



Ethiopian Institute of Architecture Building Construction and
City Development

Identifying and Designing Potential Greenways
Using GIS, the case of Hawassa City

A thesis submitted to the School of Graduate Studies of Addis Ababa
University for the Partial Fulfilment of the Requirement of Master of Science
Degree in Urban Design and Development

BY:

ADINEW DINKU

December, 2018

Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY

Ethiopian Institute of Architecture Building Construction and City
Development/**EiABC**/

IDENTIFYING AND DESIGNING POTENTIAL GREENWAYS USING GIS; THE CASE OF HAWASSA CITY

By:
ADINEW DINKU
ID No: GSR/1124/08

A thesis submitted to the School of Graduate Studies of Addis Ababa
University for the Partial Fulfilment of the Requirement of Master of Science
Degree in Urban Design and Development

BOARD OF EXAMINERS:

1) Chairman, Graduate Committee	Signature	Date
_____	_____	_____
2) Advisor		
<u>Dagim Asfaw</u>	_____	_____
3) Internal Examiner		
<u>Yeneneh Chanyalew</u>	_____	_____
4) External Examiner		
<u>Aziza Abdulfetah</u>	_____	_____

DECLARATION

I, the undersigned, declare that the Thesis entitled “IDENTIFYING AND DESIGNING POTENTIAL GREENWAYS USING GIS; THE CASE OF HAWASSA CITY” is my own original work and has not been presented for a degree in any other university or institution. All sources of material and software used in this thesis work have been duly acknowledged.

Name: Adinew Dinku Tebeje

ID No: GSR/1124/08

Signature: _____

CONFIRMATION

This is to confirm that the thesis work is complete and the candidate is ready for examination.

Advisor: Dagim Asfaw

Signature: _____

Date: December 2018

ABSTRACT

Rapid development and urbanization have to consider the natural environment for today as well as for the future. The natural environment in Hawassa is being compromised due to rapid urban development, this has led to the fragmentation of its natural mosaic. Due to fragmentation, the natural system is disconnected, connectivity of ecological service is disturbed, resulting in flood, and air pollution. In other countries, greenways, by their multi-dimensional benefits, have solved these problems. Connecting the fragmented natural environment of Hawassa by greenways could benefit in various ways; ecological service enhancement, environmental protection, and alternative transportation, reconnected flow of wildlife, livable environment, and socio-economic enhancement. The main objective of this study was identifying and designing the potential greenways of Hawassa city. All the greenway systems offer solutions for balancing the rapid development with the natural environment.

The following main tasks were designed to attain the objectives; assessment of potential areas, assessment of suitable landscape, and delineation of potential greenway network and detail design on a specific site was conducted to ease integration and implementation at local scale. The designed greenway networks fulfilled the intended functions of ecological, socio-economic, alternative transportation provision and urban environmental protection to a large extent and local scale. In this regard, the study attained promotion of local and urban access with greenways, aesthetic aspects of urban landscapes, improved recreational opportunities, improved performance and distribution of activities by greenways, an increase of efficiency and environmental aspects in the city and improved social values considering economic sustainability. A method used for suitability of landscape and city scale greenway network were delineated based on the recommendations suggested by different researchers on Geographical information system (GIS) and Least cost path(LCP) as tools. Greenways were identified using those tools. City scale greenway network was planned and selected action area was designed based on urban design procedures on the greenway framework, ecological network service, socio-cultural benefits, and alternative transportation. Finally, challenges and other issues are listed. Recommendation for Hawassa city administration and other stakeholders were forwarded for future planning and to point out the direction of research on the issue.

Keywords: - Greenway, Natural Environments, Sustainable Development, Least Cost Path, Fragmentation

Acknowledgment

First and foremost, I would like to forward my heartfelt thanks and appreciation to my advisor Dagim Asfaw who supervised me from which the paper in the preliminary stage, for his fruitful support, inspiration, and guidance in getting this work into reality. Then my heart full thanks go to Hawassa City Administration to provide significant data which made this paper resource full.

I would like to express my appreciation for my families for their inspiration, encouragement and help throughout my education.

I would also thank my classmates for giving me feedback and comments starting from the beginning of the interview and giving constructive information.

Last and all thanks are given to almighty Lord Jesus for giving me all I need.

Table of Contents

LIST OF TABLE	VIII
LIST OF FIGURE.....	IX
LIST OF MAP	XI
LIST OF DIAGRAM	XII
LIST OF ACRONYMS	XIII
PART ONE	1
1. CHAPTER ONE - INTRODUCTION.....	1
1.1 Background.....	1
1.2 Location of the study area	2
1.3 Problem statement	3
1.4 Objectives of the study	4
1.5 Research questions	4
1.6 The significance of the study.....	4
1.7 The scope of the study	5
1.8 Limitation of the study	5
1.9 Organization of the study	5
2. CHAPTER TWO – RESEARCH METHODOLOGY.....	7
2.1 Research Design	7
2.2 Description of the study area and boundary	8
2.3 Identification and interpretation of greenway objectives for Hawassa	9
2.4 Method Description	9
2.5 Data Collection.....	12
3. CHAPTER THREE – LITERATURE REVIEW	15
3.1 Theoretical Framework	15
3.2 Definitions, concepts, and types of the greenway	15
3.3 Types of greenway	16
3.4 Greenways for urban sustainability	17
3.5 Problems of natural environment and greenway opportunities.....	18
3.6 Impacts of urban functions on water	18

3.7	Challenges of greenway planning and design	18
3.8	Challenge of development and nature conservation in Hawassa	19
3.9	Purpose and benefits of greenways	20
3.10	The methodology of planning and Design	22
3.11	Urban design dimension and the benefits of greenway	23
3.12	Functions of a greenway along lake shore /riparian corridor.....	25
3.13	Effects of human activities on riparian corridors/lake shoreline	26
3.14	Effects of recreational activities on riparian corridor	26
3.15	Effects of channelization on riparian corridor	26
3.16	Corridor design of greenway.....	27
3.17	A vision for community design.....	29
3.18	Case studies	29
3.19	Summary of Review and Case Analysis	34
4.	CHAPTER FOUR- DATA PRESENTATION AND ANALYSIS	36
4.1	Data Presentation and Analysis	36
4.2	Assessment of Demand Area.....	36
4.3	Assessment of Suitability of Location in Hawassa for Greenways.....	42
4.4	Defining Greenway Path using the LCP	50
4.5	Evaluation.....	50
4.6	Adjustments.....	50
5.	CHAPTER FIVE: RESULTS AND DISCUSSION	51
5.1	Results	51
5.2	Discussion	69
5.2.2	Use of potential existing trials.....	70
5.2.4	Strengths.....	72
5.2.5	Applicability.....	73
5.3	Summary of analysis tasks and findings	73
6.	CHAPTER SIX.....	76
	<i>CONCLUSION AND RECOMMENDATION.....</i>	76
6.1	Conclusion.....	76
6.2	Recommendation.....	76

PART II..... 82

7. CHAPTER SEVEN - DESIGN 82

7.1 Introduction 82

7.2 Site selection..... 82

7.3 Compatibility of greenway 85

7.4 Physical Context..... 94

7.5 SWOT analysis of action area 107

7.6 Program development..... 109

7.7 Conceptual development 111

7.8 The master plan of the action area..... 112

7.9 Greenway at the local scale 114

7.10 Ecological features 121

7.11 Socio-cultural features 127

7.12 Alternative transportation features 131

BIBLIOGRAPHY 134

List of Table

Table 1: Summary of data collection and analysis methods	13
Table 2: List of Data, type, and character Used in GIS (Source: fieldwork and structural plan of Hawassa) .	14
Table 3: Prioritized problem, their causes, and effects of Hawassa city.....	20
Table 4: Corridor feature and tread width (Time-Saver Standards for Urban Design, P-513)	28
Table 5: Environmental suitability of uses and activities within sensitive environments (Time-Saver Standards for Urban Design, P-513).	28
Table 6: Summary of review findings; sustainability factors and greenway framework, features, and strategies	35
Table 7: Suitability factor scheme adapted from (Conine A. et, 2004) , (Miller ,W. et al., 1998) , (Blob, 2016) and (Donald, Alan, & Robert , 2003) and (Teng, M. et al., 2011)	42
Table 8: Coverage of Proposed Greenway network with Demand locations (Generated from GIS Multi-Ring Buffer tool)	70
Table 9: Types of greenway projected for Hawassa	72
Table 10: Summary of analysis and findings	73
Table 11: Design Criteria and guidelines for ecological aspects of the greenway.....	79
Table 12: Design Criteria and guidelines for socio-cultural aspects of the greenway.	80
Table 13: Design Criteria and guidelines for alternative transportation aspects of the greenway.	81
Table 14: Resources, issues and key functions defined for segment one. (Source: Field Survey)	89
Table 15: Resources, issues and key functions defined for segment two (Source: Field Survey).	90
Table 16: Resources, issues and key functions defined for segment three. (Source: Field Survey)	91
Table 17: Resources, issues and key functions defined for segment four (Source: Field Survey).	93
Table 18: Total coverage of street network and surfacing (Source: Filed survey and structural map).....	99
Table 19: Findings/SWOT of action design area	108
Table 20: Design strategies	109
Table 21: Programs and design features (Source: Study).	110
Table 22: Stormwater management systems used in the site	126
Table 23: Stormwater management evaluation scheme of vehicular carriageway before and after.	126

