed by landscape ecologists, this theory underscores the critical importance of considering the spatial configuration, connectivity, and interactions of urban green infrastructure (UGI) within the broader urban landscape (Forman, 1995). At the core of this theory is the recognition that urban green spaces do not exist in isolation, but rather as interconnected elements within a dynamic, heterogeneous landscape. The spatial arrangement, size, and distribution of these green spaces can have a significant impact on their ecological function and the services they provide to urban residents (Breuste et al., 2013). For instance, the Landscape Ecology Theory emphasizes the importance of maintaining and enhancing the connectivity of

urban green spaces, such as through the creation of green corridors or stepping-stone habitats. This connectivity is essential for the movement and dispersal of wildlife, the flow of ecosystem processes, and the provision of recreational opportunities for human residents (Ahern, 2007). Conversely, fragmentation and isolation of urban green spaces can disrupt these critical ecological and social functions.

Moreover, the Landscape Ecology Theory highlights the need to understand the interactions between urban green spaces and the surrounding built environment. The proximity and integration of green spaces with residential areas, transportation infrastructure, and other urban land uses can influence the accessibility, usage patterns, and ecological performance of these green spaces (Forman, 2014). By considering these spatial relationships, urban planners and designers can work to optimize the synergies between the natural and built components of the urban landscape. The application of the Landscape Ecology Theory has led to the development of innovative urban planning and design approaches, such as green infrastructure networks, multifunctional landscapes, and urban biodiversity corridors. These strategies aim to create a more harmonious and resilient urban ecosystem by leveraging the spatial and functional relationships between green and built elements (Tzoulas et al., 2007).

Social-Ecological Systems (SES) Theory: The Social-Ecological Systems (SES) Theory provides a comprehensive framework for understanding the complex and dynamic nature of urban green spaces. This theory recognizes that these green spaces are not merely physical or ecological entities, but rather, they are complex systems that involve intricate interactions between social, ecological, and physical components (Ostrom, 2009). At the heart of the SES Theory is the acknowledgment that urban green spaces are shaped and influenced by a diverse array of stakeholders, including citizens, policymakers, urban planners, and environmental managers. These social actors, with their varying interests, values, and decision-making processes, play a crucial role in the creation, management, and utilization of urban green spaces (Colding et al., 2013). The SES Theory also emphasizes the importance of the ecological components within urban green spaces, such as the biodiversity, ecosystem processes, and environmental conditions that are essential for the provision of ecosystem services. These ecological elements are not independent of the social and physical components, but rather, they are inextricably linked and mutually influential (Pickett et al., 2016).

Furthermore, the SES Theory recognizes the physical infrastructure and built environment as integral parts of the urban green space system. The spatial arrangement, design, and connectivity of green spaces within the urban landscape can either facilitate or hinder the flow of social and ecological interactions (Wolch et al., 2014). By adopting the SES Theory, urban decision-makers can gain a more comprehensive understanding of the complex dynamics that shape and govern urban green spaces. This, in turn, can inform more holistic and effective strategies for the planning, management, and governance of these critical urban assets (Ernstson et al., 2010). For instance, the SES Theory encourages the consideration of diverse stakeholder perspectives, the integration of social and ecological data, and the exploration of feedback loops and cross-scale interactions. This approach can help to identify and address the underlying drivers of urban green space issues, such as inequitable access, ecological degradation, or conflicts between different user groups.

By grounding UGI development and management in these various theoretical frameworks, practitioners can create and maintain urban green infrastructure that is both ecologically sound and socially beneficial, contributing to the overall sustainability and resilience of cities.

2.9. Empirical literature review

Urban green infrastructure (UGI) is increasingly seen as a crucial tool for addressing the challenges posed by urban growth and enhancing sustainability. However, the widespread implementation of UGI is impeded by various constraints, particularly in developing nations. To optimize the social, economic, and environmental advantages of UGI, cities must incorporate UGI solutions into their urban planning, design, and management strategies. While green spaces in urban areas offer numerous benefits, their creation and upkeep encounter obstacles, especially in regions with industrial activities and high resource consumption (Telelew, 2018).

For instance, Zeleke (2008) highlighted that the proportion of green areas in Mexico City is decreasing by 3.7 percent annually, with buildings frequently replacing and diminishing the city's green spaces. One common and hazardous issue in cities that have lost their green areas is the encroachment of illegal settlements and other unauthorized constructions on these areas originally designated for public use. These problems are particularly prevalent in the outskirts of urban areas. In general, the challenges can be categorized as planning issues, problems related to development and investment, lack of awareness about the benefits of green spaces, and a

shortage of professionals in the field (Girma, 2020).

A study conducted in Uganda, as reported by Akola (2017), identified various factors that impact the management of green areas. These factors include limited financial resources, insufficient institutional capacity, and a lack of commitment. Despite the presence of stakeholders who were willing to participate in green areas management, the poor implementation of policies had a negative effect on land use planning (Telelew, 2018).

The Johannesburg Development Agency (2001) states that Gauteng's urban green infrastructure is confronted with a number of difficulties. Inadequate enforcement of local bylaws, unpermitted building conversions, overcrowding in residential properties, unlawful dumping and littering, uncontrolled informal and street trading, deterioration of residential buildings, low maintenance and reinvestment, overcrowding, illegal building occupation, vulnerability of homeless children, inadequate and limited public spaces and recreational facilities, problems with waste management service delivery, and issues with street and traffic light malfunctions are some of these challenges. The creation and administration of urban green infrastructure in Gauteng are hampered by these issues (Kefale, 2017).

Guinea's urban centers are growing faster than planned and have not integrated green infrastructure, which has created a number of environmental problems. Among these difficulties are rising temperatures, air and water pollution, devastation of mangrove ecosystems, and greenhouse gas emissions. Urban green infrastructure is not supported by a separate policy framework and has not received national priority. Due to a lack of political direction, urban green infrastructure has received little attention and awareness, which has caused it to be converted to other uses. Furthermore, there is a connection between the use of urban green spaces and the development of infrastructure, business, residential, and industrial facilities, as well as the unapproved use of open spaces and mountain slopes (Keita and Kourouma, 2023).

The study carried out in the town of Debrebirhan highlights the value of institutional frameworks and their ability to provide and oversee green infrastructure in urban settings. Unfortunately, there are not enough funding or human resources in the current structure that is in charge of putting green infrastructure into place, keeping an eye on it, and evaluating it. For the size of the town, the few ward-level positions allocated to green space development are insufficient. The majority of open positions for specialists in the development of greenery are at the kebele level,

which engages with the community directly but is underfunded. Furthermore, the budget allocated for greenery development is insufficient. These findings indicate a lack of attention from the town administration towards urban greenery, leading to environmental degradation. The provision and management of green infrastructure require a multidisciplinary and integrated approach involving various stakeholders (Reta, 2021).

2.10. Conceptual Framework

In the context of sustainable Urban Green Infrastructure (UGI) development and management, the conceptual framework involves examining the interrelationships between various factors and their impact on the final outcome. The framework focuses on the goal of Sustainable Urban Green Infrastructure (SUGI), which is influenced by two main factors: urban green infrastructure development and urban green infrastructure management. The development process involves planning, designing, and implementing green spaces, such as parks and gardens, shaped by policies and legal frameworks. The management component involves governance and maintenance of these green spaces, including decision-making processes, resource allocation, and ongoing maintenance. Challenges of UGI development and management include funding, public engagement, institutional coordination, and monitoring. These factors directly impact the success and sustainability of UGI, determining resources, stakeholder involvement, and oversight. The framework emphasizes the interdependence of these factors, with policies, legal framework, development, and management all contributing to achieving sustainable UGI. Addressing these interconnected elements is crucial for creating and maintaining a resilient and environmentally-friendly urban landscape. The successful integration and harmonization of these factors contribute to achieving sustainable UGI development and management in urban settings, as exemplified by the case of Adama City.

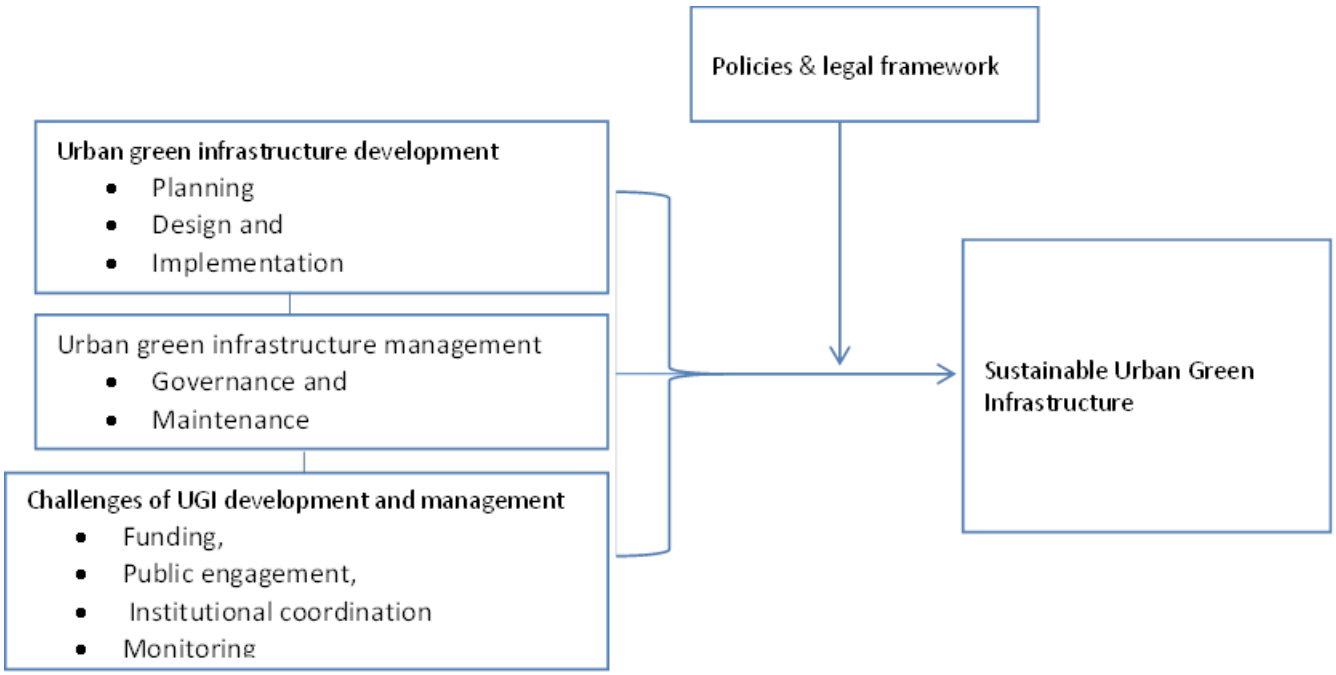


Figure 1 Conceptual framework of the study

Source: Authors construct, 2024

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of the study areas

3.1.1. Location, Climate and Population

Adama was established as a railway station in 1916 and is situated approximately 99 km southeast of Addis Ababa. The city's founding and strategic location have been shaped by favorable economic, social, and geographical conditions that have been instrumental in its growth and development. The study area is ranging from Positioned at latitudes 8°2ϑ - 8°36′N and longitudes from 39°13′ - 39°18′E (Figure 2), Adama has an elevation of 1580 meters above sea level. The city experiences an average annual rainfall of 838 mm and a temperature of around 20°C. The predominant soil type in Adama is Andosols, characterized by light sandy comprising approximately 90% sand and 10% sandy-clay (ASTU, 2016). The flourishing plant life in Adama reflects the fertile soil conditions in the city, with hills having degraded, shallow, and stony soils. The 2020 population projection data from the Central Statistical Agency (CSA) estimates Adama's total population to be 414,240 individuals, with males accounting for 202,747 and females for 211,493 (CSA, 2020).

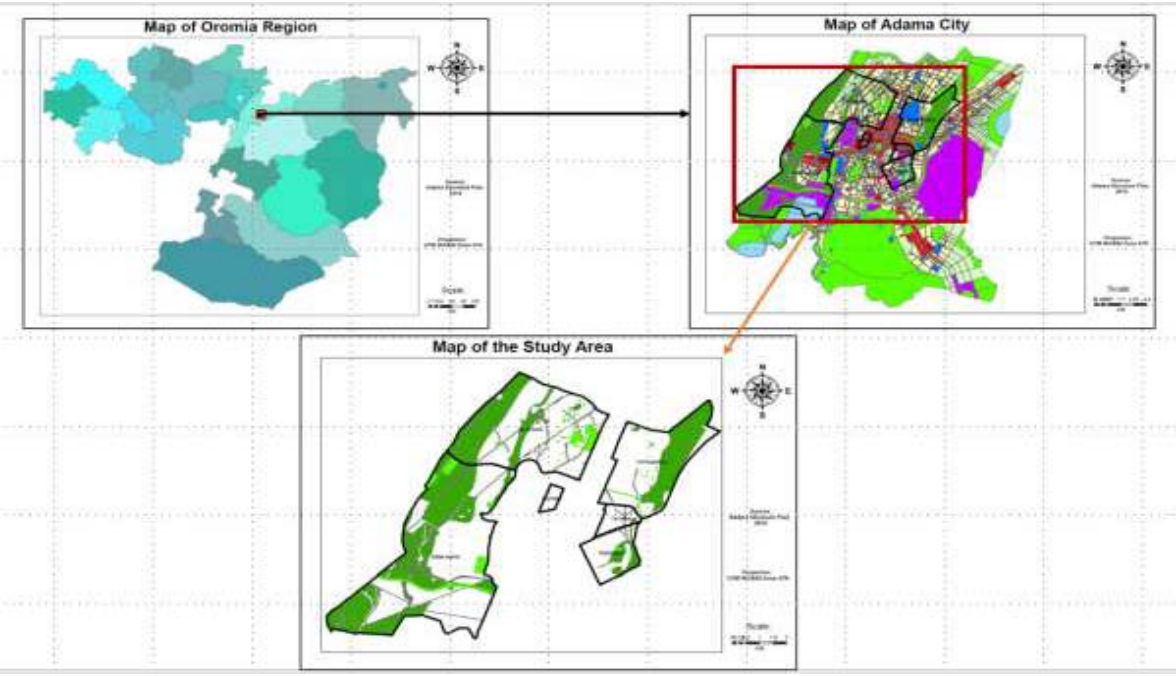


Figure 2 Location map of Adama City
Source: Adama Municipality (2024)

3.1.2. Physical Characteristics

Adama is situated within the main structural systems of the East African Rift Valley, specifically within the Wonji Fault Belt. Geological studies indicate that the current physical features of the area are a result of past volcanic tectonic and extensive activities, which deposited sediment primarily of fluvial (related to rivers) and lacustrine (related to lakes) origins. Consequently, the main topography of Adama and its surrounding region consists of volcanic domes and cones, depressions controlled by faults, and fault scraps (Bulti and Sori, 2017). The city is predominantly located between two mountain ridges, occupying relatively low and flat terrain with an average elevation ranging from 1600 to 18,000 meters above sea level. The land exhibits a gentle slope ranging from 1-10% (ASTU, 2016).

3.2. Research Approaches and Design

This study employed descriptive research design tailored to the research's depth and comprehensiveness. The research utilized a combination of surveys and expert interviews to gather numerical data and qualitative insights respectively. The surveys aimed to capture people's preferences and opinions regarding urban green infrastructures, while the expert interviews provided valuable perspectives on the development and administration of such infrastructures. Numerical inventory data formed the primary basis of analysis, with percentages and indexes utilized to interpret the data, highlighting its quantitative nature. The research strategy centered around surveys, employing questionnaires to evaluate the various factors on urban green infrastructure development and management, as well as to gauge residents' perceptions of the associated benefits. In summary, the study adopted a descriptive research design to comprehensively describe the state of affairs of the sustainability of green infrastructure development and management in Adama City.

To maintain coherence, this study adopted a sequential mixed-methods approach for data collection and presentation of findings. The initial phase involved gathering quantitative data, which then informed the development of interview questions. Interviews were subsequently conducted, and the results were presented accordingly. The discussion section encompassed a range of findings. Conversely, the qualitative research methodology focused on subjectively assessing beliefs, attitudes, and behaviors. This approach relied on the researcher's perspectives and insights to thoroughly investigate and provide a deeper understanding of the study.

3.2.1. Population, Sample Size and Sampling Techniques

Based on data provided by the Adama City Administrative Office, Adama City underwent expansion in all directions. At the time, the city administration consisted of six sub-cities: Bole, Aba Geda, Dembela, Boku, Dabe, and Lugo. These sub-cities were further divided into 19 *woredas*, with each sub-city containing three *woredas*, except for Aba Geda sub-city that has four *woredas*. To assess the sustainability of green infrastructure development and management in the city, a sample of one woreda was selected from each sub-city, resulting in a total sample size for this study was six. Specifically, the *woredas* of Oda, Goro, Chafe, Hangatu, Migira, and Melka Adama were selected using a purposive sampling method from the total of 19 woredas. These six woredas were chosen from the total of 19 woredas based on their ability to provide valuable insights into the sustainability of green infrastructure development and management in the city.

The study employed simple random sampling methods to select the sample respondents. Moreover, since the study aimed to gather detailed information from individuals actively engaged in green infrastructure management or possessing expert knowledge in the field, a purposive sampling method was also utilized to select key informants and resource persons. Around 6 key informants were purposively chosen from various levels offices which include the city, sub-city, and *woreda*, to provide valuable insights for the study.

The study selected a purposive set of *woredas* (administrative divisions) and determined their respective sample sizes based on the total populations. The selection of *woredas* was proportional to their size of population, using data from the Central Statistical Agency's 2022 projection.

Various factors, including the study's objectives, geographical area, time constraints, and cost considerations were taken into account to draw the sample and determine the sample size from the overall population of 102,059 households. Using the sample size was determined by using the Slovin‘s formula (Serakan, 1992):

The formula for the sample was given in equation (i) at the 95% confidence level with significance level of (5%)

The Formula for sample size: $$n = \frac{N}{1 + N\,(e^2)}$$ ---------- (i)

Where:

Where:

n = Sample size to be studied

N= Population size

e = margin of error 5%

From the above formula, the sample size for this study was:

$$n = \frac{102{,}059}{1+102{,}059\ (0.05)\text{^}2}$$

$$n = \frac{115{,}059}{1+255.147} = \frac{102{,}059}{256.147}$$

n = 398.4

The sample in this study is 398

As a result, a stratified random sampling method was used to select a total of 398 participants. This formula accurately calculated the appropriate sample size to ensure an accurate representation of the entire population, taking into account the desired level of precision. The participants were selected from each of the six *woredas* in proportion to their respective sizes, ensuring an unbiased representation of households (Table 1). To maintain fairness, a systematic random sampling technique was employed during the selection process.

The proportional allocation formula to determine the sample size for each woreda. The formula would be: n_i = (N_i / N) * n

Where:

n_i = the sample size for the i-th woreda

N_i =the population size of the i-th woreda

N =the total population size across all woredas

n =the total sample size (398 in this case)

Let's go through an example calculation for the Oda woreda:

Oda woreda population (N_i) = 8,334

Total population across all woredas (N) = 102,059

Total sample size (n) = 398

Plugging these values into the formula: n_i = (N_i / N) * n : For example the sample size of Oda woreda

= (8,334 / 102,059) * 398

= 0.0817 * 398

= 32.5 (rounded to the nearest whole number) = 33

Table 1 Sample size survey

Sub – city	*Woreda*	No of population	Sample proportion
Aba Geda	Oda	8,334	33
Bole	Goro	29,955	117
Dabe	Chafe	23,131	90
Boku	Hangatu	10,559	41
Lugo	Migira	13,616	53
Dembela	Melka Adama	16,464	64
Total		**102,059**	**398**

Source: Adama Municipality (2024)

3.2.2. Data collection methods,

To accomplish the study's objectives, a combination of primary and secondary data was utilized to gather the necessary information. Primary data were obtained through household surveys, focus groups discussions and key informants, and field observations methods. By analyzing the data collected from household surveys, the study assessed the perspectives of households regarding the benefits of green spaces and the factors that influenced their decision-making regarding their management.

Household Survey: To gather information from participants, this study utilized a survey questionnaire that combined closed-ended and open-ended questions. The decision to use survey questionnaires was justified due to their accessibility, ease of administration, and ability to directly gather information from respondents. Conducting an official survey followed a structured and systematic approach to collect information from a specific group of individuals. Initially, the questionnaire was developed in English and later translated into local languages, specifically Afan Oromo. Prior to data collection, enumerators were recruited and trained to administer the questionnaire. The household survey questionnaire covered various topics, including participants' demographic and socioeconomic characteristics, the availability and accessibility of green infrastructure, their perceptions of its benefits, and the factors influencing the development and management of green infrastructure. By utilizing this tool, valuable data

was collected, allowing for the acquisition of quantitative data suitable for statistical modeling.

Interview of Key Informants: The key informants for this study primarily consisted of City Officials, Urban Planners, Environmentalists, NGOs and Community Organizations, and City Maintenance and Public Works Staff in Adama City. City Officials, including those from the planning department, municipality, or environmental department, possessed valuable insights into the policies, regulations, and strategies relevant to the development and management of urban green infrastructure. A total of six key informants were interviewed as part of the data collection process. Conducting key informant interviews aimed to provide in-depth insights and generate comprehensive information, both on the specific topics addressed in the semi-structured interview format and broader aspects of green area management. The interview process was guided by a carefully prepared checklist, encompassing subjects such as the condition and type of development, as well as the management of green areas.

