Green Infrastructure Planning Practices in Adama Town

[The case of Migira Pond area]

Gifty Mathewos

A Thesis Submitted to

Department of Architecture, Urban Design and Planning

School of Civil Engineering and Architecture

Presented in Partial Fulfilment of the Requirements for the Degree of

Master's in Urban Planning and Design

Office of Graduate Studies

Adama Science and Technology University

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Advisor: Dr Berhane Mehary [PHD]

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Approval of Board of Examiners

We, the undersigned, members of the Board of Examiners of the final open defense by **Gifty Mathewos** have read and evaluated her thesis entitled "**Green Infrastructure Planning Practices in Adama Town, Oromia Regional State, Ethiopia** [The case of Migira Pond area]." and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master's in Urban Planning and Design.

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Declaration

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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Signature: _____

This MSc Thesis has been submitted for examination with my approval as thesis advisor/supervisor.

Name: Dr Berhane Mehary [PHD]
Signature: _____

Date of submission: ----------

ACKNOWLEDGEMENT

Above everything, I thank my Almighty God for being and guiding me all the time during my academic study and at the time of this research.

I am grateful to my advisor, Dr Berhane Mehary [PHD] for his overall and unlimited support. It is also my pleasure to acknowledge officials of the Adama Town Administration and the residents who have been willing to assist in providing me information without reservation.

I would like to thank my husband Ato Ameyu Wakjira for his support, love and encouragement throughout my study time. My thanks and appreciation also goes to my dad Ato Mathewos Tera and to all my families for all-rounded concern, technical & moral supports.

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ACRONYMS

ATA	Adama Town Administration
CSA	Central Statistical Agency
FGD	Focus Group Discussion
GI	Green Infrastructure
GIS	Geographic Information System
GS	Green Structure
KIIs	Key Informant Interview
MDGs	Millennium Development Goals
MSE	Micro and Small Enterprise
MUDH	Ministry of Urban Development and Housing
NUPI	National Urban Planning Institute
ORAAMP	Office for the Revision of Addis Ababa Master Plan
OUPI	Oromia Urban Planning Institute
SP	Structural Plan
UGI	Urban Green Infrastructure
UN	United Nations
WCED	World Commission on Environment and Development
WHO	World Health Organization

ABSTRACT

Green infrastructures (GI) are eco-friendly structures of urban areas which can deliver multiple benefits from the valuable urban space it occupies, compared with single purpose of engineering infrastructure. However inhabitants resided in Town of Adama in general and Migira Pond area in particular have not been benefited from the integration of economic (urban agriculture as GI), social (health and aesthetic) and environmental (resilience to climate change) as components that a livable urban center should provide to its population. These is due to inadequate environmental friendly urban design and planning that considers green infrastructure (GI). The overall research objective is therefore to assess the existing condition and to design green infrastructure for Migira Pond area in Adama Town. The research is believed to contribute to broaden knowledge base of various stakeholders on green infrastructure so that urban development plan and design should integrate all ecosystem services proportionally to that of grey infrastructure. The study focused on a participatory approach where various actors and stakeholders were involved at different stage of this research. The researcher employed both qualitative (focus group discussion, key informant interview, case study) and quantitative research methods. The study employed random sampling methods to select individuals which can provide necessary information on the units of study with sample size of 48 respondents for fill survey questionnaire. The results of the study indicated that due to inadequate emphasis given to design and planning across the Town, informal settlements that mushroomed messed up the land use plan elsewhere in the site covered by this study too. The level of community awareness on protecting green spaces has been found very low and hence they used to dump solid wastes, and Migira Pond at large scale is converted to grey and black water due to failed sanitation system, weak waste management, and poor protection methods. Green and blue infrastructures are nature given resources that need to be protected, developed, and managed by all stakeholders to make urban environments more resilient, sustainable, livable and equitable. Findings of the study will add information on how the main principles of green infrastructure have been incorporated in current planning practices in Adama Town. Moreover, the findings will inform policy makers in their decision making process on how to consider green infrastructure planning principles to protect urban spaces. The future, Green infrastructure may hold new opportunities, for example, in terms of new technologies to improve its delivery, streamline its management and monitoring, and facilitate community involvement. What is clear is that green infrastructure will need to be a flexible and dynamic resource that is capable of adapting to the changing demographic land use system and landscape of Migira pond area as well as Adama Town of the future.

Key words: Green Infrastructure, Migira pond, Flooding, Urban agriculture, Sustainability.

CHAPTER ONE

1. INTRODUCTION

Cities are important habitats for arrays of human, physical, socio-economic, political and cultural capitals. Given this fact, it is important to think carefully about the human and nature interplaying in city formation and maintaining the balance between various man-made actions and the transformation of the physical environment in the process of urbanization. Cities however, stand in the face of serious threat in the form of unplanned urbanization and land use that leads to ecological imbalances and climate change. Unplanned urbanization has been costly in all parameters of sustaining a healthy environment for human and ecologically friendly use of natural capital. Many cities in developing countries have faced tremendous challenges related poor land use plan where industries and residential site are located in neighborhoods, mushrooming slums, no system of green infrastructure, poorly designed roads and drainage systems etc. The sustainability concept has generally been defined to include components of environmental protection, economic development, and social equity, commonly referred to as the 'triple bottom line.'

Green Infrastructure [GI], a concept referring to managed networks of green space and their associated ecosystem services (Benedict & McMahon, 2006) has been highlighted as important in achieving overall sustainability goals. Furthermore, Green Infrastructures are eco-friendly structures that safeguard the living in the non-living built-up urban areas. These beneficial structures have been challenged by the process of urbanization in the cities of Sub-Saharan Africa (Todaro MP, 1997)1. These is because urban green infrastructure planning and ecosystem is at an infant level (Haase et al., 2014; Pauleit et al., 2017). As a result, the concepts and principles of urban green infrastructure planning are poorly understood in most of the sub-Saharan African countries (Shackleton et al., 2017). Ethiopia is one of the most rapidly urbanizing countries in sub-Saharan Africa [Lamson-Hall, P., Angel, S., DeGroot, D., Martin, R., & Tafesse, T. (2018)] where urbanization is largely taking the place through unplanned urban growth which aggravates environmental problems (Ministry of Urban

[1] Todaro MP, (1997), Policy research division working paper, population council, New York

Development and Housing, 2015). Literature on green infrastructure planning in Ethiopia is quite scarce and therefore the role of green infrastructure addressing these challenges is still largely unknown. Available literatures focused on issues such as adaptation to climate change (Lindley et al., 2015), conditions and opportunities of green infrastructure in relation to water resilient cities (Herslund et al., 2017).

This paper attempts to understand the current status of green infrastructure planning practices and needs for and ways to achieve improvement from the perspective of planning and to explore the benefits of green infrastructure [GI] particularly emphasizing in Migira Pond area of Adama Town. Furthermore, the study will try to address some urban spatial design issues such as aesthetic performance of green infrastructure [GI] and other socio-cultural issues of landscape design in line with global concern of adaptation to climate change.

1.1 Background of the Study

Adama was established as a railway station depot in 1916 G.C. Its establishment and development has been influenced by conducive economic, social and geographical conditions. Because of its strategic location, economic and administrative importance, the Town is one of the fast growing urban centers in Ethiopia. At this time, the Town is serving as gateway to overseas, it is one of a main commercial, manufacturing, trade shows, bazar, conference and educational centers next to Addis Ababa. In addition, access to railway, having the best and fastest road connection with Addis Ababa, being surrounded by agricultural potential areas, and the service that the Town Administration has been striving to agglomerate contributed to Adama to become an ever-warm, busy Town. Adama Town is on one the largest development corridors of Ethiopia, hence attracting business promoters, professional of various educational backgrounds, causal labourers etc. The Town has been expanding horizontally in order to accommodate the increase in population as a result of natural population growth and in-migration. This partly contributed to the increase of informal settlements in different areas of the Town especially at the peripheries. This trend demonstrates the significant impacts on sustainable development and become threat to compromise the quality of life within the Town. Thus, urban green infrastructure is identified as an alternative nature-based and cost-effective remedy to some of these negative consequences (Pakzad & Osmond, 2016).

Urban green infrastructure in Adama Town is an emergent issue. This is partly due to lack of appropriate green infrastructure approach that well integrates into the planning and governance system. Owing to this fact, benefits that can be obtained from green infrastructure resource are still mostly missed. Therefore, this study explores the current situation of urban green infrastructure development practices and helps to identify the opportunities and constraints in the utilization of green infrastructure development in the Town. The study also helps to consider the interest and preference of communities on green infrastructure planning and development and provide a new idea for town planning, architecture, policy-makers, and managers and landscape specialists to consider the existing gaps in their future planning and development activities.

1.2 Problem Statement

Adama Town is located along the main development corridor and on the high way to port, hence it has been expanding very rapidly into large urban centre attracting investors, producers, professionals and labourers. Though attracting investment and development promoters is a good idea for the town to flourish, shifting plots that have been allotted for residential and green areas to industries is among the malpractice in terms of town planning and design.

Green infrastructures are very well known to provide environmental, social and economic benefits to communities (forest research, 2010). However, the green infrastructure of Adama Town is not developed, managed and protected very well to fulfil the environmental, social and economic benefits to the community [Adama Structure Plan Revision Project City Wide Study Report November, 2017]. Inadequate implementation capacity of each land use for the purpose it has been planned and designed remained problematic, hence the green areas were shifted to other land uses. As a result the natural ecosystems become scattered across the landscape and displaced by new land-use developments (Geneletti, 2004; Lafortezza et al., 2008).

Storm water in poorly designed sewage systems dismantles roads, business buildings, and residential houses as well as erodes soil forming gullies. Poor drainage also increases the risk of polluting water. Improving the functionality and spatial connectivity among various land uses are prerequisite to mitigate the effect of climate change and in turn to increase the

value of the goods and services that ecosystems provide (Grimm *et al.,* 2008; Hodgson *et al.,* 2009).

The green infrastructure therefore, is a smart solution for today's land use planning. Above all, it offers us the opportunity for balancing the ecosystem. It is through such dynamic system of managing urban and pre-urban land use ecologically sustainable, all-inclusive and spatially coherent town development plan can be achieved.

1.3 Objective of the Study

The overall research objective is to assess the existing condition and to design green infrastructure [GI] for Migira pond area, in Adama Town.

1.3.1 Specific Objectives:

1. To assess the existing green, grey and blue structure of the case site in respect to Adama Town's functional and physical structures.
2. To consider the opportunities (socio-economic benefits, environmental and aesthetic values) with respect to green infrastructure development and possible barriers to sustain and develop Migira Pond.
3. To develop design and planning solution for green infrastructure development by considering the beneficial aspect of the pond.

1.4 Research Question

Based on the problem statement, the findings of this thesis will try to answer the following research questions. These are:

1. What is the present status of the green infrastructure in the Town and how is the green infrastructure going to be used in the study area?
2. What are the factors affecting green infrastructure development along Migira Pond area?
3. How to design Migira pond area with self-sustaining and environmentally friendly programs so that these could improve quality of life of the residents?

1.5 Scope and Limitation of the Study

The scope of the study is restricted to the selected Kebele of Adama Town. The study will focus on Adama with particular emphasis to the socio-economic, environmental, and aesthetic performance of green infrastructure in Migira Pond area. The core intent of the study is on green infrastructure planning practices by underlining the residents benefit after developing green infrastructure design options.

Limitation of the Study is that the Adama Town administration officials were going through a basic administrative reform paradigm that it was difficult to talk to the right person at the right time with right mood. Unfortunately, people who were not happy with the reform were not willing and/or open to respond to the questionnaires and usually push the interview to the lower level employees. I felt time shortage and observed reluctance of some respondents [Town dwellers] to share their time due to time pressure with their own businesses.

1.6 Significance of the Study

The research of green infrastructure planning and design into urban development will contribute to knowledge available in the study area regarding the economic, social and environmental benefits from urban green infrastructure. The outcome of the study may also be used for policy considerations, for planning and designing urban green infrastructure and create awareness for the residents about the multifunctional values of green areas in Migira pond area as well as in Adama Town. It is also a partial fulfillment required for MSc in Urban Planning and Design for the researcher that will have academic significance to be used as a reference for those interested in green infrastructure development in urban settings.

1.7 Report structure

This research report is organized in to six parts. The first chapter comprises general introduction of the green infrastructure and concept of sustainability, based on the literatures related to my topic. This section also includes: background of the study, statement of the problem, objectives of the research, research questions, scope and limitations, and significance of the study. In the second chapter, I discuss my core issues and get further information from different perspectives and various approaches on the subject understudy. Description of the case site, data collection methods and procedures of the study make up

the third chapter. The fourth section takes account of Migira pond area as a case site which is used to investigate the subject matter. This section also includes analysis, findings, and discussions. Chapter five includes design solutions and guidelines leading to the sixth section which point out the concluding remarks and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter is keen to the discussion of the theoretical and conceptual issues used to frame the study. The study has made use of various theoretical insights in order to understand the subject understudy from different perspectives, which will be discussed in the following sections.

2.1 Definition and Main Issues of the Research

2.1.1 What is Green infrastructure?

The ideas for green urban structures began in the 1870's with concepts of urban farming and garden allotments[2] though this concept of Green Infrastructure (GI) has been practiced in 1990's in the United States of America [USA] as an emerging livable Town development practice, different urban development professionals have defined Green Infrastructure [GI] in very close related manner.

1. Naumann et.al (2011a)[3] defined Green Infrastructure (GI) as "Green Infrastructure is the network of natural and semi-natural areas, features and green spaces in rural and urban, and terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services. Green Infrastructure can be strengthened through strategic and coordinated initiatives that focus on maintaining, restoring, improving and connecting existing areas and features, as well as creating new areas and features".
2. Green Infrastructure describes the network of natural landscape assets which underpin the economic, socio-cultural and environmental functionality of our cities and towns-i.e. the green spaces and water systems which intersperse connection and

[2]HiltrudPotz and Pierre Bleuze2012. Urban green –Blue grids for sustainable and dynamic cities. Delft: Coop for life.
[3]Naumann, S., D. McKenna, et al. (2011a). Design, implementation and cost elements of Green Infrastructure projects. Final report Brussels, European Commission.

> provide vital life support for humans and other species within our urban environments. 'Individual components' of this environmental network are sometimes referred to as 'Green Infrastructure assets', and these occur across a range of landscape scales—from residential gardens to local parks and housing estates, streetscapes and highway verges, services and communications corridors, waterways and regional recreation areas etc.'[4].

Urban green infrastructure has been suggested to provide multiple benefits to urban residents' through creation of interconnected network of green spaces (Benedict & McMahon, 2002; Gill, Handley, Ennos, & Pauleit, 2007; Kato, 2011; Mell, 2008). Its elements can include a variety of green spaces such as parks, open spaces, playing fields, pocket spaces, small incidental green space and neighborhood gardens that are linked by tree-lined streets and waterways, around and between urban areas (Said & Mansor, 2011).

Well-planned and managed urban green infrastructure needs to be considered as an integrative part of the town, since it is indispensable for the functioning of the town in a sustainable manner (Sandstrom, 2002). In recent times, green infrastructure has been identified as a specific strategy to support resilience in cities (Ahern, 2007). The integration and strategic planning and delivery of networks of connected green space described as green infrastructure has become a major discourse in urban greening and is increasingly accepted as a policy and planning approach (Davies et al., 2015; Lennon, 2014). Thus, to successfully plan and implement a high-performing urban green infrastructure capable of delivering multiple benefits, adoption of a set of principles in planning become necessary (Pauleit et al., 2017). These principles relate to the content as well as the process of planning (Ahern, 2007; Benedict & McMahon, 2012; Kambites & Owen, 2006; Lafortezza, Davies, Sanesi, & Konijnendijk, 2013; Mell, 2008; Pauleit, Liu, Ahern, & Kazmierczak, 2011). In parts of Europe, North America and Asia, green infrastructure planning principles and approaches have been receiving more attention and green infrastructures is considered as essential urban infrastructure (Lafortezza et al., 2013).

[4] Australian Institute of Landscape Architects Green Infrastructure Report (2012).

2.1.2 Green infrastructure approaches

Ely and Pitman (2012) identified three main approaches to implementing green infrastructure

1. **Ecosystem services approach (ESS).** This approach emphasizes the services that nature and natural cycles provide to society (Costanza et al., 2014, Millennium Ecosystem Assessment, 2003). These services can be found globally (e.g., carbon cycle), or locally where they can be restored and maintained within urban settings to provide benefits in that setting.
2. **Green Spaces Network approach**. This perspective emphasizes the importance of conserving and linking green spaces and nature corridors in cities to improve the functioning of ecosystems. This approach is consistent with the more traditional infrastructure approach in which networks are built in order for a city to function (Benedict and McMahon, 2002).
3. **Green engineering approach**. This viewpoint considers GI to be a subset of traditional engineering infrastructure whereby typical practices have green elements added to them which can provide ecosystem services such as cooling through the installation of green roofs and living walls (Margolis and Robinson, 2007).

2.1.3 Forms of Green Infrastructure

The different physical forms of GI are very diverse, however, the main categories are described below (European Commission, 2012:

a) Public parks and gardens, including urban parks, open space reserves, cemeteries and formal gardens.
b) Greenways, including river and creek corridors, cycle-ways and routes along major transport (road, rail and tram) corridors.
c) Residential and other streets, comprising street verges and associated open space pockets.
d) Sports and recreational facilities, including ovals, golf courses, school and other institutional playing fields, and other major parks.
e) Private/semi private gardens, including shared spaces around apartment buildings, backyards, balconies, roof gardens and community gardens.

f) Green roofs and walls, including roof gardens and living walls.

g) Squares and plazas, including both public and private courtyards and forecourts.

h) Natural green space, including national parks and nature reserves, wetlands and coastal margins.

i) Utility areas, including quarries, airports, and large institutional and manufacturing sites. This category also includes unused land reserved for future use.

j) Agricultural and other productive land, including vineyards, market gardens, orchards and farms

Figure 2.1: Physical forms of green infrastructure

Source: Green Infrastructure: An integrated approach to land use

2.1.4 Framework for green infrastructure planning

Green infrastructure planning offers a conceptual framework to be adapted to local context, as illustrated below. This framework is driven by the four core principles. Combined, the principles act in two directions: 1) to respond to the particular urban challenges and 2) to underpin practical actions on the ground.

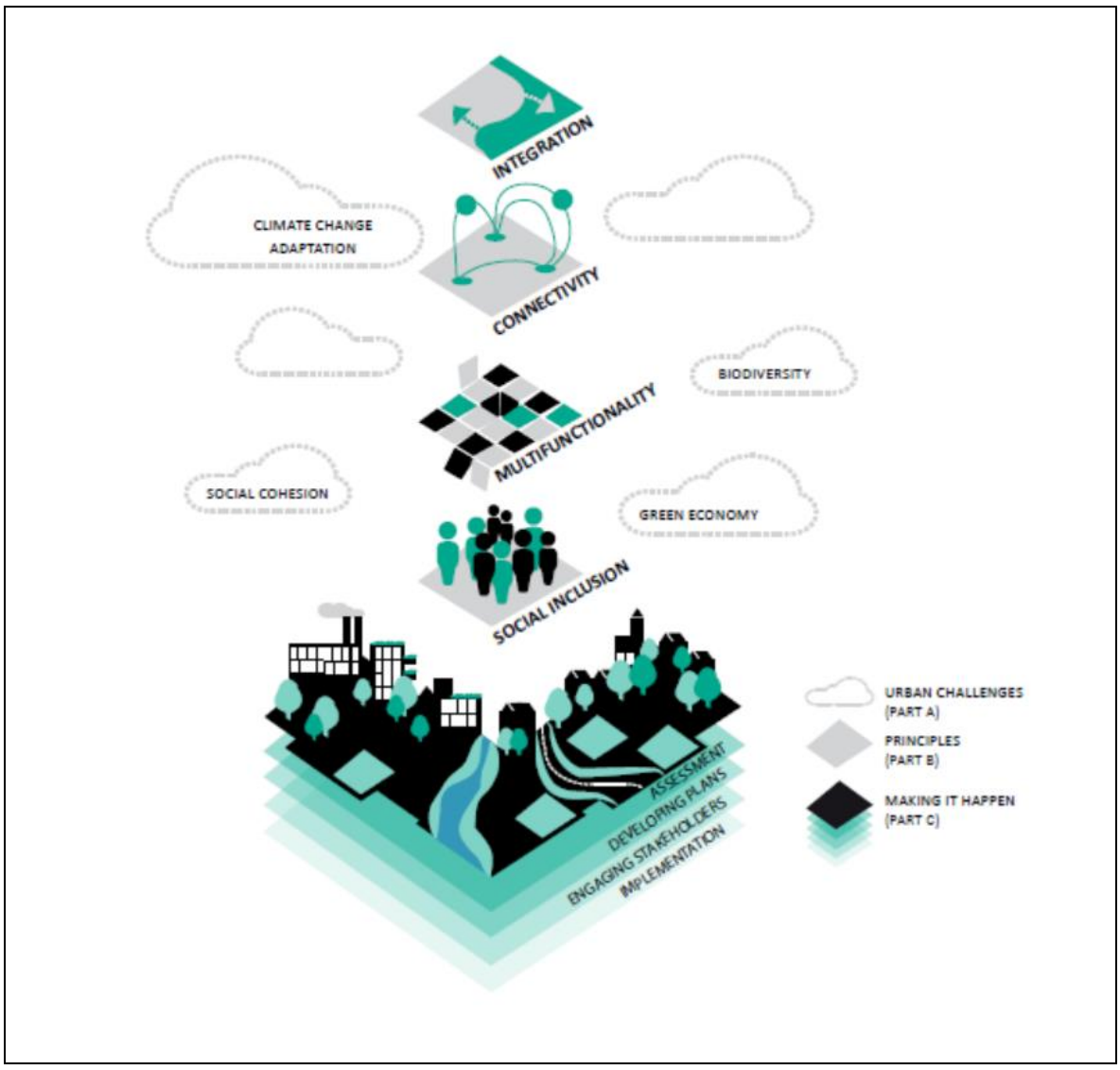


Figure 2.2: Framework for green infrastructure planning

Source: Australian Institute of Landscape Architects Green Infrastructure Report (2012).

2.1.5 Principles of green infrastructure planning

I. Green-Grey integration

Green infrastructure planning seeks to integrate and coordinate urban green spaces with other infrastructure, such as transport systems and utilities.[5]

Integrating infrastructure can lead to multifunctional solutions which provide various benefits simultaneously (multi-functionality). For example, vegetated road buffers can improve aesthetic values, reduce noise and air pollution, while dispersed planting strips or rain gardens in high flood-risk neighborhoods can enhance the storm water management capacity of conventional grey systems and buffer climate change effects (Climate Change Adaptation).

Two key features which distinguish Green Infrastructure from its 'grey' counterparts are **multi-functionality** and **connectivity**. Prominently,

a) Green Infrastructure [GI] can deliver multiple benefits from the valuable urban space it occupies, compared with single purpose engineering infrastructure.
b) Green Infrastructure [GI] also 'value adds' by linking and connecting existing green assets, which provides benefits both for people, by enhancing public use opportunities, and for the environment by improving urban ecosystem health and countering habitat fragmentation.

II. Connectivity

"…involves both structural and functional connections between green spaces, in order to create added value from an interlinked system;

...targets clearly defined functions and benefits for humans and wildlife, recognizing the different kinds of connectivity (ecological, social and abiotic) and the potential for synergies between them;

[5] Benedict, M. A., McMahon, E. T., 2006. Green infrastructure: Linking landscapes and communities. Washington, D.C. Island Press, p37.

…matches aims and strategies to different spatial scales – regional, city and local – and ideally is integrated across them"[6].

III. Multi-functionality

Multi-functionality concerns the ability of green infrastructure to provide several ecological, socio-cultural, and economic benefits concurrently. A green infrastructure planning process expressly considers how to deliver these benefits instead of leaving it to chance. This is not simply a case of 'the more functions the better'. Potential trade-offs and conflicts between functions need to be assessed, as well as the capacity of different green infrastructure elements[7]. For instance, using land for intensive recreation may conflict with the protection of species sensitive to disturbance. These kinds of conflicts can sometimes be avoided by physically separating incompatible uses (e.g., through zoning, visitor management or agreements with land users), or by planning them so as not to happen at the same time (e.g., when breeding or flooding is expected). This means it is not only the functions themselves and the associations between them that are important, but also their spatial and temporal dimensions.

Further, the benefits of multi-functionality should be considered in relation to who needs them and who has access to them. Otherwise, green infrastructure planning could deliver benefits only relevant or accessible to certain groups in society [8](Social Cohesion). To avoid this trap, a strong element of public participation is critical (Social Inclusion).

Therefore, Urban green infrastructure has economic and livelihood, environmental, social and cultural benefits. Therefore, Green infrastructure provides benefits to people, ecosystems and the economy. It is a key component for sustainable growth of communities.

IV. Social inclusion

Social inclusion in general refers to the involvement of a wide range of social groups (including vulnerable ones that are often excluded) in all spheres of life. Making green infrastructure planning socially inclusive demands attention to the needs of these different

[6] Benedict, M. A., McMahon, E. T., 2006. Green infrastructure: Linking landscapes and communities. Washington, D.C. Island Press, p37.

[7] Hansen, R., Pauleit, S., 2014. From Multi-functionality to Multiple Ecosystem Services, A Conceptual Framework for Multi-functionality in Green Infrastructure Planning for Urban Areas. AMBIO 43, 516-529.

[8] Rodriguez, J.P., et al, 2006. Trade-offs across space, time, and ecosystem services. Ecology and Society 11 (1), art. 28.

groups. Of particular concern are those with the most difficulties accessing information and articulating their interests, such as immigrants or ethnic minorities; or people who are homeless, unemployed or poor. If not carefully managed, initiatives to involve citizens in planning produce results that favor some and not others, by further empowering those in advantaged positions, or encouraging resistance from narrow interest groups to policies designed for the public interest[9]. In order to avoid these pitfalls, it is essential that governing institutions are capable of not only listening to a range of interests, but also channeling and balancing them.

Social inclusion is related to social cohesion, yet these are not the same. The latter concerns the outcome of green infrastructure planning with regard to its social effects (Social Cohesion), while socially inclusive green infrastructure planning is instead a process of including all social and cultural groups people in decision-making – one end goal of which is green infrastructure that is equally accessible to them and meets their various needs (Multi-functionality).

2.1.6 Quality indicators of Green Infrastructure planning

While the four core principles provide a fundamental basis for green infrastructure planning, certain supporting quality indicators should be also taken into account:

1. **Multi-scale:** green infrastructure planning aims to link different spatial levels, ranging from metropolitan regions to individual sites.
2. **Multi-object:** All types of urban green and blue spaces, regardless of ownership and origin, can be considered as part of a green infrastructure network.
3. **Inter- and Trans disciplinary:** green infrastructure planning aims at linking disciplines, as well as science, policy and practice. It integrates knowledge and demands from different fields, such as landscape ecology, urban and regional planning, and landscape architecture, and is ideally developed in partnership between local authorities and other stakeholders.

[9] Cook, B., Kothari, U. (eds), 2001. Participation: the new Tyranny? Zed Books Ltd. New York.

2.1.7 Green Infrastructure Development Standards

- Urban and regional planning shall incorporate green infrastructure (GI) early on in the process. Enough areas for green open spaces shall be set aside and incorporated in the town's/cities' spatial plan. This shall be seen as a legitimate investment [MUDH, 2015].

- Urban green infrastructure (UGI) shall be managed and administered in the interests of the local community and shall address its needs [MUDH, 2015].

- Urban green infrastructure (UGI) shall be managed in accordance with environmentally sustainable measures. Its design should promote biodiversity and nature conservation [MUDH, 2015].

- Private Green shall be encouraged by creating campaigns to promote for more plants and less impermeable surfaces in private compounds [MUDH, 2015].

Table 2.1: Green areas (Open spaces within Blocks) standard

Variables	Minimum Area per person		
	1st level urban center	2nd level urban center	3rd level urban center
Green area	$2m^2$ per person	$2m^2$ per person	$1m^2$ per person
Variables	Minimum Area per person		

Source: Land use Planning Standards for structure plan preparation, OUPI, 2011

Table 2.2: Sport & Recreational facilities (Stadium and Play field) Standard

No	**Levels of Urban center**	**Minimum Area (ha)**	**Types of open Space**
1	First Grade	10	District level play field; Zonal stadium; Regional stadium; International stadium, Olympic sport complex
2	Second Grade	10	District level play field; Zonal stadium; Regional
3	Third Grade	1	District level play field;
4	Grade Four	1	District level play field;

Source:-Land use Planning Standards for structure plan preparation, OUPI, 2011

According to World Health Organization [WHO], cited in Good Practice of Urban greening (IADB), 1997, cities should provide $9m^2$ of undeveloped (unpaved) open space for each

inhabitant. WHO also suggested that, designing green area networks, residents should live within a 15-minute walk from any green space. Likewise, National Urban Planning Institute [NUPI] neighborhood green areas should provide $2m^2$, for every person/resident.