List of Figure

Figure 1: As land gets developed, seen here from left to right, the natural space that remains become highly fragmented (American trail.org.).....	2
Figure 2: Location of the study area.....	3
Figure 3: Greenway framework (Author).....	15
Figure 4: Typical cross section near a sensitive area. (Time-Saver Standards for Urban Design, p-501).....	22
Figure 5: Types of Trail and Corridor (Time-Saver Standards for Urban Design, P-506)	27
Figure 6: Types of Trail and Corridor (Time-Saver Standards for Urban Design, P-506)	28
Figure 7: Serenbe greenway (Serenbe Community Trail.com).....	31
Figure 8: Garnet oaks, preservation and recreational greenway.	33
Figure 9: Natural Features and Retails among the identified location (Source: Field Work 2017).....	38
Figure 10: Historical, recreational and cultural features among identified locations (Source: Field Work 2017)	39
Figure 11: Natural, Protected, retail and service features among identified location (Source: Field Work 2017)	40
Figure 12: Recreational, scenic, natural and public features among identified location (Source: Field Work 2017).....	41
Figure 13: Some of the Potential greenway areas and natural corridor; the Potential walking path along the lake shoreline (picture taken from Tabour Mountain) (A), potential linear space along the street from St’ George Church to Fikir Hayek, and Popular trails used for a long time along the lakeshore. (C) Were included in the greenway network. (Source: Field survey 2017).....	71
Figure 14: Actual situation along the segment one (Source: Field Survey).....	86
Figure 15: Actual situation around segment one (Source: Field Survey)	87
Figure 16: Actually started action to protect and beatification of the corridor (Source: Field survey)	88
Figure 17: 6-meter wide trail along lakeshore facilitating all the activities along the lake (Source: Filed Survey)	89
Figure 18: On the actual situation of segment two (Source: Filed Survey)	90
Figure 19: On the actual situation of segment three (Source: Filed Survey)	92
Figure 20: On the actual situation of segment three (Source: Filed Survey).	93
Figure 21: Existing situation between the lake and the community (source: filed survey)	95
Figure 22: Section of city old market to Municipal Square (Source: Field Survey and Secondary data).....	97

Figure 23: Street section of the 7th day Adventist church to Municipal Square (Source: Filed survey and secondary data) 97

Figure 24: Section of trail adjoins the lake shoreline /dyke (Source: Field survey) 97

Figure 25: The actual situation on the routes connecting the lake shore to surroundings (Source: Field survey) 98

Figure 26: Sidewalks and the public in the realm and the urban blocks in terms of vegetation (Source: Field Survey) 105

Figure 27: the Topographic character of location between the urban landscape and the lake (source: field survey) 105

Figure 28: Environmental challenges 107

Figure 29: Overall view of the new plan. 114

Figure 30: Overall view of the new plan. 114

Figure 31: Sectional view of new segment one 115

Figure 32 Three dimensional views of the new segment one 115

Figure 33: Sectional and three-dimensional view of new segment two 116

Figure 34: Three-dimensional view of new segment two 117

Figure 35: Sectional and three-dimensional view of new segment three 118

Figure 36: Sectional and three-dimensional view of new segment four 119

Figure 37: Three dimensional view of new segment four 120

Figure 38: Sectional and three-dimensional view of new segment four extensions to Amorage del Park. 120

Figure 39: Three-dimensional view of new segment four extensions to Amorage del Park. 121

Figure 40: The proposed plan situation of more vegetation and continuity for wildlife 121

Figure 41: Showing buffer zone to protect the lake 122

Figure 42: The proposed environmental protection scheme. 122

Figure 43: Mechanisms added to improve ecological service of the action area 123

Figure 44: Proposed buffer zone to protect the lake and wildlife 123

Figure 45: Before and after view of segment three 124

Figure 46: Proposed reforested lake buffer and urban corridors 124

Figure 47: Proposed reforested social landscape 125

Figure 48: Proposed wildlife corridor along the lake 125

Figure 49: Sample Street section which shows the stormwater controlling techniques 126

Figure 50: Proposed greenway and urban mass 127

Figure 51: Connector trails that integrate the city scale segments with the community 128

Figure 52: Connector trails that integrate the city scale segments with the community..... 129

Figure 53: New proposed and improved the social place..... 130

Figure 54: Streetscape view with different types of social space and massing support social interaction 130

Figure 55: New greenway proposed for more people and more activities..... 131

Figure 56: Proposed surfacing and materials 131

Figure 57: New pedestrian and biking environment 132

Figure 58: The proposed intersection, the first picture (A) Showing the existing circular intersection and the rest three (B, C & D) showing the proposed geometry and contents of right-angle intersection. 132

Figure 59: Proposed crossing 133

List of Map

Map 1: Map showing the location and their concentration of demands of connectivity across Hawassa city (Source: Field Work 2017)..... 37

Map 2: Map showing the hierarchy of roads in Hawassa city (Source: Structural plan of Hawassa). 45

Map 3: Map showing Road Surface in the city of Hawassa (Source: Hawassa city Recent Base Map and Field Survey). 46

Map 4: Road density in the city of Hawassa (GIS – Density analysis)..... 47

Map 5: Area of residential and urban activity centers in Hawassa (Source: Filed work, 2017). 52

Map 6: Potential locations by their natural content and residential zones (source: Fieldwork and a base map of Hawassa)..... 52

Map 7: Map showing the current land use of Hawassa (Source: Administration of Hawassa city Planning Department, 2017)..... 53

Map 8: Map showing land availability for the greenway in the city of Hawassa. 55

Map 9: Map showing availability of roads for the greenway in Hawassa city. 56

Map 10: Map showing the relative attractiveness of land patch for the greenway in the city of Hawassa (Source: the result of Analysis from Land use). 57

Map 11: Map showing the suitability of areas based on their protection status for the city environment..... 58

Map 12: Map showing protected area suitability of Hawassa city..... 59

Map 13: Location of demand connectivity by greenways in Hawassa 60

Map 14: Map showing the density of locations to be included in the greenways..... 60

Map 15: Map shows topography suitability as a factor for greenway network. 62

Map 16: Map showing, Suitability of topography for movement (A) and scenic potential location in terms of Height (B)..... 63

Map 17: Weighted and overlay of all analysis, cost rater of Hawassa for the greenway..... 64

Map 18: First run greenway route generated of the LCP model. 65

Map 19: Conflicts of the first run generated greenway routes one another. 66

Map 20: Shows the overlay of the proposed greenway network and Hawassa city existing network..... 67

Map 21:Identifying and correcting root alignment (A) First run model of LCP and (B) After adjustment of alignment. 67

Map 22: Adjusted routes. 68

Map 23: Map showing the proposed greenway network and the need coverage (Source: Field survey). 69

Map 24: Potential existing vehicular free trail included in adjusted greenway network. 70

Map 25: Location map (Source: Georeferenced Google map and Greenway network generated on part one of this Studies). 83

Map 26: Action area (source: Georeferenced Google map and Greenway route generated in Part on this study). 84

Map 27: Public nodes near and around project area (source: Google Map and Field Survey). 84

Map 28: Segments proposed greenway network defined in the action area (Source: Part one of the study). . 85

Map 29: Existing Street network. 96

Map 30: Existing potential trails to interconnect the greenway segment with the actual community. (Source: field trip)..... 96

Map 31: Existing land use of the project area (Source: Land use map)..... 100

Map 32: Building pattern of the actual situation of the project area (source: Base map). 101

Map 33: Sensitive landscape in the project area (source: structural plan and written documents)..... 102

Map 34: Active frontages in and around the action area (Source: Field survey). 103

Map 35: Public focal points to meet, buy, sell and interact (Source: Field Survey). 104

Map 36: Conceptual map of the action area. 112

Map 37: Proposed layout of design with greenway segments/ 113

List of Diagram

Diagram 1: Research Design 7

Diagram 2: Process flow diagram (Author). 36

List of Acronyms

- GIS: Geographical Information System
GISP: Geographical Information System Planning
LCP: Least Cost Path
LID: Least Impact Design
EPA: Environmental Protection Authority
SNNPRS: Southern Nations and Nationalities People Regional State
MWUD: Ministry of Works and Urban Development
FUPI: Federal Urban Planning Institution
STA: Salmon Trails Association
NASA: National Aeronautics and Space Administration
ENTA: Ethiopian National Transport Agency
EMA: Environmental Management Agency
DEM: Digital Elevation Model
TEEB: The Economics of Ecosystems and Biodiversity
WTO: World Trade Organization
USGS: United States Geographical Survey
CAD: Computer Aided Design
SWOT: Strength Weakness Opportunities and Traits
CO2: Carbon Dioxide

PART ONE

1. CHAPTER ONE - INTRODUCTION

1.1 Background

The growth in urbanization and associated development pressures have led to land use change and major ecological pressures on the landscape in both developed and developing countries. Development/urbanization is a process of subdividing the land into lots and altering the physical landscape for the purpose of housing, roads and commercial use within communities (Jongman and Pungetti, 2002). Developing land for human needs reduces the amount of natural space (Hellmund et. al., Paul, & Daniel et. al., 2006), as natural spaces diminish, so does habitat diversity, the great variety of forests and other natural resources (Smith, 2006).