Focus group discussion: The objective of the group discussions in this study was to gather diverse perspectives and experiences from participants regarding the development and management of urban green infrastructure, ultimately leading to a comprehensive understanding. The groups identified for these discussions included Urban Planners, City Officials and Administrators, Environmental Experts, Business and Economic Representatives, and Non-Governmental Organizations (NGOs), with approximately 10 members participating in each focus group discussion by dividing in two groups. To ensure a balanced representation, participants in the discussions encompassed individuals who had access to green areas and were involved in their management. A guide was used to lead the focus group discussions, with the researcher's role being to facilitate an open and free exchange of thoughts, opinions, and experiences related to the study's topics. Participants shared insights on the characteristics of green infrastructure in the research areas, as well as the factors that influenced both its development and maintenance.

Field observation: The researcher conducted on-site observations to document and understand the physical characteristics and spatial aspects of the study area. These observations served to complement and compare data collected through other methods of data collection. The purpose of this approach was to examine the diverse impacts of urban growth, particularly its influence on the development and management of green infrastructure within the research area. In terms of

secondary data, it was collected from various sources, including books, journals, articles, reports from the City Sanitation and Green Areas Development and Management offices at different time points, and electronic resources. The researcher also reviewed records from institutions such as the Environmental Protection Agency, Central Statistical Agency (CSA), and Adama Land Development and Management Office.

Pilot testing: The quality and effectiveness of the research instruments and data collection procedures in this study were ensured through a conducted pilot testing. A small sample of participants representing the target population was selected, and asked to complete the questionnaire. The purpose of pilot testing was to identify any potential issues or shortcomings in the questionnaire, such as ambiguities, difficulties in understanding, or missing variables. Feedback from the participants was collected, and their responses were analyzed to refine and improve the questionnaire and data collection procedures. Pilot testing contributed to enhancing the validity and reliability of the study by ensuring that the research instruments were clear, comprehensive, and capable of capturing the relevant aspects of the Sustainability of GI development and management in an urban setting, the case of Adama City.

3.2.3. Methods of analysis

3.2.3.1. Survey Data Analysis

The researcher utilized primary data collected through survey questionnaires, key informant interviews, and assessments to address issues concerning the sustainability of green infrastructure development and management. Qualitative data analysis was employed to interpret the qualitative data obtained from focus group discussion, observations and interviews with a focus on understanding the community's perception of green area development and management. Quantitative data, on the other hand, was subjected to descriptive and inferential statistical analysis. Descriptive statistics, including measures such as frequencies, and percentages, were used to describe the data. The quantitative data collected through survey questionnaires were carefully processed, coded, cleaned, and entered into a computer for analysis using SPSS statistical software. Additionally, secondary data obtained from various sources were organized and analyzed to complement the findings from the survey.

Moreover the assessment of land use change was conducted using Arc GIS software. Prior to the primary data analysis, pre-processing techniques were applied to correct any distortions or degradation in the image data and improve the clarity of the images. In order to gather pertinent

data satellite imageries and mapping were conducted in the study area. The land sat image datasets that includes the acquisition dates, sensor path/row resolution, and the source of the images used in this study are summarized in Table 2 below. The images were freely acquired from the USGS (https://earthexplorer.usgs.gov/). ArcGIS 10.8 was used to classify the image and to delineate the study area. All the images were taken with little cloud cover (< 10%).

Before image classification, all Landsat images used for this study were checked for geometric correction. All Landsat images were geometrically rectified by USGS to the projection of UTM, Zone 37N, 1984 spheroid, and WGS 84 Datum. In this study, about 600 training site samples were collected from each LUC class representative for the 1991, 2001, 2011, and 2021 study periods. A supervised classification method of maximum likelihood classier algorithm was used to produce thematic LUC classes of the reference years. Maximum likelihood classier was selected as it is confirmed by various LULC change studies for its ability in generating accurate LULC classification (Jacob et al. 2015).

The classification categories are used according to Anderson (1976) for level I and modified from Aryaguna & Saputra (2020) which was applied for Banjarmasin city (Table 2).

Table 2 Land feature classification types

Land use/cover	Description
Vegetation	Deciduous forest, mixed forest lands, palms , forest, palms, orchard, herbs, climbers, gardens, inner-city recreational areas, parks and playgrounds, grassland and vegetable lands.
Waterbody	Explain large and small rivers crossing Adama town
Agriculture	Areas of land prepared for growing agricultural crops and also areas currently under crop and land under preparation
Bare land	Exposed soils, area of active excavation, lands without vegetation, crops or grasses, and barren soils
Built up Areas	Residential, commercial and services, industrial, socio-economic, infrastructure asphalt roads, buildings, and urban areas

Source: Anderson et al., 1976

Land cover change detections were done from land cover categories derived for different periods (Singh 1989). In this method, a land cover map and area of each cover type were produced for four reference years (Andualem et al., 2022) comparisons between the subsequent land uses/

cover changes were made for four periods of analysis such as between 1991 and 2001, 2001 and 2011, 2011 and 2021, and 1991 and 2021.

The spatiotemporal in land use/covers classes of the four-period series of maps were analysed based using tables and graphs. In addition, a conversion matrix showing the direction of change in each LUC class over space and time was also done for four periods of analysis using ArcGIS 10.8. As a result, the changes over the past 30 years were analysed with a rate of change for each land cover class calculated in terms of the percent of change (Andualem et al., 2022) and rate of change using equation 1and 2 respectively.

$$Percentage\ of\ change = \frac{A-B}{B} * 100 \ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 1)}$$

$$Rate\ of\ change\ (ha/year) = \frac{A-B}{C} * 100 \ldots\ldots\ldots\ldots\ldots \text{(Equation. 2)}$$

Where = A is an area of LULCC (ha) of previous year land cover, B is an area of LULCC (ha) in time of current year land cover and C is the time interval between A and B in years (number of years between A and B).

The analysis of remote sensing data, acquisition dates, and path/row information presented in the following table (Table 3) holds great significance in understanding and monitoring the Earth's surface and its transformations.

The provided information pertains to remote sensing data acquisitions conducted on different dates using various sensors and sources. On 18/12/1991, data was acquired using the TM (Thematic Mapper) sensor on Landsat 05, with a path of 168 and row of 54, resulting in a pixel size of 30x30 meters. The data was sourced from the USGS (United States Geological Survey). Similarly, acquisitions were made on 5/12/2001, 9/12/2011, and 26/03/2021 using the same sensor, path, row, and pixel size, but with updates to the sensor version - TM/Landsat05 for the first three dates and OLI/08 (Operational Land Imager) for the last date. The images were freely acquired from the USGS (https://earthexplorer.usgs.gov/). ArcGIS 10.8 was used to classify the image and to delineate the study area. All the images were taken with little cloud cover (< 10%).

Table 2 Landsat image data

Remote sensing data, acquisition date, path/row					
Date of Acquisition	**Sensor**	**Path**	**Row**	**Pixel**	**Source**
18/12/1991	TM/Landsat05	168	54	30*30	USGS
5/12/2001	TM/Landsat05	168	54	30*30	USGS
9/12/2011	TM/Landsat05	168	54	30*30	USGS
26/03/2021	OLI/08	168	54	30*30	USGS

Source: USGS (https://earthexplorer.usgs.gov/), accessed on 10/04/2024

Accuracy Assessment

The accuracy of the classified image can be checked by comparing classified pixel points with pixel points collected as a reference from fieldwork, Google Earth, and top sheet maps Congalton & Green 2008). As per Plourde and Congalton, (2003) recommendation 50 sample per classes. In order to classify images, pixels were sorted according to their data file values into a limited number of distinct data categories (Bogoliubova, 2014). In Arc GIS 10.8, random sample points (50 for each land use) were made for LU/LC mapping for the years 1991, 2001, 2011 and 2021 in order to undertake an accuracy evaluation for the categorized pictures. To quantitatively assess the accuracy, statistical methods like overall accuracy and kappa value were applied.

$$\text{Overall Accuracy} = \frac{\text{Total number of correctly classified pixel (diagonal)}}{\text{Total number of reference pixel}} * 100 \text{ --------- } \textit{Equation 3}$$

$$OA = \frac{TCS}{TS} * 100$$

Where OA= overall accuracy, TCS=totally corrected samples and TS=Total samples

While the Kappa coefficient KC (eq. 5) is generated from a statistical test, and describes the accuracy of a classification compared to a random classification (Rwanga and Ndambuki, 2017; Aliani et al., 2019). Its value varies between 0 and 1, where 0 indicates a total accidental classification, while 1 indicates a very accurate classification. According to Gidey et al. (2017), good classifications have KC>0.8, while bad classifications have KC<0.4

$$KC = \frac{TS * TCS - \sum(\text{Column total} * \text{row total})}{TS * TS - \sum(\text{Column total} * \text{row total})} * 100 \text{ --------- Equation 4}$$

User Accuracy= $\frac{\text{Number of correctly classified pixel in each category}}{\text{Total number of reference pixel in that category (the row total)}}$ *100--Equation 5

Producer Accuracy= $\frac{\text{Number of correctly classified pixel in each category}}{\text{Total number of reference pixel in that category (the column total)}}$ *100-Equation 6

Summary of the research methodology is given in table 3 bellow.

Table 3 General description of research methodology of objectives

Objectives	**Type of Data**	**Source of data**	**Data analysis**
Patterns of green Infrastructure	Both Qualitative and Quantitative	Geo-Spatial Field observation Questioner, KII	- Structural landscape Arc GIS version 10.8 - Qualitative description
Challenges of UGI development and management	Both Qualitative and Quantitative	House hold survey, KII Field Observation	descriptive statistical method such as percentiles, tables, charts
Sustainability of UGI development and management	Both Qualitative and Quantitative	House hold survey, KII Field Observation	Descriptive statistical and Qualitative description

Source: Authors construct (2024)

3.2.4. Validity and Reliability Measures

The validity of the study was assessed through the employment of multiple methods. Firstly, a thorough literature review was conducted to establish a strong theoretical framework and ensure alignment between the research questions and existing knowledge and concepts pertaining to urban green infrastructure development and management. This approach improved the overall validity of the study by grounding it in established theories and concepts. In addition, careful attention was given to selecting the research site, from six Sub City of Adama, Oda, Goro, Chafe, Hangatu, Migira, and Melka Adama *woredas*, to ensure its representativeness of urban areas facing similar Sustainability of green infrastructure development and management. This step enhanced the external validity of the study, allowing for the generalization of findings to similar contexts.

The researcher developed a structured questionnaire specifically tailored to capture pertinent information regarding the Sustainability of urban green infrastructure. The questionnaire underwent pilot testing to identify and resolve any potential issues related to clarity and comprehensibility. This process bolstered the reliability of the collected data.

Moreover, the reliability of the questionnaire was assessed using the Cronbach's alpha

coefficient, a widely used statistical measure that indicates the internal consistency or reliability of a scale or questionnaire. By calculating the Cronbach's alpha coefficient for the questionnaire items, it was possible to assess the reliability of the instrument and ensure that the items consistently measured the intended constructs. Through meticulous consideration of validity and reliability measures, the study aimed to provide a robust and trustworthy examination of the sustainability associated with urban green infrastructure development and management in Adama city.

3.3. Ethical consideration

One of the primary concerns when conducting research that involves gathering ideas from various individuals and organizations is the ethical treatment of the research subjects. It is essential for the researcher to maintain strict confidentiality regarding the ideas expressed by these individuals and respect participants rights and dignity. The data collectors obtained consent from households, sectorial experts, respondents of questionnaire surveys, and key informants. These individuals were fully informed about the research objectives and expected outcomes.

The participants were given assurance that their personal information would be treated as confidential and would not be made open for the public or shared with any third party without their full consent, if necessary. This was clearly stated at the beginning of the questionnaire booklet. Both the researcher and the enumerators informed the respondents that their responses would be kept highly confidential. In addition to the ethical considerations regarding human subjects, research ethics also involve giving proper credit to data and scholarly research produced by others. This includes citing and acknowledging information obtained from academic sources, as well as data generated by individuals or organizations, in order to maintain the intellectual and scientific integrity of the research. The researcher made an effort to acknowledge and properly cite all the information obtained from scholarly literature and data sources. In addition, the proposal and assessment tools are assessed by Institutional Review Board (IRB) of the center for Environment and Development Studies of the Collage of Development Studies, as per Addis Ababa University IRB guideline.

CHAPTER FOUR
RESULT AND DISCUSSION

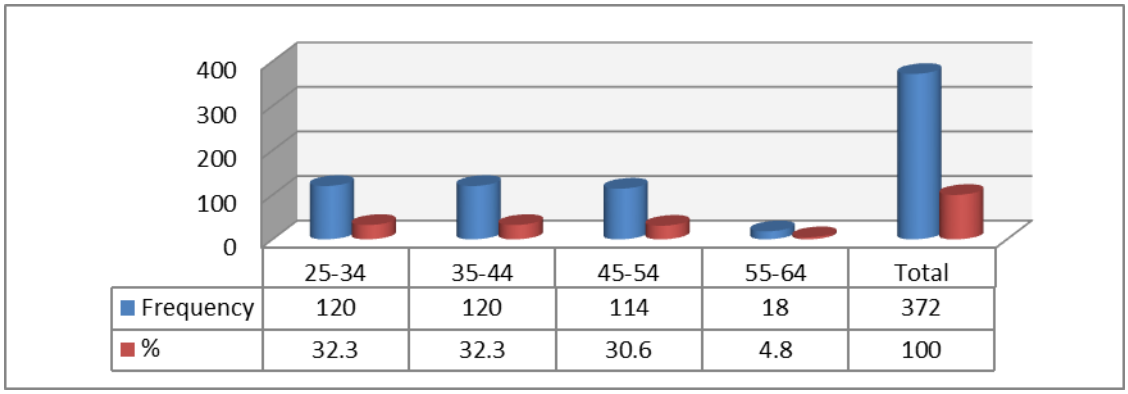
4. Sustainability and Challenges of Urban Green Infrastructure Development and Management

In this chapter, the data and information obtained from questionnaires, interviews, and field observations have been systematically arranged. Initially, 398 participants, but after considering non-response and other factors, the final sample size comprised 372 individuals, representing a response rate of 93.4%. The land use data was examined using GIS software and the survey data was by descriptive statistical methods such as calculating percentages, averages, and proportions. This analysis yielded a clear description and interpretation aligned with the research objectives and questions.

4.1. Demographic characteristics

Understanding the perspectives and preferences regarding urban growth and infrastructure (UGI) development and management in Adama City is greatly influenced by the demographic characteristics of the respondents. Analyzing the demographic profile of the participants offers valuable insights into how various groups of individuals perceive and engage with the urban environment. Factors like age, gender, education, and occupation can shape the priorities, needs, and expectations concerning UGI development. By examining the demographic characteristics of the respondents, we can develop a comprehensive understanding of the diverse perspectives and formulate tailored strategies for UGI development and management that address the specific needs of Adama City's population.

The analysis of the sex of the respondents in relation to the sustainability of Urban Green Infrastructure (UGI) development and management reveals that there is a gender disparity in the participation and representation within this field. The data shows that males constitute a majority, accounting for 65.3% of the total respondents, while females make up 34.7%. This gender imbalance may have implications for the sustainability of UGI initiatives as it suggests potential differences in perspectives, experiences, and priorities between genders. To ensure long-term sustainability, it is crucial to address this disparity by promoting equal opportunities for both males and females to participate in UGI development and management. This can be achieved through targeted outreach, education, and initiatives that encourage and empower women to engage in decision-making processes related to UGI, fostering a more inclusive and diverse approach to sustainability.

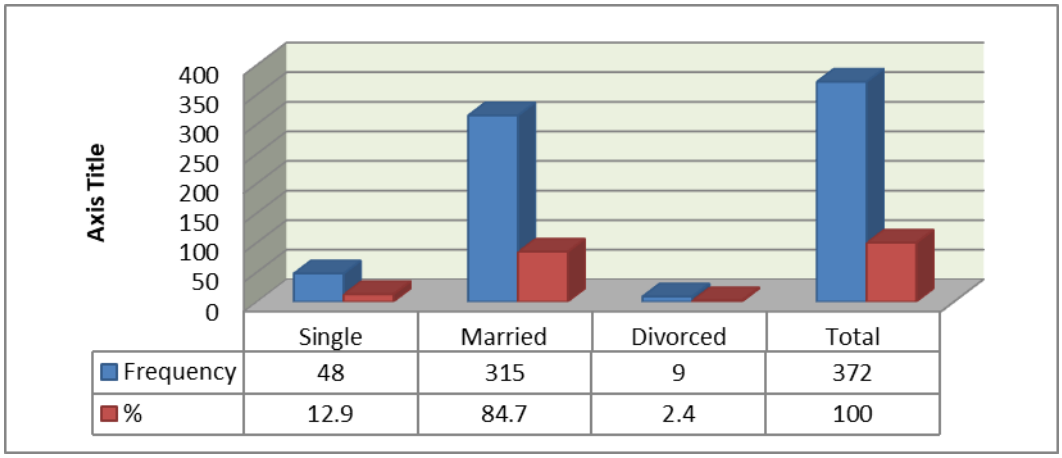


	25-34	35-44	45-54	55-64	Total
Frequency	120	120	114	18	372
%	32.3	32.3	30.6	4.8	100

Figure 4 Age of respondent

Source: Own Survey (2024)

The analysis of respondent ages reveals several important findings. The largest age group in the sample is 25-34 years old, making up 32.3% of respondents, followed closely by the 35-44 age groups, also at 32.3%. The 45-54 age group represents 30.6% of respondents, while the 55-64 age group has the lowest representation at 4.8%. These results indicate a relatively even distribution of respondents across younger and middle-aged groups, with fewer older individuals participating. Understanding the age breakdown of respondents is vital for evaluating perspectives and preferences regarding Urban Green Infrastructure (UGI) sustainability. Different age brackets may have varying levels of awareness, needs, and priorities regarding UGI, highlighting the importance of tailored approaches and strategies to ensure UGI initiatives are inclusive and effective.

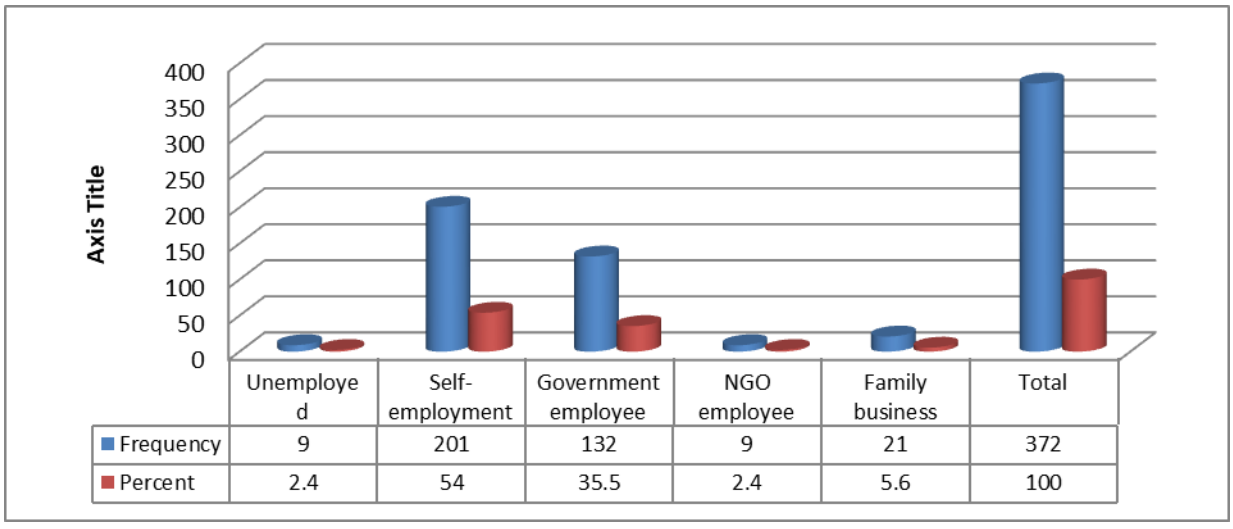


	Single	Married	Divorced	Total
Frequency	48	315	9	372
%	12.9	84.7	2.4	100

Figure 5 Marital Status of respondent

Source: Own Survey (2024)

The results of the study showed that majority of respondents are married, making up 84.7% of the total sample. In contrast, single individuals account for 12.9% of respondents, while divorced individuals represent a smaller percentage at 2.4%. This breakdown indicates that married individuals are the most prevalent group among respondents concerning the sustainability of Urban Green Infrastructure (UGI) development and management. Recognizing the marital status of respondents is important for understanding potential variations in viewpoints, responsibilities, and decision-making processes. Married individuals may have distinct considerations and priorities compared to single or divorced individuals, which should be considered when planning UGI initiatives.