FUPI 2006, Structure Plan Manual also suggests 15-20% of the urban land use should be apportioned for urban green area. Thus, incorporating adequate urban green area in the urban land use system is mandatory. Moreover, once every piece of urban land is developed for built up and other infrastructures, it may be difficult and/or expensive to develop new green areas unless there are planned from the very beginning.

On the other hands, the Federal Ministry of Construction and Urban development also announce that the general land use standards of urban planning should be based on 30%, 30%, 40% i.e. (30% green area, 30% physical infrastructure, 40% built up areas) for newly established urban centers. However, 25%, 25%, 50% i.e. 25% green area, 25% infrastructure, 50% built up areas is recommended in the city.

2.1.8 Urban agriculture as Green infrastructure

According to Mougeot (2000), the general definition of urban agriculture is the growing of plants and the raising of animals for food and other uses within cities and peri-urban areas. It also includes the production delivery of inputs, the processing and marketing of products.

Nowadays, urban agriculture is an innovative green infrastructure practice that is undergoing a renaissance due to a confluence of factors. [10]Most importantly it lies to address a variety of issues which are seen as critical to the ongoing sustainability and livability of urban environments such as public health, healthy food access, green space, air and water quality, economic development, and community engagement. It represents a tangible and accessible opportunity for town residents to improve household, food and nutrition security. In addition to this, urban agriculture is considered as a component of green infrastructure [GI] and new approaches to urban design and development in the context of climate change adaptation. It also embodies an understanding of urban environments which seek to integrate cities into a continuous, productive landscape of ecosystem services.

[10] The potential for urban agriculture in New York City.

Urban agriculture is therefore, increasingly being seen as an emerging business opportunity in urban areas of the developing nations. While the economic challenges compared with farming in rural areas are considerable, a variety of factors are making farming in cities an increasingly viable enterprise from an economic perspective. The most significant of these is that consumers in urban areas are becoming increasingly conscious of the health, environmental, and social impacts of the industrial food system and are actively seeking alternatives.

Case study- Seeing Green: Urban Agriculture as Green Infrastructure

[11]***Seeing Green*** is a research project that studies specific urban agricultural sites in the New York city area in order to demonstrate how urban agriculture should be considered as a viable and important component of a City's green infrastructure.

Focus on one of New York's greatest environmental challenges which is its combined sewage overflow (CSO) problem. The outdated sewer system is designed to collect storm water runoff, domestic sewage, and industrial wastewater in the same pipe on its way to a sewage treatment plant. When the rain is heavy, though, volume exceeds capacity and untreated wastewater flows right into the waterways.

Lesson learned from the case study

Green infrastructure is a term that refers to a wide range of technologies and systems to improve water quality through the capture and reuse of storm water. In an effort to support farming in the city and help scale it up, **the research** set out to prove scientifically the environmental benefits of rooftop and other urban farms, in particular their ability to manage storm water, with their research project ***Seeing Green.***

Urban agriculture standards

a) Competent authorities shall promote urban agriculture in order to function as part of the food security system and urban safety net [MUDH, 2015].

[11] Seeing green-urban agriculture as GI

b) Competent authorities should create bigger networks of urban agriculture, away from fragments and pieces towards a cohesive whole system. Solutions should be found based on interconnectedness of the systems as whole units, rather than separate units [MUDH, 2015].

c) Effective implementation of urban agriculture shall include educational campaigns and legislative action, so that all categories of the population have long-term access to a plot and joint activities are carried out by a number of public and private stakeholders [MUDH, 2015].

2.2 Blue-Green System in Urban Context

Water is one of the most essential elements of life. Clean and adequate fresh water plays a paramount importance to the survival of all living organisms and the smooth functioning of ecosystems and economies (Curry, 2010 cited in Munir Younis Abdullahi 2014)[12]. The natural physicochemical properties of water render its vital importance to sustain the living planet Earth and every form of life on its face, including human beings. Its vital role in many human activities including agriculture, industry, domestic, electric power generation, transport and recreation shows that to what extent water is an integral part of human life. The normal functioning of a natural system such as a human body depends entirely on the availability of adequate quantity and quality of water.

A Blue-Green system aims to recreate a naturally-oriented water cycle while contributing to the amenity of the structure by bringing water management and green infrastructure together. This is achieved by combining and protecting the hydrological and ecological values of the urban landscape. So, green infrastructure is not just about green spaces like parks and open spaces, but it also incorporates blue infrastructure including sustainable urban drainage, swales, wetlands, rivers, canals and their banks, and other water courses.

Recently, Cities are vulnerable to many types of shocks and stresses concerning environmental issues. They are disconnected from their ecology for various reasons. This point is emphasized by Gandy (2004) thus "…the relationship between water and urban space can be understood by features such as new moral geographies and modes of social

[12] Munir Younis Abdullahi (2014), Inner City Riverside Development and Land Use Transformation: in the context of Addis Ababa

discipline based upon ideologies of cleanliness". Most modern cities have centrally controlled drainage systems. This invisible water infrastructure system disconnects urban land-use from the logic of the watershed as well as people's experience from the ecological processes of the landscape (Stokman, 2008). While in others case, water bodies have become so polluted that they are becoming problematic part of the urban fabric. Therefore, cities account for a significant share of total water use and, often, misuse. As pointed out, unsustainable management of the water resource threatens the economic activities that take place in cities, many cities in developing countries face challenges; these include rapid population growth, squatter areas of significant size or scale, rapid economic growth, unwise town planning, and the negative impacts of climate change. In such cities, simply keeping pace with the increasing demands that are placed on the water resource seems a nearly impossible task.

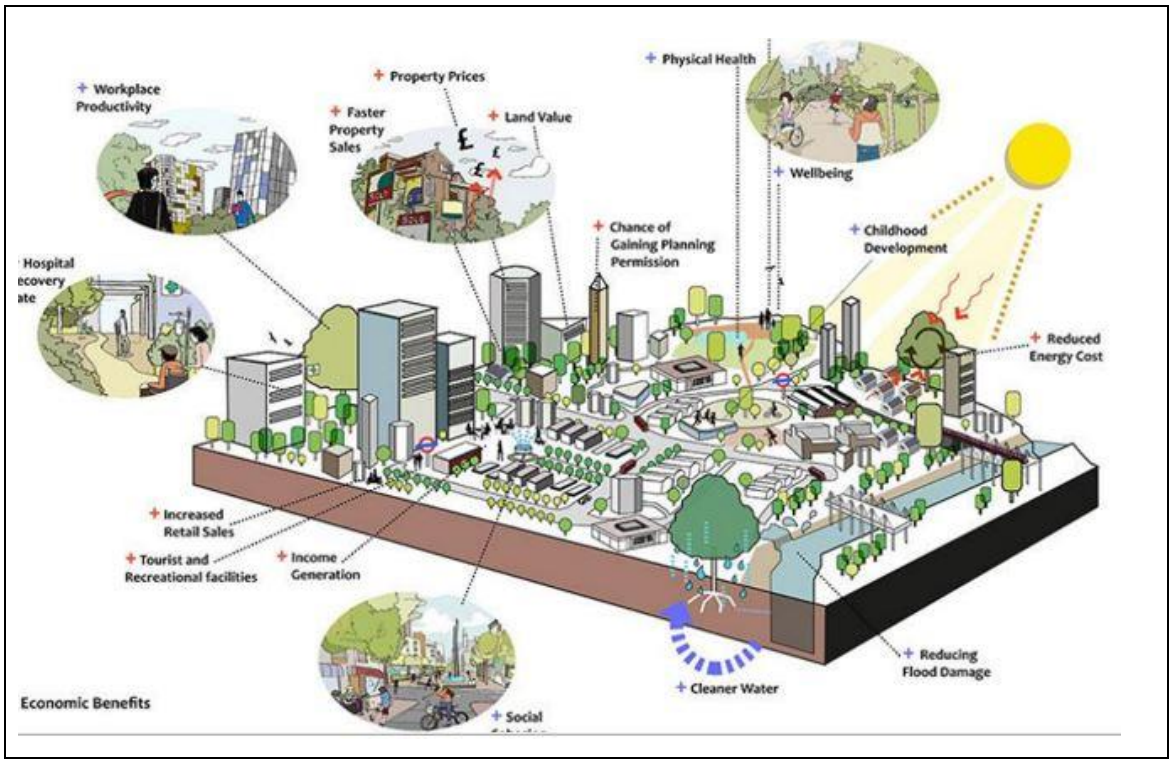


Figure 2.3 Benefits of Blue-Green system in urban context

Source: Australian Institute of Landscape Architects Green Infrastructure Report (2012).

2.2.1 Watershed management

The relationship between urban water management and the health of urban environments has only recently become a focus of researchers; however, this area has developed quickly with numerous issues being investigated (Wong, 2011). Relevant water issues include:

- access to secure and clean water supply;
- clean water environment;
- flood protection;
- urban design strategies; and
- mitigating urban heat.

Green infrastructure [GI] is increasingly being recognized as an alternative to traditional engineering approaches to urban water management through integrated water cycle management and Water Sensitive Urban Design (Water by Design, 2010). The physical form of GI in terms of urban water management includes, but is not limited to, bio filtration systems, storm water harvesting, passive landscape irrigation, permeable surfaces and green roofs.

Water management and water sensitive urban design (WSUD) is a key form of green infrastructure, which has many benefits that increase the resilience and network aspect of green infrastructure.

Blue component standards

a) Existing water features should be integrated into the green open space landscape [MUDH, 2015].
b) Extra installation of water features shall be restricted because of high maintenance costs of water features (e.g. fountains, ponds etc.) [MUDH, 2015].

2.3 Sustainability Concepts and Definitions

Sustainability has been widely touted as a goal and ideal in urban planning, and defining and implementing the concepts has become a global topic of concern. Many interpretations of sustainability exist, and these definitions help to serve as a foundation for achieving sustainable development (Elliot, 2006). The most frequently cited definition of sustainable development and a foundation for future conceptions of sustainability comes from WCED

[World Commission on Environment and Development]'s 1987 report, Our Common Future, which proposes that "development is sustainable when it meets the needs of the present without compromising the ability of future generations to meet theirs" (WCED, 1987, p. 8, Elliott, 2006, Agyeman, Bullard, and Evans, 2003). In addition to its environmental focus, the WCED [World Commission on Environment and Development] definition includes concepts of economic development and social equity, signifying an important shift from traditional conservation-focused definitions, such as that of the 1980 World Conservation strategy (Agyeman, Bullard, and Evans, 2003). The commission focuses on giving "overriding priority" to the needs of the world's poor as well as "the environment's ability to meet present and future needs" (WCED, 1987, p. 62). Further emphasizing the inclusion of equity, the report states that "even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation" (WCED, 1987, p. 62). Elliot (2006) highlights the inherent tensions presented in this concept of sustainability, including the conflicting interests between present and future generations, between human well-being and environmental protection, and among socio-economic classes.

2.3.1 Tensions and Challenges

Sustainability literature highlight the importance of focusing simultaneously on the goals of environmental protection, economic development, and social equity. However, these ideals include inherent conflicts and tensions, creating challenges for their implementation in practice.

Several authors acknowledge the challenges in addressing the tensions among the ideals of environment, economy, and equity and offer critiques of the sustainable development concept and its implementation.

Campbell's (1996) definition of sustainable development emphasizes the inherent tensions in the goal of supporting environment quality, social equity, and economic development, using a triangular model to describe these three priorities and their associated conflicts inherent in planning. Campbell (1996) describes the conflicts between each ideal. **First**, he calls the conflict between economic growth and equity 'the property conflict,' which is the tension caused by a society that both defines property as a private commodity and also relies

"on government intervention (e.g. zoning, or public housing for the working class) to ensure the beneficial social aspects of the same property," (Campbell, 1996, p. 416). According to Campbell (1996), this conflict between growth and equity "defines the boundary between private interest and public good" (Campbell, 1996, p. 416). According to Campbell (1996), this conflict between growth and equity "defines the boundary between private interest and public good" (p. 416). **Second**, the conflict between economic growth and environmental protection is described as 'the resource conflict'-- that businesses need to conserve resources for future use, but they resist regulation (Campbell, 1996, p. 417). **Finally**, Campbell names the conflict between social equity and environmental preservation, 'the development conflict,' and defines it as the difficulty of providing both economic subsistence and sustainable conditions for the natural environment simultaneously (Campbell, 1996, p.418).

The goal for planners, then, is to balance these three systems. Campbell's interdisciplinary view of planning links social theory with environmental science and policy, as he suggests "that planners should do better in combining social and environmental models" (Campbell, 1996, p. 420). Stressing the significance of the development conflict, Campbell (1996) emphasizes planners' role in helping to solve environmental and economic equity issues simultaneously through arranging procedures for stakeholder decision-making. He also emphasizes planners' abilities to "put forth specific, far-sighted designs that promote the sustainable town" (Campbell, 1996, p. 430), and to understand conflicts at a regional scale and the potential for use of technology, strategies based around an outcomes approach. Thus, for Campbell, the planner's task consists of a combination of procedural facilitating and guidance toward sustainable outcomes. Overall, he states, "In the battle of big public ideas, sustainability has won: the task in the coming years is simply to work out the details, and to narrow the gap between its theory and practice" (Campbell, 1996, p. 421).

2.4 Factors affecting green infrastructure planning

2.4.1 Land use – Land cover

Common approaches to mapping green infrastructure in urbanized landscapes regularly focus on measures of land use or land cover and associated functional or physical traits. Emissions of heat-trapping greenhouse gases from energy, industrial, agricultural, and other activities, and humans also affect climate through changes in land use (activities taking place

on land, like growing food, cutting trees, or building cities) and land cover (the physical characteristics of the land surface, including grain crops, trees, or concrete). For example, cities are warmer than the surrounding countryside because the greater extent of paved areas in cities affects how water and energy are exchanged between the land and the atmosphere. This increases the exposure of urban populations to the effects of extreme heat events.

Decisions about land use and land cover can therefore affect, positively or negatively, how much our climate will change and what kind of vulnerabilities humans and natural systems will face as a result. Impacts of land use- land cover includes

1. Effects on communities and ecosystem services
    - Choices about land-use and land-cover patterns have affected and will continue to affect how vulnerable or resilient human communities and ecosystems are to the effects of climate change.
2. Effects on Climate Processes
    - Land-use and land-cover changes affect local, regional, and global climate processes.
3. Adapting to Climate Change
    - Individuals, businesses, non-profits, and governments have the capacity to make land-use decisions to adapt to the effects of climate change.
4. Reducing Greenhouse Gas Levels
    - Choices about land use and land management may provide a means of reducing atmospheric greenhouse gas levels.

2.4.2 Climatic modification

A large body of research has been undertaken to examine the climatic effect of green infrastructure in urban settings. Green infrastructure [GI], including trees, green roofs, as well as Water Sensitive Urban Design practices have been found to modify urban climates through:

- urban heat island mitigation;
- reduced energy use and emissions; and
- air pollution interception and mitigation (McPherson et al., 2005).

Therefore, green infrastructure has the potential to ameliorate the effects of climate change in urban environments, thereby increasing resilience and livability, and reducing energy consumption.

2.5 Challenges and Opportunities for Developing Green infrastructure

In the past, green spaces have often been valued for limited uses, such as for sport/recreation, or simply for their aesthetic appeal. The term green infrastructure reflects the fact that green spaces can perform a number of functions, often simultaneously. One site could be providing several functions at once, providing us with multiple benefits. The real benefit of green infrastructure to planning is that it can help deliver other local, regional and national policy objectives, not just those related to green space. The challenge is ensuring that green infrastructure is capable of providing functions which will meet numerous planning objectives; that requires thorough design, planning and management.

2.6 Benefits of Green Infrastructure

Developing and improving green space in key locations within urban and semi urban areas are argued to have significant benefits which are reflected in increasing property and land values. Investment in green space can lead to higher returns for the property sector. Greener areas have a better image and attract more visitors, bringing with the retail and leisure spending and providing job and rental opportunities. This in turn increases land and property values (NENW, 2008: 9). More specifically green infrastructure [GI], being a spatial structure providing benefits from nature to people, aims to enhance nature's ability to deliver multiple valuable ecosystem goods and services, such as clean air or water.

This in turn will:

- Protecting ecosystem state and biodiversity
- Improving ecosystem functioning and promoting ecosystem services
- Promoting societal well-being and health
- Supporting the development of a green economy and sustainable land and water management.

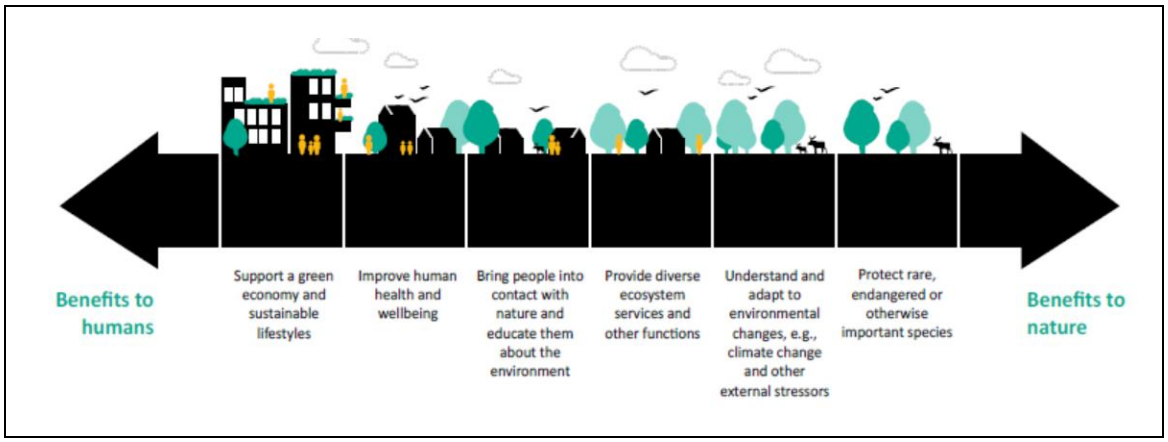


Figure 2.4: Benefits of green infrastructure

Source: Australian Institute of Landscape Architects Green Infrastructure Report (2012).

One of the key attractions of green infrastructure [GI] is its ability to perform spatial functions in the same spatial area. In contrast to most "grey" infrastructure which usually have only single objective, green infrastructure [GI] is multifunctional such promoting compatibility between grey and green infrastructure [GI] to deliver benefits to wide range of stakeholders, general public as well as the natural environment.

2.7 How to Scale up the result of the Study

Given inadequate of large-scale green infrastructure programs and research analyzing their performance, it is uncertain whether one can estimate potential benefits from a community-wide program simply by scaling up smaller-site design solutions. In other words, the benefits from a specific project may or may not have a linear relationship to the scale of a project. The relationship would have higher tendency of being linear if the site on which scale up has been implemented would have similar attribute with the study site. Instead of having a linear relationship, it is also possible that green infrastructure could function an opposite way. This would be the case if the benefits accrued from a practice have a proportionately greater effect on a large scale than they would if practiced over a small area. In effect, the green infrastructure practice would provide the maximum level of benefit only after achieving a certain scale of implementation. For example, the water quality improvement from a constructed wetland would be significantly and disproportionately larger than the water quality improvement from a smaller-scale rain garden.

When a decision is made to expand green infrastructure [GI] in project areas, there are two Ways of doing it. The first is to expand the original project areas, or create separate new ones. That choice depends on what is best for each individual municipality and can be decided by the task force. I believe, creating new project areas may be preferential, as it allows a community to focus efforts on higher need areas, areas that create the most storm water, or areas of varying geology or land use. A community will most likely have several critical need areas, which may or may not be adjacent to each other, and the multiple project area approach provides flexibility in meeting those needs. An equally important consideration within spatial scaling is the concept of an ecological threshold, which can be described as "the point at which there is an abrupt change in an ecosystem . . . or where small changes in an environmental driver produce large responses in the ecosystem" (Groffman et al 2006).

Case study: Grand Rapids, Michigan

The city of Grand Rapids has been promoting the use of green infrastructure for a number of years, which can be seen in the Grand Rapids Sustainability Plan and Green Grand Rapids Master Plan. Green infrastructure projects such as green roofs, rain gardens, pervious pavement parking lots, and rain barrels on public and private properties have been implemented without a structure to systematically calculate the benefits of water volume reduction on overall water quality. The city of Grand Rapids is utilizing the GIPS approach to increase the number of green infrastructure projects and to quantify those benefits on a larger scale.

Grand Rapids Baseline Calculation Methodology

The Rational Formula was used by an experienced staff member because it is a widely-used method of estimating peak runoff flow rates from a given rainfall event. The flow rate is calculated using the simple equation:

$Q = C * I * A$

Where Q is the runoff volume (gallons or cubic feet); C is the runoff coefficient (a higher number represents a more impervious surface); I is the rainfall intensity (we used a 1-inch rainfall, of unspecified duration); and A is the area (acres).

This method does not take into account such other variables as antecedent moisture conditions and time of concentration. While more accuracy could be useful, we believe that municipalities are better served by using a relatively simple calculation of the baseline so that it matches with similar calculations of the volume retention capacity of proposed green infrastructure projects, and a valuable comparison can be made.

In Grand Rapids, the first project area is a sewer shed and was divided into 22 sub-sewer sheds. Each of the sub-basins was visually scanned to estimate its predominant land use and density. Determining run off coefficient and volume of runoff for a 1-inch storm for each sub-basin in both cubic feet and gallons was the next step. Since this is just the volume of storm water that runs off the land, which isn't affected by the intensity of the rainfall nor any time differences, these sub-basin volumes can be added to get an estimate of the total runoff generated. This total volume is used as the baseline for runoff under existing (pre-green infrastructure) conditions.

In the Grand Rapids project, we estimated the reduction in runoff volume to be achieved by the green infrastructure and subtracted that volume reduction from the total runoff for the study area. Accurate calculations of the reductions from individual projects will be available from engineering designs for those projects, but they can also be estimated during the earlier planning stage using a tool such as the Green Values® Calculator.

Conclusive Summary

The benefits of a specific project may or may not have a linear relationship to the scale of a project. Before directly implementing design solution proposed for an area for other areas, the status and characteristics of an area need to be studied well and the feasibility of solution need to be ensured. And different modification mechanisms and considerations need to be thought deep to attain working solution for specific site I want to implement the project.

2.8 Empirical Experience of Urban Green Infrastructure

Ideas for green urban structures began in the 1870s, with concepts of urban farming and garden allotments. The development of green infrastructure has varied in its focus in the UK, Europe and North America. This diversity has been described as being heavily dependent on the main planning issues in each of these geographical regions. The UK has seen green infrastructures development through the ideas of Garden Cities and the protected designations of green spaces (Howard, 1985). In Europe, the development of green infrastructures has been linked with the development of the urban greening agenda and the need to develop integrated green space effectively with in high density landscapes (Beatley; 2000; 2009).

In contrast to the UK and Europe, green infrastructure is a concept originating in the United States in the mid-1990s has its foundations in landscape conservation (Benedict and McMahon, 2006). The term 'green infrastructure'' is sometimes expanded to multifunctional 'green infrastructure. Multi-functionality in this context refers to the integration and interaction off different functions or activities on the same piece of land.

2.8.1 Case studies

I. Aurora, Illinois USA

Faced with aging infrastructure, an already impaired local water way and projected population growth, Aurora wanted to strengthen its downtown economy while providing environmentally and economically sustainable solutions to its storm water management issues.

The City's leaders recognized the potential value green infrastructure could provide in solving some of these issues and began to analyze where GI might be appropriate. The resulting plan, highlighted in Aurora's Rooftops to Rivers program, seeks to bring green infrastructure to scale and attain quantifiable, replicable results.

Figure 2.5: Aurora green infrastructure development

Source: The Value of Green Infrastructure

II. Portland, Oregon USA

As in most urbanizing areas, Portland's increasing development has led to greater volumes and velocities of storm water runoff, which has threatened critical waterways. Combined sewer overflows have also decreased water quality in the region. In search of methods to alleviate these environmental strains, the City of Portland Bureau of Environmental Services analyzed the key ecosystem benefits of replacing traditional grey infrastructure with green infrastructure in their ten year "Grey to Green" program, which encourages innovative storm water management. In addition to ecosystem benefits, the city has begun to research the many additional social and economic benefits that GI can provide. For example, in its "Energy and Greenhouse Gases" section, the report calculates the energy savings from the Grey to Green's proposed 43 acres of green roofs. The calculations estimate an annual savings of 63,400 kWh (ENTRIX 2010). The next step would be to translate this energy-savings benefit into a monetary value by multiplying by a price per kilowatt-hour. While as yet no monetary value has been assigned for these benefits, the city is working toward a better understanding of the underlying additional value green infrastructure can provide its communities.

Figure 2.6: Portland green infrastructure development

Source: The Value of Green Infrastructure

III. Gauteng city region, South Africa

They assess both the natural and constructed landscapes and how the services provided by green assets are perceived, understood and valued. They extend their understanding beyond environmental protection and conservation by viewing green landscape features as a network of infrastructure, something essential to city development.

They conclude by translating "green benefits" into spatial planning terms, and suggests ways of guiding future green infrastructure planning and management in South Africa. It deals with transforming current planning approaches, understanding the importance of green infrastructure, identifying who will benefit from green infrastructure planning, preparing the new generation and ways to plan for green(er) cities through practical planning and initiatives.

Figure 2.7: Gauteng city region green infrastructure development

Source: planning for green infrastructure: options for South African Cities

2.8.2 Lessons drawn

The preceding analyses indicate that interventions on green infrastructure demand need:

- Political commitment and support;
- Ensuring social acceptance through community participation and other stakeholders;
- Designing green infrastructure programs in integration and holistically with the overall city development strategies (policy frameworks, city-wide land use development plans, socioeconomic and institutional interventions etc.);

CHAPTER THREE

3. METHODOLOGY OF THE STUDY

3.1 Definition of Case Study

The study is conducted on squatter settlement area mainly through on site observation and mapping on selected case area. The detailed analysis of the study area is given below in sub section 4.1.1 where I described the location, population, socio-economic status and environmental conditions of the site. The reason for selecting this particular site as mentioned in section 1.2 above is because of its worsening environmental problems (Squatter status and condition of green infrastructure, accumulation of waste that is threatening the health of residents and people passing by, environmental degradation of the area etc.).

3.2 Case Study Selection Criteria

Urban forest, parks, street trees and buffer vegetation's provide clean air for breathing, have aesthetic values and places for recreation, and can be source of income and use as carbon sinks. Due to almost non-existence of environmental friendly urban design and planning for Adama Town in general and Migira Pond area in particular, the above mentioned and many other benefits have not been tapped. What has been the focus of the municipal administration is the number of plots transferred to individuals and the amount of lease collection per square meter not the quality of the environmental goods for the citizens.

Even in the newly developed areas in Town, the proportion of green areas is almost insignificant. I as a young researcher want to assess the opinion of the general public on green infrastructure (GI), the proportion they would suggest on the total areas that are to be developed, how to link the green infrastructure [GI] planning practices into sustainability concept for the benefits of the people, what problems are threatening the communities as the result of the low focus given to green infrastructure [GI] by the planners and designers of

Adama Town. Thus, Migira Pond area has been selected for my research because it has multiple characteristics I am interested in to study.

3.3 Study Approach and Methods

The study focused on a participatory approach where various actors and stakeholders were involved at different stage of this research exercise. I employed both qualitative (focus group discussion, key informant interview, case study) and quantitative research methods. Thus, the study used mixed research methods and triangulated the findings of the quantitative with that of the qualitative analysis.

3.4 Source of Data

For this study both primary and secondary data sources were collected from various sources to achieve the intended objectives. Primary data was obtained from key informant interviews [Appendix II] and personal observation [Appendix V] while secondary data were obtained from reviews of different documents, policies, strategy, regulation, standards and guidelines related to current green infrastructure planning practices [Appendix VI]. The documents were analyzed with regard to the concept and principles of green infrastructure and were selected from the Ministry of Urban Development and Housing, and Oromia Urban Planning Institutes by consultation with experts from different sectors. The following criteria were used for selection: First, the planning documents should represent strategies, which refer to the planning, implementation and management of green infrastructure on a national, regional, and city level, and second it should be put into force and still be in use. In addition thematic studies were collected from municipality.

3.5 Sampling Technique and Method

Both Non- Probability and Probability sampling methods were conducted. The Non-Probability sampling method is based on purposive sampling methods to select individuals which can provide necessary information about the issue being studied. The researcher purposely selected environmental protection authority officers, urban planners, town infrastructure officers and land development and management officers for interview in order to get data on the values of recreational parks and street trees, the present status of recreational parks, runoff management, urban farming, and challenges for the development

and management of green areas in the study area. Probability/Random sampling method is used because it is considered as the best technique of selecting a representative sample in which each and every member of the population has an equal chance of being selected.