A development has an indirect impact on a land it leaves untouched. As we convert land, we fragment a landscape into smaller and more isolated patches of nature (See Figure 1). The new pattern and mosaic that we have created on the landscape greatly alters the way in which natural systems function, any change in their habitat because of human nature of human nature alteration for development will affect their ability to survive ((Hellmund et. al., Paul, & Daniel et. al., 2006)

Today in many cities globally greenways, a linear natural corridor that performs natural functions while offering desirable results protect and conserve nature, social and cultural character and serve as alternative commuting along the corridor (Turner, Shafer, & Lee, 2000). Greenways are planned, designed and implemented for their various functions: they provide open space for public access, recreational use, protecting and improving natural resources, alternative transportation (Fabos, Julius Gy., 1995; Ahern J. , 1995). This natural corridor brings ecological/environmental, social/cultural and transportation benefits to the city, and is viewed as a natural system approach in the city planned first, so that different parts of the city can be connected, second pedestrian flow is possible, third view as a link between different parts of the city ((Ahern J. , 2004; Fabos, 2004) .

In the context of Ethiopia, cities are growing at a rapid rate of urbanization which creates development demand on physical infrastructure, land and, energy (EPA, 2002). These interventions put the country in a struggle with urban issues, unsustainable use of land, fragmentation of the natural environment, loss in natural resource and public needs like green space and transportation.

This thesis uses the concept of a greenways system as a primary driving factor in shaping Hawassa's sustainability. The main purpose is to reveal useful findings for the city of Hawassa in the provision of the greenway system. We will use phase by phase tasks, identifying locations of Hawassa its natural, scenic, public destinations and tourism. Identifying the most suitable landscape for greenways that link those locations after delineation of corridors on the suitable landscape shall be done using LCP. Finally, an action area in this greenway framework shall be selected to test integrations of defined greenway corridors in the existing urban fabric.

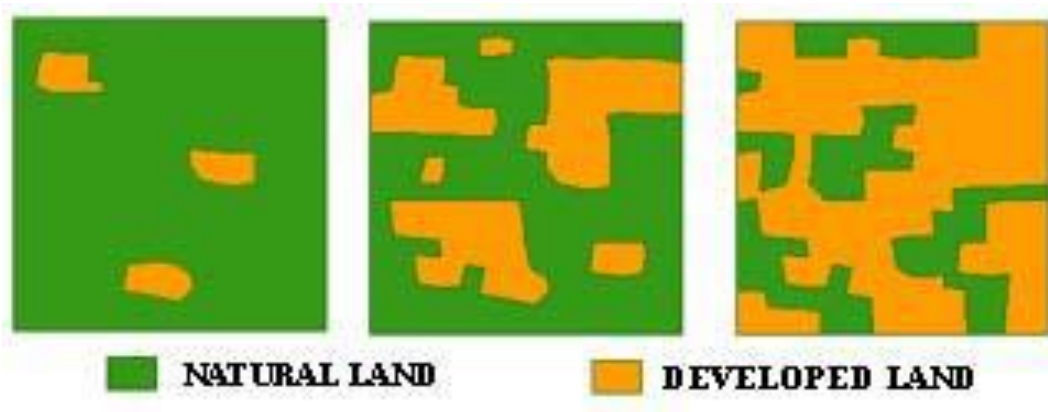


Figure 1: As land gets developed, seen here from left to right, the natural space that remains become highly fragmented (American trail.org.).

1.2 Location of the study area

Hawassa is located in the regional state of Southern Nations Nationalities Peoples State (SNNRPS) about 275km from the capital of Ethiopia, Addis Ababa. This is the administrative city of the regional state. It is situated along the international road that connects Addis Ababa with Nairobi at a distance of 275 kilometers south of Addis Ababa. It is bounded by Lake Hawassa on the west and north-west, Chelelaka marshy area on the east and south-east, Tikur Wuha River on the north and Altamura Mountain on the south. It lies on a relatively flat plain in the rift valley topographic region having an average elevation of around 1,690 meters above sea level (m.a.s.l.). The approximate geographical coordinates of the hinterland of Hawassa extends between 37° 52' - 39° 11' East longitude and 06° 27' - 07° 40' North latitude, and covers a total area of 8282.6 km².

The hinterland comprises eight Woredas, found in Oromiya National Regional State (Shashemene, Arsi Negele, Kofele, and Siraro) and from Southern Nations Nationalities and People's Regional State (Hawassa Zuria, Shebedino, Dale and Boricha).

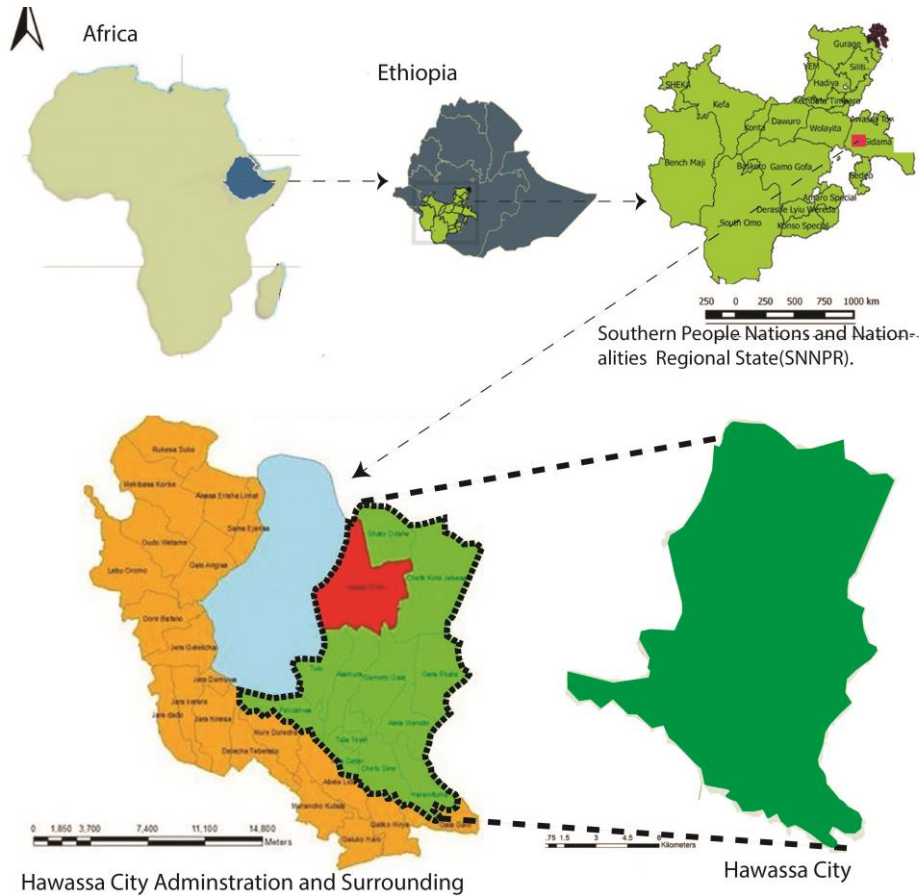


Figure 2: Location of the study area.

1.3 Problem statement

Hawassa’s ecological environment is being compromised for urban development; this has led to fragmented green mosaic. Due to this fragmentation, the natural system is getting disconnected (Hawassa City Administration, 2014). The city is facing flood challenges and high volumes of runoff. Social lifestyle is changing (MWUD,FUPI, 2006). Dependency on the motorized mode of transportation is observed in Hawassa, is causing residents associated lifestyle illness (Jane, Jacobs, 2007). Hawassa is struggling between the problem of urban development and the natural environment (MWUD,FUPI, 2006). Development and rapid urbanization are changing the natural mosaic and are restructuring the land use. Building a wide range of transport infrastructural networks, building different structures for different uses in the city and for people need is among those factors. Urban areas facing serious fragmentation of natural areas, changing in lifestyle, motor dependency, and deterioration of ecosystem, loss of natural habitats and extinction of species are becoming evident (Alliance(STA), 2012).