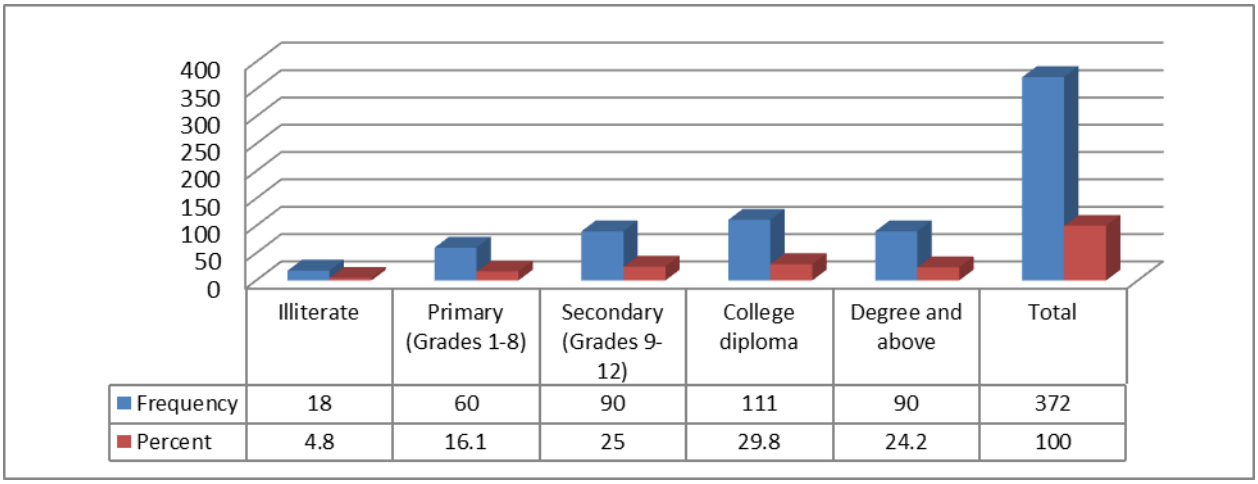


	Unemployed	Self-employment	Government employee	NGO employee	Family business	Total
Frequency	9	201	132	9	21	372
Percent	2.4	54	35.5	2.4	5.6	100

Figure 6 Means of livelihood

Source: Own Survey (2024)

The respondents' livelihoods in relation to Urban Green Infrastructure (UGI) sustainability shows that self-employed individuals make up the majority at 54%. This suggests that those with their own businesses or self-employment have a significant role in UGI initiatives due to their control over resources. Government employees, comprising 35.5% of respondents, also play a crucial role in influencing policy decisions and implementation. Family business owners (5.6%) and NGO employees (2.4%) also contribute to UGI sustainability. However, the low representation of unemployed individuals (2.4%) highlights a gap in engaging this group. Understanding the diverse perspectives and contributions of individuals from various livelihood backgrounds is essential for a comprehensive and inclusive approach to UGI sustainability.



	Illiterate	Primary (Grades 1-8)	Secondary (Grades 9-12)	College diploma	Degree and above	Total
Frequency	18	60	90	111	90	372
Percent	4.8	16.1	25	29.8	24.2	100

Figure 7Level of education of the respondent

Source: Own Survey (2024)

The data shows that individuals with a college diploma make up the largest proportion, representing 29.8% of the total sample. Respondents with a secondary education (grades 9-12) account for 25% of the sample, while those with a degree and above make up 24.2%. Individuals with a primary education (grades 1-8) constitute 16.1% of the respondents, and a small percentage (4.8%) is categorized as illiterate. This distribution highlights the importance of education in UGI sustainability efforts. Higher levels of education can contribute to a better understanding of environmental issues, sustainable practices, and the benefits of UGI. Individuals with a college diploma and above may possess the knowledge and skills necessary to actively participate in UGI development and management. However, it is important to ensure that UGI initiatives are accessible and inclusive, taking into account the perspectives and needs of individuals with lower levels of education. Providing educational opportunities and raising awareness about UGI among individuals with lower levels of education can foster a more

inclusive and sustainable approach to UGI.

4.2. Awareness of Green Infrastructure

The study aimed to assess the level of awareness within the city through the use of structured questionnaires and interviews. The findings indicate that a significant number of households, businesses, government officials, and professionals lack awareness or choose to disregard the importance of green infrastructure and its associated values.

The table presents the respondents' answers regarding their familiarity with green infrastructure. The responses indicate the following: 33.9% of the respondents answered "Yes" when asked about their awareness of green infrastructure, while 64.5% responded with "No." A small proportion of respondents, 1.6%, expressed uncertainty with the response "Not sure." The survey result suggests that a majority of the respondents lack familiarity with green infrastructure. In addition the findings from focus group discussions and key informant interviews, it was substantiated that both the community and stakeholders have a low level of awareness regarding green infrastructure. This lack of awareness could potentially indicate limited adoption of green infrastructure practices and hinders the mobilization of support and resources from stakeholders. Without a solid understanding of green infrastructure, community members and funding agencies do not prioritize or invest in sustainable infrastructure development, impacting the overall sustainability of green infrastructure projects.

Table 4 Awareness of green Infrastructure

	Frequency	Percent
Yes	126	33.9
No	240	64.5
Not sure	6	1.6
Total	372	100.0

Source: Own survey, 2024

The study made an effort to gather the perspectives of respondents through interviews and personal observations. The findings revealed a prevailing sentiment among residents of feeling neglected and disregarded, which resulted in a lack of awareness regarding the significance of establishing livable environments. Moreover, there was a noticeable sense of detachment and a lack of personal investment among the residents towards the green infrastructure present in their city. This detachment was further exacerbated by challenges such as a lack of commitment from relevant stakeholders and ineffective implementation of policies by government officials.

Consequently, the residents expressed their dissatisfaction with the inadequate benefits derived from the development and management of green infrastructure within their community. The study shed light on the disconnect between the aspirations and expectations of the residents and the current state of green infrastructure, highlighting the need for more inclusive and responsive approaches to address these concerns.

4.3. Urban Green Infrastructure Development

Urban green infrastructure has become an increasingly important element of sustainable urban planning and design in recent decades. Analyzing changes in various land use categories, including vegetation, water bodies, bare land, agriculture, and built-up areas, can provide valuable insights into the shifting landscape of urban environments. A study examining the period from 1991 to 2021 could reveal significant transformations, potentially highlighting the growth of green spaces, the expansion of built-up areas, and the evolution of other land use types within the urban context. Understanding these dynamic patterns can inform urban planners and policymakers as they work to create more livable, sustainable, and resilient cities that balance the needs of the natural and built environments.

4.3.1. Patterns and Trends Urban Green Infrastructure

4.3.1.1. Spatio- temporal Distribution of Land use/cover

The spatial and temporal distribution of land use/cover (LULC) refers to how different land use categories are spread across a specific area over time. Analyzing land use/cover maps generated from Landsat images in 1991, 2001, 2011, and 2021 provides crucial information about spatial arrangements and changes over time. These maps visually depict the distribution of land use categories in the study area during the specified period. By comparing these maps, the LULC change provided the transitions and transformations, achieving a comprehensive understanding of the dynamics and impacts of land use change.

LULC Classification Accuracy Assessment

The accuracy of each land-cover class was evaluated by comparing the results of the land-cover classification to the ground truth using a confusion matrix. The accuracy assessment table (Table 7) displays data on the precision of land cover classification across four years: 1991, 2001, 2011, and 2021. It includes information on total accuracy, producer and user accuracy, and the Kappa statistic for each class, determined using confusion matrices. Overall accuracy rates for the years

were 88%, 86%, 86%, and 88% respectively, with corresponding Kappa coefficient values of 86.5%, 88.4%, 88.5%, and 85.5%. The results indicate that agriculture classification had the highest agreement with reference data in 1991, while bare land classification remained consistently accurate. Vegetation and built-up categories also showed high accuracy levels. Water classification varied in accuracy, with the best agreement seen in 2021. Overall accuracy remained stable, with a slight improvement in 2021. The Kappa Coefficient values which range between 0 and 1 suggest moderate to substantial agreement between classified results and reference data over the years, highlighting variations in accuracy among different categories over time. Kappa coefficient value of 0.6-0.8 indicates substantial and 0.81–1.0 perfect agreement (Chen, 2019).

Table 5 Accuracy Assessment (in Percent)

	1991		2001		2011		2021	
	Accuracy %							
Land Use	**User's**	**Producer's**	**User's**	**Producer's**	**User's**	**Producer's**	**User's**	**Producer's**
Agriculture	90	90	82	87	88	79	90	77.5
Bare land	88	86	88	88	88	87.8	84	91.3
Vegetation	90	92	88	88	94	93.6	88	91.6
Built-up	89	100	86	100	91	100	100	87.7
Water	98	86	88	96	98	97.7	80	100
Overall Accuracy	**88**		**86**		**86**		**88.4**	
Kappa Coefficient	**86.5**		**88.4**		**88.5**		**85.5**	

UA: user's accuracy PA: producer's accuracy OA: overall accuracy KC: kappa coefficient
Source: authors construct 2024

4.3.1.2. Land use/land cover change during the period 1991-2021

The land use/cover maps derived from Landsat images in 1991, 2001, 2011, and 2021 demonstrate the observed changes over time. By comparing the maps from different years, it can be identified that shifts in land use practices and detect potential environmental impacts. This data allows us to monitor and analyze the dynamic nature of our land resources.

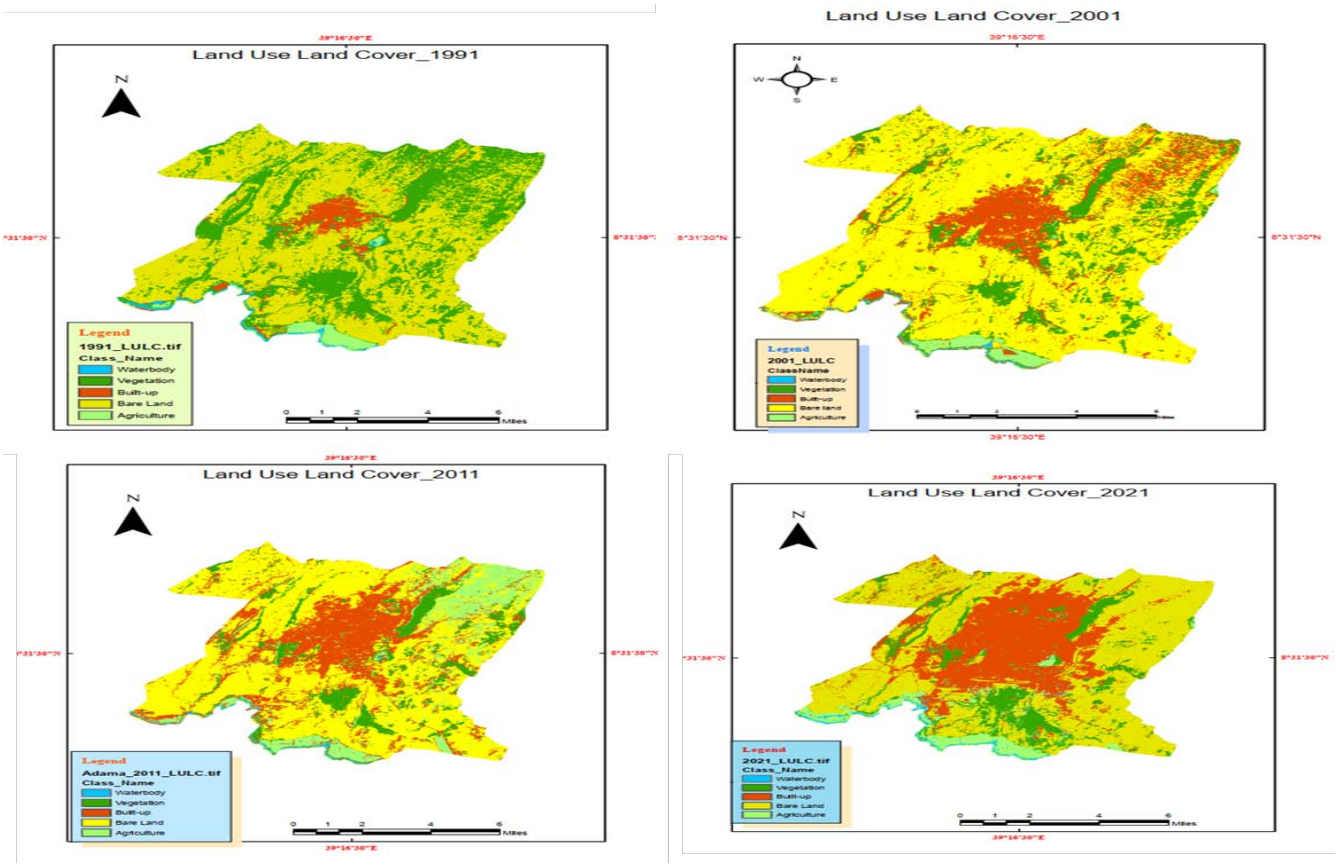
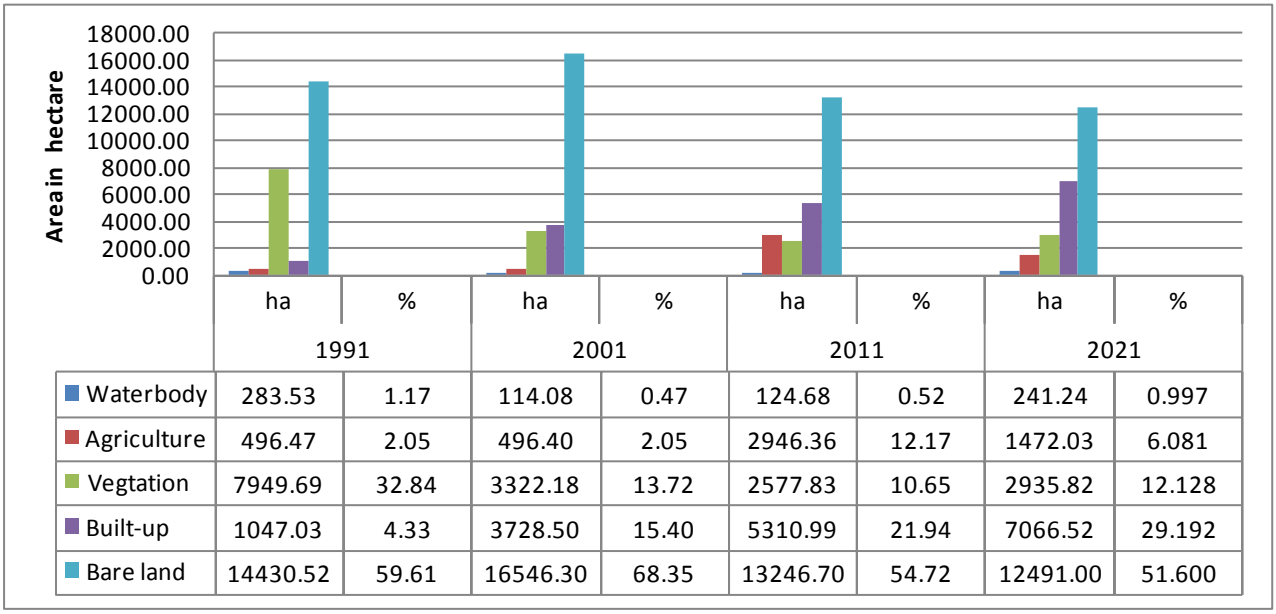


Figure 8 Map of Land use classification from 1991 to 2021

Source: Source: Author's construct, 2024

As shown in figure 9, the patterns and trends of green infrastructure in Adama have undergone significant changes over the years. In 1991, the land use/cover distribution was diverse, with bare land at 59.61%, occupying the largest share followed vegetation at 32.84%, and built-up areas at 4.33%. However, there have been noticeable shifts in land use percentages since then. Water bodies decreased from 1.17% in 1991 to 0.47% in 2001, but slightly increased to 0.52% in 2011 and further to 0.997% by 2021. Agriculture expanded significantly from 2.05% in 1991 to 12.17% in 2011 but declined to 6.081% by 2021. The vegetation area decreased to 10.65% in 2011 but experienced a slight increase to 12.128% by 2021. This increment can be attributed to the implementation of the green legacy initiative, which has been carried out over the last five years. The most significant change occurred in the expansion of built-up areas, which grew from 4.33% in 1991 to 29.2% in 2021. Bare land decreased from 59.61% in 1991 to 51.60% in 2021.



	1991		2001		2011		2021	
	ha	%	ha	%	ha	%	ha	%
Waterbody	283.53	1.17	114.08	0.47	124.68	0.52	241.24	0.997
Agriculture	496.47	2.05	496.40	2.05	2946.36	12.17	1472.03	6.081
Vegtation	7949.69	32.84	3322.18	13.72	2577.83	10.65	2935.82	12.128
Built-up	1047.03	4.33	3728.50	15.40	5310.99	21.94	7066.52	29.192
Bare land	14430.52	59.61	16546.30	68.35	13246.70	54.72	12491.00	51.600

Figure 9 The graphical representation of the LULC proportion for 1991,2001,2011,2021
Source: Author's construct (2024)

The analysis of land use/land cover change in Adama City during the period 1991-2021 offers valuable insights into the evolving landscape and spatial transformations that have occurred over the past three decades. By examining the shifts in land use and cover categories such as agriculture, bareland, built-up areas, vegetation, and water to have a comprehensive understanding of the dynamic processes and drivers that have shaped the city's environment.

Table 6 Land use/Land cover change of Adama city between 1991and 2021

LU/LC Type	Change 1991 -2001		Change 2001 -2011		Change 2001 -2021		Change 1991-2021	
	Ha	%	Ha	%	Ha	%	Ha	%
Waterbody	-169.5	-59.8	10.6	9.3	116.6	93.5	-42.3	-14.9
Agriculture	-0.1	0.0	2450.0	493.6	-1474.3	-50.0	975.6	196.5
Vegetation	-4627.5	-58.2	-744.4	-22.4	358.0	13.9	-5013.9	-63.1
Built-up	2681.5	256.1	1582.5	42.4	1755.5	33.1	6019.5	574.9
Bare land	2115.8	14.7	-3299.6	-19.9	-755.7	-5.7	-1939.5	-13.4

Source: Author's construct (2024)

Over the three-decade period from 1991 to 2021, Adama City witnessed varying changes in its land use/cover patterns. Water bodies experienced an overall decrease of 14.92%, from 2011 to 2021. Agriculture showed a net increase of 196.5%, notably expanding by 493.5% from 2001 to 2011 but declining by 50.04% in the following decade. Vegetation decreased by 63.07% overall, with significant drops in the early years but a slight increase in the most recent period. Built-up areas expanded dramatically by 574.9%, with consistent growth over the years. Bare land

fluctuated, ultimately decreasing by 13.4% from 1991 to 2021, with notable increases and decreases in different periods.

The following data illustrates the overall changes in land use cover from 1991 to 2021, encompassing both gains and losses. It provides a comprehensive overview of the net transformation that has occurred during this period.

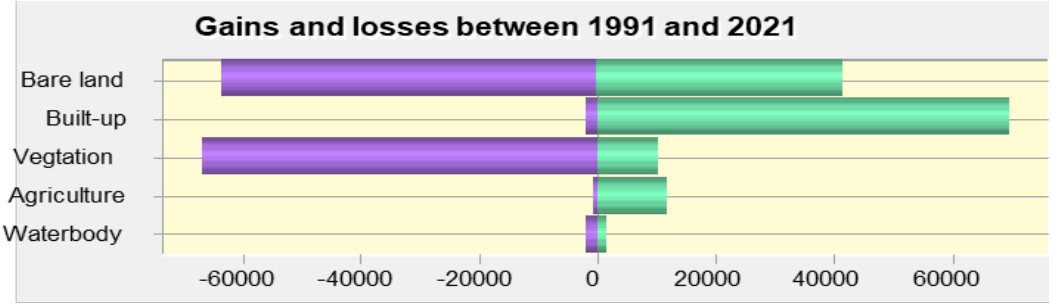


Figure 10 Gains and Loss between 1991 and 2021

Source: Author's constructed (2024)

The conversion of vegetation to other land features can be analyzed in table 8 based on the data provided. From 1991 to 2001, there was a significant conversion of 308.5 hectares of vegetation to agriculture, 39.84 hectares to bareland, 27.73 hectares to built-up areas, while 42.19 hectares remained unchanged, and 6.86 hectares were converted to water. Similarly, from 2001 to 2011, there was a relatively smaller conversion of vegetation, with 11.27 hectares to agriculture, 8 hectares to bareland, 13 hectares to built-up areas, 12.93 units remaining unchanged and 21.5 units converted to hectares. Finally, from 2011 to 2021, there was a significant conversion of 233.68 hectares of vegetation to agriculture, 816.58 hectares to bareland, 434.68 hectares to built-up areas, 1446 hectares remaining unchanged and 1.95 hectares converted to water (certain areas, natural vegetation cover was lost and replaced by the creation or expansion of water features, such as lakes, rivers, or wetlands).

Table 7 Conversion of vegetation to other land features in hectares

	Agriculture	Bareland	Built-up	remain un changed	Water
1991-2001	308.5	39.84	27.73	42.19	6.86
2001-2011	11.27.8	13.6	1400	12.93	21.5
2011 – 2021	233.68	816.58	434.68	1446	1.95

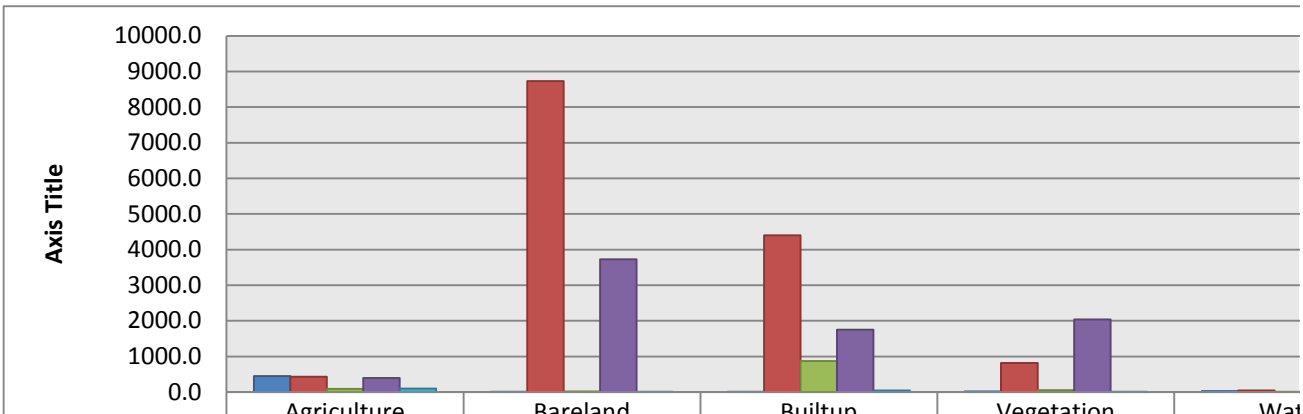
Source: Own survey (2024)

The data on the conversion of vegetation to other land features provides insights into the implications for Urban Green Infrastructure (UGI) development and management sustainability.