3.6 Sample Size and Techniques of Data Collection

For this study the researcher employed questionnaire based survey, interview checklists for focus group discussions (FGD) and key informants' interviews (KII), and documenting own observations during site visits. Multiple data collection techniques were used in order to get reliable information on the quality, accessibility, use, challenges, management as well as the community perception on urban green infrastructure and other study questions covered by this research.

To get a reliable data the researcher selected 70 respondents from the study area. For the qualitative approach I used Creswell (1998) recommendation which is 5 – 25 participants. Therefore, for the key informant interview 3 individuals from the department of greenery/environmental protection authority office, 3 urban planners, 4 individuals from Adama Town infrastructure office and 4 land development and management officers were selected for interview purposely (Appendix II). Key informants were selected based on their knowledge and involvement in urban planning, green infrastructure planning and management, and/or issues of current green infrastructure practices. The main instrument used to interview the officials was semi-structured interviews, which contained open-ended questions whereby the respondents were given the chance to discuss all issues of concern. The main topic of the semi-structured interviews was on how far the principles of green infrastructure are incorporated in current green infrastructure planning documents and practices. Moreover, the key informants were asked about barriers that hinder the adoption of green infrastructure both at planning and practice level. The key informants were also asked to propose solutions to overcome the constraints that hinder the adoption of green infrastructure planning. Furthermore 8 participants were selected for focus group discussion from different sectors of Adama Town Administration and interested individuals on the study (Appendix IV).

In addition, for the quantitative approach 48 respondents living in Migira pond area especially on the environmentally prone were selected to respond to the questionnaire

prepared by the researcher. 8 participants were selected for focus group discussions (FGD) from the respondents who responded to the questionnaire survey (Appendix III). Small sample size is selected because in Migira pond area the dwellings have similar characters and I expect most people have similar answers and the decisions that will be made based on the results do not have significant consequences on the well-being rather it will benefit the society at all . In addition the time given for the study is limited. In the quantitative approach I evaluated the socio-economic profile and perception about green-blue infrastructure and their access to green infrastructure.

Data from the key informant interviews were analyzed using the theoretical proposition strategy recommended by Yin (2003), which requires interview data to be analyzed under key themes. Based on this strategy, the responses from key informant interviews were categorized under themes such as integration of the urban green infrastructure planning principles, and existing barriers and solutions for their effective application. For further analysis and discussion, the data obtained from key informant interviews were supplemented by personal observation.

3.7 Ethical Considerations

The following ethical guidelines were out into place for the research period.

1. The Dignity and wellbeing of the respondents' was protected at all times
2. The research data remained confidential throughout the study and the researcher obtained participants permission to participate in the study voluntarily.
3. The research study is independent and impartial.

3.8 Method of Data Analysis

Data analysis is the process of systematically reaching and arranging the responses of questionnaire, interviews, observation, focus group discussion and other materials that the researcher collected to enrich the study. After the data were collected from various sources information has been organized and analyzed using different software packages like, ArcGIS, AutoCAD, Sketch Up, Adobe illustrator, Adobe Photoshop, U-lead video studio and Microsoft office. The organized data took certain form and the researcher built the explanation for this form of data. In qualitative research, coding is a useful way of organizing

data (Mikkelsen, 2005). Statements that were given by different informants were organized according to particular categories of themes. Thus, some meaningful responses have been placed in the analysis as quotes.

Table 3.3: Software used for analysis

No	Software type	Version	Purpose
	ArcGIS	10.4	For creating, editing, manipulating, mapping, analyzing and disseminating geographic information
	AutoCAD	2007	For preparation of 2d and 3d plans
	Sketch Up	2014	To provide 3d view
	Adobe illustrator	2016	Graphic driven software used primarily for creating vector graphics
	Adobe Photoshop	2016	Image editing software
	Microsoft Office	2016	Used to create documents and presentations, to organize, format and calculate data with formulas.
	U-lead	2017	For capturing, preparation, and editing

Source: Own data (April-June 2019)

3.9 Difficulties and adjustment during field work

Some residents were reluctant to give any information, but after I explained the purpose of my survey and showed my identification card as well as the supporting letter from my university, then I managed to build better rapport to overcome their fears and concerns. I slowly built my rapport with them and at the end they were very much cooperative and supportive.

In general I observed that the people do not trust people coming outside of their neighborhoods. Since the settlement is informal, several people have feeling of insecurity on their property because of the bad experience they have had in the past with the government officials.

3.10 Research Design

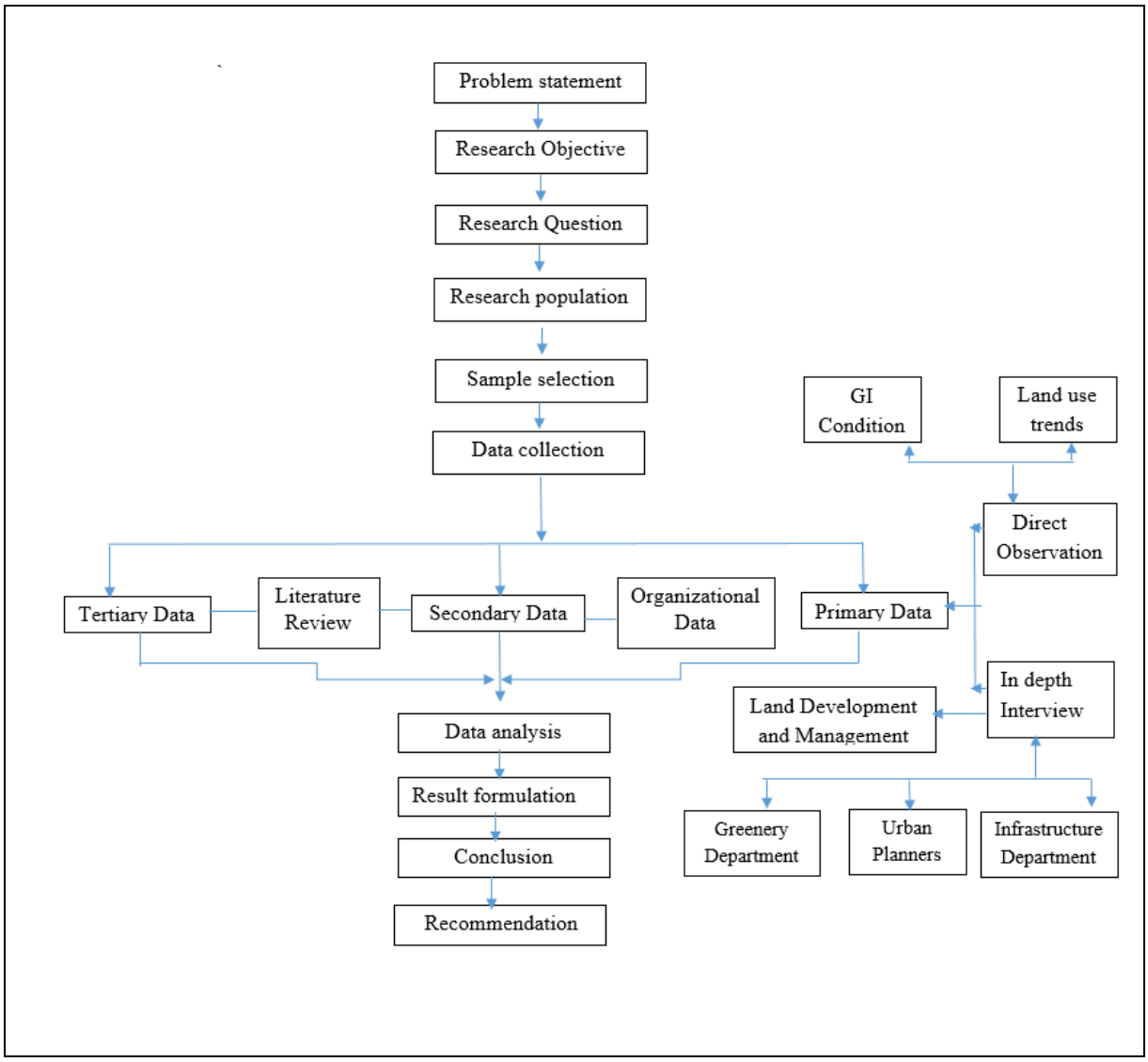


Figure 3.8: Research Design

Source: Own data (April-June 2019)

3.11 Conceptual Framework

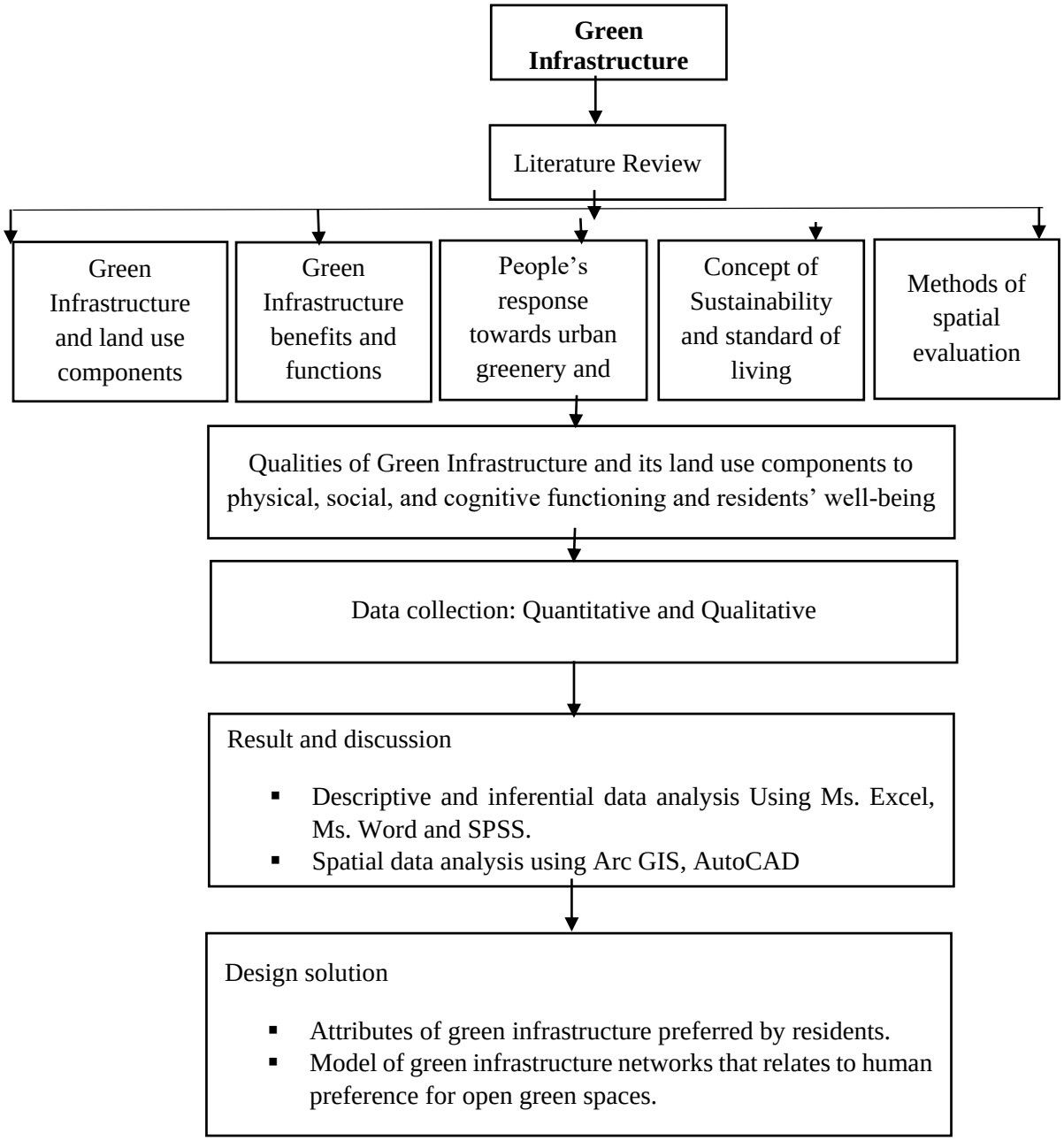


Figure 3.9: Conceptual Framework of Green infrastructure

Source: Own data (April-June 2019)

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Contextual Review

4.1.1 Description of the Study Area

Adama is one of the largest and most populated Towns in Oromiya National Regional State. It is located at 8º33`35``N - 8º36`46``N latitude and 39º11`57``E – 39º 21`15``E longitude.

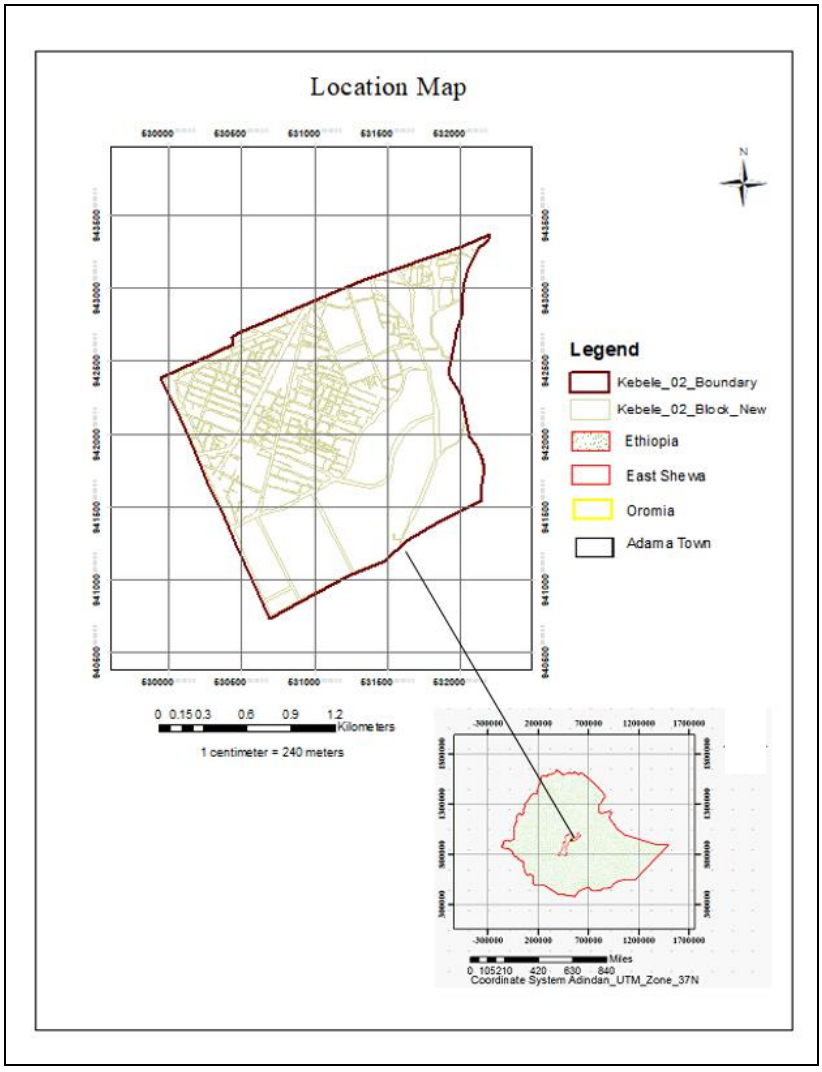


Figure 4.10: Location Map

Source: Own data (April-June 2019)

The case site is commonly called Ganda Migira [Kebele 02]; which is located at the South eastern part of Adama Town Administration [ATA]. It is relatively in low elevation area therefore, seasonal flooding from different catchments including diversion of manmade ditches are collected into this area. Ganda Migira [Kebele 02] is one of the periphery Kebeles surrounded by Dabe Solloque in the east, in north by Kebele 11 and 13, in west by Kebele 03 and in south by Boku Kebele.

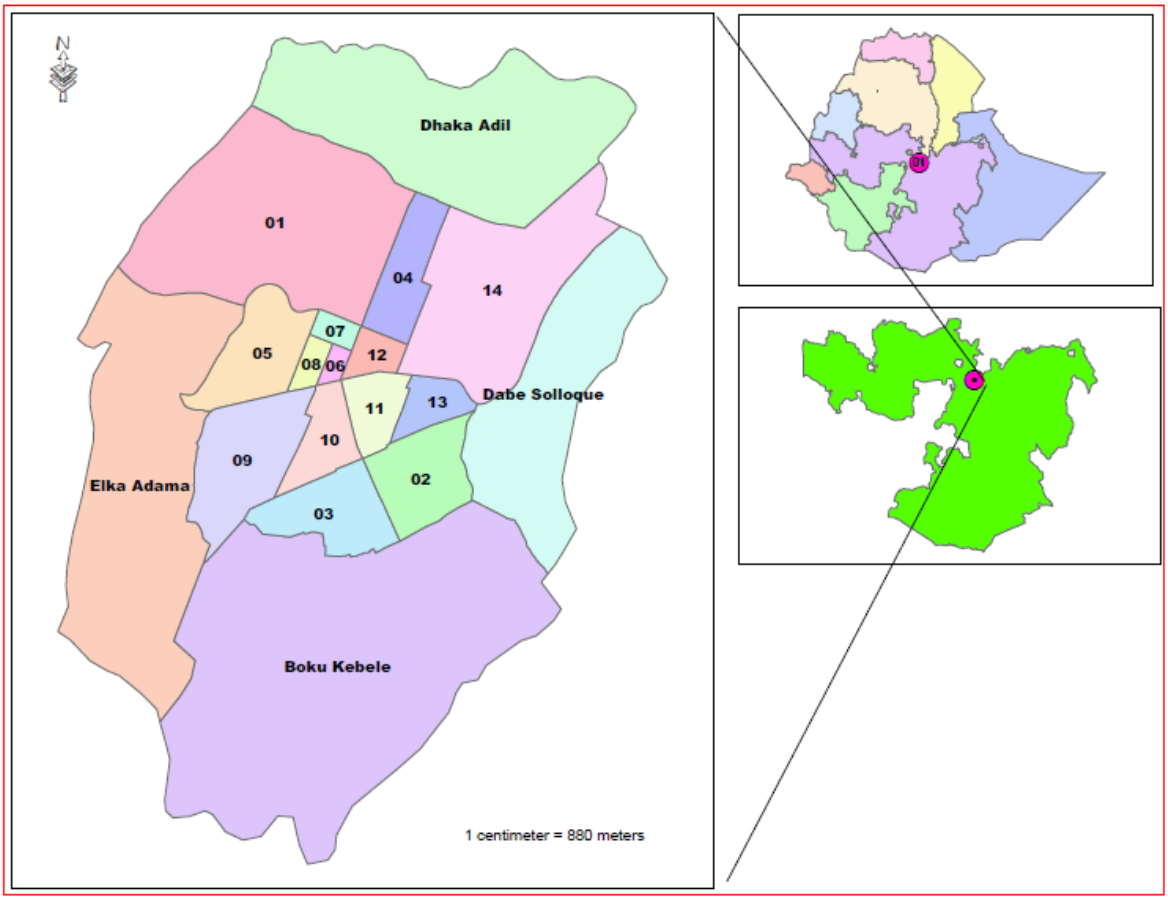


Figure 4.11: Location map of Adama Town in Its National and Regional Settings

Source: Food Security Attainment Role of Urban Agriculture: **A Case Study from Adama Town by Mesay Mulugeta**

It is important to investigate the integration and linkage of the study area with the vicinity localities as well as with the Town's spatial structure. Especially the service, infrastructure and facility distribution in relation to the vicinity areas and the linkage and accessibility to the planning area are important elements so as to ensure integrity with the influence area. The study area is easily accessible by local transportation means (vehicle, horse pulled cart) and it has good connectivity with other parts of the Town with major Arterial Street. The

figure below shows the site integration and setting from different important services, public spaces and landmarks; the Town center, municipality, university, and other important public offices reside.

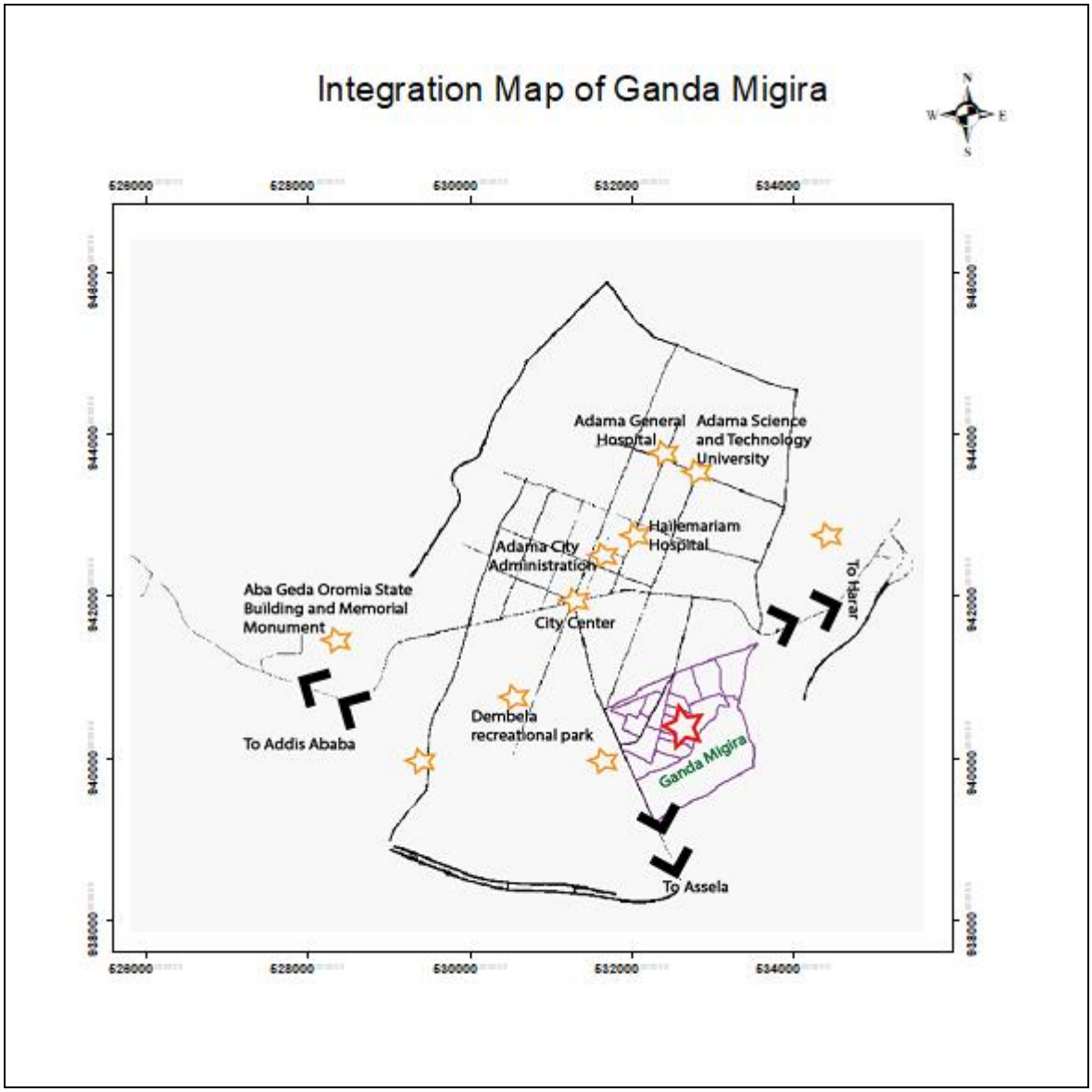


Figure 4.12: Location and Integration Map of the case Site

Source: Own data (April-June 2019)

Ganda Migira [Kebele 02] is also characterized by illegal settlement in addition to its seasonal flooding. The key characteristic that delineates an illegal settlement is that the occupier's lack of ownership of the land parcel on which they have built their houses. These could be vacant government or public land, or marginal land parcels like railway setbacks

or "undesirable" marshy land. Thus when the land is not under "productive" use by the owner, it is appropriated by squatters for building houses.

In the case of Adama, the term illegal invasion of land refers to two basic processes. The first step includes the development of rural settlements and/or illegal land occupation, which usually starts, with the establishment of small rural/semi-rural housing units and settlements. The second step consists of illegal land transfer from these original settlers to others/new settlers. The lack of any legal document certifying the right to the land occupied by the residents is taken as the major characteristics for defining illegal settlements in Adama. As per information, from Town Administration shows that more than half of the households in unplanned periphery areas of Adama have no user rights to the plot they occupy. This implies that all these housing units were built illegally. Since my case study area is populated by informal settlers, some residential units are developed at the environmental sensitive area near Migira Pond. Besides, concerning the land use, some incompatible uses like traditional animal fattening within the residential quarter were observed during my site visits especially at the west of Migira Pond. Therefore, it is vital to take in to consideration the issues discussed here while proposing new techniques and designing solution for green infrastructure.

4.2 Physical Site Analysis

4.2.1 Geological Setting of Adama Town

Adama is located within the Main Ethiopian Rift valley which extends from the southern Afar Rift to Konso highland in southern Ethiopia. The Town lies on plain land made up of volcanic rocks formed by geodynamic movements. These conditions have been some of the reasons why the Town is said to be vulnerable for earthquake. The Town lies on the quaternary volcanic rocks that were formed with the formation of the rift. Thus, the sediments that dominate the floor of the rift are alluvial and lacustrine deposits. The major tectonic lines, which are aligned in NE-SW direction in the Rift floor, form numerous local graven and horst structures (Rift-in-Rift structures) [OUPI, 2017].

The central volcanoes are rooted along these tectonic lines and are characterized by collapsed calderas, among which the Boku caldera occupies the southern part of Adama in the Main Ethiopian Rift (MER). The volcanic products from the Boku volcano can be grouped as

alkaline and per alkaline rhyolite lava domes, flows, and pyroclastic falls, which cover the floor complex ignimbrite deposits [OUPI, 2017].

The geology of the Project area /planning area constitutes the lower most part of the tertiary volcanic succession of the Ethiopian Plateau and it essentially belongs to the pre-Oligocene and Oligo-Miocene volcanic stages. Younger Stratoid Basalt rocks are observed in the vicinity of the area. Pyroclastics and Associated Sediments are found in and around the study area. It consists mainly of tilted beds of acid pyroclastic rocks like ignimbrite and acidic agglomerates with sedimentary intercalations at the upper part. Minor basaltic rocks are also found [OUPI, 2017].

The drift geology overlies the solid geology and the former consists of alluvial and lacustrine deposits i.e. sand, silt clay, diatomite, and limestone and beach sand [OUPI, 2017].

N.B: Q = Alluvial and lacustrine deposits; Qd = Tuff and pyroclastic rocks

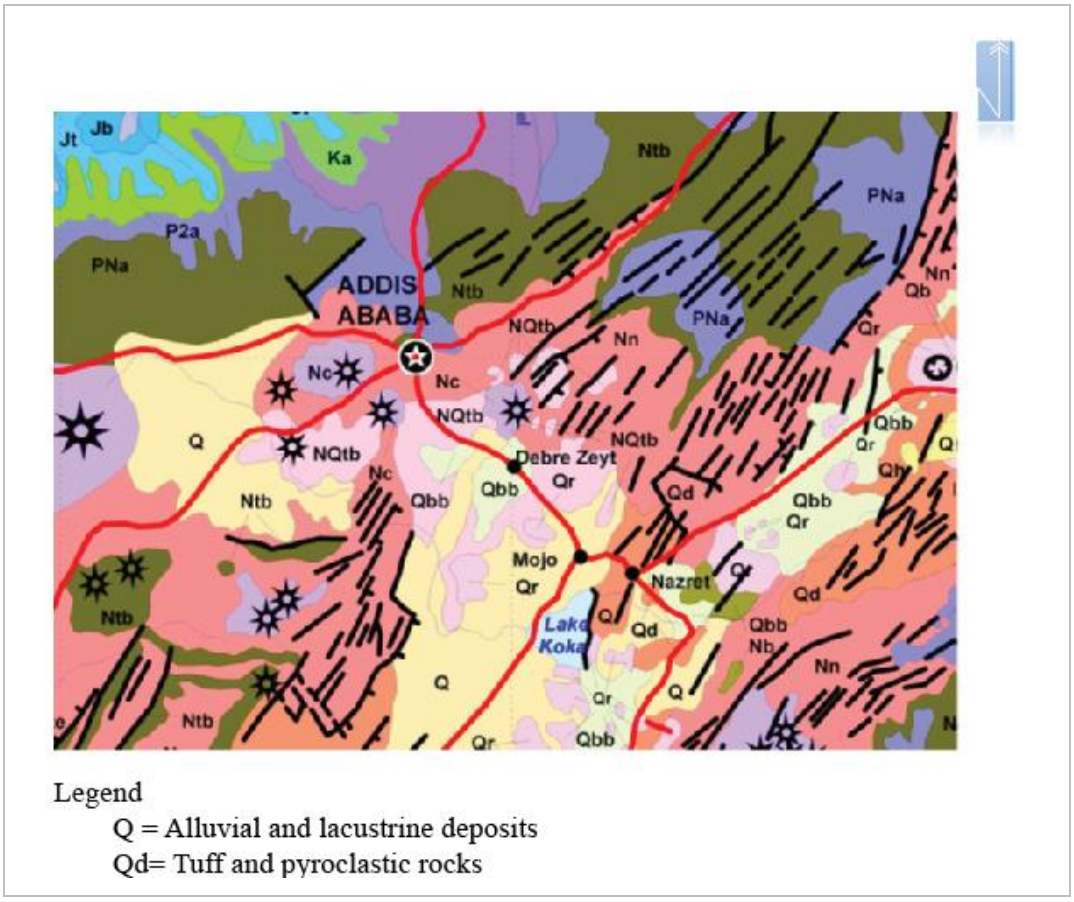


Figure 4.13: Geology in the Vicinity of Adama

Source: NDP Report of Dabe Soloqe, Adama, December 2015.