Considering these issues of rapid urbanization, fragmentation of nature, extinction in biodiversity, it is necessary to assess and find strategies for reconnecting the natural elements and better

link the development and ecological protection mechanism. Greenways in other countries have solved the problem by connecting the fragmented natural environment. Likewise greenways can benefit Hawassa on various ways like, better ecological network, socio-cultural promotion, creating public space network, improving community attachment with nature, creating sustainable alternative transportation that reduces air pollution, enhancing health benefits for walking, running biking, reconnect the wildlife route, biodiversity maintenance, and environmental protection, like reduction flood, run-off, and erosion.

1.4 Objectives of the study

The main objective of this study is to identify and design potential greenways of Hawassa that link city's potential areas.

Specific objective

- To identify the potential greenway areas of Hawassa city.
- To assess the suitability of existing urban environment for greenway delineation.
- To identify suitable greenway route that links potential areas.

To design greenway segments from the whole network on actual specific site of Hawassa for its integration and implementation at local scale.

1.5 Research questions

This thesis is intended to answer the main question, “how can one identify and design the potential greenways of Hawassa city?”

Specific Questions

- What types of potential greenway areas are found in Hawassa city?
- Which areas are a suitable landscape for the greenway in Hawassa city?
- How to delineate suitable greenway corridors that link potential areas?
- How to design a segment of the whole greenway network in the city that is proposed

1.6 The significance of the study

This study reveals useful findings for the city of Hawassa as well as for the field of planning, urban design and city administration showing that greenway network is a strategic planning and design tool for city's sustainability. Hawassa city can benefit from the results by receiving specific and scientifically sound recommendations regarding benefits and future direction of greenways for the city and mechanisms to identify suitable landscape to integrate greenway network and attain goals of a sustainable city.

This study encourages further planning, design and supports the city's effort in building a more sustainable and livable city. Furthermore, this study provides a methodology for assessment and identification of suitable landscape and route defining tasks which could improve current planning and design procedures in the city of Hawassa and other similar cities in the country.

1.7 The scope of the study

The spatial or geographic scope of the study is to cover assessing and locating the potential area in cities of Hawassa, currently authorized as political and administrative boundary included in this study. It is limited to assessing at planning scale for producing city scale greenway corridors as a system then design a segment of the single corridor to test its integration and implementation on actual situation at the local scale.

The thematic scope focuses on the assessment of potential areas and assessment of suitable landscape and existing situation in relation to the objectives of the study. This study mainly focuses on the suitability of landscape; identifying city's potential for greenway and developing potential greenway networks at city scale then preparing detail design at local scale.

1.8 Limitation of the study

In this study, most of the data are gathered from Hawassa city administration different concerned bodies. The data are written copies that are major limitations for the study. Digitalizing and organizing data was time taking the task, In addition, collecting data's like locations of high population destination was the difficult tasks for this study. Availability, accuracy, organization and registration time of data was a major limitation, these limitations have the possibility can limit the number of factors used in suitability assessment and distort the result. The other limitation was bureaucracy; working with officials timelines and different stakeholders availability of the concerned bodies is essential for updated data, this was a limitation for the study.

1.9 Organization of the study

This study is presented in two parts. Part one includes; chapter one deals with background information of the study, location of the study area, statement of the problem, research question, objective, significance of the study, scope of the study and limitation of the study; chapter two research methods and data; chapter three deals about literature review; chapter four deals with implementation of methods at city scale; chapter five presents result, discussion and findings; chapter six presents conclusion, recommendations and future detail implementation direction of study area. Part two includes;

chapter seven design, which present testing the network on a specific site using implementation strategies and guidelines.

2. CHAPTER TWO – RESEARCH METHODOLOGY

2.1 Research Design

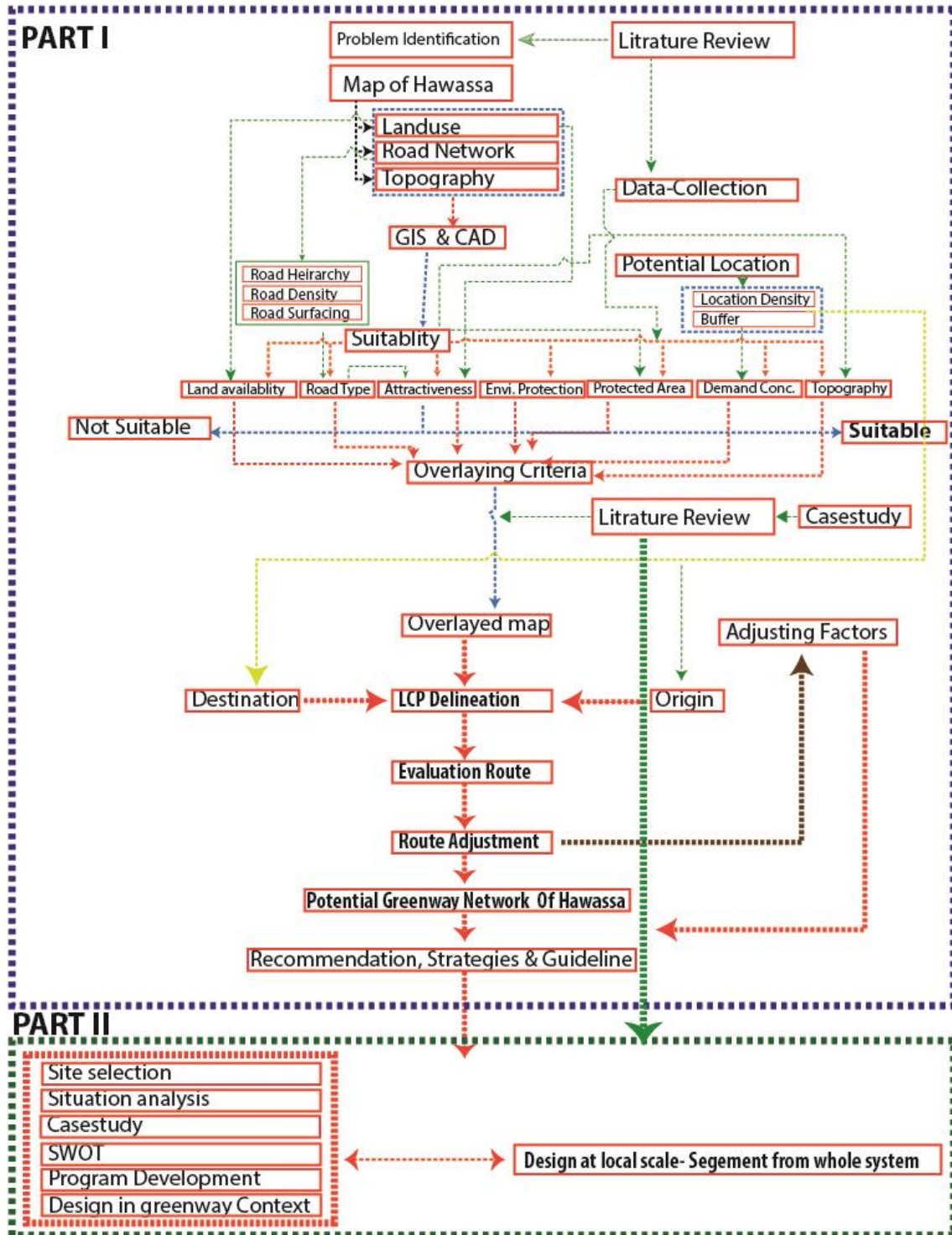


Diagram 1: Research Design

2.2 Description of the study area and boundary

The study area is located in Hawassa city which is in the southern part of Ethiopia. Hawassa is a medium sized city with a population of about 358,725 inhabitants (2007 profile, statistics office of Hawassa), and taken as a secondary city. The city of Hawassa has based on natural resources. Currently, those resources are the main income-generating resources. They bring higher value for the wellbeing of the inhabitants as well as for the 200,000 per year visitors (2007 profile, tourism office of Hawassa) in the city. However, currently, the protection of those natural features and enhancement of urban habitat connectivity is stressed in conflicting fragmentation and degradation by a reason of new construction activities and infrastructure development, mismatch between natural landscape and land use plan. According to an interview with the environmental protection, tourism and biodiversity officials of Hawassa city administration these are a willingness to move towards a more sustainable and eco-friendly city.

According to the tourism office of city administration, Hawassa has many potential scenic natural landscape but most of these environments are not accessible. In order to encourage daily journeys greenway to have a potential to form a sustainable form of mobility within the built urban form as an alternative travel route and environmental protection (Ahren 1995; Searns 1995; Walmsley 1995; Conine et al. 2004). Greenway network is the best naturally connecting systems for less accessible places. The most scenic potential landscapes across the city; Burkito hot spring, which is less accessible with an average of 1000 visitors for natural healing per day. The highest accessible is lake Hawassa (*Tourism office of Hawassa*).