From 1991 to 2001, there was a significant conversion of vegetation to agriculture, bareland, and built-up areas, indicating the expansion of human activities and potential loss of green spaces. This highlights the need for UGI development strategies that prioritize preserving and integrating vegetation within urban areas. From 2001 to 2011, the conversion of vegetation decreased, suggesting possible efforts to control land conversion and promote sustainable land management practices. However, the significant conversion of vegetation to built-up areas during this period indicates the continued urbanization trend, necessitating effective UGI planning to maintain ecosystem services. From 2011 to 2021, there was a substantial conversion of vegetation to agriculture and bareland, underscoring the importance of sustainable land use practices and UGI development to mitigate the impacts on natural resources and maintain ecological balance.

4.3.1.3. Change detection matrix of LULC types between 1991 and 2021

The change detection matrix reveals significant LULC (Land Use/Land Cover) transitions in the study area between the analysis periods (Figure 11). The most notable change is the substantial expansion of Bareland, gaining 433.0 ha from Agriculture, 4,396.6 ha from Builtup, and 819.8 ha from Vegetation areas. This suggests a significant increase in bare or unproductive land, potentially due to factors like urbanization, infrastructure development, or changes in agricultural practices. The Vegetation category also saw substantial gains of 3,723.4 ha from Bareland and 398.9 ha from Agriculture, indicating a reversal of the Bareland expansion in some areas, possibly through afforestation or natural vegetation regrowth. The Builtup category expanded by 90.5 ha from Agriculture and 50.8 ha from Vegetation, reflecting ongoing urban development. The Water body area increased moderately, gaining 25.5 ha from Agriculture and 12.4 ha from Builtup, likely due to the creation of new water bodies or expansion of existing ones. Overall, the matrix highlights a complex interplay of LULC changes, with Bareland and Builtup categories gaining at the expense of Agriculture and Vegetation, while some areas also experienced a reversal of these trends. This information can be valuable for land use planning, environmental management, and monitoring the impacts of development on the local landscape.



	Agriculture	Bareland	Builtup	Vegetation	Wat
Agriculture -	445.1	4.4	3.7	16.2	25.
Bareland	433.0	8729.6	4396.6	819.8	41.
Builtup	90.5	18.2	874.7	50.8	12.
Vegetation	398.9	3723.4	1748.9	2034.9	36.

Figure 11 Change detection matrix of LULC types between 1991 and 2021
Source: Own survey (2024)

4.3.2. Urban Green Infrastructure Planning and Design

The assessment of the City's structural plan has determined that its main goal was to implement an urban development strategy that designates specific proportions of land for different purposes. These purposes include allocating 30% of the land for infrastructure, 30% for green infrastructure, and 40% for built-up areas. As part of this plan, various elements of urban green infrastructure (GI) were suggested, such as parks, gardens, sports fields, playgrounds, and green areas along rivers and buffers. After examining the structural plans, it was found that approximately 39% of the total land area of the city was set aside for these urban GI components, which consist of parks, sports fields, and playgrounds.

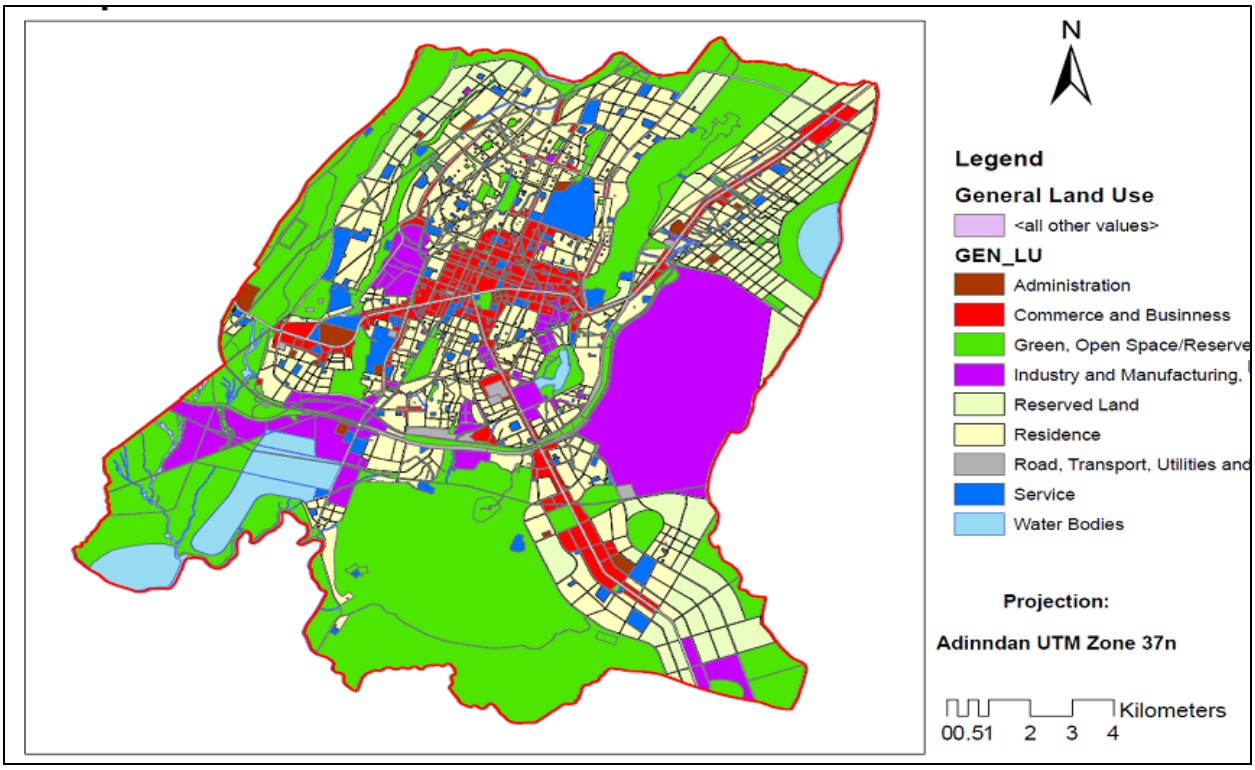


Figure 12 Proposed Land Use of Adama City
Source: Oromia Urban Planning Institute (2024)

The Structure Plan outlines the allocation of land and the corresponding percentages assigned to different categories within the city (Figure 12). The analysis aims to examine the proposed general land use of the Structure Plan for Adama City. This analysis will focus on evaluating the area and percentage coverage of each category, as presented in the following table. By understanding the distribution of land use in Adama City, we can gain insights into the urban development strategy and the emphasis placed on various types of infrastructure and green spaces. This analysis provide a comprehensive overview of the planned land use and highlight the significance of urban green infrastructure in the city's structural planning.

Table 8 Proposed General Land Use

S/N	General Land Use	Area (Ha.)	Percentage (%)
1	Housing	3933.67	20.4
2	Commerce	1197.97	6.2
3	Service	867.16	4.5
4	Administration	182.57	1.2
5	Manufacturing	2887.45	15
6	UGI Components	8088.97	39.1
7	Road and Transport	2099.42	13.6
	Total Land Use	19257.21	100

Source: In 2019 Adama City proposed land Use plan (2024)

The data presented highlights the significant commitment to integrating green spaces and infrastructure within the city through the ratio of 40:30:30 urban development strategies. According to the 2019 Adama City proposed land Use plan 39.1% of the total land area allocated for urban green infrastructure (UGI) components there is a clear emphasis on promoting environmental sustainability, offering recreational opportunities, and improving the overall quality of life for residents. The design designating a substantial portion of land for UGI components, such as parks, gardens, and other green areas, the city demonstrates recognition of the numerous benefits these spaces provide.

4.3.2.1. Comparative Analysis of existing UGI Components With sampled study area

The objective of this analysis is to assess the proposed and existing Urban Green Infrastructure (UGI) components in selected sample *Woredas*. The main focus is on evaluating the area and percentage coverage of these UGI elements, as presented in table 10. The aim is to offer a thorough overview of the UGI components within the selected sample *woreda*, emphasizing their contribution to sustainable and livable urban environments.

Table 9 Existing UGI of Targeted Woredas

No.	*Woreda* Name	Area (Ha.)	Existing UGI Area in Hec.	Coverage %)
1	Gooroo	471.3	48.11	10.21
2	Oda	54.92	1.02	1.86
3	Chaffe	227.32	3.8	1.67
4	Migira	106.31	5.5	5.17
5	Hangatu	116.39	3.56	3.06
6	Malka Adama	501.4	20.54	4.10
	Total Area of Sample *woreda*	**1477.64**	**82.53**	**5.59**
	Total area of UGI Adama City	**19257.21**	**8088.97**	**39.1**

Source: Adama City Existing land use plan (2024)

Among the woredas surveyed in Adama City, the green area coverage varies significantly. Goro has the highest coverage at 10.21%, with the total of the 471.3 hectares stipulated for urban green infrastructure (UGI) already implemented. In contrast, Oda and Chaffe have much lower UGI coverage, at only 1.86% and 1.67% of their total areas, respectively. Migira (5.17%) and Hangatu (3.06%) have relatively better UGI coverage compared to their total areas. As for the largest woreda, Malka Adama, it has a 4.10% UGI coverage, with 20.54 hectares under UGI out of the total 501.4 hectares meant for this purpose. Overall, the combined UGI coverage across

the sample woredas is 5.59%, or 82.53 hectares out of the 1477.64 hectares allocated for UGI. However, this is significantly lower than the 39.1% green area coverage planned for Adama City as a whole, which covers 8088.97 hectares out of the total 19257.21 hectares. This disparity between the current UGI allocation in the selected districts and the city's overall green area target of 39.1% highlights the need for substantial efforts to enhance green infrastructure development in these areas. The current green infrastructure coverage, at just 5.59%, is considerably smaller than the desired 30% target, emphasizing the importance of allocating more resources and intensifying efforts to close this gap.

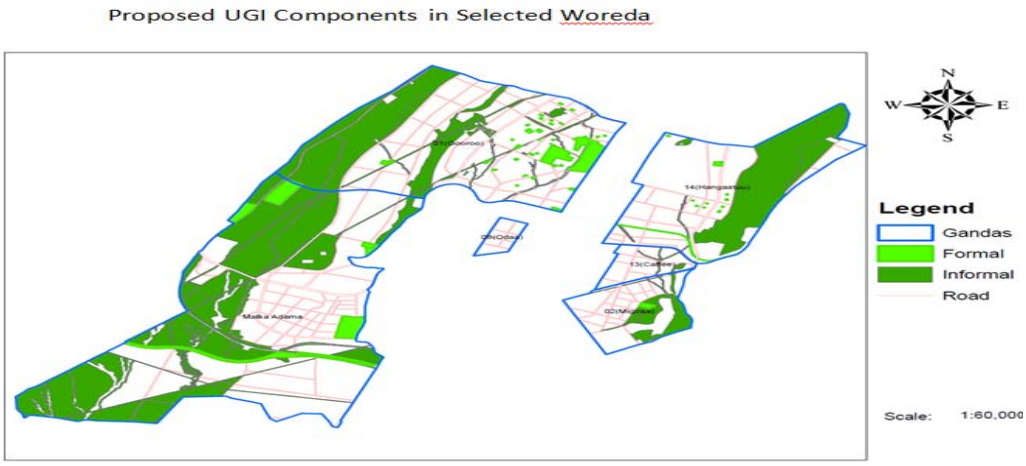


Figure 13 Proposed UGI Components in Selected Sample Woreda
Source: Oromia Urban Institute, 2024

The analysis reveals that the current allocation of green infrastructure in the specified *Woredas* is significantly below the target (30%) set by the urban development strategy of the country. This has important implications for the sustainability of UGI development and management. Insufficient green infrastructure coverage can lead to various sustainability challenges.

To assess the presence or availability of different aspects of urban green infrastructure (GI), participants were asked to share details about the existence of various components like parks, playgrounds, sports fields, urban forests, and green corridors in their local area. As shown in Figure 10, the survey respondents reported that there localities don’t have sufficient green areas. They classified their respective residence areas as "No Green Area," the lack of playgrounds, sports fields, parks, rivers or streams, street trees, and urban forests. Specifically, a vast majority of respondents reported that their areas do not have playgrounds (87.1%), sports fields (95.2%), or urban forests (78.2%). Conversely, in areas categorized having better "Green Area," the area has different (sloppy) landscape. The respondents who reported have playgrounds, sports fields

and parks account about 12.9%, 4.8% and 41.9% respectively. Presence of street trees is most prevalent GI reported by 83.1% respondents where approximately one-fifth (21.8%) of these areas are in boast urban forests. In addition, the vast majority of respondents interviewed expressed concerns about the limited accessibility and inadequate quantity and quality of green areas in the city. They emphasized that the availability of green spaces falls much below the needs of the population, and they recommended urgent policy action to address and resolve this issue.

respective measurements per individual within the chosen *woreda*. Therefore this study helps in understanding the availability and distribution of GI resources in the area.

The table 12 provides information on the green infrastructure (GI) components per person in different *woredas* of Adama City, including population size, existing GI component area, and average GI components per capita. For instance, in Gooroo *woreda*, the average GI component area per person is approximately 16.06 square meters, while on average 1.22, 1.64, 4.04 and 3.37 square meters per person for Oda, Chaffe, Migira, and Hangatu woredas respectively. Malka Adama woreda has approximately 12.48 square meters GI per person. Overall, the surveyed *woredas* of Adama City have an average of approximately 8.09 square meters of GI components per person (Table 11). Gooroo and Malaka in Adaama ***woredas*** are located on the outskirts of the city and include forest land and mountains within their boundaries. Consequently, the per capita Green Infrastructure (GI) of the woredas is higher compared to others. However, the four woredas located in the city center (Oda, Caffee, Migira, and Hangaatu), the average GI per capita is 2.49%, revealing a disparity between the GI per capita in the city center and the outskirts. Consequently, it is evident from the analysis that the existing GI components in the mentioned Woredas are inadequate to meet the recommended international and national standards for green infrastructure per capita.

Table 10 Existing GI components Per capita

No.	Woreda Name	Population Size	Existing GI components (in m^2)	GI components per capita (m^2)
1	Gooroo	29955	481100	16.06
2	Oda	8334	10200	1.22
3	Chaffe	23131	38000	1.64
4	Migira	13616	55000	4.04
5	Hangatu	10559	35600	3.37
6	Malka Adama	16464	205400	12.48
	Total Area		**825300**	**8.09**

Source: Own survey (2024)

4.3.2.2. Connectivity Practice of Urban Green Infrastructure

According to information obtained from the key informants the lack of consideration for connectivity among various urban green infrastructure components in planning documents, policies, and strategies pertaining to current green space planning has a notable impact on the sustainability of Green Infrastructure Development and Management. The lack of consideration

for connectivity among urban green infrastructure components can have detrimental effects on the overall sustainability of the development and management of green infrastructure. Without a focus on physical and functional linking of these components, the potential benefits and effectiveness of the green infrastructure system may be compromised. The absence of a broader network and a fragmented system of urban green infrastructure components in the study city implies a missed opportunity to create a more interconnected and resilient green infrastructure network. This can hinder its ability to provide crucial ecosystem services, address environmental challenges, and contribute to the overall sustainability goals of the area.

Furthermore, the evaluation of the structure plans for the city reveals that urban green infrastructure components were proposed in a fragmented manner, with no attempt made to create a comprehensive network of interconnected urban green infrastructure components.

However, the city's latest proposed structure plan introduces a new category for land use, along with its subcategories and detailed information. The purpose of this new land use category is to utilize 30% of the total land designated for the planning period, as required by Ethiopia's urban land development policy. While connectivity appears to be improved in the outer areas of the city, there is still a lack of comprehensive planning to ensure connectivity throughout the entire city. The proposal for this land use has been categorized accordingly and can be observed in the accompanying maps.

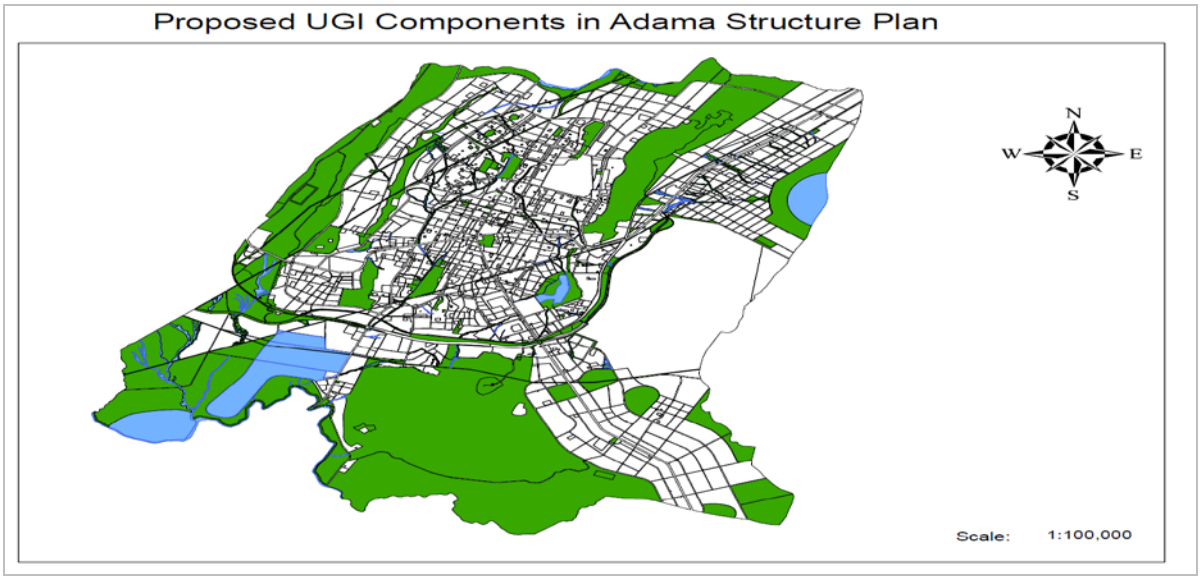
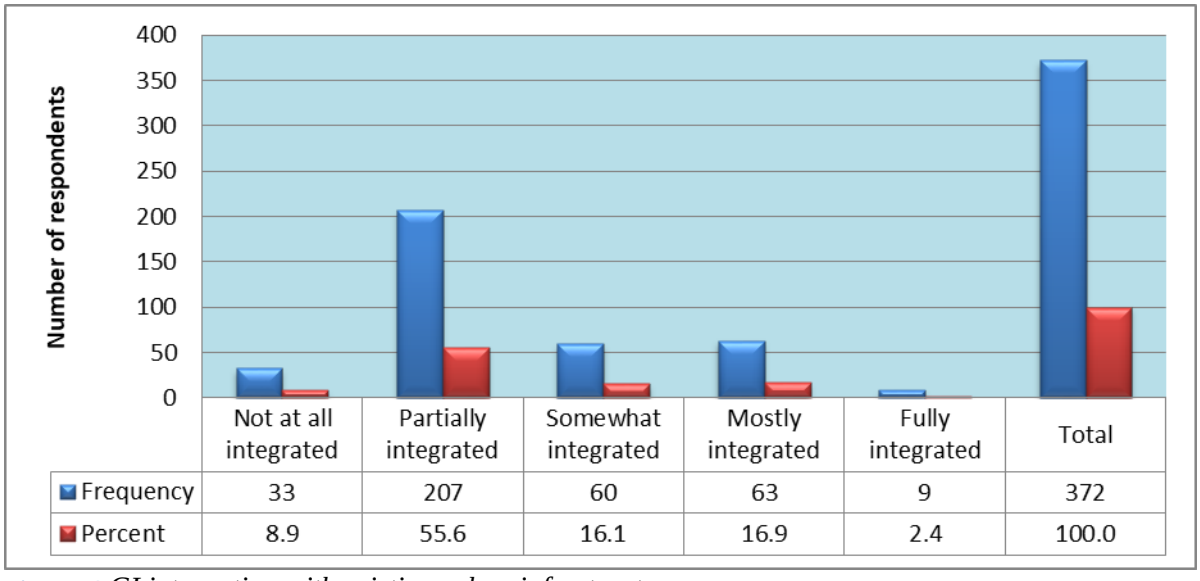


Figure 15 *Planned urban GI components in the structural plan*
Source: Authors Construct (2024)

4.3.2.3. *Green Infrastructure Integration with Existing Urban Infrastructure*

The green infrastructure elements integrated with existing urban infrastructure is a key factor in determining the sustainability of Green Infrastructure Development and Management. The provided figure 16 displays the responses of the survey participants. The survey data reveals that most respondents (55.6%) reported partial integration of green infrastructure elements with existing urban infrastructure. A notable portion of respondents (16.1%) described the integration as somewhat integrated, while a similar percentage (16.9%) characterized it as mostly integrated. A smaller fraction (2.4%) indicated that the integration was fully integrated. However, a minority of respondents (8.9%) expressed that there was no integration at all between green infrastructure elements and existing urban infrastructure.