4.2.1.1 Geological structure of the study area

I observed land opening (crack) on the residences fence around Muslim Mosque in Migira Pond area. Information from the municipality shows this crack happened in 2005 (E.C); which has an extension from Adama Science and Technology University up to Bollo School. This opening (crack) ends at Migira Pond as shown in the figure below is where the seasonal flooding accumulated and sinks into the ground.

Figure 4.14: Photo of fault line with land opening along fault alignment at Migira seasonal pond area
Source: Adama Town administration

The occurrence of repeated step faulting makes it clear that the study area is located on still active and deep tectonic zone. In the study area there was severe refolding of rock bodies. This refolding of rock has shown foliation structures which area characterized by tension and laminar fractures. These fractures, in the central part of the Main Rift Valley, are represented by Wanji Fault Belt (Mohr, 1971; Di Paola, 1972).

As per information from Adama Town administration, a large number of thermal springs and fluid flows are associated with these geological structures which discharge hydrothermal fluids and flows of seasonal flooding through these structures. The geological structures, especially fault lines in the study area, have negative impact in infrastructure development and building construction. It also plays great role in water circulation. Therefore, the Town

Administration should have to give attention to these structures in plan preparation, in land-use proposal and height regulation of building in order to minimize failures and destructions. Appropriate adoption of green infrastructure is also needed to mitigate current and future challenges in order to meet boarder community goals and manage existing development.

4.2.2 Soil type

The major soils categories of Adama district are Andosols, Cambisols and Luvisols. Most of the soils of the district are Andosols, which cover 677.64km^2.The remaining 234.37 km^2 and 56.26 km^2, are respectively covered by Cambisols and Luvsols. The origin of soils of the rift valley floor, they usually develop from volcanic ashes and have limited depth; they are poorly drained and workable which limit their agricultural potentialities. Cambisols and Luvisols belong to one soil family Cambisols and are young compared to other tropical soils, in some cases due to lack of cementation have weak or no structure and this reduces their agricultural value. Though most Luvisols have problems related to root distribution that reduces their agricultural potential, compared to some tropical soils, they are good agricultural soils. In areas of steep slopes Luvisols are however unproductive[13].

The project site is covered with light dark clay soil, which is very thick layer and has the expansive nature that swells when wet and cracks when dry. The function of green infrastructure is therefore, to prevent soil erosion, by creating connection and integration with the existing nature and restoring the nature by conservation works in the degraded environment.

4.2.3 Rainfall

The average annual rainfall at Adama is about 866.25 mm. The maximum monthly average rainfall is about 200 mm. Most of the rain occurs in summer season (June to September) [taken from NDP report of Dabe Solloque, 2015].

[13] Egis International in association with IAU-IdF and UrbaLyon, NDP Report of Dabe Soloqe, Adama, December 2015*:*

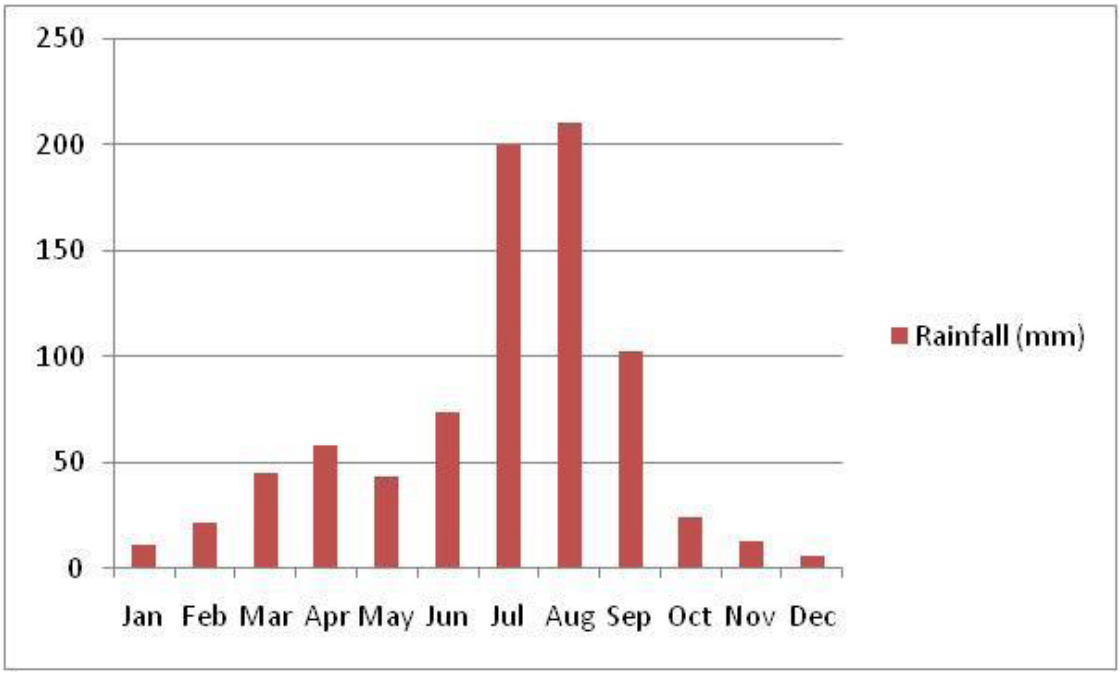


Figure 4.15: Climate of Adama: Average Rainfall (mm)

Source: NDP Report of Dabe Soloqe, Adama, December 2015*:*

4.2.4 Temperature

The mean annual temperature is 21°C. It can be classified as semi-humid to semi-arid climate, which characterizes the altitude range between 1300 to 1800m a.s.l. In Adama the hottest month with the maximum mean temperature of 31°C is May. The monthly minimum mean temperature is Nov & Dec with the temperature of 11.5°C. The maximum temperature varies between 25.8°C and 31°C while the minimum monthly values vary between 11.5°C and 17°C [taken from NDP report of Dabe Solloque, 2015].

N.B: [In general, the Town enjoys hot and dry weather for the greater part of the winter and warm and sunny climate in summer, which grants the Town with attractive weekends and summer resort release.]

4.2.5 Sunshine hours

The values from Adama station (1990-2002) showed that the annual average sunshine hour is about 36901 hrs. Making the daily average of sunshine hours vary between 6.5 and 9.5 hours. [14]

4.2.6 Wind speed and direction

According to NDP Report of Dabe Soloqe, Adama, December 2015 the wind speed in Adama is high with seasonal variation. The minimum wind speed occurs during September (1.65m/s), while the wind with high velocity occurs during December, January and February (3.05-3.2 m/s). The values calculated over 10 years (1990 to 1999) indicate that the mean is 2.31 m/s (the maximum wind speed recorded was about 10m/s). The prevailing wind direction of the Town is Northeasterly with seasonal variation.

4.2.7 Construction material

NDP report of Dabe Soloqe shows rocks, basalt, ignimbrite, rhyolites, scoria, pumice, sand, sand, gravel, clay, soil and selected materials are construction materials available in abundance in close range purposeful for construction of roads, houses and other infrastructure. These materials are mainly obtained from the hinterland. Few quarries of basalt, ignimbrite and rhyolites are found in Adama Town. Most of these quarrying activities are carried out at artisanal level at the foot of ridges and gullies. The quarrying activities are degrading the land, aggravating deforestation and endangering the physical infrastructures. Thus, it needs immediate intervention for better management of the resources. The intervention includes: abandoning quarrying undertakings in sensitive areas, selection of appropriate quarry sites and preparation of norms and standards for upgrading the quality of materials, and devising strategies for economic exploitation of the resource and rehabilitation works should be made in the old quarry sites.

4.2.8 Hydrology

Awash is located in the Awash River Basin to which seasonal streams and floods flow to. Awash River irrigates most agricultural fields and sugar cane plantation in the Upper and

[14] Egis International in association with IAU-IdF and UrbaLyon, NDP Report of Dabe Soloqe, Adama, December 2015

Lower Awash Basin and source of drinking water for human and animals in East Shewa of Oromia and Afar Regions. The river is source of irrigation for medium and small-scale farms as well as source of drinking water for both human and animals.

Figure 4.16: Photo of some considerable urban agriculture development within the Town boundary
Source: OUPI, Nov, 2017

4.2.8.1 Groundwater Hydrology

The level of ground water ranges from 20m around *Melka Hida* area to more than 100 meters around Technical College. The general ground water flow direction is deduced to be southward. The groundwater resources that mainly found following the Awash River, has not been exploited to the best level of its potential. Rather increasing human intervention has made it more vulnerable for contamination. There are about 10 boreholes at *Melka Hida* well field, which are located at some 7 Km southwest of the Town. These wells were sources of freshwater for the Town. Currently, this source is reserved and can be used any time in the future due to its high potential. Hence, the well field should be protected from contamination. Therefore, the site should be restricted by avoiding different establishments that can potentially pollute the existing groundwater system. However, well-managed industries that have no any groundwater threatening pollution effect can be established in northern and north western sector of the well field [taken from NDP report of Dabe Solloque, 2015].

4.2.8.2 Natural Hazards (Flooding)

The nature of the topography has created three drainage sub catchments. One is that drains to Awash River and the other two closed basins. Absences of the appropriate storm water drainage network and loose nature of the ground, lack of natural outlet and unplanned human intervention have largely made Adama Town vulnerable to flooding and significant amount of land is being threatened by erosion.

Flooding is a significant natural hazard in Adama attributing to its location within the flat lying rift. The main causes of flooding in Adama Town are both natural and manmade as shown below;

- Rainfall (precipitation)
- Soil types (with low permeability or impermeable)
- Poor drainage design in the Town
- Climate change (affecting precipitation)
- Floodplain encroachment (building on floodplains)
- Change of land use (deforestation, compaction of soil)
- Inadequate planning controls within whole catchment area (local & national) and
- Inadequate drainage capacity (urbanization) & siltation (natural)

In the study area, most of the runoff comes from northeast of (Adama Science and Technology University site), Golba Tegene and some parts of the central and eastern parts of the Town draining to Migra Pond. The runoff from various directions develops into damaging flood storm that could have the power of creating deep gorges with high discharge when it reaches at Migira Pond increasing the size of the backflow of water to settlement areas close to the pond. . As per the information gathered from dwellers and elders, the seasonal flooding has been increasing from time to time. The reasons for this were deforestation, land-use change, natural drainage closure (diversion).

Figure 4.17: Photo of seasonal flooding at Migira Pond area; accumulated there from different catchments
Source: OUPI, Nov, 2017

Unlike other areas; some parts of the accumulated seasonal flooding of Migira Pond dries-out during dry season for two major reasons. The first one is from evapo-transpiration and sinking through geological structures and the second one is that the soil of Migira is clayey silt which has swell-shrinkage properties.

Figure 4.18: Photo of Migira Pond area in dry season
Source: Own data [April-June 2019]

In order to solve the problem, storm water drainage network and artificial outlet should be installed. In addition, watershed management works should have to be conducted in the Adama catchment, especially on the ridges and drainage channels.

4.3 General Characteristics of the Case Site

Adama is found within the Wonji Fault Belt which is one of the main structural systems in the Ethiopian Rift Valley. Its physiographic condition is, therefore, mainly the result of volcano tectonic activities that occurred in the past, and also partly the result of the deposition of sediments, which are considered largely of fluvial and lacustrine origin. Adama is regarded as seismically active area concerning earthquake hazards with the probability occurrence of 0.99 in every 100 years (NDP Report of Dabe Soloqe, Adama, and December 2015).

Adama has an elevation variation from 1442m to 2048m above mean sea level and with about 606m elevation difference between the low elevation and high elevation. The high elevation is found in the northern while the low elevation is found in the eastern and southern part of the study area [OUPI 2017].

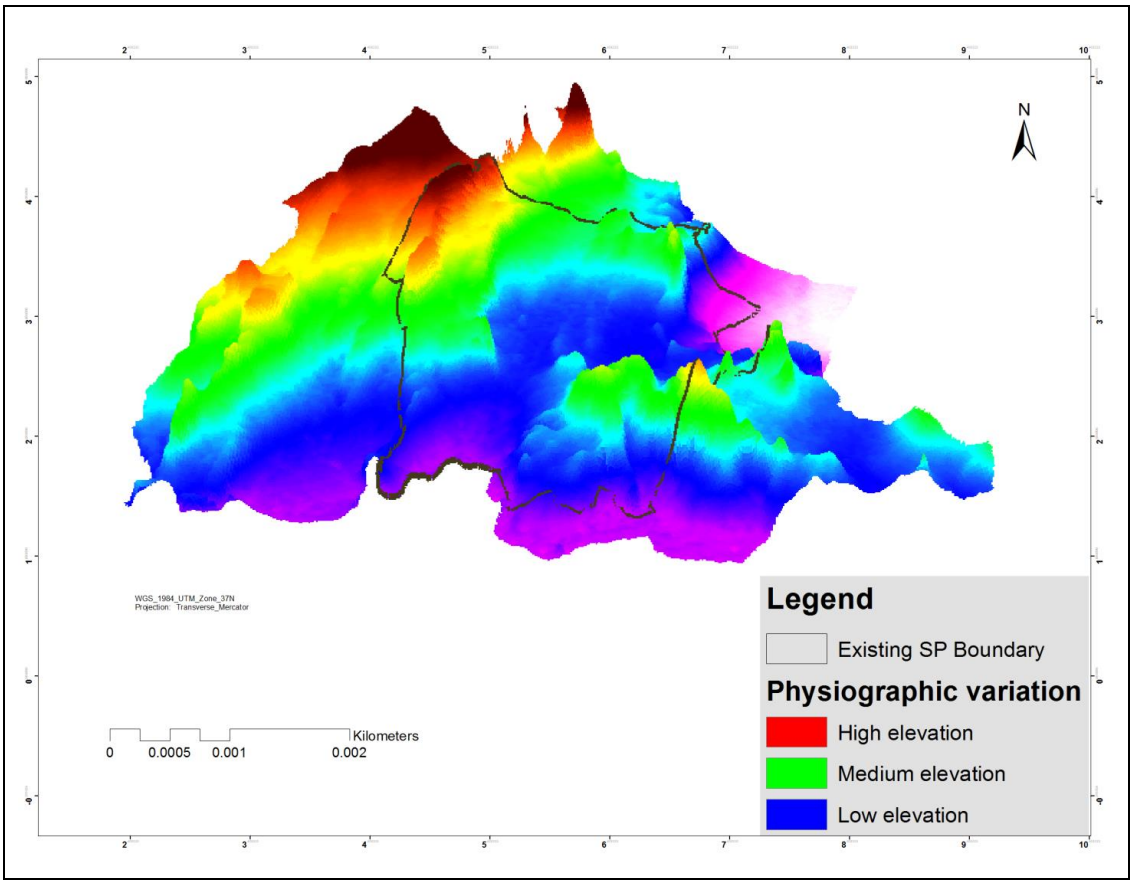


Figure 4.19: 3D physiographic variation of Adama Town

Source: [OUPI 2017].

4.3.1 Slope analysis

SlopeMore than 90% of the site is covered with flat, and gently sloping which is comfortable for farming, large scale housing development, and also industrial development. Area with slope of 15 and above needs special physical conservation treatment to improve land cover otherwise it could be exposed to water erosion. In order to addresses issues at the site scale, it is important of connecting and integrating planning and design practices to advance green infrastructure.

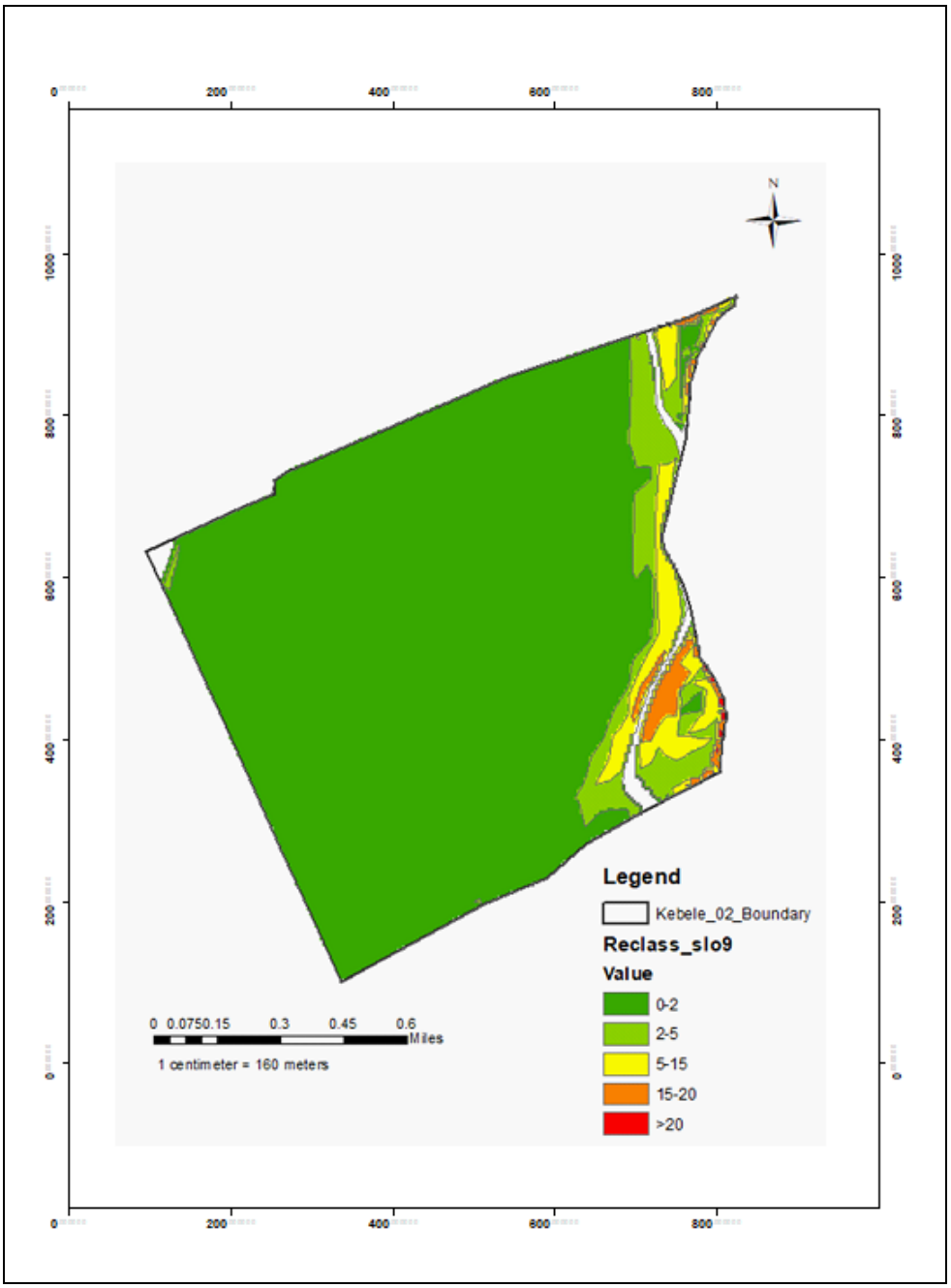


Figure 4.20: Slope analysis of Ganda Migira

Source: Own data (April-June 2019)

Table 4.4: Slope classification of Ganda Migira

Slope classification	Pixel Area	Pixel Count	Area _Sq.	Area _Ha	%age
0-2	111.7192542	26106	2916542.85	291.654285	87.39%
2-5	111.7192542	2050	229024.4711	22.9024471	6.86%
5-15	111.7192542	1283	143335.8032	14.3335803	4.29%
15-20	111.7192542	406	45358.01721	4.53580172	1.36%
>20	111.7192542	29	3239.858372	0.32398584	0.1%
Total			**3337501**	**333.7501**	**100.00%**

Source: Own data (April-June 2019)

4.3.2 Neighborhood characteristics

4.3.2.1 Land use plan assessment

The general existing land use of Adama Town includes Residential both pure and mixed, Commerce & Business, Administration, Services, Environment, Manufacturing & Storages, Road Network and Transport, and others (water bodies, projects under construction and gorges).

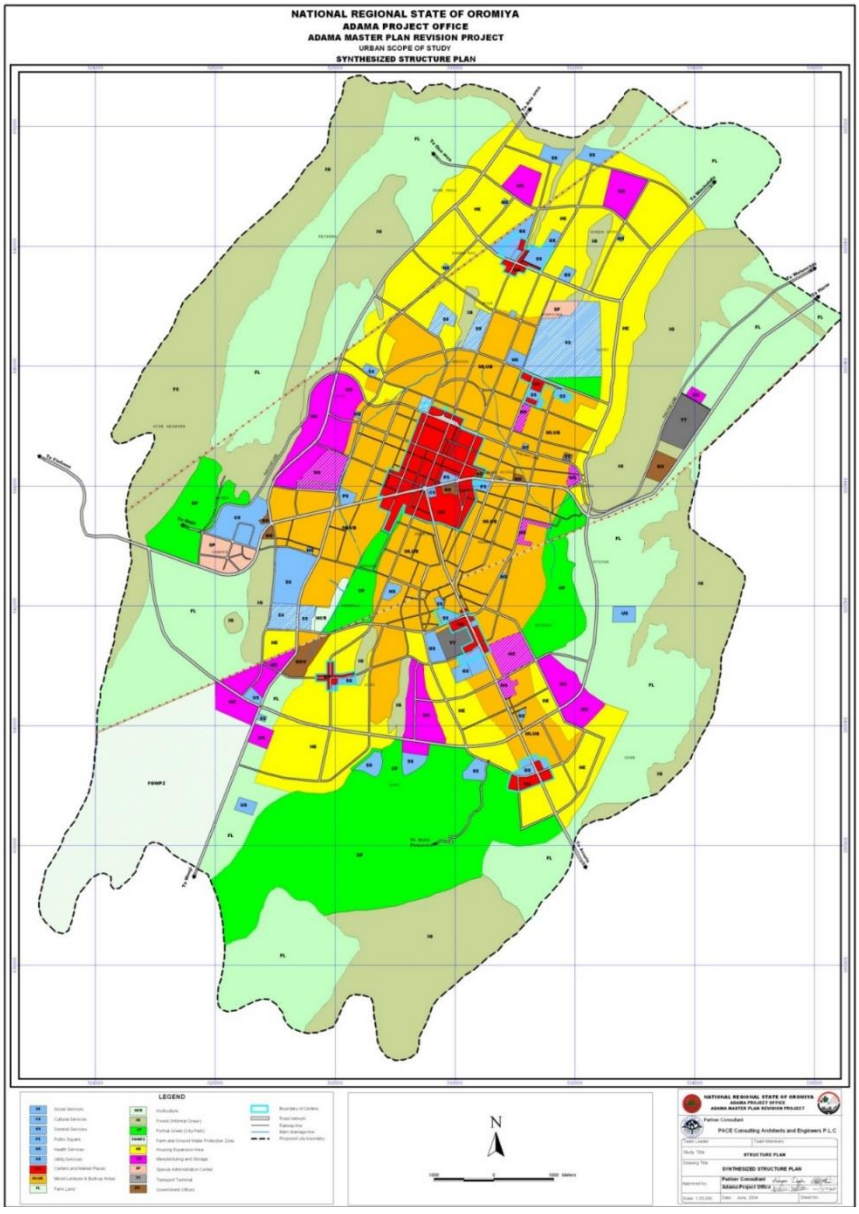


Figure 4.21: The Proposed Previous Structure Plan of Adama Town

Source: Adama Town Structural plan [June 2004]

The general existing land use with in the previous structure plan boundary is about 13,366.51 hectares of land in which its general land use is categorized in to eight (8) classes. Each land use category is summarized by the Table 4 as well as its general land use map is presented by Figure 18.

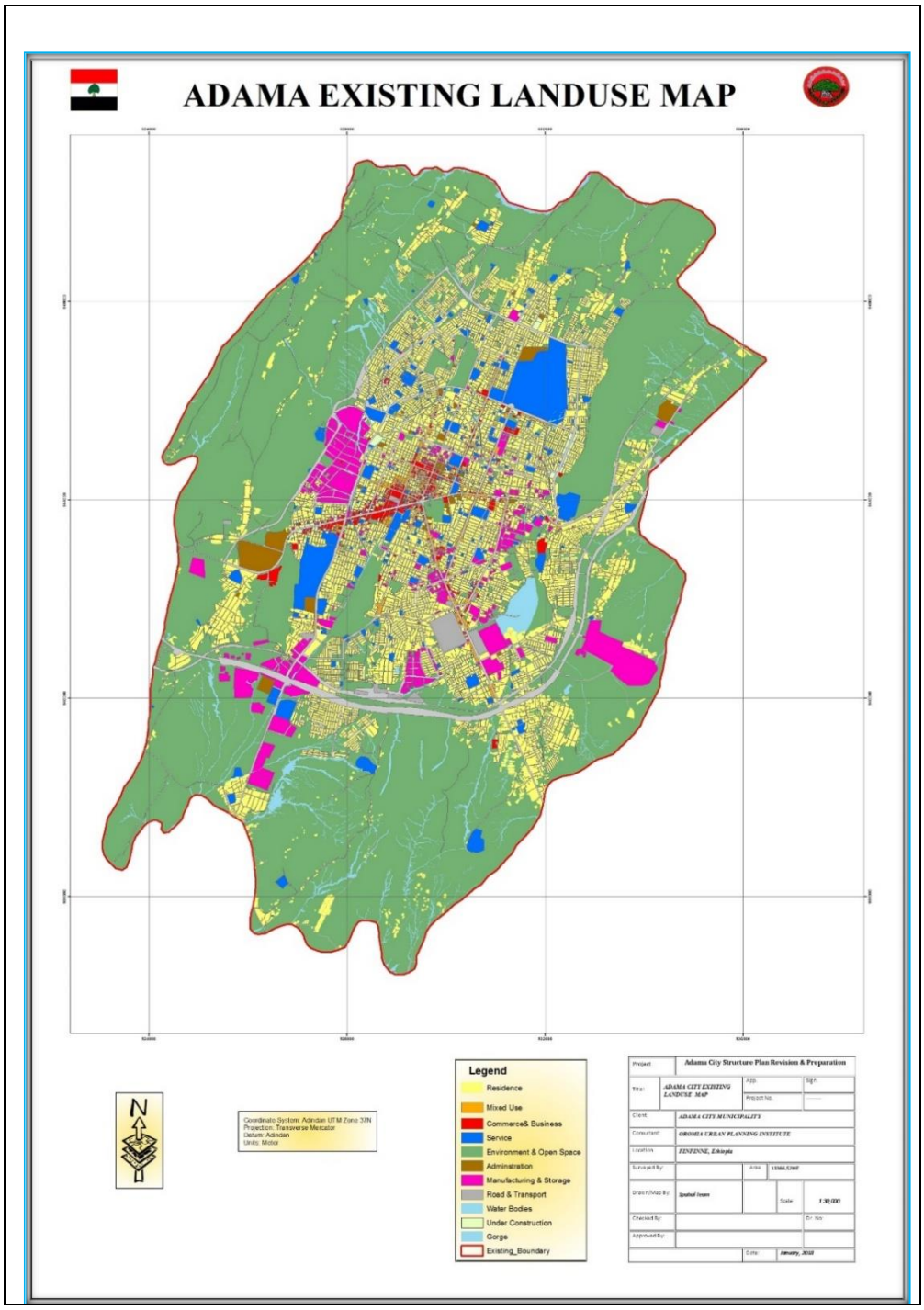


Figure 4.22: Adama Town Existing Land Use Map

Source: Adama Town Administration [Adapted from the existing land use of the Town]

Table 4.5: Existing Land Use Summary of the Town

No	General Land Use	Area (m^2)	Area (Ha.)	%age
1	Housing			
	a. Pure Residential	25202189.13	2520.22	18.85
	b. Mixed Residence	743520.02	74.35	0.56
2	Commerce & Business	1073527.90	107.35	0.80
3	Administration	1202416.50	120.24	0.90
4	Service	5154032.80	515.40	3.86
5	Open Spaces & Environmental Sensitive Areas	74794019.25	7479.40	55.96
6	Manufacture & Storage	5188484.23	518.85	3.88
7	Road Network, Transport & Utilities	16258482.82	1625.85	12.16
8	Others (Water Bodies, Projects Under Construction & Gorges)	4048527.35	404.85	3.03
Total		**133665200**	**13366.51**	**100**

Source: Adama Town Administration [Adapted from the existing land use of the Town]

The Newly Delineated Boundary of Adama Town Structure Plan

- The new boundary of Adama Town is 30,865.37 hectares [17,498.85 of hectares of new expansion is added to the already existed boundary of 13366.52 hectares].