The second reason for the proposed greenway network in Hawassa is that the city set-up reveals the structural potential for the implementation of a greenway network. Lake Hawassa and its long shoreline trails, Tabour and Alamoura Mountain, Burkito hot springs, Millennium Park for biodiversity protection as well as Tikurwuha River, palaces and monasteries as historical elements are the city's suitable spatial elements for greenway development. The elements mentioned above provide linear and nodal features for greenway alignment. Riparian greenways can protect water quality and aquatic life, and contribute towards networking of natural features thereby protecting watercourse as well as habitat connectivity as wildlife corridor (Connie et al. 2004; Turner 1995). Furthermore, the city of Hawassa has numerous open spaces for greenway development and low traffic roads, where car restrictions would not affect the urban traffic flow significantly. That suitable city and natural features make the city of Hawassa as a setting with high potential for the realization of a greenway network.

2.3 Identification and interpretation of greenway objectives for Hawassa

Most greenways implemented and underway, planned, designed and constructed a base on three main objectives. These are the provision of alternative and sustainable travel routes, socio-cultural character and wellbeing for humans and animals, urban ecological and environmental conservation and protection (Ahern J. , 1995; Fabos, 2004; Hellmund, Paul, & Daniel , 2006). While the first greenway objective aims to serve the human well-being that facilitates movements of peoples for different purpose and recreation. The second objectives aim at the social and cultural character for the site as the provision of networked public and open space for people to interact also to create an attachment with nature. The third objective aims to serve the natural systems, protection, enhancement, and linkage for the benefits of the whole. Thinking of non-motorized travel routes through greenways has been encouraged in several analysis and planning approaches. This study aims to identify greenway corridors system and design at a specific site for Hawassa.

2.4 Method Description

The main task in this study is categorized into two parts; identifying potential greenway corridors at the city scale and design segment from the whole proposed on a specific site for the actualization of the bigger plan. In the first part, identifying the potential greenway corridors takes several sub-tasks, identifying the demand area needs to connect in the greenways. These areas are the city's potential locations where cultural/social and natural resources are located in. After identifying, demand areas followed by the landscape suitability assessment to identify the suitable landscape for the greenway in Hawassa. Assessment of landscape suitability is followed by a series of assessments and map overlays that identify the best suitable landscape. Finally, greenway corridors are delineated by evaluating and adjusting the identified ones in the first part. The second part of the study is the design of the segment from the whole. Tasks like selecting a specific site from the whole then designing in detail at local/specific site scale is conducted.

2.4.1 Study tools to identify potential Greenways

For the whole process of this study to identify the potential greenway corridors in Hawassa follow a continuity of GIS-based planning approaches developed and advanced by Miller et al.(1998), Conine et al. (2004) and Teng et al. (2011). This methods and approaches by Miller and Conine are similar in that they both use GIS-based phase by phase approach. In this method one follows the other; the successor depends on the precedent. Land suitability is assessed and analyzed to identify suitable land for greenway development. Both studies begin with identifying intended greenway functions, and the relevant factors that indicate these functions in a spatial context. Within the GIS working and analysis

environment, all cells in the study area are ranked by each factor of suitability. While suitability map is the final result in the study area by Miller et al. and, Conine et al. take a further step and use the suitability map to delineate greenway corridors that pass through the highest suitability result. Suitability assessment bases on measuring factors. These factors represent a single attribute to identifying landscape. Finally, overlaying all factors to a single layer which is the sum of all factors; that the cost surface/cells of relative suitability in the study site.

GIS-based approach for greenway planning and design is found to be the most suitable planning tool with, a raster-based algorithm to determine the best option among possibilities and the most cost-effective paths between two specified locations connected depending on the given cost surface generated from suitability assessment . Least Cost path (LCP) method used to identify the first greenway corridor; the output from LCP model is the optimal path for all criteria taken during the suitability assessment (Conine A. et, 2004). Overall, this method was chosen for its optimal advantages of working on the large area; such kinds of study must undertake on wide area assessment for networking the natural and human movement needs. This phase of the study has followed suitability criteria and greenway corridor identifications, following the approaches and recommendations by Conine, Miller, and Teng.

Selecting Suitability factor

Suitability analysis is serious of assessments and map overlays that identified the preliminary corridors where the most significant greenway resources were located. These corridors become the priorities for greenway land acquisition (Jana & Rogier , 2004). Primarily need factors for suitability assessment to be set. The applications of suitability factors and criteria for ecological networks design helps to reveal evaluate and exploit the impact of protected area and availability of resources from the developed and future expansion area (R. H. G. Jongman, 2004). In suitability assessment factors mainly categorized into mainly four, physical, environmental/ecological, economic, and socio-political (Gobster & Westphal, 2004). This study mainly prioritizes environmental factors of suitability, because the goals of this assessment are finding landscape patch which is most suitable among a different landscape of Hawassa to integrate greenway network.

For the purpose of this study, the most significant issues to choose the factors for suitability regarding the actual study area among various suitability factors. Weighting factor and criteria used in this study (land availability, attractiveness, road type, environmental protection, protected area, the demand of connectivity and topography) were used also for a different study. The selected factors of suitability on other studies done before, a study by (Blob, 2016; William, Michael, Frederick, & Edward, 1998), found

given a high priority. As a result, the identified study area in Hawassa greenway analysis has also identified these factors as high priorities.

GIS as a tool

GIS is used to find the optimum route and spatial discontinuities can be useful in delimiting corridors (R. H. G. Jongman, 2004). Used to analysis combined datasets. Help to understand spatial ecological relationships much more clearly than was ever possible in the past, and helped to develop a strong methodological instrument for building greenway network (Renato & Luciano, 2004). Using GIS enables us to outline the situation as an almost continuous configuration of efficient units and results of environmental continuity (Gloria & Bernardino, 2004). And finally, GIS functionality and its spatial processes modeling capabilities led us to choose the raster structure for our data analysis.

2.4.2 Assessment of Potential areas

According to Conine, Miller and Teng approach to identify greenway Corridor and plan the network first step are assessments of potential locations that need to be connected in greenways network. These locations are natural resources and frequent human activities including, residential locations are the main origins of people, and service (Health, schools, institutions), manufacturing, recreational area, market are among locations which attract people to move (Conine A. et, 2004). From this assessment phase, a place of high concentrations of points and potential locations in Hawassa are identified.

2.4.3 Assessment of site Suitability

In this sub-phase of the method, the landscape of Hawassa is rated for factors of suitability for the stated goals of the study, and the most suitable areas for future greenways were identified on a similar fashion to Miller et al. (1993) and Conine et al. (2004). Various measuring factors for identifying suitability are selected. In suitability assessment selected factors availability of land for greenway delineations, road types, attractiveness of landscape, environmental protection, protected area assessment, demand for connectivity and topographical assessment were identified as factors to identify the suitability of study area for greenway network. Finally, all factors were mapped and overlaid. The suitability of the whole assessment criteria in GIS, the surface of cells with relative cost in terms of suitability are ranked from very high to not suitable.

2.4.4 Path delineation using LCP model

Path delineation needs origin and destinations. As discussed in previous parts of these methods, assessments of demand areas include a number of locations with origin and destinations of travel. Most residential locations by a character in most travel are taken as the origin and, other service areas, job, recreations like are taken as an end in daily frequent travel (Conine A. et, 2004, Miller ,W. et al., 1998,

& Teng, M. et al., 2011). The start and destination points were determined to be locations in the city with a character of most demand areas around the city of Hawassa. To make it specific, the relative concentrations density of demand areas of origin and destinations, and locations that the demand locations are located were defined. The intention of this point selections was to cross-connect peripheral residential point and other connection demand locations at diagonal locations from the city to create a connected web like a network that covers demand areas across the city more or less evenly. This mechanism was taken from the recommendations by Tom Turner(1998) for the urban green web that interconnects the urban center with the urban fringe (Smith, 2006, Jongman & Pungetti, 2002). With the whole data provided, the corridor was calculated by pairing origin and destinations points, in the LCP model process.

2.4.5 Evaluation

The generated suitable greenway network routes were evaluated in four stages. First, conflicts and overlays of individual routes generated using different origin and destinations; second, overlaying the generated greenway network on the existing Hawassa road networks. In this process the results of the LCP path models calculations were evaluated against the city streets and suitability level; the third stage generated greenway alignment; fourth stage suitability evaluated against Hawassa's spatial features like property and ownership conflicts.

2.4.6 Adjustments

As a final step, the whole task in identifying the potential greenway corridor of Hawassa was conducted. In this phase, the issues identified in the evaluation processes were traced back to their cause, suitability assessment, and path delineation phases after adjusted to improve the final results of suggested greenway routes.