According to the survey data, a majority of respondents (55.6%) reported that green infrastructure elements were partially integrated. This suggests that there is some level of integration between these elements and the existing urban infrastructure. However, it is important to note that this integration may not be comprehensive, indicating that there is still room for improvement. While partial integration can contribute to achieving certain sustainability goals, such as enhancing urban green spaces, further efforts are needed to enhance integration for more significant sustainability benefits.



	Not at all integrated	Partially integrated	Somewhat integrated	Mostly integrated	Fully integrated	Total
Frequency	33	207	60	63	9	372
Percent	8.9	55.6	16.1	16.9	2.4	100.0

Figure 16 *GI integration with existing urban infrastructure*
Source: Own survey (2024)

Furthermore, the problem of connectivity is evident in figure 16 of the map. As discussed by key informants, the current integration falls short of being sufficient. When evaluating the connection

between green infrastructure (GI) and the existing urban infrastructure, it is essential to conduct a comprehensive assessment of the accessibility and connectivity of GI components within the urban environment. However, our fieldwork has uncovered that the current evaluation, which considers factors like pedestrian and cycling pathways, green corridors, and linkages between parks and other urban amenities, is inadequate. Additionally, gathering feedback from stakeholders such as urban planners and community members through surveys or interviews further confirms the poor state of integration.

4.3.2.4. Sustainability Factors In Urban Green Infrastructure Planning and design

As urban centers continue to grapple with the challenges of rapid urbanization and its associated environmental impacts, the concept of Green Infrastructure (GI) has gained traction as a sustainable solution. Adama City, a bustling urban center experiencing significant growth and development, faces its unique set of environmental challenges. Understanding the social and economic factors that contribute to the sustainability of GI development and management in Adama City is crucial for ensuring its long-term effectiveness and resilience. This analysis delves into the social dynamics and economic considerations of GI in Adama City, exploring how these factors interact and influence the success and sustainability of GI initiatives, ultimately shaping the city's environmental future and the well-being of its residents.

4.3.2.4.1. Social Factors

Adama's urban planners prioritize the need for accessible and inclusive green infrastructure to ensure social sustainability. They aim to locate green spaces like parks, urban forests, and community gardens in diverse neighborhoods, considering factors like walkability, public transportation links, and affordability. The design should foster social cohesion, encourage physical activity, and reflect the city's cultural heritage. By prioritizing the social dimensions of sustainability, urban planners and designers can create green infrastructure that truly enhances the quality of life and well-being for all who visit and experience these important public spaces.

The data presented in the table 12 is derived from a survey that captures information about the visits made by household members to Green Infrastructure Components. The data collected from respondents regarding the frequency of household members visiting greenery areas is presented in the table. The responses were categorized into different frequency options. Among the total of 372 respondents, 0.8% reported visiting greenery areas on a daily basis. 4.0% mentioned visiting

several times a week, while 26.6% reported visiting once a week. Additionally, 6.5% of respondents stated that they visit greenery areas several times a month. The majority (57.3%) of respondents reported visiting greenery areas rarely. A small proportion of respondents, 4.8%, indicated that they never visit greenery areas. The data on the frequency of household members visiting greenery areas in Adama City reveals some insights regarding the social sustainability of green infrastructure development and management. The fact that a significant portion (57.3%) of respondents reported visiting greenery areas rarely suggests a potential lack of engagement or interest in utilizing these spaces. In order to identify the factors that hinder frequent visits, evaluations were conducted to assess the accessibility, quality, and appeal of greenery areas. The aim was to pinpoint any obstacles that may discourage people from visiting these areas regularly.

Table 11 Frequency of Social Factors

	Frequency	Percent
Household members visit greenery area		
Daily	3	0.8
Several times a week	15	4
Once a week	99	26.6
Several times a month	24	6.5
Rarely	213	57.3
Never	18	4.8
Total	372	100
Average time taken to access to green areas		
Less than 5 minutes	27	7.3
6-10 minutes	57	15.3
11-20 minutes	84	22.6
21-30 minutes	111	29.8
More than 30 minutes	93	25
Total	372	100

Source: Own survey (2024)

In order to gain insights into the accessibility of green areas in Adama and whether they align with the community's preferences, a study was conducted to determine the average time required to reach these areas. The above table 18 shows the data gathered from respondents in Adama City concerning the average duration to reach green areas. The responses were grouped into different time intervals. Among the total of 372 respondents, 7.3% reported taking less than 5 minutes to reach green areas. 15.3% mentioned taking 6-10 minutes, while 22.6% reported taking 11-20 minutes. Additionally, 29.8% of respondents stated that it takes them 21-30 minutes to access green areas. A significant proportion of respondents, 25.0%, reported taking more than 30 minutes to reach these areas.

The data on the average time taken to access green areas in study area has implications for the social sustainability of green infrastructure development and management. The findings indicate that a substantial number of respondents (29.8%) reported taking 21-30 minutes to reach green areas. However, it is important to note that a significant proportion of respondents (25.0%) reported taking more than 30 minutes to access green areas. This highlights potential challenges in terms of accessibility, which can impact the social sustainability of green infrastructure. Longer travel times can act as barriers, limiting the frequency of visits and engagement with green spaces, particularly for individuals with limited time or mobility constraints.

In this study, we investigate the most important factors that impact people's choices to visit green spaces using the data we have gathered. It is important to comprehend these factors in order to properly design and oversee green areas to draw in visitors and encourage their use. The data offers significant information on the frequencies and proportions of different factors that affect people's decisions to visit green spaces, as shown in the table 19.

Proximity to residence: Based on the data provided, it appears that 88.7% of the respondents considered proximity to their residence as an important factor in the development and management of UGI (presumably UGI Components). This implies that a large majority of people prioritize the convenience and ease of access to UGI Components by having it situated near their homes. The relatively low frequency of 14 (11.3%) indicates that a smaller percentage of respondents did not prioritize proximity to their residence when considering UGI development and management. This data suggests that UGI Components should take into account the proximity factor when planning their location or expanding their operations. They may want to consider establishing their facilities in areas that are easily accessible to a larger portion of their target audience or customer base.

Table 12 Factors influencing the decision to visit green areas

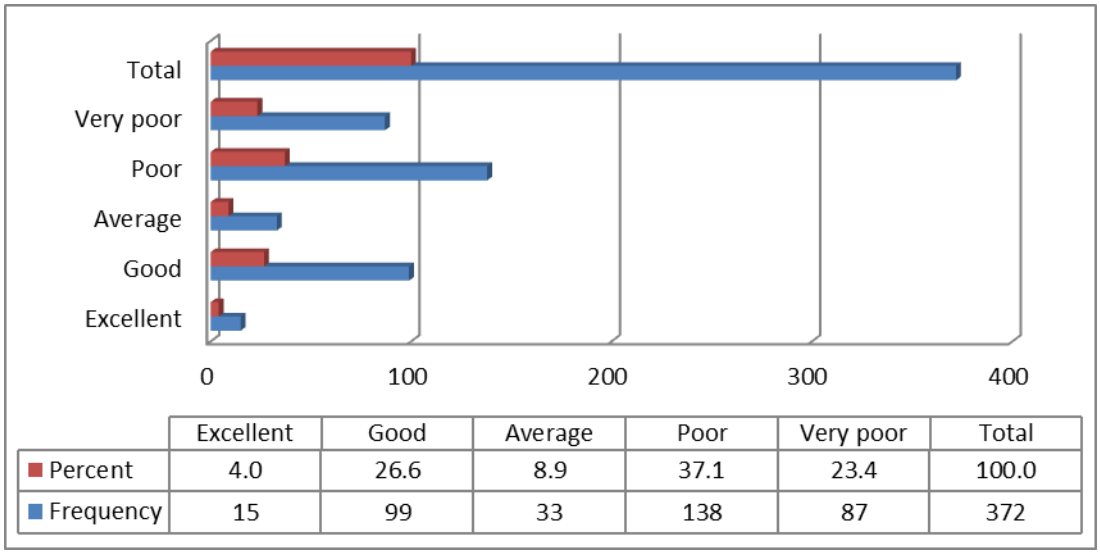
	Yes		No	
	Frequency	%	Frequency	%
Proximity to residence	330	88.7	42	11.3
Safety and security	312	83.9	60	16.1
Availability of amenities	282	75.8	90	24.2
Cleanliness	324	87.1	48	12.9
Variety of vegetation and plant species	276	74.2	96	25.8
Recreational activities offered	303	81.4	69	18.5

Source: Own survey (2024)

Safety, Cleanliness and Availability of amenities: The data reveals that safety and security, availability of amenities, and cleanliness are significant factors in UGI development and management. A large majority of respondents, 83.9%, prioritize a safe and secure environment, indicating the need for UGI Components to implement measures to ensure the safety and security of their facilities, employees, and visitors. Additionally, 75.8% of respondents value the availability of amenities such as infrastructure, utilities, and services, emphasizing the importance of providing convenient and functional amenities in the vicinity of UGI Components. Furthermore, 87.1% of respondents prioritize cleanliness, underscoring the need for UGI Components to maintain high cleanliness standards to enhance the overall experience and perception of visitors and stakeholders.

To evaluate this assessment was conducted to determine if the current state of green infrastructure components in Adama matches the community's preferences in terms of safety, availability of amenities, and cleanliness when visiting UGI Components. The assessment focused on evaluating the quality and functionality of the UGI components to determine their compatibility with these preferences were indicated in figure 13.

Analyzing the data collected from respondents regarding the quality and functionality of green infrastructure in Adama City, the following distribution was observed: Among the responses, only 4.0% rated the quality as excellent, while a larger proportion, 26.6%, considered it good. Similarly, 8.9% rated it as average, indicating a moderate level of quality. However, the majority of the respondents, 37.1%, rated the quality as poor, and 23.4% found it to be very poor. These indicators suggest that a significant portion of the green infrastructure is perceived to be of substandard quality and functionality. Therefore, there is a clear need for measures to enhance the quality and functionality of green infrastructure to meet the expectations and requirements of the users.



	Excellent	Good	Average	Poor	Very poor	Total
Percent	4.0	26.6	8.9	37.1	23.4	100.0
Frequency	15	99	33	138	87	372

Figure 17 *Quality and functionality of green infrastructure*
Source: Own survey (2024)

Variety of vegetation and plant species and Recreational activities offered: the data provided gives insights into the preferences regarding Urban Green Infrastructure development and management. For the factor of "Variety of vegetation and plant species," 74.2% of respondents considered it important, while 25.8% did not. This indicates that a significant majority value UGI that offers a diverse range of vegetation and plant species. UGI developers and managers should prioritize incorporating a variety of plants to meet this preference and enhance the overall appeal of the infrastructure. Regarding "Recreational activities offered," 81.4% of respondents considered it important, while 18.5 % did not. This suggests that a majority of individuals value UGI that provides recreational activities. UGI developers and managers should consider incorporating amenities and features that allow for recreational activities to cater to this preference and create a vibrant and engaging environment within the infrastructure. Overall, the data highlights the importance of incorporating a variety of vegetation and offering recreational activities in UGI development and management. Adhering to these preferences can contribute to the overall satisfaction and enjoyment of the community utilizing the UGI components.

The information gathered from the key informant interview aligns with the previously discussed data. there are disparities between the community's needs and the current conditions in Adama City's Gi Copmonents, as highlighted by key informants. Challenges such as inadequate pathways and transportation options hinder accessibility, limiting the community's ability to fully utilize the green spaces. Issues related to maintenance, cleanliness, and amenities further diminish the appeal and usability of these areas. To address these challenges, improvements in

accessibility, maintenance practices, cleanliness, amenities, and safety measures are necessary to create an inviting and enjoyable environment that aligns with the community's needs.

4.3.2.4.2. Economic Factors

The economic sustainability of urban green infrastructure is a critical consideration, as these spaces can have significant impacts on local and regional economies. Well-designed and maintained green spaces can increase property values, attract new businesses and residents, and generate revenue through tourism and recreational activities. Careful planning is needed to ensure the long-term financial viability of green infrastructure projects, including the development of sustainable funding models and maintenance strategies. Investing in green jobs and industries related to the design, installation, and upkeep of these assets can also contribute to economic development and create new opportunities for local communities.

Factors to consider encompass job creation and enhanced asset values as well as potential economic multipliers within the community. The data collected from respondents in study area regarding getting economic benefits from green infrastructure projects is presented in the table. Among the total respondents, 76.6% (95 individuals) answered affirmatively, indicating that they do receive economic benefits from such projects. On the other hand, 23.4% (29 individuals) responded negatively, stating that they do not obtain economic benefits

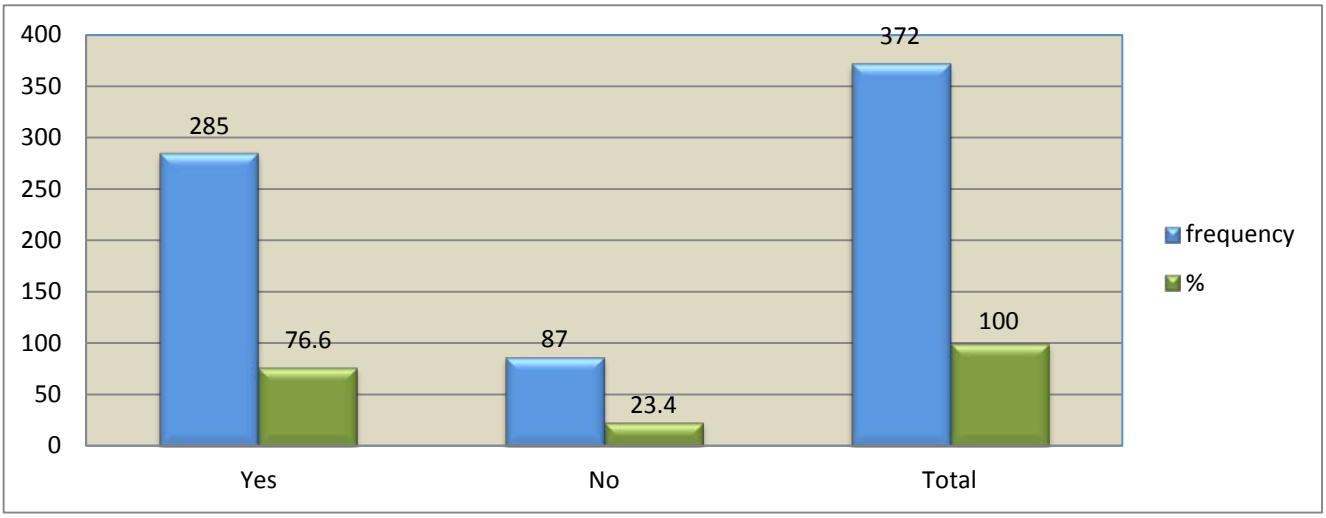


Figure 18 Getting economic benefits from green infrastructures projects

Source: Own survey (2024)

The figure 19 suggests that a significant majority of respondents, around 76.6%, perceive themselves as receiving economic benefits from green infrastructure projects in Adama City.

This finding highlights the potential for economic sustainability in the development and management of green infrastructure. The positive response rate indicates that these projects have the capacity to generate economic value and contribute to the local economy.

According to surveys conducted among property owners and developers in the recently developed Urban Green Infrastructure (UGI) area of Bole and around Obo Park, there have been unexpected changes in house values and rental rates that can be attributed to the presence of green infrastructure projects. These findings suggest that the implementation of UGI components has had a positive impact on the local economy by generating economic activity. The observed changes in house values and rental rates indicate an increase in demand for properties and make the area more attractive, likely due to the presence of green infrastructure. This implies that the UGI projects have enhanced the desirability of the area and potentially opened up opportunities for property investment.

Figure 19 Green Infrastructure projects Developed in the area

Source: Photo taken by researcher (2024)

Additionally, discussions with key informants during interviews have confirmed the transformative effect of UGI development on the lives of the local population. The economic activity generated by the UGI components has led to positive changes in the community, such as job creation, business opportunities, and other economic benefits that have improved the livelihoods of the local residents.

4.3.2.4.3. Environmental Factors

Urban green infrastructure, such as parks, gardens, and tree-lined streets, plays a crucial role in fostering sustainable communities. A key environmental factor to consider in urban green infrastructure planning and design is the impact on local climate and microclimate. Strategic tree

planting can help mitigate the urban heat island effect by providing cooling shade and evapotranspiration, reducing energy demands for cooling buildings. Additionally, conserving and expanding urban tree canopy aids in carbon sequestration, improving air quality, and managing storm-water runoff. An initiative plan focused on increasing tree coverage through targeted planting and safeguarding existing trees aligns with the broader sustainability objectives of creating resilient, livable cities that enhance environmental health. Carefully selecting tree species adapted to the local climate and designing green spaces that maximize ecosystem services are important considerations in this endeavor.

The data collected from respondents regarding the tree planting initiative plan and the strategy for conserving infrastructure components are presented in the table 20. The above table shows that a high percentage of respondents, 94.4%, indicated the availability of a green initiative plan for planting trees which promote tree planting within the city, which can have positive effects on the environment. The availability of a green initiative plan for planting trees, as indicated by 94.4% of respondents, has a positive effect on the environmental sustainability of urban green infrastructure (UGI) development and management in Adama City.

According to data from the Greenery Department of Adama municipality, a remarkable green initiative was undertaken in the city, resulting in the planting of over 16 million trees over the course of 5 consecutive years, from 2011 to 2015 on the Ethiopian calendar. This large-scale, sustained reforestation program demonstrates a strong commitment by local authorities to significantly expand Adama's urban tree cover and green infrastructure. Conserving strategies for Green Infrastructure Components in Adama city have the primary objective of preserving and enhancing their environmental sustainability and functionality. However, the absence of a specific conserving strategy for these components, as reported (table 20) by a majority of respondents (74.2%), no strategy to conserve green infrastructure components that have negative implications for environmental sustainability.

Table 13 Initiative plan for tree planting and conserving strategy

	Yes		No	
	Frequency	%	Frequency	%
Availability of green initiative plan of planting trees	351	94.4	18	4.8
Availability of strategy to conserve green infrastructure components	90	24.2	276	74.2

Source: Own survey (2024)

Furthermore, the key informants have highlighted that Bokku and Dibibisa ridges were initially identified for protection and utilization to promote environmental and socio-economic benefits for the city. However, the current situation reveals that these ridges are facing significant challenges due to the encroachment of squatter settlers and the extraction activities carried out by quarry miners. The Dibibisa ridge is being exploited by quarry miners, while the Bokku ridge is partially occupied by squatter settlers. This indicates that a significant portion of the proposed formal and informal green areas has not been implemented as intended and is being misused to some extent.

4.3.2.5. Multi-functionality of Urban Green Infrastructure

The multi-functionality of urban green infrastructure in Adama City is evident through the significant social, environmental, and economic advantages it offers to the local community. These green areas serve diverse purposes and bring multiple benefits to residents. The survey conducted in Adama City revealed several key benefits derived from these green spaces, such as enhancing mental and psychological well-being, providing venues for festivals, improving aesthetics, offering recreational activities, addressing climate change impacts, mitigating environmental degradation, and creating employment opportunities.

The respondents' perceptions and ratings of each benefit, providing valuable insights into the multi-functionality of urban green infrastructure in Adama City Presents table 15. The data indicates that the majority of respondents recognize the benefits of green infrastructure in Adama City. The highest percentage of "Yes" responses is for reducing urban heat (96.8%), followed by improved visual attractiveness (91.1%), improved physical landscape (82.3%), increased asset value (71.8%), minimizing the risk of flooding (64.5%), and improved ecosystem services (63.7%). These findings suggest that green infrastructure has the potential to contribute significantly to the sustainability of the city.

Table 14 Multi-functionality of Urban Green Infrastructure

	No		Yes	
	Frequency	%	Frequency	%
Reduce urban heat	12	3.2	360	96.8
Improved visual attractiveness	33	8.9	339	91.1
Increased asset value	105	28.2	267	71.8
Minimizing the risk of flooding	132	35.5	240	64.5
Improved physical landscape	66	17.7	306	82.3
Improved ecosystem services	135	36.3	237	63.7

Source: own design (2024)

Moreover we can analyze the multi-functionality of green infrastructure based on the frequencies and percentages of different functions attributed to it. The data provided indicates the responses of participants regarding various functions of green infrastructure. For instance, the data shows that reducing urban heat is perceived as a function of green infrastructure by 96.8% of respondents, while improving visual attractiveness is mentioned by 91.1% of participants. Additionally, increased asset value is recognized by 71.8% of respondents, minimizing the risk of flooding by 64.5%, improving the physical landscape by 82.3%, and enhancing ecosystem services by 63.7%. By examining these frequencies and percentages, we can gain insights into the perceived multi-functionality of green infrastructure and understand its effectiveness in delivering multiple benefits such as heat reduction, aesthetic enhancement, flood mitigation, landscape improvement, and ecosystem service provision.

Based on the information gathered from the Focus Group Discussion, the benefits of green infrastructure in the city are multifaceted. Firstly, integrating green spaces, trees, and vegetation helps mitigate the urban heat island effect and reduces energy consumption for cooling. Secondly, investing in the development and management of green infrastructure enhances the overall aesthetics of the city, leading to increased property values. This, in turn, attracts residents, businesses, and investments, promoting economic growth and sustainable urban development. Additionally, the role of green infrastructure in minimizing the risk of flooding and improving ecosystem services contributes to the environmental resilience of Adama City. These green infrastructure benefits are crucial for the long-term sustainability and well-being of the city and its residents.