Table 4.6: General Land use summary of the newly added boundary

No	General Land use	Existing land use	New Expansion	Total Area
		13,366.52	17,498.85	30,865.37

Source: Adama Town Administration [Adapted from the existing land use of the Town]

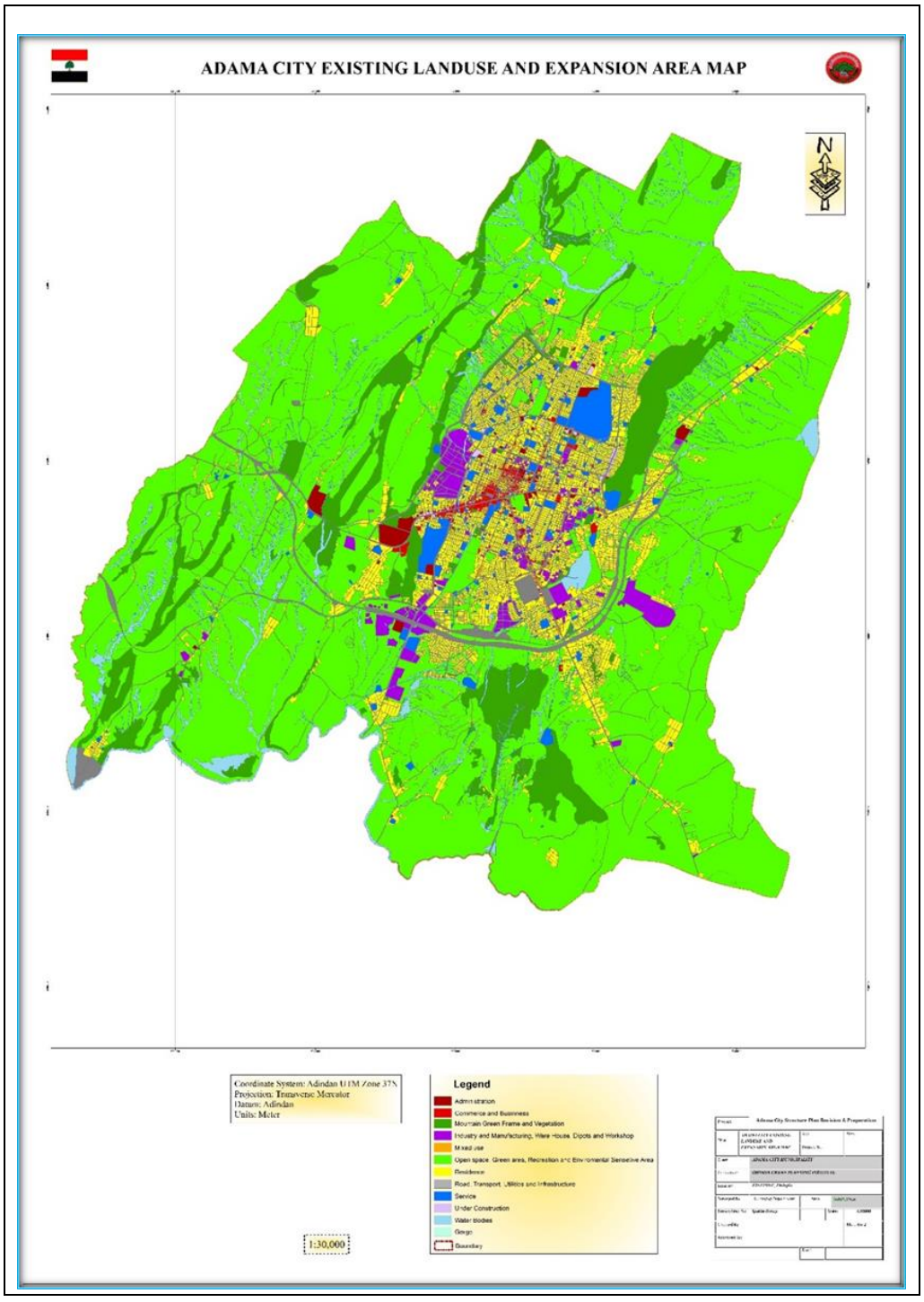


Figure 4.23: Adama Town Existing Land use and Expansion area Map

Source: Adama Town Administration [Adapted from the existing land use of the Town]

4.3.2.2 Existing land use plan of Ganda Migira

The following figure illustrates the existing land use plan of Ganda Migira. Among the land uses Residences, Migira pond, open green spaces and industries occupy predominately the existing area.

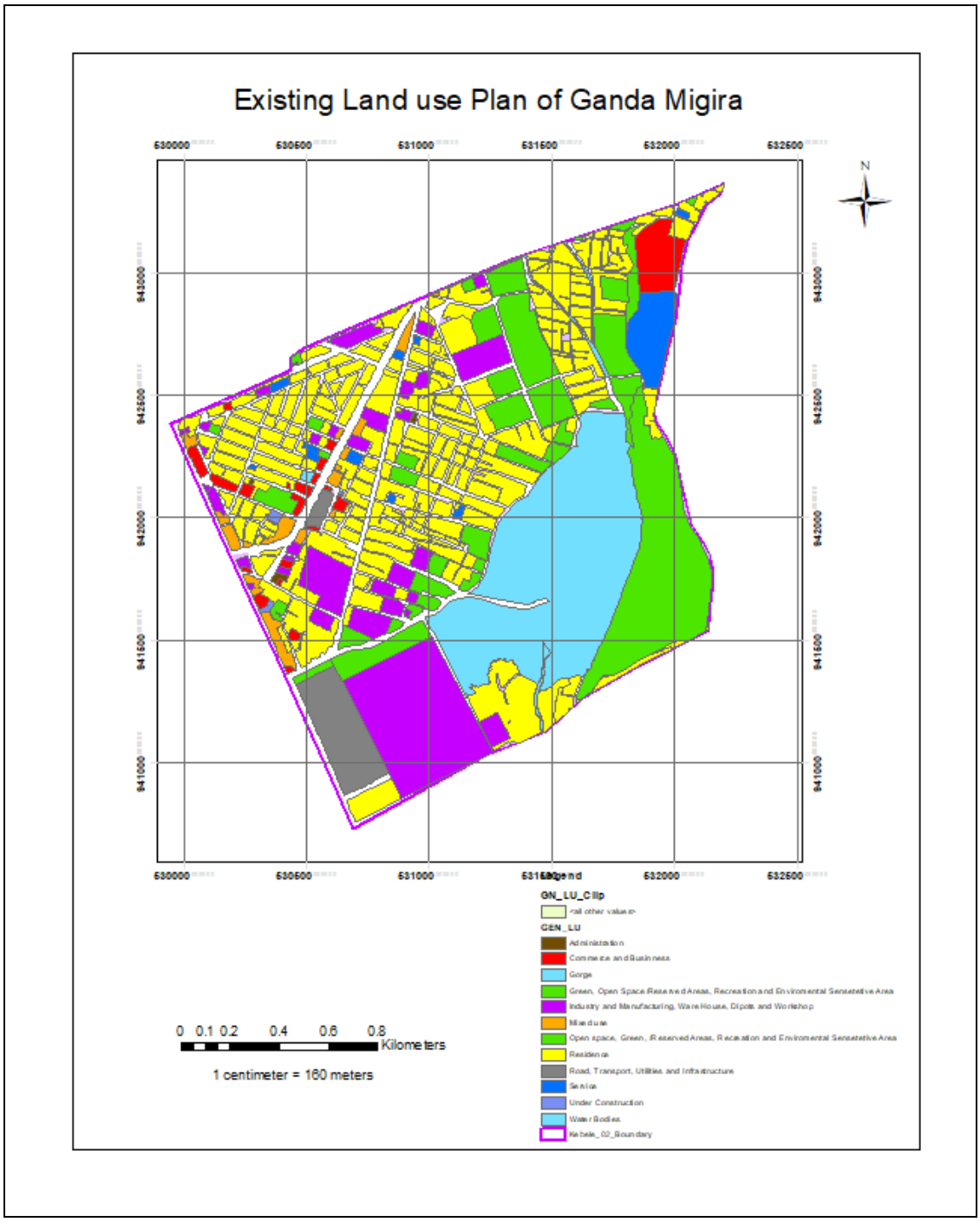


Figure 4.24: Existing land use of Ganda Migira

Source: Own data (April-June 2019) [adopted from Adama Town Structural plan]

According to the 2004 G.C structural plan of Adama Town the existing cattle fattening area of Ganda Migira [Kebele 02] was proposed as mixed use but, not implemented as per plan.

Table 4.7: Existing land use classification of Ganda Migira [Kebele-02]

No	Landuse category	Area[Ha]	Percentage[%]
1	Residential	141	42.2%
2	Commerce	8.2	2.5%
3	Service	10.53	3.2%
4	Green Open space	53.48	16.0%
5	Adminstration	0.3	0.1%
6	Industry	40	11.98%
7	Road, Transport, utilites and infrastructure	10.14	3.04%
8	Water body	54.89	16.44%
9	Under construction	0.42	0.13%
10	Mixed use	4.7	1.41%
11	Open space reserved	9	2.70%
12	Gorge	1.2	0.36%
	Total	**333.86**	**100.00%**

Source: Own data (April-June 2019)

4.4 Characteristics of the Dwelling Unit

4.4.1 Construction materials

According to the available information from Ganda Migira [Kebele 02] in 2016 G.C, among the total household 85% of settlements are illegally settled and the remaining 15% are legally settled with knowledge of Adama Town Administration [ATA] like School, Mosque, Church, Production Center, and so on. Because of lack of security of tenure the walls of most houses are built of wood and plastered with mud. However, there are few houses that were plastered with cement. In general, from the surveyed housing units about half of residential houses' physical condition was rated to be fair as observed during the survey.

Figure 4.25: Photo of construction materials of illegal housing in Migira Pond area
Source: Own data (April-June 2019)

4.4.2 Access roads and track paths

This part of the area does not have even proper track paths. Even if these are available, many of them do not have proper maintenance and therefore difficult to walk through during the rainy season. Lack of standard access to units is the problem for many residents in this neighborhood.

Figure 4.26: Photo of access roads and liquid waste drainage line in Migira Pond area
Source: Own data (April-June 2019)

4.4.3 Utility services

Squatter settlements, due to their inherent “non-legal” status, have services and infrastructure below the "adequate" or minimum levels. Such services are both network and social infrastructure, like water supply, sanitation, electricity, roads and drainage; schools, health centers, market places etc.

4.4.3.1 Water supply

In this neighbourhood 48% of the respondents use stand pipes as a source of domestic water supply and about 33.4% had water pipes in the compound while only 18.6% of respondents had water supply system in their dwellings. The problem they encounter with water supply is not the quality but frequent water cuts out as it is provided on shift which is not regular. No one knows when the water comes and when it goes. The problem of water has become a chronic for the majority of the people in Adama despite the efforts that the government is increasing the sources of water.

4.4.3.2 Power supply

A majority of the houses (about 73%) have access to electricity having their own private meter while 27% of the respondents responded that they get power from shared meter. Similar to that of water blackout days and nights are not known for electricity too.

4.4.3.3 Toilet facility

Talking about toilet facilities, a large portion of the respondents I surveyed have access to toilet facility and use dry pit latrines within compounds and shared by more than one household.

4.4.3.4 Solid and liquid waste disposal

The responses compiled after interviewing respondents showed that a large amount of solid waste is being collected by private solid waste collectors charging comparatively fair for the service they provide. 66.67% use the service of private agents for disposing solid and liquid wastes while only 8.33% of respondents use the service provided by the municipal agency disposing wastes. 25% of respondents unfortunately disposes wastes to nearby Migira pond or right on streets or into ditches.

4.4.3.5 Cooking places

Food preparation requires high standard of personal hygiene and sanitation facilities. The ownership of cooking place or kitchen was assessed and the results indicated that about 50% of respondents use private kitchens while only 20.83% use shared kitchens and 29.16% do not own kitchens. This means, many of the households are at one time or another using their living or bedrooms as kitchens.

4.5 Demographic and Socio-Economic Situation of Respondents

4.5.1 Population

The population of Adama Town is evenly distributed though all kebeles. The following table shows the population distribution and households (4.5 family size). As stated by Adama Town transport study report in Ganda Migira [Kebele 02] there are 4780 households with a total population 21,508.

Table 4.8: Population Distribution of Adama by Kebele, 2016 G.C

Kebele	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Popn	30,109	21,508	31,421	32,045	30,252	11,147	18,389	17,363	34,854	28,215	29,646	16,954	17,226	33,209
HH	6691	4780	6982	7121	6723	2477	4086	3858	7745	6270	6588	3768	3828	7380

Source: Adama Town flood mitigation proposal, 2016

4.5.2 Age of respondents

I investigated the ages of respondents to be able to find out what proportion of the settlement is capable of taking part in improvement efforts of green infrastructure as well as diversifying urban agricultural production. I have been able to clarify the size of the population that is at the height of its working and earning capacity.

According to my survey **75**% of the respondents were between the ages of 15-60 years. Therefore the majority of respondents are found in the productive age category in the study site.

4.5.3 Gender composition

A larger proportion of the urban poor are women as the jobs they have, if they have any, are paying much less than men. They often have temporary jobs and lack job security as a result. This is because women have not been included into the wider national economy, especially in education. Women in Adama too, especially those with less education, have more difficulty in accessing formal sector employment than men because the majority of women do not have access to even primary education. These and other cultural factors have resulted in a higher proportion of women having less employment opportunities than men. The majorities of those employed are in the informal sector such as petty commodity production,

domestic services and fuel wood collecting. In my case study area, I have found out that the proportion of men to that of women is slightly higher.

4.5.4 Martial status

It was found that about **50**% of respondents interviewed were married while **18.75**% are widowed. From such small study population, having **18.75**% women who have lost their husbands indicates a sort of unhealthy social situation. The widows probably have lost their husbands to HIV and AIDS or to civil wars waged about 2 decades ago.

Table 4.9: Demographic information of respondents in the study area April- June 2019

Demographic characteristics	**Frequency**	**Percent**
Gender		
Male	27	56.25
Female	21	43.75
Total	**48**	**100**
Age Range		
0-14	9	18.75
15-60	27	75
Above 60	3	6.25
Total	**48**	**100**
Marital Status		
Married	24	50
Divorced	3	6.25
Widowed	9	18.75
Single	12	25
Total	**48**	**100**

Source: Own data (April-June 2019)

4.5.4 Socio-Economic Status of Respondents

4.5.4.1 Employment Status

One of the crucial aspects of poor households is their inability to access financial resources to carry out repairs or to make extension to their original houses. Financing often addresses the needs of those with regular income and secured employment. With a growing level of

poverty and lack of access to credit the poor are left with limited choices for improving their shelter situation (cited in Samson Ayenachew June 2014)[15].

In my case study area I found out that **29.17**%, **18.75**% and **40.63**% of the respondents were employed by the government, private sector and self-employed respectively while **12.49**% were unemployed.

4.5.4.2 Workers in household

From among the respondents **62.5**% have the household heads as the main income earners in the household. A further **12.5**% are households in which spouses are the principal income earners. A small portion of **6.25**% is supported by income from offspring of working age while about **18.75**% is unknown. From among the households, those without employment are likely to suffer most for lack of financial capacity to better their living conditions.

4.5.4.3 Income

In terms of sources of income **47.9**% of respondents generated their income from wages and pensions while **16.7**% and **25**% from own formal and Informal businesses respectively. Transfers or gifts from others were cited as a source of income by **8.3**%of the respondents and **2.1**% of respondents generated their income from other sources.

Table 4.10: Socio-Economic information of respondents in the study area April-June 2019

Socio-economic status of respondents	**Frequency**	**Percent**
Employment type		
Government	14	29.17
Private sector	9	18.75
Self employed	19	40.63
Unemployed	6	12.49
Total	**48**	**100**
Worker in the Household		
Family Head	30	62.5
Spouse	6	12.5
Worker	3	6.25
Unknown	9	18.75
Total	**48**	**100**

[15] An Overview of Urban Poverty in Addis Ababa, (2001)

Income Range		
Below 1200	23	47.9
1200-2500	18	37.5
Above 2500	3	6.25
Unknown	4	8.35
Total	**48**	**100**
Income Source		
Wage including pension	23	47.9
Own business/formal	8	16.7
Own business/informal	12	25
Gift from others	4	8.3
Other	1	2.10
Total	**48**	**100**

Source: Own data (April-June 2019)

4.6 Existing Situation of Green Structure

The existing land use category identified the green land use category covers about 55.96% of the total existing land use. It is dominant category concerning its coverage [Table 4 & Figure 18]. However, the information I have got from the Adama Town Administration there is a decline of green infrastructure. Population increase at an alarming rate, skyrocketing value of land in the Town, lack of proper attention for urban green in designing and planning urban areas and the prevalence of informal settlement which leads mushrooming on each and every unoccupied sites and open areas are among the major reasons for the reduction and decline of urban green structures.

The existing green structure of the case site is analyzed on how far the principles of green infrastructure are incorporated in the current green space planning documents and practice level, Some policies, strategies and standards related to the green infrastructure development were driven from Girma, Y., Journal of Urban Management, September, 2018, [Urban green infrastructure planning in Ethiopia: The case of emerging towns of Oromia special zone surrounding Finfinne,].

4.6.1 Multi-functionality aspects of current green space planning practices

As the officials from Adama Town administration and Adama Town land development and management stated, multiple benefits and functions provided by different green spaces have been taken into account during the preparation of different planning documents, which are related to green spaces.

1. The Environmental Policy of Ethiopia, which was formulated in 1997, has an objective to plan and create green spaces within urban areas that provide recreational activities, habitats for plants and animals and improve urban microclimates.
2. The Urban Greenery and Beautification strategy, which was formulated in 2015, has an objective to develop green spaces, which reduce environmental degradation, pollution, urban floods, and which promote environmental sustainability in the urban area.
3. The Ethiopian National Urban Green Infrastructure Standard, which was formulated in 2015, has an objective to create ecologically well-functioning, aesthetically pleasing, and socially beneficial green spaces in cities and provide suitable, sufficient and ecologically viable green spaces for recreational, social, economic and environmental needs of the community.
4. The Green Infrastructure Based Landscape Design Supporting Manual, which was developed in 2011, also proposes to develop street tree plantings for shading, mitigating the urban heat island effect, reducing runoff and sequestering carbon.

The planning documents look like to be supportive of multi-functionality and an understanding of the ability of green spaces to provide multiple functions and services was present in almost all documents.

According to the information obtained from key informant interviews and observation of the field visits show that, only a few functions of urban green space (e.g. fragmented buffer zone which separate Migira Pond from its residents, illegal cattle breeding and few farming activities in dry season) were practiced. As the result, many urban green infrastructure components such as recreational, sports fields/playgrounds and also their contributions to storm water infiltration or mitigation to the seasonal flooding and heat island effect have been neglected in practice but taken into consideration in the structural plan of the Town.

Based on the survey result, most of the respondents have lower understanding on multiple benefits of green infrastructure due to lack access, knowledge and properly managed green spaces.

Figure 4.27: Photo of Green structure in Migira Pond area
Source: Own (April-June 2019)

The study shows that while planning documents are aimed at addressing the issues of multi-functionality, in practices the multiple benefits of green spaces are neglected. The finding is similar to a study by Liu (2008) which found that attention given to multiple functions of green areas is present more in statutory planning than in practice. In contrast, a review of urban green space planning practices in 20 European cites by Davies et al. (2015) and Hansen et al. (2016) shows that several ecological and social functions or services of green space are mentioned in plans and taken into account in practice.

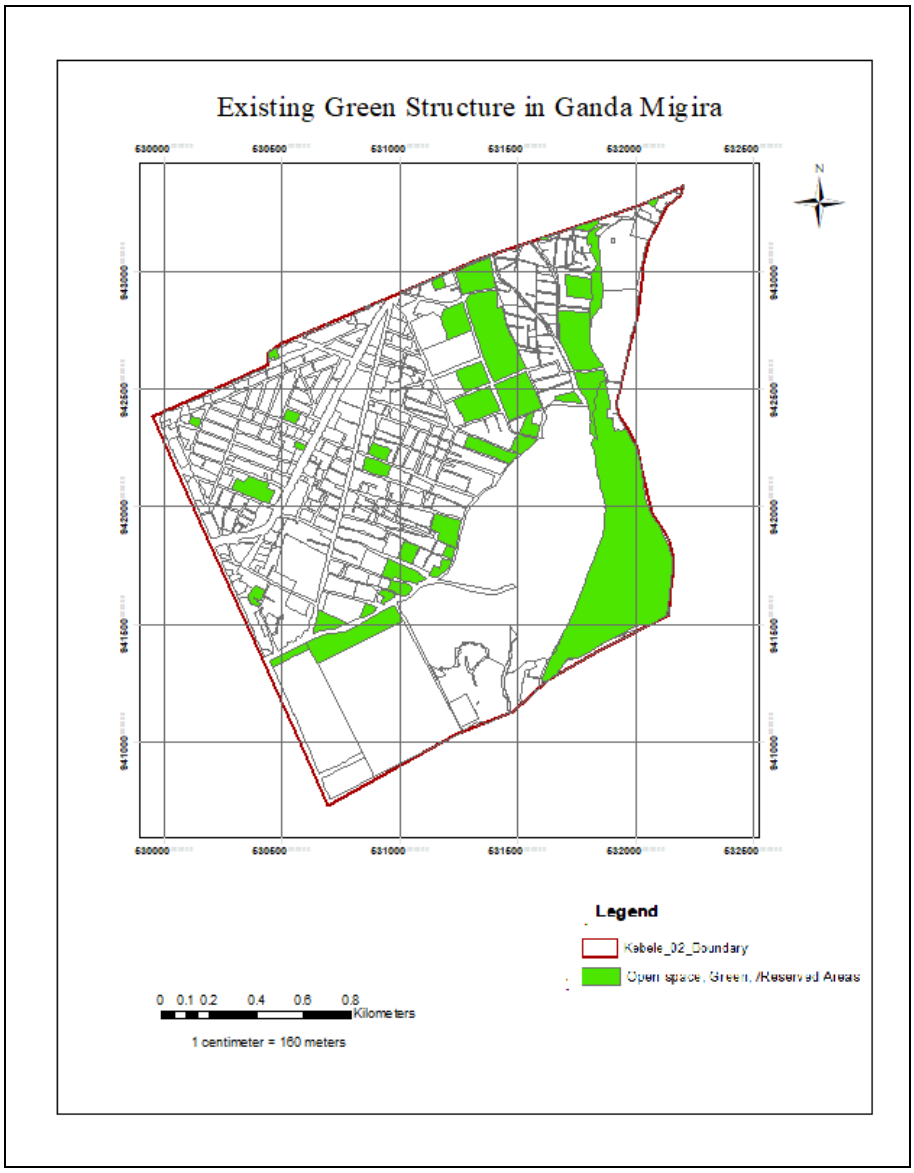


Figure 4.28: Green structure in Ganda Migira

Source: Own (April-June 2019) [adopted from Adama Town Structural plan]

The above figure shows the existing green structure of Ganda Migira [Kebele 02] with total area of 62.48ha. Out of this, 60.94ha is for Green, Open Space/Reserved Areas, Recreation and Environmental Sensitive area whereas cattle fatting covers area of 1.54ha.

4.6.2. Green- grey integration in current green space planning practice

Regarding the integration of green space with other urban grey structure the analyzed strategies, standards and guidelines, which have been related to current green spaces planning practices contained little information. For instance:

1. The Urban Greenery and Beautification Strategy has an objective to protect towns and cities from flooding by integrating green spaces with grey structure through the development of permeable surface and plantation.
2. The Ethiopian National Urban Green Infrastructure Standard requires improving storm water management and enhancing storm water quality through the regulation of river flow and protection of riverbanks. Moreover, the standards state how urban and regional planning should incorporate green infrastructure early in the process of designing of infrastructures like new roads, transit facilities and other projects by assuring enough space (both above ground and underground) and enough resources for green.
3. The Public Right of Way Management and Establishment Manual, which was developed in 2016 by the Ministry of Urban Development and Housing, has also an objective to encourage vegetation planting along the road sides and proper integration of both grey and green elements of the public right-of-way based on the current condition of green infrastructures in Ethiopia. These measures should reduce the urban heat island effect as well as noise and pollutants along roadways, and also improve air quality.

The information acquired from key informant interviews and personal observation from the field visit of the case study area shows that integration of green spaces and grey infrastructure has been practiced only in main road to Ganda Migira and around the Migira Pond. So these developed vegetated road buffer and fragmented buffer around the pond are used to improve aesthetic quality reduce noise and air pollution, and seasonal flooding.

Figure 4.29: Photo of Green-grey integration in Migira Pond area
Source: Own (April-June 2019)

Even though such attempts of green-grey integration have been found, in general their application is at an early stage indicating that there is still a considerable gap of collaboration between the grey and green spaces sectors such as transport, urban planning, housing, energy and water. In particular, the study found that infrastructural integration was limited to certain functions (like storm water integration) in the document and particular networks (like road networks) in practice, whereas there is no emphasis on expanding green-grey synergies on other built-up structures such as green building, green energy and the like.

4.6.3. Social inclusiveness of current urban green spaces planning practices

Studies show that social inclusiveness enhances effective management of green infrastructure and promotes community stewardship for green infrastructure components (Enger, 2005). This study was also aimed at assessing how the concept of social inclusiveness has been integrated into current green space planning practices. The results of the document analysis indicates that more than half of the planning documents, which relate to current green space planning practices, have considered the issue of social inclusiveness in different ways. For instance:

A. The Ethiopia National Urban Green Infrastructure Standard states that urban green infrastructure shall be managed and administered in the interests of the local community and shall address its needs. The long-term collective interests of the local community shall be prioritized over the interests of any specific interest group or sector of society.
B. The Growth and Transformation Plan (II) that was formulated in 2016 by the National Planning Commission of Federal Democratic Republic of Ethiopia has planned to increase the coverage of green infrastructure and recreational areas in urban centers of the country. Enhancing the awareness and participation of the community and stakeholders has been identified as important measures of green space planning in the document.
C. The Urban Greenery and Beautification Strategy has an objective to involve the community and stakeholders in sustainable ways during the development of urban green spaces. Moreover, the strategy states that urban greenery planning can be successful only when there is active participation of the community and the stakeholders.

D. The Participatory Urban Planning Manual that was formulated in 2007 by the Ministry of Urban Development and Housing has the objective of involving disadvantaged groups into decision-making during urban plan preparation, which includes planning of green spaces. Moreover, the manual has an objective to pay attention to the priorities, needs and constraints of the Town's population, especially to low income groups during urban plan preparation, which includes green space planning.

The above reviewed planning documents emphasize social inclusion and community cohesion in urban areas by involving community members and other stakeholders in planning and management processes as well as fostering a sense of community, the idea of social inclusiveness is less emphasized in practice. The evidence collected through semi-structured interview shows that formal communication among different sectors (e.g. the Planning and Land Management and Administration offices) are limited at different levels of government. For instance, one of the key informants said:

> "….we do not have access to major information on green spaces such as required standards and norms. This is because the formulation, preparation and approval of the plan is made at regional level by Oromia Urban Planning Institute [OUPI] excluding the direct responsible experts of the sector such as land administration and greenery department." (Key informant interview: May, 2019)

Likewise, the key informant interviews showed that most of the local communities did not participate in green spaces planning (and establishment/ management) and that there is a widespread disengagement of the local community in the preservation of green spaces in their areas. Furthermore, the local communities were not informed about issues concerning green spaces planning and management by the Town Administration. For instance, one of the respondent said that:

> "….I grew up in this Migira village and I lived all my life here but I have never seen any resident of this village being involved in green space planning and management." (Questionnaire Survey: May, 2019).

These indicate that community participation in planning which is an essential element of social inclusiveness and an essential process for identifying community need and interests and for matching plans with them was very week. In addition, the planning process lacked adequate accountability to the community while the plans lacked statutory status and mandatory implementation requirement making the community for influencing urban development in general very slim.

As Fuwape and Onyekwelu (2011), Mensah (2014) and Zakka, Permana, Majid, Danladi, and Bako (2017) indicate poor community participation in green space management is a common problem in many African cities. In contrast, partly due to long urban history, in many European cities especially cities in the United Kingdom, residents and community groups are highly involved by local Town authorities in the conservation of green infrastructure components (CABE, 2010a). Similarly, a study conducted by Davies et al. (2015) on 20 European cities shows that citizen participation in urban green infrastructure planning is widely implemented.