2.5 Data Collection

In this study, most of the data manipulation and analysis took place on the digital spatial analysis program, ArcGIS 10.3. Before the data and information record into the GIS platform searching of the essential data was the first task. Half of the data were derived from different part of the Hawassa city administration, tourism and recreational data in printed copies, fliers, website and browsers from city tourism and culture office. Digitalizing these documents in the spatial form on digital layer, different existing and future city structural plan proposal, land use from the city urban planning department was necessary. The structural plan, as a data, has located green space and protected zones with other urban land use. From the city, biodiversity protection and conservation office areas good for protection and conservations and the future plan in terms of the vision for the city were found. Terrain analysis was

made based on the data from NASA & USGS (DEM with 10-meter cell size). Based on this topography gradient highest of the city boundary for scenic value were identified. Highest points have a potential location for scenic value (Ahern J. , 1995) . Potential demand areas were studied using on-site observation and survey; this data was used for the assessment of demand areas of Hawassa.

Table 1: Summary of data collection and analysis methods

No	Objective	Data type	Data source	Method of data collection	Data Analysis
1	To identify the potential greenway areas of Hawassa city.	Updated Base map (CAD)	City municipal	Mapping	GIS
			(Planning department and Masterplan office)		Excel
					Auto-CAD
		Spatial locations of uses ,generating peoples travel from home(Land use)	City municipal	On-site survey and mapping	GIS
			(Planning department and Masterplan office)		Excel
		Potential locations	City municipals , sub-cities and on-site observations	Interview , mapping and capturing a photo	GIS
Hot spots, population and spatial locations, and centers of the city	AutoCAD				
Recreational and tourism attractions	Tourism and culture office of Hawassa ,websites ,fliers, and brushes	Browsing , Tracing and digitalizing	Excel		
2	To assess the suitability of existing urban environment for greenway delineation.	Spatial data's, land use, road network , topographic data	City municipal , Google map ,Google earth, and NASA Earth data	Browsing , conversion , classification Tracing and digitalizing	GIS
					AutoCAD
					Excel
3	To identify suitable greenway route that links potential areas.	Origin and destination	Demand area assessment and Suitability assessment from previous steps	-	GIS
					Excel
		Structural Plan of Hawassa	Suitability assessment from previous stages.		Auto-CAD
COST SURFACE or Relative suitability of influential factors map		GIS(Distance tools)			
		LCP ,Cost Distance and Cost Backlink			
4	To design greenway segments from the whole network on actual specific site of Hawassa for its integration and implementation at local scale.	Proposed Greenway network	City Municipal	-	GIS
		Base map of the city	The output of objective 3		AutoCAD
		Existing map	On-site caption		
		Picture on site	Journals		
		Observation			
		Literature			

Table 2: List of Data, type, and character Used in GIS (Source: fieldwork and structural plan of Hawassa)

Data Source	Data Description	File Type	Purpose
Hawassa City Administration , Planning Department	Manufacturing areas	Polygon	Suitability Assessment
	Social Service	Polygon	Suitability Assessment
	Residential areas	Polygon	Suitability Assessment
	Forest	Polygon	Suitability Assessment
	Recreational areas	Polygon	Suitability Assessment
	Educational Institutions	Polygon	Suitability Assessment
	Administration area	Polygon	Suitability Assessment
	Green and open spaces	Polygon	Suitability Assessment
Roads	Polygon	Suitability Assessment	
Hawassa city Administra Education Office	Elementary Schools	Point	Assessment of Demand areas
	High and Preparatory School	Point	
	Colleges	Point	
Hawassa City Administration Biodiversity protection conservation office	Animal and Plant Reserve	Point and Polygon	Suitability assessment
	Future Plan of locating Sanctuary Reserve	Point and Polygon	Suitability assessment
Hawassa City Administration Tourism and culture office	Historical Heritage	Point	Assessment of Demand areas
	Natural Heritage	Point	Assessment of Demand areas
	Potential Scenic locations	Point	Assessment of Demand areas
On site survey and observations	Retail	Point	Assessment of Demand areas
	Youth center	Point	Assessment of Demand areas
	Stadium	Point	Assessment of Demand areas
	Markets	Point	Assessment of Demand areas
	Popular Nodes	Point	Assessment of Demand areas
	Cities centers	Point	Assessment of Demand areas
	Cemeteries	Point	Assessment of Demand areas
	Transport stations	Point	Assessment of Demand areas
	Known Locations	Point	Assessment of Demand areas
	Existing Trails	Line	Assessment of Demand areas
Potential Trails	Line	Assessment of Demand areas	
City Municipal	Highways Crossing the city	Line	Suitability
	Roads	Line	suitability
	Land use	polygon	Suitability
'NASA Earth Data	DEM(Digital Elevation Model)	Raster Dataset	Terrain , view shade ,Hill sl Assessment

The data such collected were analyzed using the GIS software. Chapter four presents the analysis and results.

3. CHAPTER THREE – LITERATURE REVIEW

This chapter consists of a review of findings from a comprehensive literature search that was conducted as part of this study used as a means to understand the topic more and acquire up to date knowledge. This chapter includes theoretical framework, definition and concepts of the greenway, types of greenways, benefits, the need of greenway, and greenways for urban sustainability, challenges in greenway planning, designing and implementation examples, the methodology of planning and design.

3.1 Theoretical Framework

It is important to understand greenway networks as integrate physical and socio-cultural landscape. (Figure 3). The detailed framework and its forming elements as a theoretical base will discussed follow after this topic in detail.

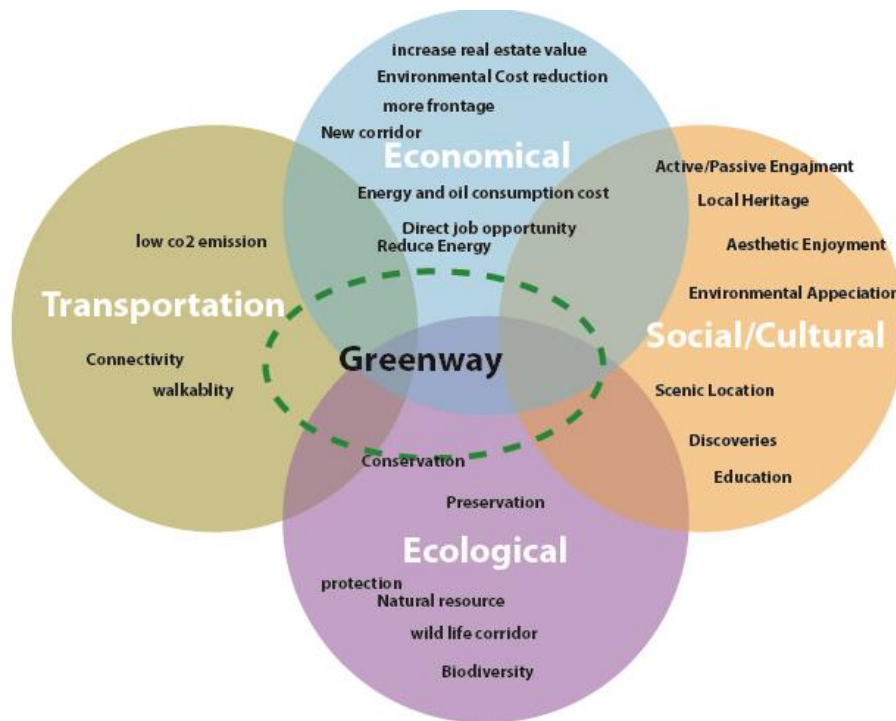


Figure 3: Greenway framework (Author).

3.2 Definitions, concepts, and types of the greenway

Greenways come in many forms and structure and serve many different functions. Because of this, many definitions exist. Three definitions of greenways are presented below. The study chose these definitions because they are widely cited by greenway scholars as their definition.

The first is a comprehensive definition from landmark book of Charles Little’s (1990), *Greenways for America*, which describes the varying function of greenways.

- 1- Any natural or landscaped course for pedestrian or bicycle passage.
- 2- Locally, certain strip or linear parks designated as parkway or greenbelt

An open-space connector linking parks, nature reserves, cultural features, or historic sites with each other and with populated areas.

A linear open space established along either a natural corridor, such as a riverfront, lakefront, stream valley, or ridgeline, or overland along a railroad right of way converted to recreational use, a canal, scenic road, and another route.

The second definitions are given by Julius G. Fabos(1995) who defined it as “a corridor of various widths, linked together in a network in much the same way as our networks of roads and rails roads have been linked. The major difference is that nature’s super infrastructure the greenway corridor networks is pre-existent”.

The third definition of greenways, given by Jack Ahren (2004) who defined greenways as Green networks of land that are planned, designed, and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use”.