4.3.3. Urban Green Infrastructure Development Project Implementation

Efficient planning, coordination, and execution are vital for the successful implementation of green infrastructure projects. This analysis hones in on the execution of green infrastructure projects in Adama city, with a specific emphasis on the development and management of its components. The data gathered from participants on the execution of green infrastructure development projects presented in a table 12 showed 25.0% and 53.2% of respondents rated the implementation of green infrastructure development as very poor and poor respectively. The reaming rated it as good (21.0%), and very good (0.8%).

Table 15 Implementation of Green Infrastructure Projects

	Frequency	Percent
Very poor	93	25.0
Poor	198	53.2
Good	78	21.0
Very good	3	0.8
Total	372	100.0

Source: Own survey (2024)

The majority (78.2%) of respondents rated the implementation as poor or very poor, indicating significant deficiencies in executing these projects. The respondents, who rated the implementation as good or very good (21.8%), provided important suggesting for successful execution. These findings have worrisome implications for the sustainability of green infrastructure development and management in Adama City. The high percentage of respondents rating the implementation as poor or very poor indicates substantial challenges and limitations in achieving sustainability objectives. Therefore, it is crucial to address the identified deficiencies and enhance the execution of green infrastructure projects to ensure their positive impact and contribute to long-term sustainability.

The provided table 17 displays information on the budget allocated for green development and management over a period of six consecutive years, based on data collected from the Adama Municipality. This data highlights the financial resources dedicated to activities related to promoting and maintaining environmentally sustainable practices and initiatives within the municipality. The green infrastructure development and management of Adama City reveals considerable improvement. The planned budget increased from 20 million birr in 2011 to 50 million birr in 2016, which totaling 200 million birr over the six years. However, the actual

performance consistently surpassed the planned budget, with rates ranging from 102.4% in 2012 to an impressive 157.2% in 2016. The total actual budget reached 239.7 million birr. Despite the implementation of green development in Adama City meeting expectations based on the initial plan, the allocated budget for this purpose is inadequate considering large size of the city. The 239.7 million birr budget for six-year period is not considered significant when compared to other projects undertaken in the city. Key informants also shared a similar sentiment, acknowledging the significance and influence of the budget allocated for green development in Adama City. However, they also recognized that the budget has limitations to adequately addressing the city's comprehensive green development requirements. The insufficient budget allocation could potentially impede the city's capacity to fully achieve its environmental sustainability objectives and cater to the needs of its expanding population.

Table 16 Planned and allocated budget for the department of greenery

Year (EC)	plan(birr)	Performance (birr.)	%
2011	20,000,000	22253611	111.26
2012	28,000,000	28692800	102.4
2013	30,000,000	31857613	106.1
2014	32,000,000	34902414	109.0
2015	40,000,000	43371715	108.4
2016	50,000,000	78644416	157.2
Total	**200,000,000**	**239722569**	**119.9**

Source: Adama city Municipality (2024)

According to key informants, the main issue regarding urban green infrastructure (UGI) development and management goes beyond budget constraints that stems from a lack of leadership attention. The lack of attention can result in inadequate resource allocation, including budgetary funds. Consequently, this can lead to delays, subpar execution, and an overall failure to achieve desired outcomes and standards for UGI.

The effective and long-lasting integration of green infrastructure into city planning is crucial. This analysis specifically showed the compatibility of green infrastructure development with the city plan. The Table 18 reveals that a significant portion of the respondents (37.9%) believe that green infrastructure is developed in alignment with the city's structural plan. This indicates that these individuals perceive a consistency between the planned development and the implementation of green infrastructure. However, 59.7% of respondents have opposing view,

where they suggested green infrastructure does not conform to the city's structural plan. This discrepancy raises concerns about potential violations of the planned framework, which can have negative consequences for the sustainability of Green Infrastructure Development and Management.

Table 17 Conformity of green infrastructure with structural plan of city

	Frequency	Percent
Yes	141	37.9
No	222	59.7
Total	372	100.0

Source: Own survey (2024)

The Adama municipality has identified GI encroachments, primarily in designated reforestation areas, as a common problem. The survey result shown in Table 19, presents data on peri-urban reforestation sites, including the actual green infrastructure (GI) areas, encroachment percentages by settlements, and designated reforestation areas are among common problem. The analysis includes sites such as Boku, Dibibissa, Migira and Dabe, Kechema, Aroge Adama, Sire Ababune, and Kurfa Gutu and Sole are affected by the problems. The data reveals variations in the sizes of GI areas, levels of encroachment by settlements, and the effectiveness of reforestation efforts. For instance, Boku has a considerable GI area of 1531.38 hectares, with a relatively high (24.48%) encroachment rate. However, a significant (98.40%) portion of the area is designated for reforestation. In contrast, Kurfa Gutu and Sole have a smaller (58.49 hectares) GI area, but they face 16.52% encroachment rate. The reforestation of this site is comparatively lower at 71.76%. Overall, the analysis show importance of considering GI sizes to address encroachment challenges, and evaluating the effectiveness of reforestation initiatives in peri-urban areas. The total combined GI area for all sites is 4124.06 hectares, with a total encroachment rate of 103.61(2.51%). In contrast, the areas designated for reforestation amount to 4020.45 hectares, representing 97.49% of the total area.

Table 18 Summary of settlement encroachments in the proposed reforestation boundaries

Peri-urban reforestation Sites	GI Actual Area (ha)	Encroachment By settlement		Reforestation	
		Area (hec	%	Area in hec	%
Boku	1531.38	24.48	1.60	1506.9	98.40
Dibibissa	487.47	8.46	1.74	479.01	98.26
Migira and Dabe	536.29	43.34	8.08	492.95	91.92
Kechema	365.26	6.89	1.89	358.37	98.11
Aroge Adama	76.76	1.66	2.16	75.1	97.84
Sire Ababune	1068.41	2.26	0.21	1066.15	99.79
Kurfa Gutu and sole	58.49	16.52	28.24	41.97	71.76
Total	**4124.06**	**103.61**	**2.51**	**4020.45**	**97.49**

Source: Own survey, 2024

The encroachments within the proposed reforestation boundaries in Adama City have important implications for the sustainability of green infrastructure development and management. The encroached areas, particularly in Boku, Migira and Dabe, and Kurfa Gutu and Sole, pose a challenge to the reforestation efforts that reduce the available peri-urban reforestation area to 4,020.45 ha. The presence of settlements covering approximately 2.51% of the peri-urban reforestation areas that calls for effective measures to mitigate encroachments and protect the designated reforestation sites. Therefore, safeguarding and expanding the remaining 97.35% (4,020.45 ha) of the peri-urban reforestation area is crucial for ensuring the long-term sustainability of green infrastructure development and management in Adama City.

According to FGD and KII respondents, green infrastructure is not developed in accordance with the city's structural plan that can lead to unplanned growth. The lack of integration between green infrastructure projects and the overall development framework undermines their effectiveness and long-term viability. Furthermore, the management and maintenance of green infrastructure assets become more challenging whenever severe discrepancy occurred between the plan and the actual development intervention.

4.4. Urban Green Infrastructure Management

4.4.1. Urban Green Infrastructure Governance

Adama city recognizes the importance of green infrastructure for building a sustainable and resilient urban environment, understanding that good governance practices are crucial for ensuring that it meets the community's needs. The study focused on evaluating the governance elements related to the development and management of green infrastructure in Adama city, with

a particular emphasis on participation, accountability

4.4.1.1. *Community Participation On Green Infrastructure Development And Management*

This study examines the involvement of the community in the planning and decision-making processes related to green infrastructure in Adama City. Effective implementation of green infrastructure projects relies on active community engagement at every stage. The table displays the data gathered on community involvement in the planning and decision-making processes in Adama City. It indicates the frequency and percentage of respondents who provided responses of "Yes," "No," or "Not sure" regarding community participation. The data in table 20 indicates that, a relatively low percentage of respondents (29.0%) answered "Yes" when asked about their participation in the planning and decision process. A majority of respondents (59.7%) answered "No," indicating that they have not participated, while 11.3% responded as "Not sure."

Table 19 Community participation and satisfaction

	Frequency	Percent
Community participation in planning and decision process		
Yes	108	29
No	222	59.7
Not sure	42	11.3
Total	372	100
Satisfaction of local community on green infrastructure		
Very satisfied	18	0.8
Satisfied	66	30.6
Average	45	28.2
Dissatisfied	168	37.1
Very dissatisfied	75	3.2
Total	372	100

Source: Own Survey (2024)

As shown in the table 21, a significant portion of respondents expressed dissatisfaction with the level of community participation. The majority of respondents reported being dissatisfied (37.1%) or very dissatisfied (3.2%). A smaller percentage reported being very satisfied (0.8%) or satisfied (30.6%). A considerable portion of respondents reported an average level of satisfaction (28.2%). The high percentage of dissatisfied and very dissatisfied responses indicates a lack of satisfaction and contentment with the current level of community engagement.

The key informant interviews revealed that the lack of knowledge among community members regarding the significance and advantages of green infrastructure contributed to the limited community involvement in the creation and administration of green infrastructure in Adama city. Reduced interest and motivation to actively participate in related initiatives are the outcome of

this lack of awareness. Even though there are some cases where people use their own money to create green areas in their local neighborhoods, overall public involvement is still quite low. While some community members may attend meetings or discussions, there is a lack of involvement in providing in-kind contributions or financial support for the development and management of urban green infrastructure. This indicates a need for targeted efforts to raise awareness about green infrastructure and emphasize the potential positive outcomes that can be achieved through community participation and support.

4.4.1.2. Decision Maker's Support And Availability Of Transparency And Accountability

The level of support from decision makers for Green Infrastructure (GI) development, as well as the transparency and accountability in the decision-making process in Adama City presented in the table 23. It showcases the ratings provided by respondents, indicating the levels of support, prioritization, transparency, and accountability.

The data reveals, a significant percentage of respondents rated decision makers' support and prioritization as poor (50.0%). A smaller percentage rated it as medium (33.9%), good (12.9%), or very good (3.2%). In terms of transparency and accountability in the decision process, a majority of respondents rated it as poor (80.0%) or very poor (4.0%), with smaller percentages rating it as medium (34.0%), good (6.0%), or very good (0.0%). The data presented indicates that transparency and accountability in the decision process of green infrastructure development and management are perceived to be lacking. A significant majority of respondents rated the transparency and accountability as poor or very poor (68.9%). Only a small percentage of respondents considered it to be good or very good (4.8%). The high proportion of respondents rating transparency and accountability as poor suggests a need for improvement in the decision-making processes related to green infrastructure. Enhancing transparency and accountability can foster public trust, ensure equitable decision-making, and promote the effective development and management of green infrastructure projects.

Table 20 Decision maker's support and Availability of transparency and accountability

	Decision makers support and prioritization		Transparency and accountability in decision process	
	Frequency	Percent	Frequency	Percent
Very Good	12	3.2	0	0
Good	48	12.9	18	4.8
Medium	126	33.9	102	27.4
Poor	186	50.0	240	64.5
Very Poor	0	0.0	12	3.2
Total	372	100.0	372	100.0

Source: Own survey (2024)

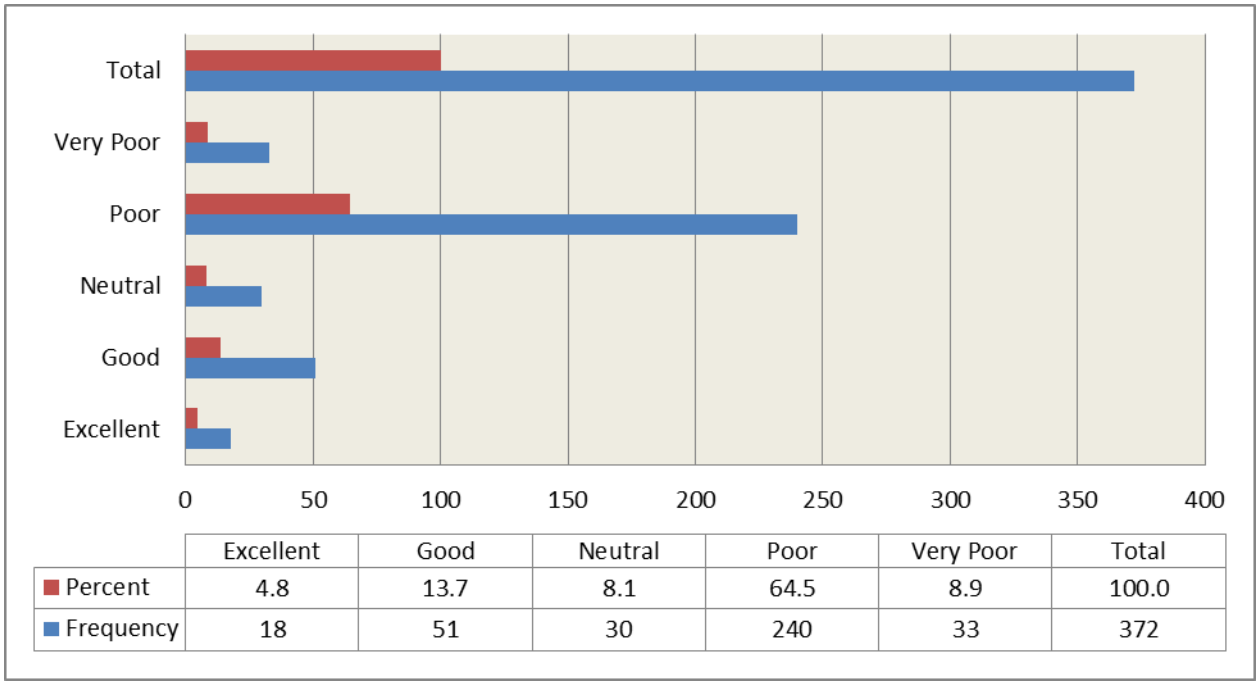
These suggests that there are significant concerns regarding decision makers' support and prioritization of GI development and management, as well as transparency and accountability in the decision process. The high percentage of respondents rating both aspects as poor or very poor indicates a lack of satisfaction and confidence in the current state of decision-making processes. This suggests that there is a lack of commitment from political leaders in the study area towards the development and management of green infrastructure (GI). Furthermore, there is a low level of adherence to urban green rules, directives, minimum standards, and other policy instruments that are designed to guide and support GI practices.

Based on information gathered from interviews with key informants, it is evident that Adama City, being a center of commercial activity undergoing rapid urbanization, has primarily focused on providing social infrastructures such as roads and housing. However, the development and management of green infrastructure components have been given lower priority by the city authorities. Moreover, according to the respondents from the interviews, there is a noticeable absence of political determination to implement policies aimed at improving various aspects related to green infrastructure. These include measures such as providing training to professionals, allocating sufficient budget, conducting regular follow-ups, carrying out frequent inspections, and ensuring the availability of necessary facilities like fertilizer, soil, water, and fences. Additionally, efforts to raise public awareness regarding the development, management, utilization, and maintenance of green areas are extremely limited in the study area.

4.4.2. Effectiveness Mmanagement and Mmaintenance of Urban green Infrastructure

The household survey data shown in Figure 11 regarding the effectiveness of management and maintenance of green areas highlights significant concerns about the current state of the

practices. As shown in Figure 20, only a very small respondent rated the effectiveness as excellent (4.8%) and good (13.7%), indicating that there are instances of successful management and maintenance. However, the majority of respondents expressed dissatisfaction, who rated with rating the effectiveness as poor (64.5%) and very poor (8.9%). This suggests considerable challenges in achieving the desired outcomes, such as inadequate maintenance, underperformance of green areas, and a lack of desired sustainability results. The high proportion of respondents indicating poor or very poor effectiveness underscores the urgent need for improvements in the management and maintenance of green areas in Adama City. According to key informant interviews, there is insufficient implementation of regular maintenance and repair activities, including inspections, cleaning, and timely repairs. This results in inadequate upkeep of the green infrastructure components.



	Excellent	Good	Neutral	Poor	Very Poor	Total
Percent	4.8	13.7	8.1	64.5	8.9	100.0
Frequency	18	51	30	240	33	372

Figure 20 Effectiveness of management and maintenance of green area
Source: Source: Own survey (2024)

4.5. Policy and regulatory Frame Work

The policies and legal framework component serves as an overarching element that shapes and guides the development, management, and overall sustainability of urban green infrastructure. This suggests that the legal and policy environment, including relevant laws, regulations, and guidelines, plays a significant role in determining the success and long-term viability of urban green infrastructure initiatives.

There are numerous important provisions included in Ethiopia's urban environment-related legal frameworks. The right of citizens to live in an environment that is healthy and clean is emphasized in Articles 43 and 44 of the constitution, while Article 92 requires citizens to protect the environment. With the goal of promoting sustainable social, cultural, and environmental resources and guaranteeing that the needs of the current generation are satisfied without compromising those of future generations, Ethiopia's Environmental Policy (Proclamation No. 9/1995) endeavors to enhance the health and standard of living for all Ethiopians. The Conservation Strategy of Ethiopia (1997) outlines strategies, action plans, and institutional arrangements for managing the country's natural, man-made, and cultural resources. Furthermore, the Urban Plan Proclamation No. 574/2008 incorporates principles that pertain to Urban Green Infrastructure (UGI), such as safeguarding communities and the environment, preserving and restoring historical and cultural heritage, and fostering sustainable development.

Ethiopia lacks specific policy and legislation that addresses the management of urban Green Infrastructure (GI) at the national and regional levels, with the exception of provisions pertaining to GI components of urban areas.

Ethiopia's 1997 Environmental Policy plays a significant role in guiding the establishment and management of urban green infrastructure (UGI) across the country. The policy provides a structure for integrating environmental considerations into various sectors, including urban planning. Specifically addressing UGI, the policy emphasizes the importance of incorporating UGI elements as recreational features within urban areas. This acknowledgment aligns with sustainability principles, as UGI enhances the urban environment's quality and promotes the overall welfare of city dwellers.

However, the Environmental Policy falls short in addressing the specific challenges and requirements of UGI development and management sustainability. It lacks comprehensive guidelines and specific provisions dedicated solely to UGI. The policy primarily focuses on broader environmental issues, and although it recognizes the significance of UGI, it does not offer detailed strategies or mechanisms for its implementation. As a result, there may be limitations in terms of ensuring the long-term sustainability of UGI in Ethiopia's urban areas. To enhance the effectiveness of the Environmental Policy in promoting UGI sustainability, there is a need for more targeted policies, regulations, and guidelines that address the unique

characteristics and challenges of UGI development and management, including considerations of biodiversity conservation, climate change adaptation, and community engagement.

As information obtained from interviews with key informants clearly indicates that multiple challenges related to cross-departmental cooperation, resource mobilization, and enforcement within the policy and legal frameworks governing urban green infrastructure (GI). The existing policies and laws do not adequately emphasize the importance of collaboration between departments and resource pooling, which hinders the effective implementation and management of urban GI projects. These barriers impede the integration of green infrastructure into urban planning processes, limit access to financing and incentives, and create bureaucratic obstacles that discourage investment and collaboration. Focus group discussions with environmental professionals and leaders have also highlighted challenges in implementing and enforcing environmental policies in Adama City, particularly due to the lack of specific guidelines and provisions dedicated to urban green infrastructure within the existing Environmental Policy. This lack of clarity hampers the ability of local authorities to implement comprehensive strategies for sustainable development and management of urban GI. To address these challenges, it is crucial to develop targeted local regulations and guidelines that address the unique requirements and obstacles associated with urban green infrastructure in Adama City.

As information obtained from interviews with key informants clearly indicates that there are multiple challenges regarding cross-departmental cooperation, resource mobilization, and enforcement within the policy and legal frameworks governing urban green infrastructure components. The existing policies and laws fail to sufficiently address the importance of collaboration between departments to effectively achieve the goals outlined in plans and strategies, as well as the pooling of resources for successful implementation and management of urban GI projects. Such barriers can obstruct the integration of green infrastructure into urban planning processes, hinder access to financing and incentives, and create bureaucratic obstacles that discourage investment and collaboration.

4.6. Challenges to Green Infrastructure Development and Management

The development and management of green infrastructure in Adama city pose significant challenges that need to be addressed for the establishment of sustainable and resilient urban environments. The data collected from respondents sheds light on these challenges, with

participants rating their significance on a scale from "very low challenge" to "Very high challenge" (Table 22). This information provides insights into how the respondents perceive the importance and impact of each challenge in relation to green infrastructure initiatives.

Lack of stakeholder engagement and collaboration: The data suggests that the "Lack of stakeholder Engagement and collaboration" is a significant sustainability challenge in the context of GI (green infrastructure) development and management. The high frequency at the "High" level (43.5%) indicates this is a major issue for many organizations or projects. However, the notable frequencies at the "Low" (27.4%) and "Medium" (21%) levels also show this is not a universally extreme problem, and the severity varies. The relatively low percentages at the "Very Low" (3.2%) and "Very High" (4.8%) levels further suggest this challenge is widespread but not necessarily ubiquitous or unmanageable. Overall, the data points to the need for increased focus on improving stakeholder engagement and collaboration as a key aspect of addressing the sustainability challenges in GI development and management.

Table 21 Sustainability Challenges of GI Development and management

	Very Low		Low		Medium		High		Very high	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
• Lack of stakeholder Engagement and collaboration	12	3.2	102	27.4	78	21	162	43.5	18	4.8
• Lack of Land Availability and Competition	12	3.2	111	29.8	81	21.8	153	41.1	15	4
• Limited Funding	12	3.2	51	13.7	78	21	198	53.2	33	8.9
• Poor monitoring or follow-up of the performance of urban green infrastructure	21	5.6	66	17.7	96	25.8	141	37.9	48	12.9
• Abuse of urban green infrastructure components	6	1.6	36	9.7	96	25.8	108	29.0	126	33.9
• corruption in the dev.t and mgt of UGI	9	2.6	39	10.5	63	16.9	102	27.4	159	42.7

Source: Own survey, 2024

Lack of land availability and competition: The analysis of the sustainability challenges of GI (Green Infrastructure) development and management suggests that the most significant challenge is the "Lack of Land Availability and Competition," which is rated as "High" with a frequency of 41.1%. This indicates that the limited availability of land and the competition for its use is a major obstacle in implementing and maintaining green infrastructure projects. The other challenges, such as "Very Low" (3.2%), "Low" (29.8%), "Medium" (21.8%), and "Very High" (4%), also play a role, but the "Lack of Land Availability and Competition" appears to be the most pressing issue that needs to be addressed to ensure the long-term sustainability of green infrastructure development and management.