4.6.4. Connectivity aspect of current green spaces planning practices

During my analysis of different documents from municipality on issues related to connectivity of different green spaces were not given due consideration. None of the documents considered how to link green spaces physically and/or functionally. According to information obtained from the key informant, the idea of a network and connectivity was difficult during planning process. Because, there is a highly fragmented green space system in the Town as confirmed by key informant and also lack of adequate knowledge at national and local levels resulting from the newness of the concept of making green space has significantly affected the plan implementation practices.

4.7 Existing Situation of Blue Structure

As the officials from Adama Town infrastructure department stated; Adama Town is drained by a number of different sized seasonal streams and erosion formed gullies which usually start from the sides of the sloppy scarps, ridges and domes. Most of these streams are valley type and there is artificially developed drainage way which serves as the only outlet. During large storms almost all runoff from the surrounding high slopes drain in to the Town causing flash flood. These seasonal streams initially begin as rills and gully on the slopes and

progressively join to the main streams that have dissected the low lying flat land which ultimately fed into the Awash River. While some the streams and gullies sink in the lower slopes [like Migira area].

The main streams have relatively deep wide and V-shaped valleys. In places the whole profile of the sediment is cut down to the hard core while on the other hand the smaller streams and gullies are characterized by narrow down cutting valleys which sometimes have nearly verticals walls.

The northern and western part of the area contain relatively well developed drainage pattern. The western part characterized by nearly parallel streams running NNE-SSW that have short tributaries which start from the side of the bounding ridges. The streams drain to the Awash River. In the northern part of the area, Mermersa is the main stream in to which seasonal water from the surrounding high lands drains. It flows mainly to the east and later it drains in to swamp in north western part of the study area. Drainage of eastern and south eastern parts of the area is not well developed. Many streams and gullies which are usually non-graded sink in to the loose deposits in the low lands. Particularly those small streams that emanates from the eastern of Dibibisa dome sink in to the sediments along north_ east line giving a probable alignment of buried fault or fracture zone [OUPI, 2017].

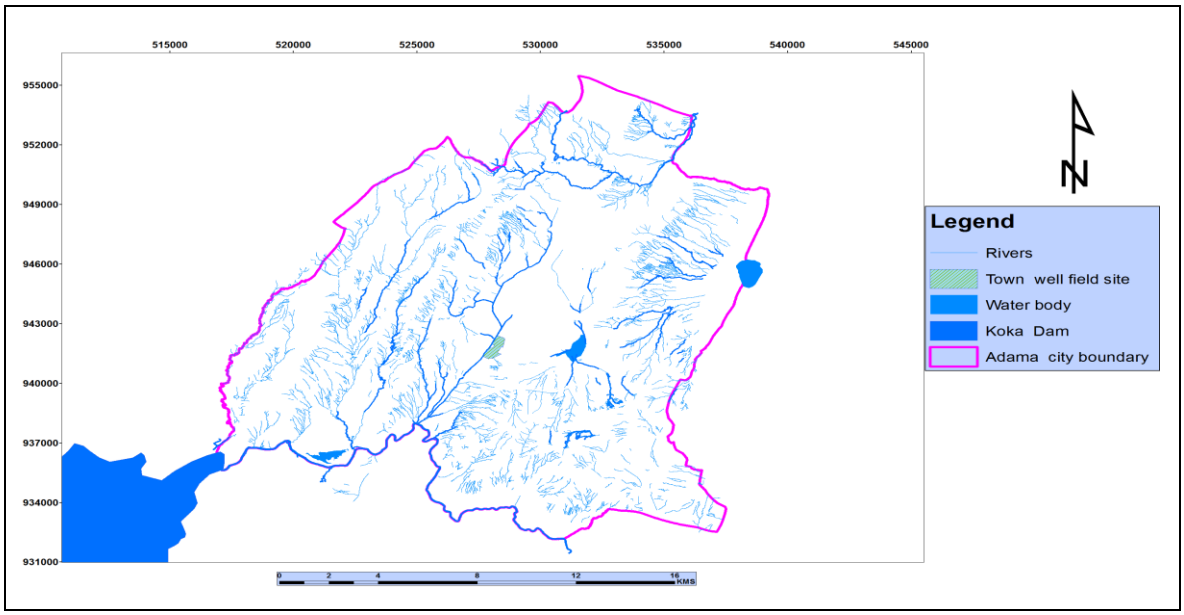


Figure 4.30: Surface water potential map of the Adama Town

Source: Adama Town Structural plan

The topography orientation of the area is rugged as it encompasses an area flat and gently sloping east wards and presence of hills and ridges. The western part of the area forms Migira flood plain where as in the eastern part it is intercepted by shallow and deep cut gullies. Adama Town Administration has two macro watersheds, namely Awash and Migira macro-watersheds.

The existing pond in 'Migira' and related drainage system in upper and middle catchments were the target areas of study. As per information from Adama Town Administration, the Eastern – Western parts of watershed of Adama Town Administration [ATA] directs finally towards 'Migira' pond from various sources of flooding from upper catchments of:

1. From the southern direction of the Town, the upper catchment includes Boku shenen, across express high way, being constructed by China road construction. From Lugo, above Boku Michael (Kebele 03, Tikurabay, RRC (Erdata mastebaberia), and below Boku Michael;
2. From the northern direction of the Town from Dhaga Adi, Bolle, around Derartu Building, Kebeles 13, 14, ASTU areas, passing through Kebele 13 then to 14, finally to Migira.
3. From central part of the Town, Adama Boset Elementary School, below Pikok, joining those drainages coming from the direction of Tikurabay.

Figure 4.31: Discharge coming from different catchments toward Migira Pond
Source: Own (April-June 2019)

The pond is under capacity to accommodate high discharge coming from different streams. According to the field observation and reviewed documents the highest flow or stream contributor is from the upstream which is artificially directed or diverted from the expressway.

Figure 4.32: Photo of two drainage canals diverted to Migira from Expressway
Source: Flood mitigation project of Adama Town, 2016

The inlet level of the flow streams to this pond is below the maximum pond water level. Hence, it serves as a channel for backflow towards the residences. Moreover, there is large

amount of sediment and rubbishes accommodated in the pond. The cumulative of these all creates the backflow effect to RCC store and its surrounding.

Figure 4.33: Photo of Blue Structure of Migira Pond area
Source: Own (April-June 2019)

As shown in the above figure, Migira Pond at the larger scale is being converted to grey and black water due to improper sanitation system, weak waste management, and poor protection methods. It is common to see industrial, domestic and municipal wastes being dumped into the drainage. Therefore my study site is exposed to such problems in the fullest extent particularly when there is heavy rain.

As per the questionnaire survey, Migira pond is one of the threat for Migira residents because as its level increases during the rainy season; it overflows back to the surrounding residents. Their attitude or interest regarding the problem were

- 41.6% of the respondents want a solution for the existing flood problem as well as issues related to informality without resettlement,
- 37.57% of the respondents want to be accommodated in nearer area without affecting their social relationships,
- 20.83% of the respondents also need resettlement in anywhere.

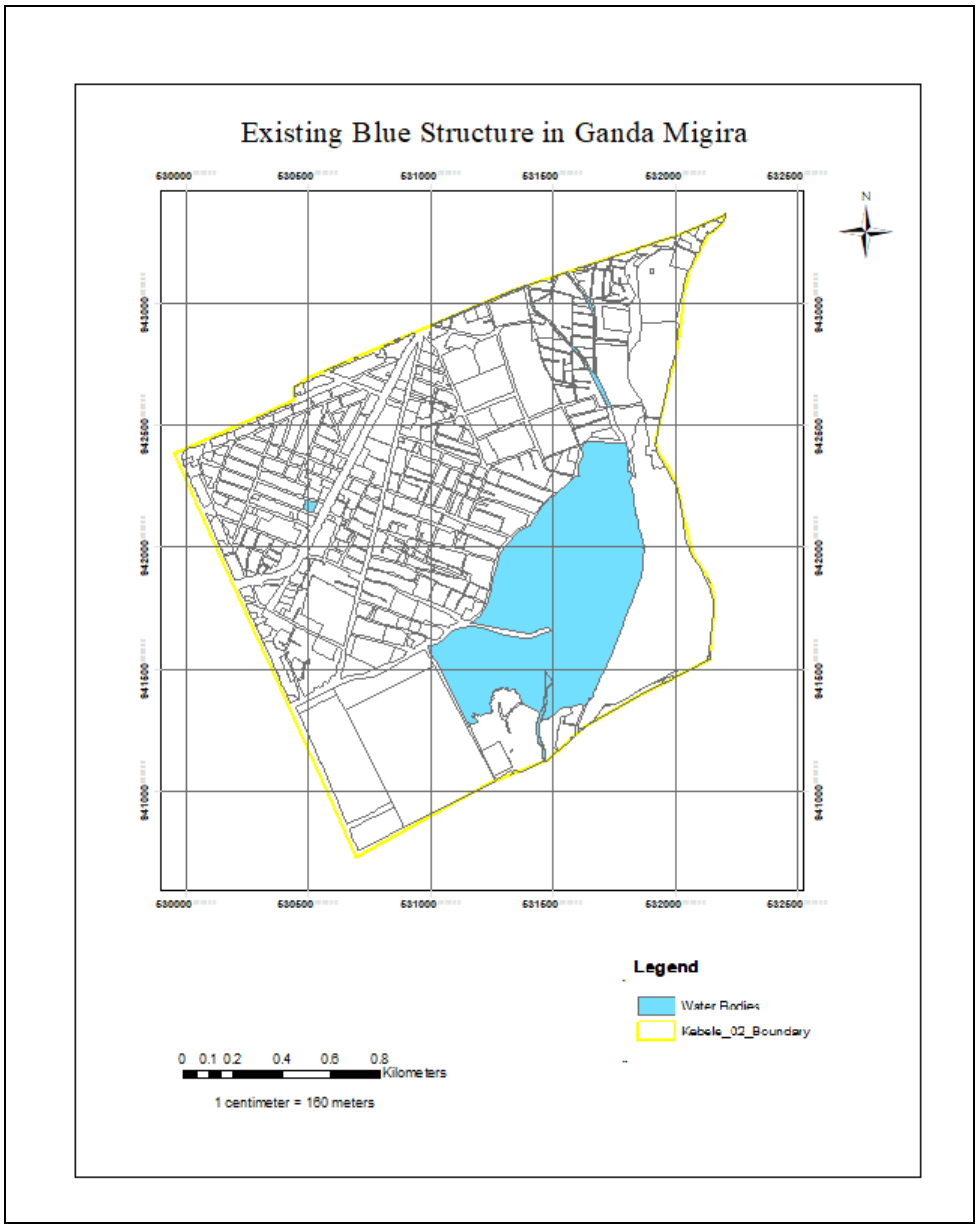


Figure 4.34: Blue structure in Ganda Migira

Source: Adama Town Structural plan

The above figure shows the existing blue structure of Ganda Migira [Kebele 02]. Migira seasonal water body covers area of 54.69ha, whereas the swampy area covers 0.2ha.

4.7.1 Existing problems associated to Migira Pond

From the feasibility study and existing data, the problem associated with the existing Migira's pond is not only the drainage systems in Migira watershed, but associated with Adama Town drainage system as a whole. Some concepts related to the problems were

driven from Flood Protection and Drainage System in Adama Town and Surroundings, studied by Technical Committee, April, 2014 are:

- Adama Town doesn't have drainage Master plan and the existing constructed drainage structures do not have a proper record of the drainage network and hydraulic capacity.
- Migira's pond drainage system, in particular is not properly panned and designed i.e. the main out fall drains to Migira that collect storm water from central and northern direction of Town and lay at lower place of Migira Pond.
- The drainage systems in Adama Town as a whole and Migira pond in particular have been illegally connected to untreated sanitary sewage from industry and business centers and dumping of domestic wastes from house households in drainage system which hinder smooth flow of storm water in drainage system and pollute water inter the retention pond and Awash River.
- Maintenance and cleaning services of drainage network not properly implemented to lack of comprehensive management in each Kebele, so lot of drainage line seen fall and full of rubbish (solid waste) and domestic wastes.
- As it is observed, during feasibility study, the current condition of Migira's pond bed is filled with the big amount of sediments, disorder, rubbish and organic matter, in which resulted the bed level of the pond is above the bed level of the main in flow. That is why the retention pond storage capacity is not sufficient to accommodate the amount of water drains from upper catchment.
- There is a sign of landslide (crack) forming folds around Migira pond; this embankment is long and joined two kebeles, which is inconvenient for the inhabitants and areas social life.
- Because of defined and associated problems around Migira pond flood cause stream bank erosion, degrade environment and water quality, damage residence resources, changing stream bed morphology and ecosystem, causing trouble, further health risks especially in the last 3 or 4 years
- From the previous laboratory Tests the soil which occupies the pond area is clayey silt soil having medium plasticity nature, non-dispersive and is impermeable. There

are wide opening cracks in the pond area depicting the presence of fissure/fault line underneath the thick soil cover.

4.7.2 Solid and Liquid waste management nearby Migira Pond

Increasing amount of solid and liquid waste is being generated as a result of rapid rate of urbanization and expanding industries of various sizes in Adama Town. This in turn presents greater difficulties for waste disposal as there is malfunctioning sewerage system in the Town. Weak governance system, frequent staff turnover, ineffective institutional capabilities have opened ways to out of control urbanization processes and also illegal mushrooming settlement in Adama. Had the urbanization process been guided by well-planned and designed urban land use is in place and the Town Administration could have introduced the modern way of city life and raised awareness and developed skills. Adama remains one of the loving home and business centers for all residents.

As it was observed and data obtained from Adama urban sanitation and greenery department the major types of solid and liquid wastes in the Town are generated from residential/households, commercial/business centers, institutions, industries, street sweeping, institution, construction and demolition, health facilities and municipality itself. Drainage channels constructed for conveying runoff water in some parts of the Town longtime ago has been damaged. The majority of the population of the Town use onsite sanitation facilities (waste is disposed of within individual plots) and a very minor proportion use offsite facilities (waste is transported to another site); while a significant proportion use open fields and storm water drains.

Based on my observation, domestic wastes from the households and sewer lines are the major sources of pollution. This drainage line seems no more an opportunity unless the Town government or concerned officials take measure to raise awareness of the residents to cooperate with the local administration to hold accountable those who dispose wastes. The officials must rehabilitate to make the sites to become centre of attraction not repelling. Unemployed youth can be supported to own, manage and generate income to improve their living standard and that of their families.

Figure 4.35: Photo of solid and liquid waste management around Migira Pond
Source: Own (April-June 2019)

4.7.3 Urban agricultural activities attached to Migira Pond

Some cities have adopted urban agriculture as a strategy to decrease urban unemployment, to improve urban food security, and nutritional status and to generate income for the urban poor in general and the disadvantaged groups such as women, and the disabled.

In Adama according to the structural plan, urban agriculture accounts about 1.45% of the environmental land use category and almost nil of the total land use under the study. It is safe however, to say that many poor urban households engage in local production of food, vending and related activities (e.g. production of food grains, vegetables, dairy and feed supply) as the main or complementary strategy to secure food supply for their families and/or to earn cash.

In the case site only 12 respondents that have economic activities attached to Migira Pond. Some of the major activities include vegetable gardening, animal fattening, dairy farm and poultry production. Due to poor environmental sanitation, disposing wastes to drainage line, and poor economic return; 75% of respondents around Migira Pond did not want to risk their health by producing the products because they feel that the water source is not clean and suspect high level of pollutant elements in it.

Figure 4.36: Photo of Urban agricultural activities attached to Migira Pond
Source: Own (April-June 2019)

4.7.3.1 Potentials and Challenges of developing urban agriculture in the case site

Potentials of developing urban agriculture in the case site

Urban Agriculture could be one of sustainable green infrastructures in Migira Pond area by providing multiple advantages to the inhabitants and people visiting the area daily for various reasons. Redesign and planning if integrates urban agriculture as Green Infrastructure [GI] would enhance the economy of each household participating in vegetable and fruit farming on walls and roofs. Urban farming and woodlots contributes as buffer on Migira Pond protection if it is practised along properly. The cooperation and willingness of inhabitants is decisive as well as provision of technical and capacity building support to the individuals interested in promoting urban agriculture is crucial to achieve effective urban agriculture and Green Infrastructure [GI] linkage. This enormous potential for enhancing Green Infrastructure [GI] through promoting urban agriculture improves the livelihood of the participating urban farmers as well as increasing the effectiveness of climate change adaptation. Increasing land cover and protecting pond area would increase the benefits (socio-economic, environmental, aesthetic and recreational) that are hardly found in the study sites of Ganda Migira [Kebele 02] as well as across the Town in general.

Challenges of developing urban agriculture in the case site

Despite the positive attitude, urban agriculture as an income generating activity face a number of challenges. These include:

- Lack of technical assistance such as improved and appropriate technologies for strengthening production;

- Lack of research support on urban agriculture in order to generate new technologies and methods of work;
- Lack of incentives and/or support to encourage the sector considering its contribution towards meeting the needs of the Town's inhabitants, particularly the poor and unemployed;
- The high level of water pollution due to poor coverage by adequate sanitation in many areas, the uncontrolled discharge into the water ways from public toilets, broken sewerage and storm drains, factories and offices, health centres, garages, institutions such as schools and colleges etc., all of which increase the contamination of vegetable products by pathogenic organisms
- Lack of skilled technicians for promoting and training urban agriculture skills;
- Challenges to established producers, such as urban dairy farmers, due to resettlement and relocation into unsuitable areas to continue.

4.7.4 Measures Taken to Overcome Problems associated to Migira Pond

To mitigate the problems related to Migira Pond area, a number of alternative options and intervention measures, from previous studies haven reviewed.

1. **Adama Town structural plan [2004 G.C]**

The structural plan revision work in 2004 was targeted at exploiting the potentials of Adama to get a worldwide, national, regional, and local importance by improving quality of the built and natural environment. The completion of the structural plan has led to the preparation of detailed studies on specific issues to facilitate the implementation process of the revised plan of Adama. One of the issues identified for study is the development of city /Public Park in the Town. The 2004 structural plan reserved (confirmed) the proposals of 1995 master plan with some improvements and proposed additional parks.

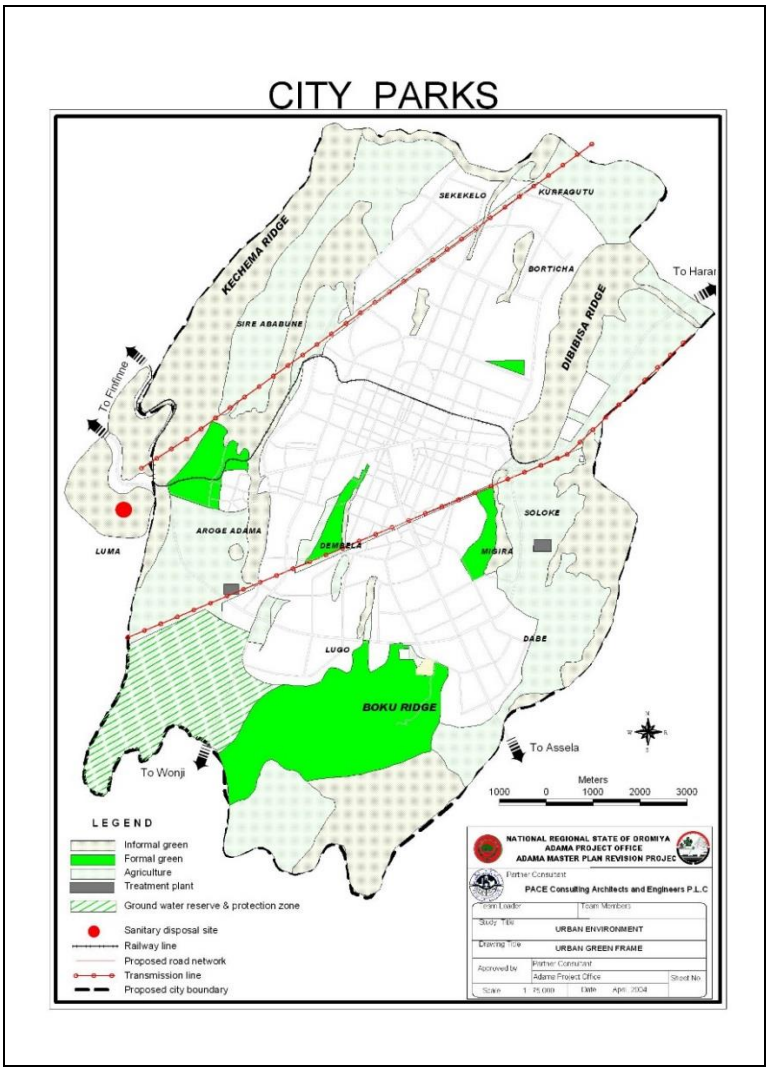


Figure 4.37: Proposed formal and informal green of the revised structural plan of Adama

Source: Adama Master plan revision project, August, 2004

Total area of the proposed parks [formal green] is 1281.6 ha [which is 9.6% of total proposed area (i.e. 42.72m2per person)]. Each park will have unique function with appropriate area to carry it out. For instance, the proposed park in Migira covers an area of 115.4 ha (67.2 ha plain and 48.2 ha cliff). The plain part of this site is also waterlogged necessitating appropriate drainage system. The size of the park opens the opportunity of developing it for various park functions. The proposed sewage and drainage lines of the eastern side of the Town will pass through this site necessitating maximum integration of the two functions [Adama Master Plan revision project, August, 2004].

Table 4.11: Location and area coverage of proposed public/City park of Adama, June 2004.

Proposed city Park	**Area coverage**	**Location**
Dembela city park (Dembela plain)	85.1	Kebele 09
Migira Park (Migira plain and ridge)	115.4	Kebele 02
Community park (College park)	18.4	Previous Kebele 03

Source: Adama Master plan revision project, August, 2004

As per information from the study of environmental team in August, 2004 G.C accessibility of the site in 2004 was almost nil. The proposed road network in 2004 does not enhance the accessibility to the park but will improve the access to the vicinity. The site at that moment was being used for agriculture purpose by the nearby peasant settlements.

Remark

Even if the Revised Structural plan indicated detailed direction for green frame development for the Town, it has not been implemented so far. Unpredicted population growth in the case site resulted conversion of prime agricultural, wetlands and forest to urban use such as housing, road and industry. The existing green cover is half less than the proposed in 2004 therefore, it is important to integrate and consider urban green development as integral part in the land use planning if Adama Town Administration is willing not to repeat the same mistakes that have been done in Addis Ababa over the last 130 years.

2. "EIA study by HAWAS engineering plc. Before 2012 G.C"

The technical feasibility study of the project [Diverting Migira Pond to other side of the mountain] was conducted by **HAWAS engineering plc.** [A consulting firm hired by Adama Town Administration].

Three technical options suggested by **HAWAS engineering plc.** Were:

a. Excavating the ridge saddle to have an opened channel
b. Tunneling the existing ridge
c. Pumping of the storm water through the top of the ridge

Remark

HAWAS engineering plc. Presented three technical options without preparing detail study of the potential impacts of the project by taking the most feasible one from the three options. In my opinion the above three alternatives, under a, b, c, are simply relocating the pond, i.e. creating another artificial pond, similar to the existing pond behind Migira hill or shifting the crisis to other community and environment on the other side of the hill. To my knowledge all three options have similar except they are different in implementation tactic and cost of relocation of the water.

3. **"EIA report in Diverting Migira Pond to other side of Mountain"; Promoter Adama Town Administration, by G-two Investment and environmental consultancy, April, 2012**

Lack of safe diversion of Migira Pond water and related infrastructure facilities are remained to be among the critical problems identified by the Town administration. Therefore the Town admiration decided and committed to open channel for safe discharge of water from the pond by hiring a consultancy firm which undertakes detail environmental impact assessment [EIA] and prepare resettlement action plan [RAP] for the project affected people [PAP]. The EIA report document was taken from **HAWAS engineering plc.** and EIA was conducted by **G-two Investment and environmental consultancy.**

Major Problems identified by G-two Investment and environmental consultancy are:

1) Due to absence of outlets at the lowest point of the eastern catchments of Adama Town, the flow accumulates in a depression, which has two major drawbacks:
    a. This depression has become a breeding place for mosquito,
    b. It creates large swampy area that could be development/expansion area for the Town,
2) Back flow of storm water from Migira Pond to Adama Town

G-two Investment and Environmental Consultancy identified the potential impacts of the project by taking the most feasible one from the three technical options suggested by HAWAS engineering plc.

Option -2: Tunneling the existing ridge was selected because it has no adverse effect on the ridge continuities, no conflicting issues with other services like ring road and green park projects, and least expensive compared to the above two options.

Remark

This option is also simply relocating Migira Pond and identified problems [such as pollution, waste and malaria] to other side of the mountain. Social issues and economic damage as well as environmental related risks were not considered. In addition to this the cost implication of about birr 20.05million birr was huge. With much lesser or about equal amount of money Migira pond area could have been developed into environmentally friendly, economically paying and social sound project.

4. **"Design of Adama Migra Pond Inundation and Flood Control Project, by Water works Design and Supervision Enterprise, May, 2013 G.C".**

According to this study **four** alternative options were suggested, which are summarized and analyzed below:

a. **Pumping and detention Pond**: which includes construction of detention pond and installation of pumping station, with 40m head to cross the Migira Hill.

Advantage	**Disadvantage**
Remove inflow water from the pond	High Construction cost
	Needs pump station
	Failure of the pump may take place
	Foreign currency is required
	24 hours monitoring & standby

b. **Tunneling:** it is underground passage dug through a hill, which is dug for water way without disturbing the upper surfaces of the Migira Hill.

Advantage	Disadvantage
Give access to the outflow,	Requires foreign technology,
Reduce large excavation [no adverse effect on Migira Hill].	Technically not feasible, from geological setting.

c. Open or cut and cover Hill Crossing: is deep excavation and construction.

Advantage	Disadvantage
Give access to the inflow water from the pond.	Deep excavation [40m length and 15m-60m width to incoming flood].
	Forms a big dissection of the ridge that could conflict with other anticipated services like ring road and city park project.

d. Diverting storm water (drainage) toward Awash River, The possibility of diverting storm water partially or totally from Migira catchment to Awash River.

Advantage	Disadvantage
Minimize the inflow of water from the upper catchments	Big construction cost to divert the direction
	Technically not feasible due to topographic feature

Remark on the above four alternatives:

- Draining Migira Pond artificially can only be considered as pond relocation, another pond will be formed in downstream areas, especially in Dongore Tenku and Dongore Rukete farmer's association and at the southern edge of part of Dabe Soloke rural farmers associations.
- Constructing detention reservoir is additional cost.
- Construction required substantial quantities of material and extracting significantly affect in several way including changing landscape.
- Expected detention areas are reserved for the expansion of Wolenchiti sugar corporation, farmers' farming & grazing lands.
- Immediately behind Migira Hill there is a ring road to be affected.

- Diverting is unpredicted; because topographic feature of the Town requires to have a place equal or lower than Migira retention [a minimum about 5.5 km length of drainage channel] is needed.

5. "Flood Protection and Drainage System in Adama Town and Surroundings'' in 2014

This study was conducted by Adama Science and Technology University [ASTU] and Adama Town Administration [ATA], as joint project. According to this study **four** alternatives were suggested, which are summarized and analyzed below:

a) Construction, maintenance & rehabilitation

Advantage	**Disadvantage**
Saving Life & resources of the inhabitants in Migira [Kebele-02]	Quality measures can't be attained due to time constrains

b) Resettlement of the residences, being affected and to be affected.

Advantage	**Disadvantage**
Permanent solution for the inhabitants and local Government	Expenses to resettle the inhabitant [provide land and compensation]
	Rehabilitation expenses after resettlement
	Disturb social bond of people

c) Control Migira Pond and Preserve Natural aesthetics of area

Advantage	**Disadvantage**
Turn Migira Pond to natural water harvesting.	Silt and sold particle deposit from upper and middle catchment
Do not affect farm, grazing land of downstream and infrastructures, behind Migira	

Relatively need low capital investment for construction of dyke, upper catchment and control mechanism	Urgent relocation and compensation for dwellers that live in and around Migira Pond
Preserve natural aesthetic and beauty	Might be sources of malaria, typhoid and diarrhea diseases

d) Partly divert the drainage

Advantage	**Disadvantage**
Minimize the pressure on Migira Pond	Expenses and natural degradation
	Relatively need high maintenance and administration cost

Remark on the above four alternatives:

The above four alternatives usually focuses on the usage of the pond. Since ponds are a major asset which provides enormous opportunity in water security sector. Similar to Migira Pond, poor quality ponds suffer degradation to an extreme level due to surface water pollution and because of their small volumes compared to lakes and rivers. The above alternatives majorly lacks detail strategies, planning principles and design mechanisms to give solution for the problem associated to Migira pond and on the usage of the pond.