Various key ideas to note within this definition of greenways, initially, greenways are based on linear systems aid in transportations of species, resource, people with in urban environment, linkage /connectivity is the other aspects of greenway aid to link different geographic areas, social , functions , which increases ecological, social and economic synergy. Multi-Functional/Multi-Objective attribute is the other aspects of greenways; they achieve multiple functions across the three ecological, economic and social goals of sustainability. Sustainability is the other key aspect of greenways focus on the three goals which are, social, economic and ecological/environmental.

3.3Types of greenway

Fabos(1995) also has identified three types of greenways in their purpose and functions at the same time although recognizing that they are increasingly overlapping in comprehensive greenways network ,comprehensive greenway network described according to the author , kind of greenways functioning recreational , historical resources preservation and protecting the natural environment “greenways of ecologically significant corridors and natural systems; recreational greenways and greenways with historical heritage and cultural values”.

Greenways are also classified depending on the purpose for which they are being created. Jack Ahren (1995) Created classifications systems for five categories of goals: cultural resource protection, historical, recreational, biodiversity and water resources related and development control. Since greenways are multi-functional, one or all of these goals may be incorporated into a greenway plan.

Charles Little(1990) in his book *Greenway for America* classified greenways into five different types based on motivating purposes which include environmental as well as recreational goals:

Urban riverside (or another water body) greenways, usually created as part of (or instead of) a redevelopment program along neglected, often run-down, city waterfronts.

- Recreational greenways, featuring paths and trails of various kinds, often relatively long distance, based on natural corridors as well as canals, abandoned rail beds, and public rights-of-way.
- Ecological significant natural corridors, usually along rivers and streams and less often ridgelines, to provide for wildlife migration and species interchange, nature study, and hiking.
- The scenic and historic route, usually along a road, highway or waterway, the most representative of them making an effort to provide pedestrian access along the route or at least places to stay apart from the car.
- Comprehensive greenway systems or networks usually based on natural landforms such as valleys or ridges but sometimes simply an opportunistic assemblage of greenways and open spaces of various kinds to create an alternative municipal or regional green infrastructure.

(Little, 1990, P.4)

3.4 Greenways for urban sustainability

For the first time in history, two third of the world population by 2050 will live in urban areas (Ahern, 2011). These changes in the geography of the settlement will greatly impact land use, resources, quality of life, and social equity of cities, creating a need for sustainable development practices within urban areas. Building new infrastructure and again replacing or updating when they get old presents an opportunity to create the greenway system that supports the natural processes in cities in order to improve sustainability. Greenway is an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations (Benedict & McMahon, 2002). Greenways constitute an integral component of natural infrastructure and add to the sustainability and resilience of a city.

The typical function of greenways, as suggested by geographer Rutherford Platt(1994) , include water resource protection and pollution abatement, riparian enhancement and biodiversity, flood hazard reduction, recreation, environmental education, noise attenuation , microclimate enhancement , for both cooling and pollution abatement, and the reduction of bank erosion and downstream sedimentation. This function of greenway put at primary level help to resist anti-nature activities and to achieve sustainability in many dimensions, social/cultural, alternative sustainable development and for ecological service.

3.5 Problems of natural environment and greenway opportunities

Many times greenway projects are initiated when peoples perceive a problem in the landscape, decline in green space, flooding, conservation and connectivity to minimize fragmentation. (Paul Cawood & Daniel, 2006).

3.6 Impacts of urban functions on water

Water is one of the world's most precious natural resources. In human activity, it is both a critical and assets for most destinations. Clean, accessible water is an integral resource, running most of the public and tourism sector's functions; from hotels and restaurants to leisure facilities and transportation. Water-dependent tourism is growing today, with many of the world's coast Lines and lakes being some of the most popular tourist destinations today. Many of those natural attractions where water is an essential element, the key to the tourism sector and thus a source of tourism-related employment and income in countries worldwide. Yet freshwater reserves are being threatened by a growing world population, excessive water consumption, weak water and water surrounding management; poor sanitation and global climate change. Increased water demand by tourists and local communities has an impact not only on human needs but also on flora and fauna. Without good planning and adaptation, development opportunities are missed and millions of lives are put at risk (WTO, 2016). Waterfronts are settlements, civilizations or commercial developments that come up along water bodies like rivers, coastal regions or lakes, acting as lifelines for development of cities. The construction of tourist facilities and infrastructure also increases the number impervious surfaces, which in turn increases the amount of polluted runoff reaching water bodies (Davies, 2012)

3.7 Challenges of greenway planning and design

Despite many possible benefits of urban greenways, there are also considerable challenges to greenway planning in urban areas, two of which are relevant for this study. A major challenge is represented by the possibility of conflicting greenway functions. In particular, the objective of environmental protection is only to an extent compatible with the recreation and travel function of urban greenways. While green-ways may increase landscape permeability for species, conflicts with other uses may occur. Especially in urban areas, limited space only allows for rather narrow greenways and the presence and activities of humans are likely to cause great disturbances to urban wildlife (Ahern 1995). In turn, unmaintained and wild-growing greenway vegetation can evoke fear and discomfort in greenway users (Sandstrom, 2002). Yet, greenways are aimed at fulfilling these functions simultaneously.

According to Ahern (1995), occasional incompatibility of greenway goals is an inherent feature of multifunctional greenways and has to be solved with compromises and trade-offs between functions.

Possible compromises are the addition of specific management plans, or the withdrawal of one of the intended functions if compatibility cannot be achieved. However, too little is known about the real effects of greenways on urban wildlife to understand how to solve the conflict between species protection and utilitarian greenway functions (Ahern, 2011).

As mentioned above, the second challenge for urban greenway planning is the limited availability of open and green spaces in urban settings, where space is predominantly taken up by roads and buildings (Sandstrom, 2002). Many cities follow an opportunistic approach to greenway planning, as existing linear structures are converted into greenways, such as the disused railway for the New York City Highline, or the sewer line embankment in London. Other cities such as Maastricht and Antwerp plan for large infrastructure projects to transform existing linear infrastructures entirely for greenway implementation. However, if a demand-based approach is used that aims to connect certain areas in a city with new routes, as in this study, there is little flexibility in greenway delineation, and the compatibility of greenways with the existing infrastructure is uncertain (Sandstrom, 2002).

Related with rapid population growth over the years is a threat to the urban environment. Cities currently are faced with challenges of lack of green spaces to integrate greenway as a strategy keep the urban environment sustainable, the relative scarcity of suitable sites in the city limits routing options (Britt, 2015).

3.8 Challenge of development and nature conservation in Hawassa

In the Hawassa Lake catchment, soil erosion is a serious environmental problem. The main causes are human activities, whereby the natural vegetation cover is removed or damaged through construction activity, transport, agriculture, grazing, etc. (MWUD,FUPI, 2006). A related problem of erosion is siltation, as eroded materials carried by the water in streams and rivers cause undesirable deposition and sedimentation in the water sources (Termorshuizen, J. W.,& Opdam,, 2009) The lake level is currently declining as a result of increase in the surface area, some studies indicate the possibility of cyclic lake level rise (MWUD,FUPI, 2006). Thus according to Hawassa city integrated development plan recommendation, it is relevant to implement erosion-mitigation measures in the watershed as well in urban areas through planting trees; terracing and securing forested areas and other vegetation covers.

Drainage, environmental deterioration of lake Hawassa include its catchments, shortage of green/public open space and unemployment, poverty, and different social issues areas identified among major problems in Hawassa (Hawassa City Administration, 2014) see Table 3.

Table 3: Prioritized problem, their causes, and effects of Hawassa city.

Problems	Cause /Factors	Effects/Consequences
Drainage	Uncontrolled run-off <ul style="list-style-type: none"> •surfaces imperviousness •Flat topography •blockage of existing drainage •provision of drainage without study and design 	<ul style="list-style-type: none"> ▪Pollution the lake ▪The spread of the malaria epidemic ▪Deterioration of roads ▪Submergences of properties and amenities ▪Siltation of drainage lines
Lack of proper conservation and protection for lake Hawassa	<ul style="list-style-type: none"> •Unmanaged wastes and associated with urbanization and industrialization •The absence of designated buffer zone around the lake and uncontrolled expansion of developments •Lack of awareness about the fragile nature of the ecosystem •Lack of organization responsible for isolated lake management •Unreserved access to the lake and its resources •Deforestation and land degradation in the catchment •Uncontrolled land use activities poor •Wastewater management practice that pollutes the lake 	<ul style="list-style-type: none"> ▪Pollution and siltation of the lake ▪The increase of the lake area, and the decrease in the volume of water due to evaporation ▪Deterioration of the aesthetic value of the lake and its surroundings ▪Contamination and destruction of aquatic life in the lake ▪Uncontrolled human activities adjacent to and on the lake
Shortage of green and public open spaces	<ul style="list-style-type: none"> ▪Existing parks and green areas around the lake Hawassa are poorly planned and managed ▪Lack of green areas and parks within the developed and recent expansion areas ▪Lack of attention by the municipality ▪Inadequate organizational and financial capacity to develops green areas and parks ▪The master plan gave minimum priority ▪The absence of strong policy, laws, and regulations ▪Low public awareness about the designated green areas, and its participation in their realization and protection 	<ul style="list-style-type: none"> ▪Reduced attractiveness ▪Reduce the tourism industry ▪Social destruction; youngsters exposed to bad habits, low social interaction ▪Deterioration of microclimate conditions

3.9 Purpose and benefits of greenways

3.9.1 Alternative transportation and greenways

The instruments in greenways make public interests in linear and networked systems for the sustainable urban built environment. This linear networks of natural character routes are much different from the typical hard surface and asphalted surface often associated with other modes of transportation networks, like biking, hiking, horseback riding are associated with this network enable accessibilities to

a greenways natural areas thereby promoting ,safeguarding of the environment from additional impacts (Donald, Alan, & Robert , 2003).