Limited funding: The analysis of the sustainability challenges of GI development and management based on the provided data indicates that limited funding is a significant barrier. The frequency of "High" and "Very high" funding challenges is 53.2% and 8.9%, respectively, suggesting that the majority of GI projects face substantial financial constraints. The "Medium" funding challenge is also relatively high at 21%, while the "Very Low" and "Low" funding challenges account for only 3.2% and 13.7%, respectively. This suggests that securing adequate and consistent funding is a major sustainability challenge for GI development and management, and addressing this issue through innovative financing mechanisms, increased public-private partnerships, and targeted policy support should be a priority for stakeholders.

Poor monitoring or follow-up of the performance of urban green infrastructure: The data suggests that the sustainability challenges associated with the development and management of green infrastructure (GI) in urban areas are significant. The high frequency (37.9%) of "High" responses and the significant percentage (12.9%) of "Very high" responses indicate that poor monitoring or follow-up of the performance of urban green infrastructure is a major concern. This highlights the need for more robust and continuous monitoring systems to ensure the long-term viability and effectiveness of GI projects. Addressing these challenges will be crucial for the successful implementation and maintenance of sustainable urban green infrastructure in the future.

Abuse of urban green infrastructure components: The data indicates that the most significant challenge is the "Abuse of urban green infrastructure components." According to the data, 29.0% of respondents rated this challenge as "High," and 33.9% rated it as "Very high." This suggests that the misuse, vandalism, or improper treatment of GI components is a major concern for the long-term sustainability of these initiatives. The relatively low percentages in the "Very Low" and "Low" categories (1.6% and 9.7%, respectively) further emphasize the importance of this challenge. Addressing the issue of abuse and ensuring the proper use and protection of urban green infrastructure will be crucial for maintaining the effectiveness and longevity of these systems.

During a focus group discussion with city professionals and leaders, it was revealed that the current city plan included significant provisions for green spaces, which were intended to be developed over a long period of time. However, a majority of the planned amenity open spaces

and the College recreational park, which covers 18 hectares, have been misused and repurposed for other types of land uses. Additionally, informal and formal green spaces have also experienced partial encroachment. Currently, there are only four city parks (Dembala, Boku, Migira, and Chaffee parks) and a few undeveloped amenity spaces remaining as per the original plan.The abuse of green infrastructure components undermines their ability to deliver the desired environmental, social, and economic benefits, jeopardizing the long-term sustainability of these initiatives. Getahun and Gebremedhin's (2019) study on urban green infrastructure in Bahir Dar revealed that private development, unauthorized grazing, and illegal solid waste dumping have severely compromised the area's ecological integrity and aesthetic value. The researchers also noted weak law enforcement and poor coordination among municipal departments. Similarly, Kibru et al.'s 2018 study found that individuals with lower environmental awareness and civic responsibility are more likely to engage in destructive behaviors like littering, trampling vegetation, and infrastructure vandalism in Hawassa's urban green spaces. This underscores the need for targeted public education campaigns to promote stewardship and respect for urban green assets.

Corruption in the development and management of urban green infrastructure: The analysis of the Sustainability Challenges of GI Development and management indicates that the most significant challenge is "Corruption in the development and management of Urban Green Infrastructure (UGI)." According to the data, 27.4% of respondents rated this challenge as "High," and a staggering 42.7% rated it as "Very high." This suggests that corruption, misappropriation of funds, and lack of transparency in the processes related to UGI are major impediments to the long-term sustainability of these initiatives. The relatively low percentages in the "Very Low" and "Low" categories (2.6% and 10.5%, respectively) further emphasize the gravity of this challenge. Addressing corruption and ensuring accountability and transparency in the development and management of UGI will be crucial for the successful and sustainable implementation of these important green infrastructure projects.

4.7. Discussion

Urban Green Infrastructure (UGI) plays a vital role in enhancing the environmental, economic, and social aspects of cities, thereby improving the overall quality of life (Jennings et al., 2016). The presence of an adequate UGI is crucial for achieving a sustainable urban environment and enhancing the well-being of residents. In this context, a study was conducted to examine the

sustainability of GI development and management in Adama city. The analysis of UGI status over the past three structural plan periods (1991-2021) revealed a complex situation. The findings clearly demonstrated a significant decline in UGI land use, accompanied by an increase in built-up areas within the city. However, there was a slight increase in vegetation area by 2021, which can be attributed to the implementation of the green legacy initiative carried out over the past five years. These findings are consistent with previous studies conducted in Addis Ababa city, where urban green spaces, especially urban forests, have undergone reduction, while built-up areas have expanded over the past two decades (2003-2016) (Azagew, 2021). Similarly a study conducted in the three Ethiopian towns of Sebeta, Sululta, and Legetafo found significant changes in urban land use patterns between 2003 and 2016. Over this period, the urban built-up area expanded dramatically and substantial decreases in urban green infrastructure (GI) components within these towns (Girma, 2019). These patterns reflect a landscape transformation characterized by a decline in natural and agricultural areas and an increase in urbanization and built-up areas.

The proposed structural plan for Adama City demonstrates a green coverage of 39.1%, surpassing the national urban strategy goal of 30%. When compared to countries like the United Kingdom, Italy, India, and Slovenia, Adama City's allocation of land for green infrastructure is relatively favorable. For instance, Leicester, Greater Manchester, and Ferrol City have designated 25%, 17%, and 46% of their land area, respectively, for urban green infrastructure components (Girma, 2019). Similarly, Bangalore, Vienna, and Ljubljana have allocated 57%, 51%, and 43.4% of their total land area for urban green infrastructure components in their plans (Vazques, 2011; Comertler, 2017), as highlighted by Fuller and Gaston (2009). However, the result of the study notes that the current green infrastructure coverage falls significantly below the desired target, which the average green coverage of 5.59% is observed in the six selected districts. These comparisons emphasize the need for Adama City to enhance its efforts in incorporating and expanding green infrastructure to align with international practices and standards.

Based on the available data, it is evident that the existing green infrastructure (GI) components per capita in the study area do not meet the national standard set by Ethiopia, which is 15m2 per capita. The surveyed woredas in Adama City have an average of approximately 8.09 square meters of GI components per person. When compared to internationally accepted and more

applicable standards such as the United Nations' recommended 30 m2, the European Union's 26 m2 per capita, the public health bureau of the USA's 18 m2, and the WHO's 9m2 (Jabir, 2021), it is clear that the urban GI components per capita in the city fall significantly below these benchmarks. From this perspective, the development and management of green infrastructure in the study city are deemed insufficient. The per capita urban GI components in the study area are very low and do not align with any international standards proposed by these institutions.

Effective green infrastructure development and management go beyond simply understanding the extent of coverage in urban areas. It involves considering factors such as accessibility, condition, and interconnectivity (Cortinovis and Benedetti, 2018). Regular maintenance plays an important role in preserving the visual appeal of green infrastructure, which can have a positive impact on how the public perceives and accepts it. When green spaces are well-maintained, they contribute to a sense of community pride and are more likely to attract public use and engagement (Tzoulas, 2007). Additionally, studies have shown that regular maintenance helps in promptly identifying and addressing issues, preventing minor problems from escalating into major repairs or replacements. By conducting timely maintenance, the lifespan of green infrastructure elements can be extended, reducing the need for expensive replacements and ensuring that investments in infrastructure are optimized (Narula & Sanyal, 2016). However, in the specific case of Adama City, the study area mentioned, there are significant challenges in achieving desired outcomes. These challenges include inadequate maintenance, underperformance of green areas, and a lack of desired sustainability results. The majority of respondents expressed dissatisfaction, with 64.5% rating the effectiveness and maintenance as poor, and 8.9% rating it as very poor. Similar findings were observed in a study conducted in Addis Ababa, where the highest number of park users (49.2%) felt that the parks were not well maintained (Azagew, 2021). These observations align with the findings of Fuwape & Onyekwelu (2011), who noted that some parks and botanical gardens in African cities such as Ibadan, Lagos, Kano, Kaduna (Nigeria), Accra (Ghana), and Freetown (Sierra Leone) had portions that were converted into refuse dumps. Therefore, it is crucial for park managers in the city to recognize that park users are not interested in visiting poorly cleaned and visually unattractive urban parks (Azagew, 2021).

Green infrastructure should be planned and designed as a connected network rather than isolated patches (Ahern, J., 2007). However, in the specific study area mentioned, the evaluation of the

city's structure plans reveals that urban green infrastructure components were proposed in a fragmented manner, without any attempt to create a comprehensive network of interconnected elements. Survey data shows that a majority of respondents (55.6%) reported that green infrastructure elements were only partially integrated. This finding is consistent with a study conducted in the Emerging Towns of Oromia Special Zone surrounding Finfinne (Sebeta, Sululta, and Lega Tafo), which also identified a highly fragmented urban green infrastructure system in the study towns, as confirmed by key informants (Girma, 2019). Similarly, in Addis Ababa city, there is a lack of integration and coordination among sectors of urban green infrastructure, and the planning and management activities of green infrastructure are fragmented under the current structure of the city (Azagew, 2021).

The limited availability of land and competition for suitable spaces can hinder the establishment and expansion of green infrastructure projects, such as parks, green spaces, and urban forests. It may result in inadequate allocation of land for green infrastructure, leading to insufficient coverage and accessibility of green spaces within the city (Schifman et al., 2017). Similarly, the study conducted in Adama shows that land-use competition between urban greening initiatives and other infrastructure development, such as road networks and housing projects, has resulted in the relocation or removal of existing green assets. This not only diminishes the overall quantity of green infrastructure but also disrupts the continuity and connectivity of the city's green spaces, reducing their ecological and social benefits (Fekadu et al. 2022). The result of the research is that there is a high level of competition and a scarcity of land availability, with a frequency of 41.1% that is compatible with the study mentioned above. This suggests that a significant barrier to developing and sustaining green infrastructure projects is the scarcity of land and the competition for its usage.

The consecutiveness and integration of green infrastructure promotes physical and mental well-being by providing opportunities for recreation, exercise, and stress reduction (Kabisch, N., Qureshi, S., & Haase, D., 2015) and create opportunities for social interaction, community engagement, and cultural activities (Bolund, P., & Hunhammar, S., 1999). In the study area a significant portion of respondents (57.3%) reported visiting greenery areas rarely suggests a potential lack of engagement or interest in utilizing these spaces because of factors that hinder frequent visits, evaluations were conducted to assess the accessibility, quality, and appeal of

greenery areas. For instance the findings indicate that a substantial number of respondents (29.8%) reported taking 21-30 minutes to reach green areas, however, it is important to note that a significant proportion of respondents (25.0%) reported taking more than 30 minutes to access green areas. Longer travel times can act as barriers, limiting the frequency of visits and engagement with green spaces, particularly for individuals with limited time or mobility constraints. Studies point out that public green space should be at the center of the neighborhood and not more than five minutes' walk for the residents (Haq, 2011). Moreover, as Stanners & Bourdeau, 1995; Handley et al., (2003) in Brussels, Copenhagen, Glasgow, Gothenburg, Madrid, Milan and Paris, residents live within 15 minutes' walk from public green spaces (Girma , 2019). The finding of the study is consistent with the study conducted in Emerging Towns of Oromia Special Zone Surrounding Finfinne (Sebeta, Sululta and lega Tafo) which is more 10 minutes travel to find green area due to the low provision of urban GI components in the study towns

Green infrastructure projects can bring about positive economic effects by improving property values, attracting investments, and creating employment opportunities (Colding, Lundberg, & Folke, 2006). The findings from the study area indicate that a significant majority of respondents, 76.6% (95 individuals), reported receiving economic benefits from such projects. For example, research conducted in Accra, Ghana, revealed that properties situated near green spaces commanded higher market values compared to those lacking such proximity. Additionally, the establishment and upkeep of urban parks, green roofs, and greenways can generate job opportunities (Kotey and Osei, 2015).

According to Benedict and McMahon's study (2006), elements of green infrastructure such as parks, greenways, and urban forests collectively enhance their ability to provide important ecosystem services. Additionally, research indicates that integrated green infrastructure can contribute to climate resilience by reducing cities' vulnerability to extreme weather events like floods, heatwaves, and storms (European Commission, 2013). The findings of a study in Adama city show that a significant majority of respondents in the study area recognized the substantial benefits of green infrastructure. These respondents confirmed that green infrastructure plays a significant role in reducing urban heat (96.8%), improving visual attractiveness (91.1%), enhancing the physical landscape (82.3%), increasing asset value (71.8%), mitigating the risk of flooding (64.5%), and providing improved ecosystem services (63.7%). Similarly, a study conducted in Bahirdar yielded consistent findings, with the majority of respondents perceiving

that green areas are beneficial for the urban environment.

According to Zakka et al. (2017), the presence or absence of policies, legislations, and guidelines plays a crucial role in influencing the provision and management of urban green infrastructure (UGI). For example, a study conducted in African cities revealed that weak policy, legal, and regulatory frameworks led to inadequate, ad hoc provision, and poor management of UGI components (Azagew, 2021). Similarly, in Addis Ababa city, the provision of UGI components has been happening without a dedicated UGI policy or sufficient regulations (Abeje, 2007; Desta & Yeshitila, 2011; Girema, 2019). The findings in the study area in Adama confirm the absence of comprehensive guidelines and specific provisions solely dedicated to UGI. While the policy recognizes the importance of UGI and focuses on broader environmental issues, it lacks detailed strategies or mechanisms for its implementation.

The effective development and management of urban green infrastructure necessitates comprehensive governance, serving as the driving force behind sustainable practices (Hall and Pfeiffer, 2000). Additionally, green infrastructure is recognized as a vital natural system that supports life (Benedict and McMahon, 2006). The sustainable development of urban green infrastructure can be examined through the lens of governance in UGI planning and management, encompassing a range of objectives and approaches. Insufficient priority and attention given to urban green infrastructure (UGI) contribute to its degradation and inadequate provision in cities (Collins, 2014). The study conducted in Nairobi city by Makworo & Mireri (2011) also highlighted that green spaces for recreation and environmental protection receive less priority in the city's development and spatial planning Azagew, 2021). Similarly, in urban centers of Ethiopia, particularly Addis Ababa, authorities have not allocated sufficient attention and funding for UGI component development (Thomas, 2013). Likewise, findings from the study conducted in Adama city revealed that a significant percentage of respondents (50.0%) rated poor support and prioritization from decision makers. Moreover, there is a perceived lack of transparency and accountability in the decision process of UGI development and management, as a majority of respondents rated it as poor or very poor (68.9%). Additionally, a significant portion of respondents expressed dissatisfaction with the level of community participation, with the majority reporting dissatisfaction (37.1%) or strong dissatisfaction (3.2%). These findings indicate a governance problem and insufficient attention in the development and management of urban green infrastructure.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1. Conclusion

In conclusion, the sustainability of developing and managing urban green infrastructure (UGI) in Adama City requires collective efforts to tackle various challenges. The analysis of the available data highlights the importance of sustainable planning, conservation, and integration of green infrastructure within the city. While the proposed structural plan demonstrates a commitment to allocating land for green infrastructure, there is a significant gap between the current coverage and the desired target, indicating the need for increased investment and resources. The limited accessibility and inadequate quantity and quality of green areas reported by respondents underscore the significance of addressing policies and improving the availability and distribution of green infrastructure components. Additionally, the lack of consideration for connectivity among these components poses challenges to the sustainability and effectiveness of the UGI system. Therefore, it is crucial to engage in comprehensive planning, enhance evaluation methods, and involve stakeholders to improve connectivity and integration, ultimately contributing to the overall sustainability goals of the area.

The study findings show that Adama City experienced significant changes in land use and cover patterns from 1991 to 2021. Water bodies decreased by 14.92%, vegetation decreased by 63.07%, built-up areas expanded by 574.9%, and barren land decreased by 13.4%. Agriculture expanded by 493.5% from 2001 to 2011, but declined by 50.04% in the following decade. This indicates a shift in landscape, with a decrease in natural and agricultural areas and an increase in urbanization and built-up areas. Effective planning and conservation efforts are needed to maintain a sustainable and balanced green infrastructure in Adama. The study findings highlight several key issues that impact the sustainability of green infrastructure projects in Adama City. These issues include discrepancies between green infrastructure projects and the city's structural plan which is about 59.7% of respondents suggested green infrastructure does not conform to the city's structural plan, encroachments in designated areas that the total combined GI area for all sites is 4124.06 hectares, with a total encroachment rate of 103.61(2.51%), deficiencies in project implementation and maintenance that majority of respondents expressed dissatisfaction, who rated with rating the effectiveness as poor (64.5%) and very poor (8.9%), and a lack of

awareness which is majority of the respondents (64%) lack familiarity with green infrastructure and understanding among stakeholders. Additionally, community engagement and participation should be prioritized to align projects with community needs and foster a sense of ownership.

Moreover the study highlights the economic benefits associated with green infrastructure, such as increased house values and rental rates, which can contribute to sustainable economic growth as per the total respondents, 76.6% (95 individuals) answered affirmatively, indicating that they do receive economic benefits. However, the research also identifies challenges in the development and management of green infrastructure, such as inadequate budget allocation, poor monitoring and follow-up practices, limited public awareness and support, poor maintenance, and corruption. To overcome these challenges, it is crucial to allocate sufficient budgets, improve monitoring and maintenance practices, build technical expertise, enhance capacity, and implement anti-corruption measures. In conclusion, the findings underscore the need for inclusive strategies, community engagement, improved implementation and maintenance practices, and anti-corruption efforts to ensure the sustainability and effectiveness of urban green infrastructure in Adama City, ultimately creating a more sustainable and livable urban environment for its residents.

5.2. Recommendations

Adama City is focusing on developing and managing its green infrastructure to ensure long-term viability and maximize benefits. A comprehensive study has provided general recommendations for sustainable development and management. These recommendations aim to maximize the potential of green areas, enhance their contribution to residents' well-being, and contribute to a greener, more resilient and sustainable future in the city.

Raise Awareness: Implement comprehensive awareness campaigns to educate residents, businesses, government officials, and professionals about the importance and benefits of green infrastructure. This can be done through workshops, public events, educational materials, and online platforms to promote understanding and support. The campaigns should highlight the multiple benefits of UGI, such as improved air and water quality, enhanced biodiversity, and increased resilience to climate change. By raising awareness and fostering education, Adama City can generate public support and participation in UGI initiatives, ensuring their long-term sustainability.

Strengthen Project Implementation: To improve the execution of UGI development projects, Adama City should address issues such as inadequate funding, prolonged implementation periods, and lack of leadership attention. It is essential to allocate sufficient resources, both financial and human, to support UGI projects. This can involve securing dedicated funding for UGI initiatives, streamlining project timelines, and assigning dedicated personnel to oversee and manage the implementation process effectively. By strengthening project implementation, Adama City can ensure timely and successful completion of UGI projects, thereby maximizing their sustainability and impact.

Improve Accessibility and Distribution: Improve its green infrastructure by enhancing its availability and fair distribution. This can be achieved by evaluating existing green areas and identifying areas lacking access. By referencing international and national standards for green space per capita, the city can establish new green spaces in underserved areas, improve existing green areas, and integrate green infrastructure into new development projects. Enhancing amenities like seating, pathways, lighting, and recreational features will also enhance the attractiveness of green spaces, fostering community ownership and appreciation..

Promote integration and connectivity: Adama City should prioritize the integration and sustainability of green infrastructure by developing comprehensive planning strategies that prioritize connectivity among green spaces and their integration with existing urban infrastructure. This includes linking green areas with roads, pedestrian pathways, and public transportation systems. By enhancing connectivity, the green infrastructure system can support ecosystem services and ecological functions. Adama City should update its structural plan and zoning regulations to incorporate green infrastructure provisions and establish monitoring and enforcement mechanisms to ensure compliance.

Improve Management and Maintenance Practices: Effective management and maintenance strategies are crucial for the long-term sustainability of green infrastructure in Adama City. Regular inspections, proactive maintenance schedules, and community involvement are essential. Engaging local organizations and leveraging community knowledge can ensure ongoing monitoring and maintenance of UGI components. Allocating dedicated funding and ensuring trained personnel are also essential for proper care and longevity of green infrastructure components.

Encourage Income-generating opportunities: Adama City can promote job opportunities by investing in green infrastructure projects. The city could explore public-private collaborations and funding from diverse sources to support these initiatives. Evaluating the economic impacts of urban green infrastructure (UGI) projects can showcase their value and attract additional investment. This assessment could cover aspects like job creation, tourism potential, property values, and cost savings. Fostering economic sustainability is key to ensuring the long-term viability and financial feasibility of UGI projects in Adama City.

Develop and implement targeted Green Infrastructure policies: The study suggests a national-level urban green infrastructure (GI) policy in Ethiopia. The policy should emphasize multi-functionality, connectivity, and integration, and flow down from national to regional, urban, and department levels. Adama city should establish guidelines and regulations for executing green infrastructure projects, based on national and regional policies and laws. The policy should emphasize cooperation between departments and resource mobilization for efficient implementation. Clear instructions on planning, design, construction, and maintenance of UGI should be provided, along with criteria for integrating it into new development projects.