6. "Adama Town flood mitigation project proposal" October, 2016

Adama Town has experienced serious incidents of flood and caused major disturbances, destroying property and resulting in loss of life. Extreme flood events in Adama Town result in loss of life and cause substantial property damage. In June of 2016 G.C, flooding tragically resulted in the loss of lives and properties in Adama Town. In an effort to identify potential mitigation measures to this natural disaster, a steering committee and flood mitigation technical task force with nine members has been established. The technical committee consisted of representatives from ASTU, Adama Town Administration and Awash Basin Authority (AwBA) established and conducted studies to propose flood mitigation measures.

- Identified Problems and Proposed short term Solutions in Migra Pond and Surrounding area were:

I. Over toping of Migira to RRC store

The flooding occurred around this pond is mainly due to over flow of Migira Pond which damaged RRC compound.

Figure 4.38: Picture of RRC store

Source: Flood mitigation project of Adama Town, 2016

Proposed short term solutions

- Making dyke along fence of RRC at east direction to drainage line feeding Migira Pond with selected material
- Cleaning silt and treating water way comes from upper catchment

II. Adama Industrial Park

This receive water from upper catchment of Industrial Park to Migira through artificial water way. High volume of water from wide watershed is joined to discharge at Migira Pond which will increase the discharge at Migira and erode the stream course favor the formation of large gorges in settlement area

Figure 4.39: Drainage inappropriately diverted to Migira Pond

Source: Flood mitigation project of Adama Town, 2016

Proposed short term solutions:

- Diversion works from the drainage of expressway to Dabe natural stream/waterway
- Provision of silt trap structure along the course
- Closing the artificial waterway that drains to Migira

I. Surrounding of Migira Pond

The pond is under capacity to accommodate high discharge from different streams. The inlet level of the flow streams to this pond is below the pond level. Moreover, there is high amount of rubbish and sedimentation. The cumulative of these all creates the backflow effect to RRC store and its surrounding.

Figure 4.40: Migira Pond during heavy rain

Source: Flood mitigation project of Adama Town, 2016

Proposed short term solutions

- Creation of awareness of waste disposal mechanisms
- Data collection about settlers
- Displacement and rehabilitation of the settlers under risk
- Maintaining the external dyke

Remark

Here, Migira Pond is identified with its overtopping nature to the nearby RRC and Adama industrial park areas. The nature of this pond is gradually changing by indicating the increasing of its level and its closed nature that has no outlet to the other catchment. In this study it is highly recommended for Migra Pond to study the geological, geotechnical, hydrogeological and geophysical nature of the subsurface nature.

4.8 Barriers preventing the adoption of green infrastructure planning

In the search for further development of urban landscapes, the concept of green infrastructure planning has become central in policy documents and as a planning tool (Lindholm, 2017). Nevertheless, there are a number of barriers associated with implementing the concept and its planning principles in the current green space planning practices of the study area. The barriers have been related to the following potential factors.

1. First, lack of awareness and poor involvement. The poor involvement of the local community coupled with limited awareness of the benefits of green infrastructure has made the local community to view urban green space planning and protection as the sole responsibility of government. Regarding this, a key informant from greenery department reported that:

   > "…., the concept of green infrastructure is new to most of us. As a result, low attention has been given to integrate properly the main principles of green infrastructure planning in the current green space planning practice" (Key informant interview, May 2019)

Because of these low levels of awareness, the community has the habit of using green spaces sometimes for illegal activities such as dumping solid wastes, and storing and selling construction materials, illegally holding Green Infrastructure [GI] areas.

Figure 4.41: Photo of Green spaces in Migira Pond
Source: Own (April-June 2019)

As per information from the greenery department, many plants have been planted each year, the survival rate on these plants has been low due to less or no care for seedlings once they are planted since no one is to be held accountable for common property in this country in general. Government officials who plant trees do not make official agreement with local communities on mechanisms of managing and protecting seedlings or the effort of providing environmental education is limited.

2. Second, lack of professional skills and experience. The environmental advantage and multi-functionality benefits of green infrastructure planning demands skilled professionals equipped with different disciplines such as landscape ecology, urban and regional planning, and landscape architecture (Pauleit et al., 2017).

3. Third, shortage of budget. Budget is a fundamental issue in putting any plan into action. If green infrastructure is to be taken forward then the question for providing adequate funding needs to be addressed (Mohamed, 2011).

4. Fourth, absence of collaboration among various governmental sectors. The planning and implementation of green infrastructure is not the sole responsibility of single sector, it has to be planned and implemented in an integrated way with different sectors such as transport, housing, water and energy both at regional and local levels (Benedict & McMahon, 2012).

CHAPTER FIVE

5. DESIGN PROPOSALS

5.1 Proposed Solutions for the study area

Like described before, Adama Town is highly affected by flood, soil and other natural resources degradation due to improper utilization and miss-use of natural resources. The runoff from rural areas is the leading source of impairments which affects the Town by flooding problems.

Migira pond is one of the threat to Adama Town because as its level increases during the rainy season; it overflows back to the surrounding residents of the Town especially to the RRC [erdata mastebaberia] and also to individuals who built houses without being given site plan or even user right to the plots [they own particularly on buffer zone and reserved areas around Migira Pond]. Such problems are usually solved with help of carefully designed strategies in short and long flood mitigation plans and also considering different planning approaches that can address informal and illegal developments. For sustainable flood mitigation, detail scientific approach using all necessary data is required. However, in Adama short term plan were used for the existing problem for specific rainy season.

The above six studies [presented in the above sub section 4.7.4] on Migira Pond, more than half of them focused only on flood mitigation measures which is to relocate Migira Pond on the other side the mountain which requires detail geotechnical investigation of the subsurface nature of the pond area before doing the engineering structures. In addition they propose to resettle inhabitants in environmentally sensitive area to some other place which call for socio-economic studies before taking any measure. Correspondingly only few studies put alternatives on the usage of pond but, implementation mechanisms, standards and regulatory tools were not incorporated. In the above studies attention given to urban green infrastructure development is very low. The development of urban green infrastructure activity is demonstrated through conservation of existing green belts in cites/towns, planting multipurpose tree, landscaping design, exercising urban agriculture, establishment of public

and private parks and gardens, all these component of green infrastructure [GI] has a great contribution to stabilize and regulate the cities/ towns weather condition and preserve urban ecosystem services. To ensure sustainable economic development and bring stable society it is important to implement community based participatory green infrastructure [GI] development. Its aims to minimize flood and erosion hazard and improve the livelihood of residence of the area through comprehensive and integrated natural resources development and productivity enhancement measures for improved income generation opportunities and also to optimize the use of the existing natural resources and untapped potential in both degraded areas and the remaining potential areas.

Therefore, I have developed design and planning solutions to inform the decision makers so that Migira pond and its environs will be developed to benefit communities in income generating through well-designed urban agriculture, physical and biological conversation of the pond area that contributes to the expansion of green infrastructure and increase aesthetical value of blue infrastructure. The design and planning solutions for treating pond area, promoting urban agriculture as major contributors to green infrastructure [GI] and improvement of blue infrastructure have been suggested as follows:

- Most scientific recommendations for minimum buffer widths range from 15 to 30 meters. It is 'conservative' option, provides good protection to the pond and good habitat preservation, although heavy rain, floods, or poor management of contaminant sources could not easily overwhelm the buffer.

    a) **Zone 1,** begins at the edge of pond and shall extend for a minimum distance of 6 m, measured horizontally on a line perpendicular to the water course or water body. This mainly undisturbed vegetated area aims to protect the physical and ecological integrity of the river ecosystem.

    b) **Zone 2,** *the middle zone,* shall extend immediately from the outer edge of zone 1 for a minimum distance of 18 m (up to several hundred meters, depending on pond protection objectives, stream type, soil type, or topography). This managed area of native vegetation protects key components of the pond ecosystem and provides distance between upland development and the pond side zone. Its function is to remove sediments, nutrients, and other pollutants from surface and

groundwater. This zone, in combination with Zone 1, also provides most of the enhanced habitat benefits. But it shall also allow for recreation and aesthetic benefits.

c) **Zone 3, the *outer zone***, shall extend for a minimum distance of 6 m immediately from outer edge of zone 2. This zone prevents encroachment into the riparian buffer, filters runoff from adjacent land, and encourages sheet flow of runoff into the buffer.

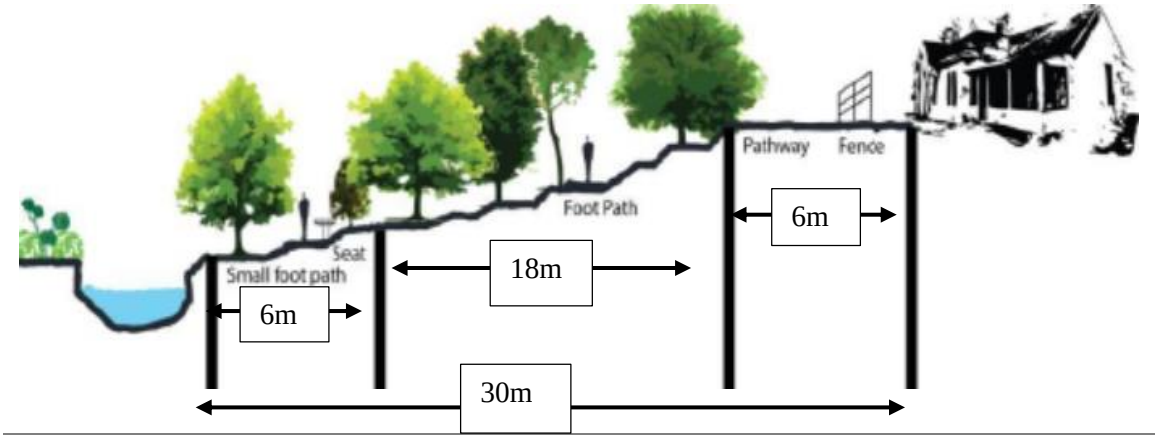


Figure 5.42: Recommended buffer width

Source: Own data (April-June 2019) adapted from MUDH, 2015.

- The buffer zone should not act as a preservation area, but rather the area should structure communal and public spaces of the Town;
- Urban farming should be promoted along the pond edge by integrating it with the green buffer zone;
- Practical green programs like community recreational open space, children play ground, etc. could be combined along the buffer zone area to activate and increase the usability of the space**.**
- Introducing fish production in Migira pond. Stocking fishes can provide many recreational opportunities as well as improve water quality. The minimum recommended buffer width for fish production is 45m.
- Animal fattening must be relocated to the South-Western parts of the Town following the prevailing wind direction. This is because currently few of them are scattered within

the residential quarters that need to be taken due consideration because of their incompatibility.

- Familiarizing Poultry production both at household and community level.
- Provision of silt trap structure, maintaining external dyke and cleaning silt and treating waterway come from upper catchment must be done to rehabilitate pond area.

5.1.1 Design and planning solution at Community Level

1. Rehabilitation of Migira Pond

Ponds are one of the most reliable and economical sources of water. Ponds are now serving for a variety of purposes, including water for livestock and for irrigation, fish production, fire protection, energy conservation, wildlife habitat, recreation, increase property values, increase environmental awareness, and enhance Town‘s attractiveness as tourist destinations, erosion control, improve flood storage capacity and landscape improvement. Thus, protecting ‘Migira Pond ‘results in safe and better environment for rich biodiversity, reduces climate change impact and provides service for the society.

Figure 5.43: Current status of Migira pond

Source: Own data (April-June 2019)

Currently, there are three cells intended to solve flood and to remove sediments and rubbishes that will create a backflow effect. But this design does not serve multiple functions, including storm water quality treatment, peak flow attenuation, and wildlife habitat creation. Figure 38 illustrates a typical multiple pond system, showing a well-designed and landscaped pond that can be an aesthetic feature.

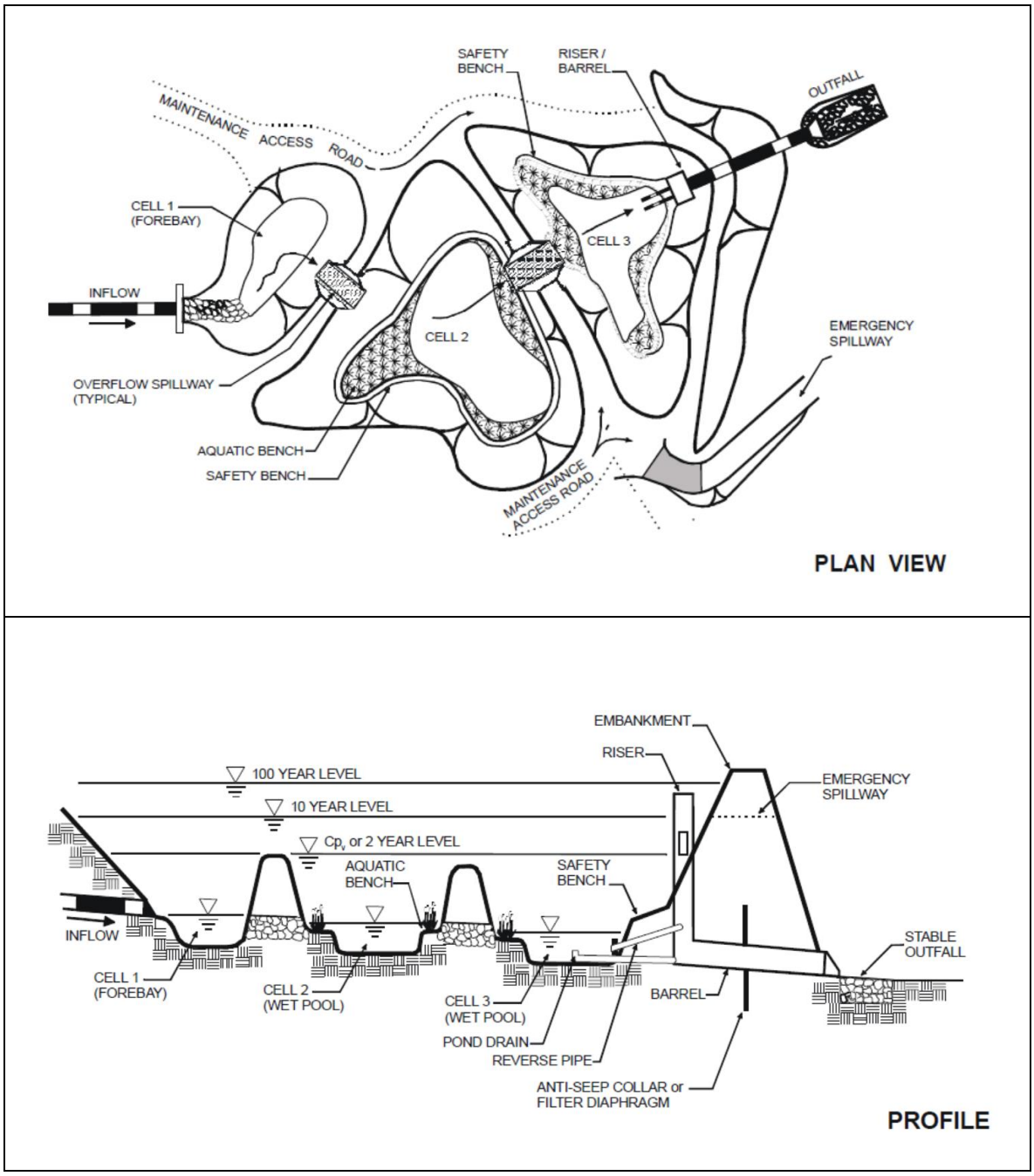


Figure 5.44: A well-designed multiple pond system

Source: Volume 4: Storm water Best Management Practices

Multiple pond systems consist of several wet pools that are constructed in a series following a forebay. The advantage of these systems is that they can improve treatment efficiency by better simulating plug flow conditions as compared to a single large wet pool. Also, these systems are in series, that provide longer flow paths and two or more storage cells for water quality and quantity treatment.

Figure 5.45: 2d and 3d Rendering of multiple pond system
Source: Volume 4: Storm water Best Management Practices

Components of Multiple pond system:

- Permanent pool – prevents re-suspension of solids
- Live storage above permanent pool – sized for a percentage of water quality volume and flow attenuation. Percentage depends on type of wet pond chosen

- Forebay – settles out larger sediments in an area where sediment removal will be easier
- Spillway system – spillway system(s) provides outlet for storm water runoff when large storm events occur and maintains the permanent pool.

Design considerations

- **Pond dimension:** the necessary water retention volume of a pond will depend on such factors as:
    a) Design rain event: How large is the damage if flooding occurs in the catchment area?
    b) Discharge rate and volume during the duration of a design rain event
    c) Necessary retention time in the pond is essential for water treatment.
    d) Most important design parameter for ponds is the depth. Commonly used and most preferred permanent water depth is between 1.2 and 2.5 m. Accordingly, storage volume will form above this level – between the permanent water level and pond banks. Ponds that are designed for water retention and treatment are often divided in two different sections – shallow section and deep section with a bank or gabion wall in between. The shallow section should be at least 0.5m deep.
- **Cross sections:** Slopes for the ponds are generally constructed within the angle of natural sloping processes, so it is crucial to do proper geological investigation.
    a) The slope of side should not be less than 3 to 1.
    b) If the pond is also being used for swimming and fishing then at least one shore should be flat and accessible for people.
    c) For long term, pond`s bed and slopes must be impermeable.

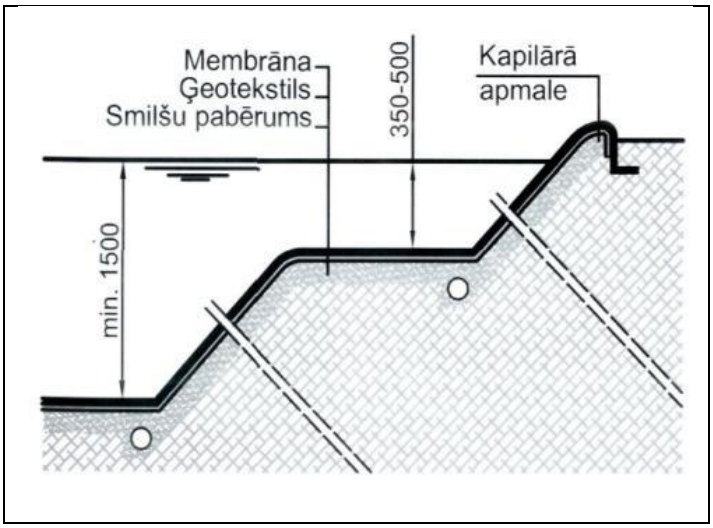


Figure 5.46: Impermeable membrane

Source: Handbook on sustainable urban drainage [2007-2013]

- **Inlets and outlets:** In cities storm water enters retention ponds typically via sewers or open ditches. It is recommended to construct an inlet manhole right before the pond for primary water treatment and filtration of large particles. The very last culvert before inlet into the pond should be equipped with bars for physical filtration reasons, not to let debris into the pond.

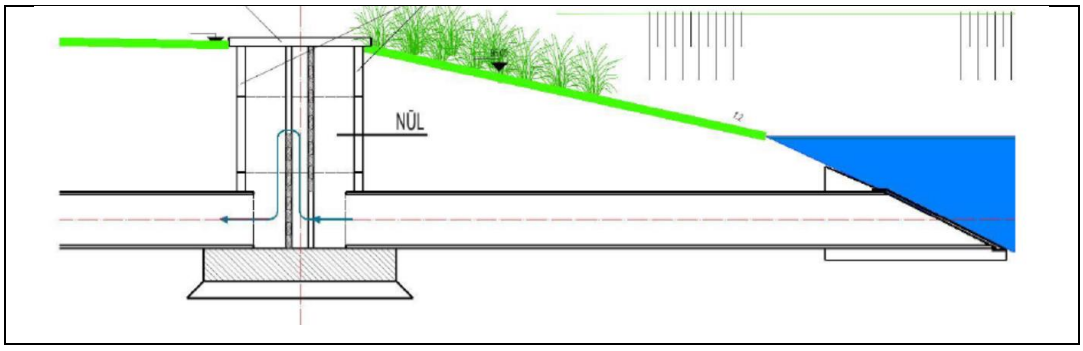


Figure 5.47: Adjustable weir regulating water level in a pond, H=1.7m

Source: Handbook on sustainable urban drainage [2007-2013]

- **Water treatment potential:**
  a) Oxygen is crucial element to ensure water treatment.
  b) When storm water is retained for a longer period of time eventually natural treatment processes take place. Nitrogen and phosphorus compounds gets absorbed by shoreline and shallow zone plants, suspended elements and sand

precipitates onto the bed. These are the reasons why pond regularly needs to be cleaned and water plants removed. Grass mowing on the sides must be done every single summer.

c) If there is a possibility for oil related pollution filters must be applied to take up runoff during the first 15 minutes of a rain event, because it`s the most polluted.

– **Landscape design:** Beautiful landscape with open water and harmonic greenery can be ensured throughout the year and in any time of the day. In such places walking trails and proper seating for viewing the pond must be implemented.

Figure 5.48; 3d rendering for landscape design

Source: Volume 4: Storm water Best Management Practices

- **Construction, exploitation and maintenance:** During the construction and digging also the maintenance plan should be designed as to ensure regular mowing, cleaning and water regulation activities.
- **Security and civic engagement:** The pond should be a beautiful and functional piece of landscape design.
- **Bio retention facilities:** provides sufficient treatment effect for following runoff pollutants: sediment, litter, metals, bacteria, oil, and organics.
    - It is one of a management practices of sustainable urban drainage system; typically consists of a grass buffer layer and a ponding area, constructed as: organic layer and plants, with underlying planting soil and sand (gravel) bed layers. Passing through the filter strip reduces the velocity of runoff; runoff flow is evenly distributed along the ponding area.

Figure 5.49: Visual reference of bio retention facility
Source: Handbook on sustainable urban drainage [2007-2013]

Function of pond

Generally the benefits of pond storage facilities can be divided into two major categories.

- The first function is related to quality including decrease downstream channel erosion, Control of sediment deposition, and improved water quality through storm water filtration (wet ponds only), provide an attractive habitat for wildlife in urban watercourses, Create better places to live, work and play.

– The other category is related with quantity. Ponds will reduce peak runoff rate increases caused by urban development, Mitigate downstream drainage capacity problems, Reduce or eliminate the need for downstream outfall improvements, Provide opportunities for evapo-transpiration from vegetation and surface water, Recharge natural groundwater/aquifer (where appropriate), and Sympathetic to the environment and the needs of the local community.

Figure 5.50: Visual reference of multiple pond system
Source: Handbook on sustainable urban drainage [2007-2013]

I recommend Migira Pond to be used for two major purposes [see Figure 45]. The first one is mainly for economic purposes – as fish farms, fishing waters, for watering the urban farm and providing water for animals and secondly as a decorative pond which is a recreational element.

Figure 5.51: Visual reference for multiple-benefits of pond system

Source: Own data (April-June 2019) adapted from Handbook on sustainable urban drainage [2007-2013]

2. Terrace farming

Terrace farming is one of the positive green programs for both as livelihood solution and green coverage for the existing situation within Migira Pond Area. In the east of Migira pond there is a mountain however, as population of the Town increased, some informal inhabitants settled nearby the mountain. There is an effort to reclaim the lost beautification by protecting/reserving the mountain although terracing shall be considered to implement storm water management practices on steep slopes.

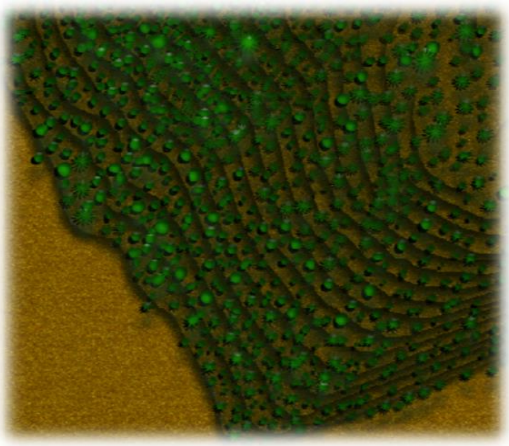
Food production along the pond edge

Trees and terraced farming of Tokyo

Figure 5.52: Typical examples of terrace farming

Source: Scientific design for bench terrace. (Ted C. Sheng, 2002)

Terracing slows rainfall and runoff by breaking the gradient of long steep slopes in steps. Ditching on a bench terrace may not be necessary since the benches are constructed to typically slope inward toward the top of slope in order to divert runoff water along the bench rather than down the slope. Vegetation is then more easily established and maintained.



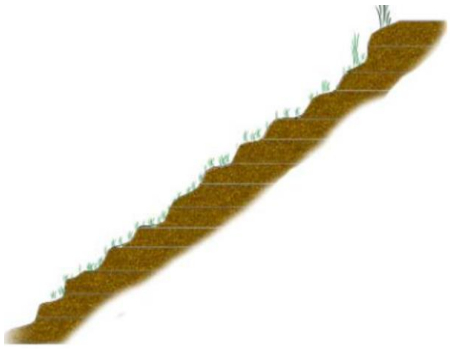


Figure 5.53: Mountain terracing

Source: Own data (April-June 2019) [adapted Scientific design for bench terrace. (Ted C. Sheng, 2002)]

Some types of agriculture terraced farming are often the best use for sloping land. They stabilize the slopes, prevent erosion, and absorb air pollution while providing jobs and food. Although the presence of tree cover improves the Town's climate and temperature.

Figure 5.54: 3d Rendering for sloping land

Source: Scientific design for bench terrace. (Ted C. Sheng, 2002)

3. Small Scale Poultry Production

Poultry is an important farm species in almost all countries. It is an important source of animal protein, and can be raised in situations with limited feed and housing resources. Chickens are ‘waste converters’: They ‘convert’ a scavenged feed resource base into animal protein. They are therefore by far the most important species for generating income. People raise chickens all around the world under widely varying circumstances. Their main objective is generally the same: maximum production for minimum costs and with minimum risks.

Poultry of all types require housing that will protect them from the wind and rain, as well as the effects of rapid changes in temperature. The house should be dry at all times, and provide good ventilation while being free from strong wind.

The design and structure of the poultry shed for the MSEs/ community level production is 6m*10m for feeding space and 3m*4m of roosting space for both laying and meat chicken.

3D detail for poultry production in small scale

A

Feeding space for both Laying and Meat Chickens

B

Different roosting space for both laying and meat Chicken

C

Top Veiw of the Poultry Shed

Figure 5.55: Poultry production shed.

Source: Own data (April-June 2019)

4. Recreational spaces for community engagement

Recreational spaces have long been recognized as major contributors to the physical and aesthetic quality of urban neighborhoods. But a new, broader view of it has recently been emerging. This new view goes well beyond the traditional value of recreational spaces as places of recreation and visual assets to communities. It focuses on how policymakers, practitioners, and the public can begin to think about recreational spaces as valuable contributors to larger urban policy objectives, such as job opportunities, youth development, public health, and community building. (Wallace, 2004).

Figure 5.56: 3d Rendering for recreational space
Source: Scientific design for bench terrace. (Ted C. Sheng, 2002)

As per information from the focus group discussion with officials of Adama Town Administration [ATA] the existing structure plan of the Town proposes Migra city Park in connection with Migira Hills. However, it is not implemented and functional rather large tracts of public or semi-public land in Migira pond area is reserved for landscaping or urban extension purposes by the Town Administration which can be used as a significant space for urban agriculture to ensure high quality of urban public spaces. In addition to home, using community spaces for urban food production and constructing green programs with the community will increase sense of belongingness among the participants. Therefore, these activate and increase the usability of space. Therefore, I plan to support urban agricultural activities with the surrounding brownfields and Migira pond to successful reuse of the property while encouraging new development and creating new job opportunities for site scale green infrastructure installation jointly with improving its aesthetic value.

Strategies regarding urban agriculture activities in recreational spaces /parks

- Add flexible outdoor spaces within park for promotion, sale and distribution of local food.
- Develop policy and procedures for establishment of community gardens within neighborhood parks
- Explore options for agriculture related improvements when renovating or constructing new public developments.

Figure 5.57: Recreational space for community engagement

Source: Own data (April-June 2019)

5.1.2 Design and planning solution at Household Level

Home Based production provides a low-cost, sustainable strategy for increasing household food security by providing direct access to food (Marsh, 1998). I try to identify approaches and opportunities to incorporate green infrastructure in to household level.

1. **Raised bed garden**

'Raised bed garden' refer to vegetation that grows directly onto a building's facade or to vegetation that is grown on a separate structural system that can be freestanding and adjacent or attached to the building's facade**.** Vertical space can be used effectively to grow food. Recent hydroponics techniques minimize space needs with plastic tubes that can be suspended on walls. Some city farmers of India attach long, narrow planters or boxes to their walls which is an eye-opening experience in how resourcefully home surfaces and community spaces can used to create spaces with these settings. During my site visit I found out the residences have the potential to use vertical spaces for home based food production.

Figure 5.58: Home garden using used plastic bottling's
Source: Own data (April-June 2019) [adapted from srfconsulting.com]

Planning and Design for raised garden

- Consider a location with levelled surface and with adequate sunlight.
- In terms of bed size, 1.2m is a common width. Lumber is often cut in 1.2m increments, and you also want to be able to access the garden without stepping into the bed.

- Length isn’t as important. Plots are often 1.2m wide by 2.4m long or 1.2m wide by 3.6m long.
- The depth of the bed can vary. 0.2m is a minimum. Plants need at least a 0.2m- to 0.4m rooting zone, so 0.4m is ideal.
- Before you establish the bed, break up and loosen the soil with a garden fork so that it’s not compacted. Go about 0.2 to 0.25 meters deep. For improved rooting, some gardeners like to remove the top layer (about a spade’s depth), dig down another layer, and then return the top layer and mix the soil layers together.

Figure 5.59: Raised bed using the vertical spaces

Source: Own data (April-June 2019)

2. Green roofs

A ‘green roof’ is a roof or deck onto which vegetation is intentionally grown or habitats for wildlife are established. Each green roof is unique and provides a different type of habitat, water storage capacity and energy saving potential. Green roofs offer significant economic benefits, including a longer roof life and heating and cooling energy savings.

Design considerations

- Roof slope
- Structures on roof have to withstand high wind uplift because of their exposed positions. A strip of gravel, stones or pavers around the edge of the roof can prevent such wind damage.
- Irrigation is needed during establishment of vegetation for some roofs and if the plants have been properly established, there should be no need for irrigation except in the most arid climates.
- Avoiding flammable materials as part of green roof components and a border of 0.5-1.0 m of stones or gravel must be maintained around parapet borders, rooftop windows, chimneys, etc.

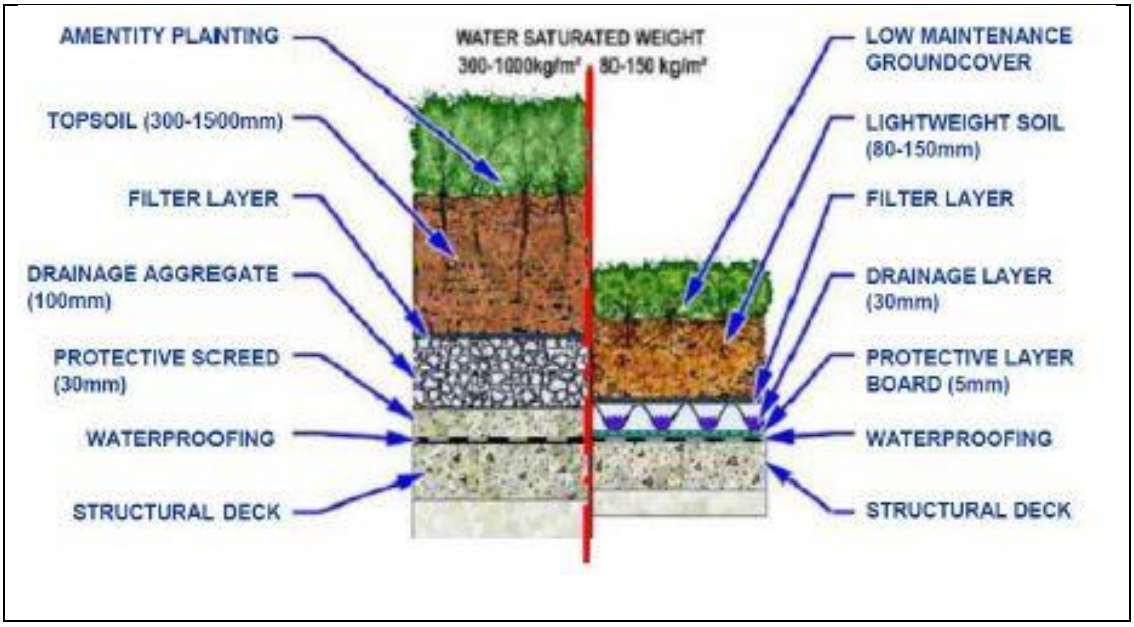


Figure 5.60: Intensive and extensive green roof

Source: Townshend, 2007

3. Poultry production at household level

Poultry production at household level is also proposed as income generating activity. During my site visit some of my respondents where interested in raising chickens at household level; the idea of poultry production appealed too many as they knew that there is a market demand.

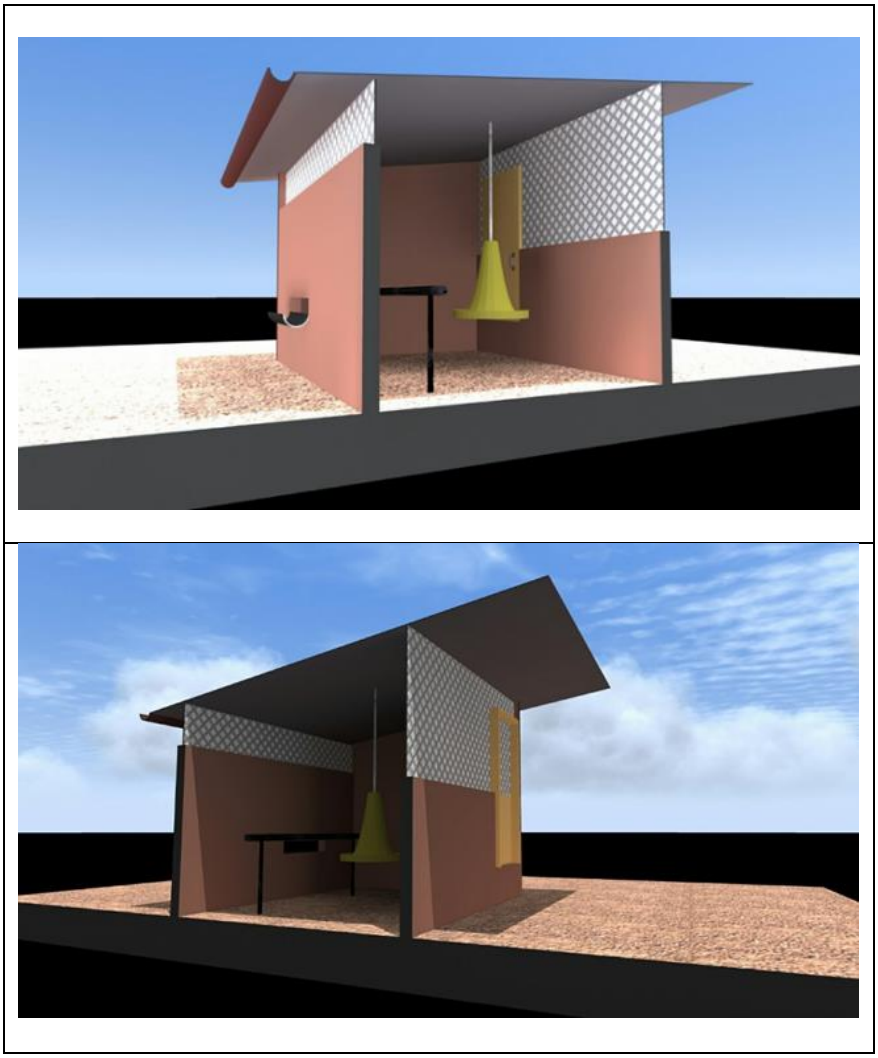


Figure 5.61: Small scale poultry production housing unit
Source: Own data (April-June 2019)

5.2 Scaling Up

Most parts of Adama Town has a poor green infrastructure with massive environmental, socio-economic problems associated with poor development and management of green infrastructure. Therefore, scaling up green infrastructure and implementing the blue-green approach could benefit the Town in multifaceted ways. Adama could more efficiently,

effectively and sustainably manage the available resources across multiple Town departments; by improving public accessibility and town wide use green infrastructure. Similarly other urban areas in Ethiopia should also consider green infrastructures as the core of their engagement so that they can be sustainable and resilient to climate change.

5.2.1 Parameters for scaling up this project

- **Core areas containing large functioning system and high population density**
  - In high population density land is always limiting factor. Therefore, to develop Green Infrastructure [GI], vertically raised gardening would be solutions
- **Identifiable water resource issues**
  - Areas which exhibit one or more community water resource problems such as significant pollutant load being discharged, informal settlement, and flooding.
- **Poor living condition**
  - Socio-economic or quality of life benefits to low income dwellers that might be associated with the implementation of green infrastructure benefits.
- **Flood prone areas with sloppy topography**
  - Poached buffer zone along water bodies need to be protected/reserved
- **Undeveloped areas not occupied by buildings or pavement**
  - Unrestricted construction of informal settlement in flood prone area

Key strategies for scaling up Green and Blue Infrastructure

1. Develop an integrated green infrastructure for the whole catchment. (riverbanks, pond scape, gorge, mountains, neighbourhoods);
2. Integrate public open space with strategy for adaptation to climate change and improvement of microclimate of the Town;
3. Incorporate small scale Green infrastructure [GI] enterprises for supporting local economy.

5.3 Ecological Services

- Reduces Energy Use:
    - When properly placed, green structures provide shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings
    - Green units release water into the atmosphere, resulting in cooler air temperatures and reduced building energy consumption.
- Improves Air Quality:
    - Like other vegetated green infrastructure features, infiltration practices can improve air quality through uptake of criteria air pollutants and the deposition of particulate matter. Green elements absorb air pollutants and intercept particulate matter which improves air quality and reduces the amount of greenhouse gases.
- Improves Community Livability:
    - When well-maintained, bio retention and infiltration practices improve local aesthetics and enhance recreational opportunities within communities.
    - There is also the potential for these practices to help reduce noise transmission through sound absorption and to improve social networks.
    - Green corridors provide beauty and privacy, which improve community aesthetics, provide a sense of place and well-being, which can strengthen community cohesion
    - Green network increases recreational opportunities for communities by improving pathways, creating places to gather and providing shade during warm weather.
    - Provide opportunities for urban foraging and food production.
- Public Education Opportunities**:**
    - Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management, home based food production.
    - Provide an opportunity for residents to contribute to the benefits of neighborhood place-making via green infrastructure.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Green infrastructures are public goods that encompass many features in the built environments at varieties of scales. Green Infrastructure as public green space makes an important contribution to economic, social and environmental well-being of Adama Town. Besides they should be strategically planned and delivered on a range of scales to provide usable space with support for natural and ecological processes. By considering different development layouts and scaling up strategies, green infrastructures can be used to deliver multiple functions to achieve sustainable communities across the Town and across the board throughout the country to other emerging urban centers.

The purpose of this study was to assess the extent to which green infrastructure planning principles in Migira pond area of Adama Town were identified as space planning. The study also helps to identify the opportunities and constraints in utilization of green infrastructure development in the case site .The problems related to Migira pond area were identified through field survey/ primary and secondary data collection and the results were analyzed.

The nature of the topography is very flat and is located in a closed basin. During the rainy season storm water collected from various catchments increases the volume of the water of Migira Pond that flows back flooding some residential areas. Due to poor land use planning at the close proximity of Migira Pond, open grazing leads to soil erosion and dumping of domestic wastes are among those contributing to silting up of the pond that in turn invaded more area as the flood water flows back. Inadequate drainage and waste management systems exacerbated the flow back causing destruction to residential houses and stores of Relief and Rehabilitation center.

The initiative to enhance green infrastructure across the study area is still at its lower level. Illegal land invasions, irregular land subdivisions and all other forms of unsafe occupation

have contributed to diminishing area allotted for green infrastructure. This problem is partly attributed to the limited implementation capacity and insensitive of the officials at the municipality to the development of green infrastructure. The study results indicated that there were various stakeholders with diverse interests in this site, but none of them has come up with workable plan to improve the socio-economic and environmental situation of Migira project since 2004.

Green infrastructure offers the opportunity to build community cohesion, maintain and create landscape features which guarantee ecosystems to deliver services such as clean water, clean air, and attractive recreational areas. It therefore I design and recommend green infrastructure to offer cultural diversity of space, natural mitigation of and adaptation to climate change and also to encourage access for everyone, the agenda that is a priority for all humanity.

6.2 Recommendations

Based on insights gained from literature, stakeholders' interviews and field observation the following recommendations are made to transform the current planning practices of green space to urban green infrastructure planning.

1. The current trend toward natural flood management provides an opportunity for policies to incorporate pond scape. Migira pond corridors should be protected and rehabilitated, which is necessary multifunctional green support for urban green structure.

2. The capacity of the existing drainage systems of Adama Town should be strengthened and also expanded. Besides, provision of silt trap structure, maintaining and upgrading the external dykes, cleaning waterway, construction of infiltration basin of retention pond must be done to rehabilitate pond area.

3. Incorporating income generating activities: Connecting and integrating the existing green and livelihood supporting activities like communal gardens, open communal recreational spaces, poultry and fishery.

4. Introducing terrace farming along the Migira hill which is positive green program both as food security and urban green coverage

5. Introducing green walls and green roofs by using green infrastructure techniques to increase green area index and to improve economic condition of the residents.

6. Improving public education and access to information, social learning and community engagement, positive experience of asset performance, changing perception of Blue-Green.

7. Solving budget shortages: to overcome the limitation of finances the Town Administration should allocate sufficient annual budget that can enable the greenery department to perform its activities effectively.

8. Professional capacity building: availability of sufficient number of skilled professionals is a prerequisite for advanced green infrastructure planning.

The green infrastructure can only be achieved if efforts are integrated and embarked on with commitment. Declaration and plans are not sufficient if not timely implemented. Green Infrastructure as a base for quality of life should be the day-to-day concern of the society and extend beyond yearly celebrations and declaration.

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APPENDIX

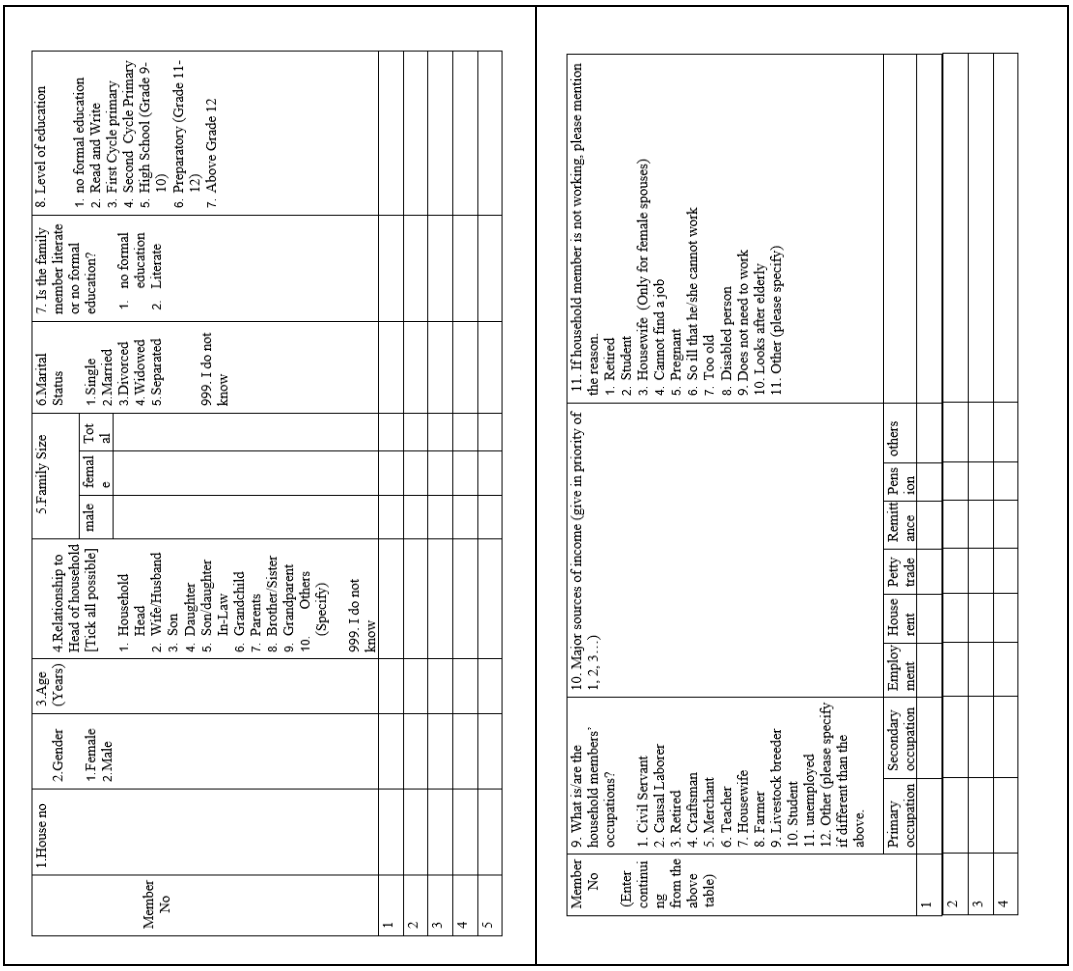
Appendix I

Questionnaires prepared for Migira residents [local communities]

Dear Respondent, I thank you in advanced for your cooperation, and honesty in answering the following questions. The aim of collecting information through this questionnaire is to conduct Academic research on Green Infrastructure planning practices and its impact in Ganda Migira. I am among graduating class students, as such I would like to assure you that, the information that you provide me will be kept confidential. No need of writing your name.

I thank you in advance!!!!!!!

I. Household characteristics



Member No	1.House no	2.Gender 1.Female 2.Male	3.Age (Years)	4.Relationship to Head of household [Tick all possible] 1. Household Head 2. Wife/Husband 3. Son 4. Daughter 5. Son/daughter In-Law 6. Grandchild 7. Parents 8. Brother/Sister 9. Grandparent 10 Others (Specify) 999. I do not know	5.Family Size			6.Marital Status 1.Single 2.Married 3.Divorced 4.Widowed 5.Separated 999. I do not know	7. Is the family member literate or no formal education? 1. no formal education 2. Literate	8. Level of education 1. no formal education 2. Read and Write 3. First Cycle primary 4. Second Cycle Primary 5. High School (Grade 9-10) 6. Preparatory (Grade 11-12) 7. Above Grade 12
					male	femal e	Tot al			
1										
2										
3										
4										
5										

Member No (Enter continuing from the above table)	9. What is/are the household members' occupations? 1. Civil Servant 2. Causal Laborer 3. Retired 4. Craftsman 5. Merchant 6. Teacher 7. Housewife 8. Farmer 9. Livestock breeder 10. Student 11. unemployed 12. Other (please specify if different than the above.			10. Major sources of income (give in priority of 1, 2, 3…)						11. If household member is not working, please mention the reason. 1. Retired 2. Student 3. Housewife (Only for female spouses) 4. Cannot find a job 5. Pregnant 6. So ill that he/she cannot work 7. Too old 8. Disabled person 9. Does not need to work 10. Looks after elderly 11. Other (please specify)
	Primary occupation	Secondary occupation	Employ ment	House rent	Petty trade	Remitt ance	Pens ion	others		
1										
2										
3										
4										

12. How long have you been living here as household/family?

- Less than 1 Year
- 1-10 Years
- 11-20 Years
- 21-30 Years
- >30 Years

II. Income, expenditure and savings

1. What are the main income sources of your family?

(Read all the options to the interviewee. 1 very important, 2 important, 3 least important, 4. Not important)

	Level of Importance
1.Wage/salary	
2. Micro and Small Enterprises	
3.Penssion	
4.Trading /merchant	
5.Rental income	
6.Assisstance of relatives /remittance	
7. agricultural income	
8. Safety Net program	
9. Other (please specify)	

2. What is the average monthly income of the household? (Other than subsistence production)

……..

3. Do you do any subsistence production? Please state the approximate equal value of your subsistence production (enter zero if not produced).

Fruits vegetables…	Egg, milk and milk products	Meat	Other [please specify]	Total

III Housing and infrastructure

1. What is your ownership status of your house?

1 ( ) Owner of the house
2 ( ) Renter
3 ( ) Provided by employer
4 ( ) User not paying rent
5 ( ) Other…….

2. What is the main building material? (The surveyor should make observation and confirm it with the interviewee - tick only one)

1 ( ) Brick
2 ( ) Concrete
3 ( ) Wooden
4 ( ) Stone
5 ( ) Soil
6 ( ) Other (specify)……
7 ( ) I do not know

3. What is the domestic water source in your house?

1 ( ) Plumbing inside the house (bathroom, kitchen, WC)
2 ( ) Water pump
3 ( ) Well water
4 ( ) Village fountain
5 ( ) Water tank
6 ( ) Interior tap water (one tap)
7 ( ) Interior water supply system (multiple taps)
8 ( ) Plumbing outside the house
9 ( ) OTHER (PLEASE SPECIFY).....

4. Do you have any problems with water supply?

1. Yes 2. No (Go to next)

5. What are your problems with water supply? (Tick as much as relevant. Can be more than one)

1 ( ) Water cuts. How frequent?
2 ( ) Not clean
3 ( ) Expensive
4 ( ) Difficult to access
5 ( ) Law quality (hardness)
6 ( ) Other (please state)……..

6. Do you use pond water for drinking purposes?

1. Yes (Go to Q*9) 2. No (please state your drinking water source).

7. What are your problems with drinking pond water? (Tick as much as relevant. Can be more than one

1 ( ) Not clean
2 ( ) Expensive
3 ( ) Difficult to access
4 ( ) Law quality (hardness)
5 ( ) Other (please state)……..

8. What type of sanitation facility do you have?

1. ( ) Interior WC with toilet flush tank

2. ( ) Exterior WC with toilet flush tank
3. ( ) Interior toilet without flush tank
4. ( ) Exterior toilet without flush tank
5. ( ) Public WC
6. ( ) Other (please specify).....

9. What type of wastewater system do you have in your house?

1 ( ) Common sewerage system
2 ( ) Septic tank disposed regularly by municipality
3 ( ) Septic tank disposed regularly by him/herself
4 ( ) Discharged directly to a river / land
5 ( ) Other (please specify)…….
6 ( ) I do not know

10. How are the solid wastes disposed?

1 ( ) Municipality collects regularly
2 ( ) Disposed to a predefined landfill
3 ( ) Disposed to a wild disposal area
4 ( ) Disposed irregularly
5 ( ) Disposed to the river/lake
6 ( ) Burning
7 ( ) Other ……
8 ( ) I do not know

11. Do you have electricity in your house?

1. Yes 2. No (Go to Q*14)

12. Do you experience any problems with power supply?

1. Yes 2. No (Go to Q*15)

13. What kind of problems do you experience? (Tick as relevant, you may tick more than one)

1 ( ) power cuts. How frequent?
2 ( ) Low voltage
3 ( ) Changing voltage
4 ( ) Other. Please specify …….

14. What is your source of energy for cooking? (Tick one)

1 ( ) fuel wood
2 ( ) kerosene
3 ( ) Buta gas
4 ( ) Electricity
5 ( ) Other……

IV Green and blue structure

1. Do you or a member of your household has any agricultural land or do urban farming?

1. Yes 2. No (Go to the next)

2. What do you think would be the benefits of the urban farming?

1.For your family	2. For the village	3.For the country

3. Are you aware of any green infrastructure services?

……

4. Is there a public open space in your village? Are you satisfied with it?

……

5. What does green infrastructure contribute to the livelihood of the residents?

…….

6. What do you think about the artificial pond?

- ( )Curse
- ( )potential
- ( ) Other…

7. For what purpose do you use the artificial pond?

- ( )Domestic use(for drinking and cooking)
- ( )Sewage/as waste disposal site
- ( )Source of water
- ( )for crop irrigation
- ( )Washing closes/vehicles
- ( )None

8. What do you think are the major problems of artificial pond in your neighborhood?

……

9. Why do you think people throw garbage and dispose wastes into the artificial pond?

……

10. What are other environmental problems you have in your village?

……...

11. Do you have any social problems in your village, if so what are they?

……..

12. Do you have any economic problems in your village, if so what are they?

…….

13. Do you have any agricultural problems in your village, if so what are they?

……...

Appendix II

Interview for Greenery department [beautification, park and cemetery development and management] officers, urban planners and land development and ownership administration officers of the Adama Town.

Questionnaire No: .....

Date of Interview: .....

Name of Interviewer: .....

Name of Interviewee: .....

Address: .....

Phone Number .....

Name of Village: .....

Name of District: .....

I. Historical Profile

1. When was the village founded? Ask for a short history of the village.

II. Demography/General Profile

1. How many people are there in the village? How many households are there?

2. Has the population of the village increased or decreased in the last 10 years? Why?

III. Administration / Leadership

1. Are there any groups, organizations, associations or cooperatives in the village? What are these? (E.g. women's savings groups, Idir Iqub, etc.).
   ……
2. Other than those mentioned above, do you know any influential people or representatives of interest groups in the village?
   .....
3. Does your district have an Environmental plan that you know of? Have you been consulted about it?
   ……..

IV Local Economy/ Livelihoods

1. What are the main jobs that people in the community do? Do certain groups specialize in certain jobs?
   ……

2. Which groups do certain jobs?
   ……...

V. Environmental Management

1. Do you inform and train your staff about green infrastructure?

□ Yes □No □□N/A

How do you think about the awareness of employees of federal, regional and city level administration on the concept of green infrastructure planning principles?

……

2. Which urban green infrastructure planning principles are integrated in current green space planning documents and practices?

Multi-functionality—————— Green-grey integration———

Social inclusiveness———————— Connectivity——————

How are the concepts incorporated in current green space planning documents and practices?

…… …….

3. What are the main gaps and limitations of current green space planning practices in integrating green infrastructure planning principles?

…… ……

4. To what extent are the principles of green infrastructure implemented on the ground? And what mechanisms are in place to ensure implantation of plans?

.....

.....

5. How does your institution work for integrating green infrastructure planning principles into planning documents and practices?

……
……..

6. Do you think there is community participation in planning and development of green infrastructure?

……
…….

7. How do relevant institutions communicate during urban green infrastructure planning and development process?

……
……

8. What are the funding mechanisms for developing urban green space? How do you think about if adequacy to undertake green space projects?

……
……..

9. How do you think the collaboration of different government sector in planning and implement of green infrastructure planning principles?

……
…….

10. Do you think professionals' in your institution are adequately qualified to integrate green infrastructure planning principles in planning?

……
……

11. What do you think are the main barriers to adoption of green infrastructure planning principles both at planning and practices level?

……
……

12. What do you think are possible measures to overcome the barriers?

……
……..

Appendix III

Focus group discussion for Migira residents [local communities]

1) What is your perception of how the plan/ green infrastructure planning will affect your group or neighbourhood?

   ……
   …….

2) How do you see the planning process and public involvement?

   ……
   …….

3) How were you involved in the planning process? How did the group's involvement affect the plan?

   ……
   ……

4) In what ways you think to improve Migira pond area?

   ……
   ……....

Appendix IV

Focus group discussion for Adama Town administration officials

I. What are the factors that delay the development of green infrastructures in general?

……
…….

II. What are the problems that affect the management of green infrastructures particularly urban agriculture in general and in Migira pond particularly?

……
……

III. In your opinion, what are the opportunities and challenges to develop and manage artificial pond areas?

……
……

IV. What is the importance of green infrastructure for the household/ community?

……
……..

Appendix V

Field observation checklist

1. The absolute location of the case site
2. Altitudinal location
    - 2.1. Lowest point ……
    - 2.2. Highest point ……..
3. Slope analysis
4. Existing natural features
    - 4.1. Gorge, mountains, valleys and the like
5. Geology
    - 5.1. Hazards prone areas
    - 5.2. Seismic area
    - 5.3. Flood prone area
    - 5.4. Soil types
6. Blue structure
    - 6.1 Status of blue infrastructure
    - 6.2 Services they are giving
    - 6.3 How much land it cover?
7. Green infrastructure
    - 7.1 Status of green infrastructure
    - 7.2 Services they are giving
    - 7.3 How much land it cover?
    - 7.4 Comparison with other surrounding parts of Adama
8 Challenges and opportunities
    - Types of challenges and opportunities
    - Extent of challenges and opportunities
9 Design solutions
    A. Applied solutions for challenges by Ethiopian professionals either on the site or on the surrounding areas
    B. Planned design solutions which are not applied yet
    C. Experiences from different projects done for similar thematic issue in different parts of the world.

Appendix VI

Planning documents reviewed and analysed in this research

No	Planning documents	Year
1	Ethiopian Environmental Policy	1997
2	Urban Plan Proclamation	2005
3	Participatory Urban Planning Manual	2007
4	Green Infrastructure Based Landscape Design	2011
5	Ethiopian National Urban Green Infrastructure Standards	2015
5	Urban Greenery and Beautification Strategy	2015
6	Growth and Transformation plan II	2016
7	Adama Structure Plan Revision Project City Wide Study Report.	2017
8	Oromia Urban Planning Institute- Environmental Study	2017