Promote stakeholders engagement and involve community: Increase community involvement in planning and decision-making for green infrastructure in Adama City through public consultations, workshops, and awareness campaigns. This will cultivate a sense of ownership and encourage active participation in green infrastructure projects, supporting their sustainability in the long run. Stakeholders, including local communities, organizations, and government agencies, should be involved in decision-making and implementation to ensure inclusive and efficient development and management of green infrastructure. Participatory processes will also instill a sense of responsibility among residents for the ongoing care and maintenance of these assets.

Strengthen institutional capacity: Adama City should enhance its institutional capacity to manage green infrastructure effectively. This involves improving cross-departmental cooperation, resource mobilization, and enforcement within existing policy frameworks. Adequate funding should be allocated for comprehensive green development, including personnel recruitment and training. Technical expertise and capacity should be enhanced for effective planning, design, implementation, and maintenance of green infrastructure projects.

This will ensure well-coordinated, efficient, and successful implementation of green infrastructure projects.

Enhance Transparency and accountability:

Adama City should establish effective monitoring and follow-up mechanisms for the long-term sustainability of green infrastructure projects. Regularly monitoring the performance and benefits of UGI projects, including their ecological, social, and economic impacts, will help identify areas for improvement and guide future decision-making. Measures should be in place to prevent abuse of green infrastructure and address corruption in development and management processes. Prioritizing transparency and accountability will help build trust among stakeholders, demonstrate the effectiveness of UGI projects, and ensure their long-term sustainability.

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APPENDIXES

Appendix 1: Household Survey Questionnaire

Household Survey Questionnaire
Addis Ababa University
College of Development Studies
Centre of Environment and Sustainable Development

A Questionnaire for Sample Household Survey

Hello, participant. I am currently pursuing my Master's degree in Environment and Sustainable Development at Addis Ababa University. Presently, I am engaged in my thesis research, which aims to evaluate the sustainability of Green Infrastructure Development and Management in urban Settings: the case of Adama City. Your active involvement and willingness to provide responses are crucial for the successful accomplishment of this research. Rest assured that your participation is entirely voluntary, and you are encouraged to answer the questions to the best of your understanding and knowledge.

Instruction: - Please mark your selected answer by circling it and filling in the blank space. You may choose more than one option if necessary.

N.B:- In this questionnaire, urban green infrastructure components refer to playgrounds, sports fields, parks, green areas along rivers, Green Streets, and urban forests.

Section 1: Demographic Information

1. Woreda: Specify the name of the district you belong to._____
2. Sub city: Indicate the name of the sub-city._____
3. Age: A. under 18 B. 18-24 C. 25-34 D. 35-44 E. 45-54 F.55-64 G. 65 or above
4. Sex: 1. male 2. female
5. Marital status:
   1. Single, 2. Married, 3. Divorced, 4. Widowed 5. If applicable, please specify.
6. Means of livelihood/Occupation:
   1. Unemployed, 2. Self-employment 3. Government employee, 4. NGO employee, 5. Family business, 6. Housewife 7. Remittance, 8. Other (please specify).
8. Level of education of the respondent (head):
   1. Illiterate 2. Primary (Grades 1-8), 3. Secondary (Grades 9-12), 4. College diploma 5. Degree and above.

Section 2: Questions on urban Green infrastructure Development and Management

2.1. Questions for Objective 1: To assess current status of green infrastructure in Adama City

1. Are you aware of the term "green infrastructure" and its significance in urban development?

A. Yes B. No C. Not sure

2. Does there exist a green infrastructure element in your residential or working area?
   A. Yes B. No
3. If your response to question 2 is yes, what type of green infrastructure element is it?
   A. Playground B. Sports field
   C. Parks D. Green areas along rivers and streams
   E. Street trees F. Urban forests G. Other (Specify) H. None
4. How well is the green infrastructure elements integrated with existing urban infrastructure (e.g., transportation networks, utilities)?
   A. Not at all integrated B. Partially integrated
   C. Somewhat integrated D. Mostly integrated E, Fully integrated
5. How would you rate the quality and functionality of the existing green infrastructure in Adama City?
   A. Excellent B. Good C. Average D. Poor
6. What is the level of support and prioritization of urban green infrastructure development by local political leaders and government officials?
   A. Low commitment B. Medium commitment. C. high commitment

2.2. **Questions for Objective 2: To assess the sustainability of green infrastructure Development and Management in Adama City:**

7. Green infrastructure is being developed in accordance with the city plan?
   A. Yes B. No
8. How frequently do you and your household members visit green spaces (e.g., parks, gardens, urban forests) in Adama City?
   A. Daily B. Several times a week C. Once a week
   D. Several times a month E. Rarely F. Never
9. On average, how long does it take you to reach the green infrastructure components?
   A. Less than 5 minutes B. 6-10 minutes
   C. 11-20 minutes D. 21-30 minutes E. More than 30 minutes
10. What factors influence your decision to visit green spaces? (Select all that apply)
    A. Proximity to residence B. Safety and security
    C. Availability of amenities (e.g., seating, playgrounds) D. Cleanliness
    E. Variety of vegetation and plant species F. Recreational activities offered
    G. Other (please specify)
11. In your opinion, how effectively is the existing green infrastructure in Adama City managed and maintained?
    A. Very effectively B. somewhat effectively
    C. Neutral D. Somewhat ineffectively
    E. Very ineffectively
12. Are there tree planting programs or initiatives in Adama City?
    A. Yes B. No
13. To what extent have the green infrastructure projects in Adama City been successfully implemented or executed and achieved their intended goals?
    A. Ineffective, B. Somewhat effective, C, Effective, D. Highly effective
14. Have you experienced any economic benefits as a result of green infrastructure projects

in Adama City? (e.g., job creation, increased property values, business opportunities)
A. Yes B. No

15. Are measures in place to conserve green infrastructure components?
A. Yes B. No C. Not sure
16. Have you observed any environmental benefits of green infrastructure development can bring to Adama City? A. Yes B. No
17. If your answer to question yes 16 is yes, what are the benefits of green infrastructure? (Select all that apply)
A. Improved air quality
B. Improved visual attractiveness C. Increased property values
D. Better stormwater management E. Promotion of physical activity and well-being
F. Biodiversity conservation G. Other (please specify)
18. Are there opportunities for community members to actively contribute to the planning and decision-making processes related to green infrastructure in Adama City?
A. Yes B. No C. Not sure
19. If yes, how satisfied are you with the level of community participation and involvement in the development and management of green infrastructure?
A. Very satisfied B. Satisfied C. Neutral D. Dissatisfied F. Very dissatisfied
20. How would you rate the transparency and accountability of these governing bodies/organizations in their decision-making processes related to green infrastructure?
A. Very transparent and accountable B. Somewhat transparent and accountable
C. Not transparent and accountable D. Don't know

2.3. **Questions for Objective 3: To identify the key Sustainability challenges in the development and management of green infrastructure in Adama City:**

21. Please indicate the challenges encountered in the development and management of urban green infrastructure in Adama City by using the following indicators: (1) Not a significant challenge, (2) Minor challenge, (3) Moderate challenge, (4) Major challenge, and (5) Very significant challenge.

No.	**Questions**	1	2	3	4	5
1	Lack of stakeholder Engagement and collaboration.					
2	Lack of Land Availability and Competition,					
3	Limited Funding					
4	Poor monitoring or follow-up of the performance of urban green					
5	Abuse of urban green infrastructure components?					
6	The difficulties associated with corruption in the development and management of urban green infrastructure.					

Yuunivarsiitii Fifinnee

Kolleejjii Qo'annoo Misooma

Gaafannoo Qorannoo Abbootii Warraa/households

Akkam jirtu? Yeroo ammaa Yuunivarsiitii Finfinneetti barnoota "Environment and Sustainable Development" digrii lammaffaa koo hordofaa jira. Ammaa immoo qorannoo barruu qorannoo koo irratti bobba'ee jira. Kunis **"Green Infrastructure Development and Management Approaches in urban areas; The Case of Adama City"** kann jedhu irratti kaayyeffate dha. Qorannoon kun milkaa'inaan akka raawwatamuuf hirmaannaa cimaa fi deebii kennuudhaaf fedhii qabaachuun keessan murteessaadha. Gaaffilee kana hamma hubannoo fi beekumsa keessaniitti akka deebistan isin jajjabeessina.

Qajeelfama:~ Mee deebii filatte irratti maruudhaan yookiin bakka duwwaa jiru guutuudhaan agarsiisaa. Yoo barbaachisaa ta'e filannoo tokkoo ol filachuu dandeessa.

N.B:~ Gaaffii kana keessatti **qaamoleen bu'uuraalee magariisa magaalaa** iddoo tapha ijoollee, dirree ispoortii, paarkii, magariisaa naannoo qarqara lageen, Magariisaa qarqara Daandii fi bosona magaalaa agarsiisu.

Kutaa 1: Odeeffannoo Dimogiraafii

1. Woreda: Maqaa aanaa keessa jirtuu._____ .
2. Kutaa Magaalaa: Maqaa Kutaa magaalaa keessa jirtuu._____ .
3. Umurii: _____ .
4. Saala: A. dhiira B. dubartii
5. Haala gaa'elaa:
   A. Qophaa kan jiru/tu, B. Kan fuudhe yookiin heerume, E. Kan Hiike, .
   D. Dubartii abbaan manaa irraa du'e E. Yoo barbaachisaa ta'e, maaloo ibsi.
6. Haala Hojii:
   A. Hojii dhabaa, B. Ofiin hojjachuu B. Hojjetaa mootummaa,
   C. Hojjetaa dhaabbata miti mootummaa, D. Daldala maatii, E. Haadha manaa
   F. Maallaqa erguu, G. Kan biroo (maaloo ibsaa).
7. Giddugaleessa galii ji'aa maatii (abbaa manaa + haadha manaa + kanneen biroo HH keessa jiran): _____ .

8. Sadarkaa barnoota deebii kennaa:

A.Dubbisuu fi barreessuu kan hin dandeenye B. Dubbisuu fi barreessuu bu'uuraa kan danda'u (dubbisuu fi barreessuu), C. Sadarkaa 1ffaa (Kutaa 1-8),

D. Sadarkaa 2ffaa (Kutaa 9-12), E. Dippiloomaa kolleejjii F. Digirii fi isaa ol.

Kutaa 2: Gaaffiiwwan Misooma fi Bulchiinsa bu'uuraalee misoomaa magariisaa magaalaa

1. Naannoo mana jireenyaa ykn hojii keessan keessatti qaamni bu'uuraalee misoomaa magariisaa jiraa?

   A. Eeyyee B. Lakki

2. Gaaffii 1ffaa irratti deebii kennitan eeyyee yoo ta'e, gosoota bu'uuraalee misoomaa magariisaa akkamii ti?

   A. Dirree tapha ijoollee B. Dirree ispoortii

   C. Paarkiiwwan D. Naannoo magariisaa qarqara lageen fi sululawwan

   E. Mukkeen daandii F. Bosona magaalaa

   G. Kan biroo (Ibsi) . H. Tokkollee hin jiru

3. Qabxiilee kanneen akka karoora itti fayyadama lafaa, dambiiwwan zoonii, fi imaammata ramaddii lafaa tilmaama keessa galchuun, lafa misooma bu'uuraalee misoomaa magariisaaf magaalichaa keessa jiru akkamitti madaaltu?

   A. Bakka xiqqaa B. bakka giddu galeessaa C. bakka bal'aa

4. Qaamonni bu'uuraalee misoomaa magariisaa bu'uuraalee misoomaa magaalaa jiran (fkn, toora geejjibaa) waliin hangam walitti hidhamee jira?

   A. Tasumaa kan walitti kan hidhame miti B. Gartokkoon kan walitti hidhame

   C. Hamma tokko kan walitti hidhame D. Irra caalaa walitti hidhame

   E, Guutummaatti walitti hidhame

5. Akka yaada keessaniitti bu'uuraaleen magariisaa jiraattota Magaalaa Adaamaa hundaaf iddoo magariisaa qaqqabummaa haqa qabeessa ta'e argataniiru?

   A. Eeyyee, hamma guddaa B. Eeyyee, hamma tokko

   C. Lakki, dhuguma miti D. Mirkanaa'aa miti

6. Giddugaleessaan qaamolee bu'uuraalee misoomaa magariisaa bira ga'uuf yeroo hangamii sitti fudhata?

   A. Daqiiqaa 5 gadi B. Daqiiqaa 6-10

   C. Daqiiqaa 11-20 D. Daqiiqaa 21-30

   E. Daqiiqaa 30 ol

7. Qaamolee bu'uuraalee misoomaa magariisaa naannoo mana jireenyaa ykn hojii keessatti bu'uuraalee misoomaa fi tajaajila maaltu jira?

A Mana Fincaanii B. Bakka tapha ijoollee

C. Bakka ispoortii D. Teessoo

E. Tajaajila mana nyaataa F. Kan biroo (Ibsi)_____ .

G. Faayidaan hin jiru

8. Misooma bu'uuraalee magariisaa magaalotaa hoggantoonni siyaasaa naannoo fi qondaaltota mootummaatiin deeggarsa fi dursa kennuu sadarkaan isaa maali?

A. Kutannoo gadi aanaa B. Kutannoo giddu galeessaa. C. kutannoo olaanaa qabaachuu

9. Gaaffii 7ffaa irratti deebii kennitu Gadi aanaa yoo ta'e sababni isaa maali jettee amanta

A. Hubannoo dhabuu B. Qabeenyi daangeffame

C. Xiyyeeffannoo yeroo gabaabaa: D. Dantaa wal faallessu

E. Deeggarsa ykn dhiibbaa ummataa dhabuu F. Gufuuwwan dhaabbilee(instituitions):

10. Caasaaleen fi malawwan bulchiinsaa (governance) qooda fudhattoota adda addaa misoomaa fi bulchiinsa bu'uuraalee magariisaa magaalaa keessatti hirmaatan gidduutti tattaaffii taasifamu qindeessuun fi walitti makuu keessatti hangam bu'a qabeessa?

A. Bulchiinsa laafaa B. bulchiinsa giddu galeessaa C. bulchiinsa cimaa

11. Deebiin kee gaafii 9 Laafaa yoo ta'e sababni maali jettee amanta

A. Malawwan danbii laafaa: B. Hirmaannaa ummataa daangeffame

C. Ga'aa dhabuu D. sirna hordoffii fi gabaasaa:

E. Malaammaltummaa fi gochoota naamusa hin qabne F. Raawwachiisummaa fi to'annoo dhabuu: G. Dambiiwwan bu'a qabeessa ta'uu dhabuu,

H. Odeeffannoo argachuu daangeffame:

12. Dandeettii fi qabeenyi dhaabbilee dhimmi ilaallatu (kan akka kutaalee mootummaa naannoo ykn ejensiiwwan) karoora, hojiirra oolmaa fi bulchiinsa bu'uuraalee magariisa magaalaaf itti gaafatamummaa qaban maali?

A. Dandeettii dadhabaa B. Dandeettii giddu galeessaa C, dandeettii cimaa

13. Deebiin gaafii 11ffaa kee laafaa yoo ta'e sababni isaa maali jettee amanta

A. Qabeenya maallaqaa daangeffame B. Hanqina ogummaa teeknikaa

C. Leenjii fi guddina ogummaa gahaa dhabuu D. Caasaa dhaabbilee dadhabaa

E. Odeeffannoo fi daataa argachuun daangeffame F. Walta'iinsaa fi tumsa gahaa ta'uu dhabuu

14. Bu'uuraaleen magariisaa magaalaa akkaataa pilaanii magaalaatiin hojjetamaa jiraa?

A. Eeyyee B. Lakki

15. Gaaffii 11ffaaf deebii kennite Lakki yoo ta'e sababni isaa maali jettee amanta?

A. Hanqina maallaqaa B. Jijjiirama imaammataa

C. Mormii qooda fudhattootaa D. Danqaalee seeraa ykn danbii

E. Daangaa qabeenya F. Kan biroo (Ibsi) ~~~~~~~~~~~~ .

16. Faayidaa hawaas-dinagdee fi naannoo misoomni bu'uuraalee misoomaa magariisaa Magaalaa Adaamaatti fiduu danda'a jettuu? A. Eeyyee B. Lakki

17. Gaaffii 15f deebiin keessan eeyyee yoo ta'e, bu'uuraaleen magariisaa magaalota keessatti bu'aa akkamii argamsiisuu danda'u jettanii yaaddu? (Kanneen ilaallata jette hunda filadhu)

A. Qulqullina qilleensaa fooyya'uu B. Dhiibbaa odola ho'a magaalaa hir'isuu

C. Heddummina lubbu qabeeyyii guddachuu D. Carraa bashannanaa dabaluu

F. Nageenya sammuu fooyya'uu F. Gatiin qabeenyaa dabaluu

H. Kan biroo (maaloo ibsi):

18. Rakkoolee misoomaa fi bulchiinsa bu'uuraalee magariisa magaalaa Magaalaa Adaamaa keessatti mudatan agarsiistota armaan gadii fayyadamuun agarsiisaa: (1) Qormaata guddaa miti, (2) Qormaata xiqqaa, (3) Qormaata giddu galeessaa, (4) Qormaata guddaa, fi (5) Qormaata baay'ee guddaa ta'e.

Lakk	Gaaffii	1	2	3	4	5
1	Hirmaannaa fi tumsa qooda fudhattootaa dhabuu.					
2	Lafti Argamuu Dhabuu, fi Dorgommiin itti baay'achuu					
3	Hanqina Maallaqa					
4	Hordoffii raawwii bu'uuraalee magariisaa magaalaa gaarii hin taane.					
5	Iddoo bu'uuraalee misoomaa magariisaa magaalaa seeraan ala fayyadamuu?					
6	Rakkoolee malaammaltummaa waliin walqabatee misoomaa fi bulchiinsa bu'uuraalee magariisaa magaalaa keessatti mul'atan.					

Appendix 2 : A SEMI STRUCTURED INTERVIEW FOR KEY INFORMANTS

Addis Ababa University

College of Development Studies

Centre of Environment and Sustainable Development

Key informant interviews

This questionnaire aims to collect data for an academic research thesis focusing on the Sustainability of urban infrastructure development and management in Urban Settings: The case of Adama City. Your honest and clear responses are crucial for the success of this study. Your participation is greatly appreciated, and your genuine input will contribute to a deeper understanding of the topic. Can you provide an overview of the current state of urban infrastructure in the area of study?

1. Could you provide an overview of the green infrastructure initiatives that have been implemented in Adama City and their intended goals and objectives?
2. From your perspective, how would you define and assess the overall sustainability of green infrastructure development and management in Adama City?
3. What are the key challenges or obstacles faced in implementing and maintaining sustainable green infrastructure projects in Adama City?
4. In your opinion, what are the critical factors that contribute to the long-term success and effectiveness of green infrastructure projects in an urban context like Adama City?
5. How would you evaluate the level of integration and coordination among various stakeholders involved in the planning, development, and management of green infrastructure in Adama City?
6. Are there any notable policies, regulations, or initiatives that have been instrumental in supporting the sustainability of green infrastructure in Adama City? If so, please provide examples.
7. In terms of resource allocation, what is the level of financial investment and funding mechanisms dedicated to green infrastructure development and management in Adama City?

8. How do you perceive the role of community engagement and public participation in ensuring the sustainability and success of green infrastructure projects in Adama City?
9. Are there any specific monitoring and evaluation mechanisms in place to assess the performance and impact of green infrastructure projects in Adama City? If yes, how effective are they?
10. Based on your expertise and experience, what recommendations would you provide to enhance the overall sustainability of green infrastructure development and management in Adama City?

Appendix 2 : FOCUS GROUP DISCUSSIONS

Addis Ababa University

College of Development Studies

Centre of Environment and Sustainable Development

Focus group discussions

This questionnaire is designed to gather data for an academic research thesis that focuses on the Sustainability of urban infrastructure development and management in Urban Settings: The case of Adama City. The use of focus group discussions is a valuable method for gathering insights and perspectives from a diverse group of participants. Your honest and clear responses are essential for the success of this study. Your participation is highly appreciated, and your genuine input will contribute significantly to gaining a deeper understanding of the topic.

1. How would you define sustainability in the context of Green Infrastructure Development and Management in urban settings, particularly in Adama City?
2. Do green infrastructure projects in Adama City align with the city's development goals?
3. How effective are existing policies in supporting green infrastructure development in Adama City?
4. What is the capacity of relevant institutions for urban green infrastructure planning?
5. How is land availability for green infrastructure development evaluated in Adama City?
6. Are there mechanisms to monitor the performance of green infrastructure projects?
7. How well do governance structures enable coordination among stakeholders for green infrastructure development in Adama City?
8. What are the key challenges or barriers to implementing and maintaining sustainable

green infrastructure in Adama City?

9. In your opinion, what are the most significant environmental, social, and economic benefits that green infrastructure has brought to Adama City?
10. How effectively do you think the local government and relevant stakeholders have been in integrating and managing green infrastructure within the urban fabric of Adama City?
11. What role do you believe community engagement and participation play in ensuring the long-term sustainability of green infrastructure projects in Adama City?
12. Are there any specific policies, regulations, or initiatives that you think should be implemented or strengthened to enhance the sustainability of green infrastructure in Adama City?
13. Based on your observations and experiences, what recommendations would you provide to improve the overall sustainability of green infrastructure development and management in Adama City?
14. Do you believe that collaboration among different stakeholders (urban planners, engineers, landscape architects, ecologists, etc.) is crucial for the successful integration of green infrastructure into urban environments?