Recently, the new coming ideology of smart growth for people, which prioritize human beings can be facilitated by greenways provide people with more recreational possibilities and alternative sustainable non-motorized transportation, it also minimizes trip length to and from work transportation.

3.9.2 Greenways as Ecological and Environmental Service

By its nature, the greenway is spatially connected concentration of useful natural resources which becomes an ecological network. The landscape fulfilling ecological functions, such as biodiversity, pollution abutment, water quality, flood control within the urban landscape. As an ecological feature, greenway holds important riparian and drainage networks of dense vegetated and forested areas along lake shoreline, a buffer for protecting effects of the built on the natural environment (Ahern J. , 2004). Considering that greenways have seen conditions highly needed for stability of the ecosystem and survival of the species population in the built and on the human intervention dominated landscape (Jongman & Pungetti, ,2002). Greenways are important valued landscaped features that support the integrity of nature and human interventions. Different disciplines on practices around nature like conservations and preservation practices are integral to supporting this advantages system of the urban area as green infrastructure in built and expansion areas.

3.9.3 Greenways as social and cultural activities enhancement

Taking to consideration that components of greenways are most of the time clearly and intentionally located in the proximity where the people live and work, recreation and popular areas (Ahern J. , 2004), the social and cultural importance needs attention. The most important condition in greenways identified for social and cultural activities is “sense of place”, greenways have an important feature in cities of built environment forming an overall sense of place for the community and for the city urban form as structuring natural elements.

Greenways become identified for their important role in providing nearby recreational opportunities and access to nature as well as for providing common ground for people to connect, interact, to see each other. So, greenways affect, positively, the patterns of social interaction within and between communities from small scale to city-wide networks. Greenways can also reveal benefits for social connection, especially, where linking at a point diverse population together from the diverse geographical location it is needed (Hellmund et. al., Paul, & Daniel et. al., 2006). In the boundary of Hawassa, there are various important locations, springs, historical location, existing popular trails, public square, market,

and other public dominated areas are integral parts and are widely associated as part of its cultural, social and historical identities need to link at the various scale of greenway system.

3.9.4 Environmental Protection

Natural systems and landscapes resources protected and incorporated into planning and design make the place more comfortable, interesting and efficient (Donald, Alan, & Robert , 2003). Many studies expose, planning and designing greenways in the city have taken environmental protection as the one and main goals to protect the natural system for the best and sustainable function of cities and the wellbeing of peoples. Developing urban greenways is an effective strategy to ensure sustainable urban development and counter ecological fragmentation (Fabos, 2004), as linear green areas are used for multiple purposes (Fabos, Julius Gy., 1995). Greenways provide sustainable planning tools for both environmental protection and economic growth, especially in rapidly changing urban contexts, that accounts for both environmental protection and economic growth (Conine A. et, 2004).

Developing near aquatic areas must be based on an understanding of sensitive resources and process. In most cases, development should be set back from the aquatic zone and protective measures taken to address indirect environmental impacts, such as streamside vegetated buffers (Donald, Alan, & Robert , 2003). Proposing greenways serve as a buffer between sensitive areas and the built environment. Environmentally protected areas are the most suitable landscape for greenway corridors and especially connecting these areas facilitates for wildlife movement, as well as for humans.

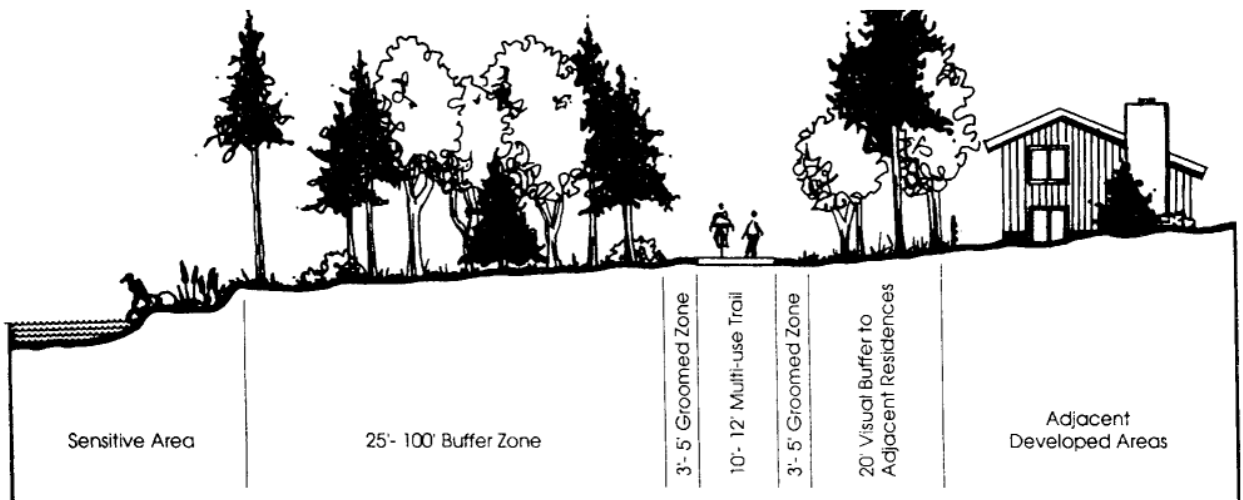


Figure 4: Typical cross section near a sensitive area. (Time-Saver Standards for Urban Design, p-501)

3.10 The methodology of planning and Design

In order to identify suitable greenway corridors in cities, following a continuity of GIS-based planning approaches advanced by Miller et al. (1998), Conine et al. (2004) and Teng et al. (2011) is

applied in many cities and studies today. The approaches by Miller et al. and Conine et al. are similar in that they both use GIS-based stepwise land suitability analyses to identify suitable sites for greenway development. Both studies start by identifying intended greenway functions, and the relevant factors that indicate these functions in a spatial context. Within a GIS environment, all land parcel cells in the study area are then ranked by each factor according to the extent to which they fulfill the specified functions. An additional rank is attributed to each factor, in line with the importance of the relevant functions (Conine et al. 2004, Miller et al. 1998). In a suitability assessment, both studies produce a greenway suitability map for the relevant study areas. While the suitability map is the final result in the study by Miller et al., Conine et al. take a further step and use the suitability map to delineate greenway corridors. For the route alignment, they draw on the GIS tool least-cost path. Four corridors have created that pass through the highest suitability scores and thus represent the most suitable greenways in the study site (Conine et al. 2004.).

3.11 Urban design dimension and the benefits of greenway

3.11.1 Social Dimension

It is difficult to conceive of space as being without social and cultural content and, equally to conceive of society without a spatial environment. The relationships are, therefore, best conceived as continuous, therefore, it is best conceived as a continuous two-way process in which people create and modify space while at the same time being influenced in various ways by those spaces (Jan Gehl, 2007). By shaping the built environment, urban designers influence-inhibit, facilitate, precipitate and modify, but do not determine-patterns human activity and, therefore, of social life. Greenway in its socio-cultural character provide flexible features for diverse social outdoor activities (Jongman & Pungetti, ,2002)

3.11.2 The Walkable Neighborhood

Walkable neighborhoods are typically characterized by having a range of facilities within 10minutes (up to 800 m) walking distance of residential areas which residents may access comfortably on foot. This is not the upper limit and walking offers the greatest potential to replace short car trips, particularly those under two-kilo meters. To encourage a reduction in the need to travel by car through the creation of mixed-use neighborhoods, with interconnected street patterns, where daily needs are within walking distance of most residents must be envisaged (Global Street, 2017). For designing Walkable neighborhood one needed to think: -

- Mixity of uses
- The interconnected pattern of street

- Creating a link between housing facilities, and community infrastructure
- To establish walking and cycling routes are fundamental to achieving more sustainable patterns of movement and to reduce peoples reliance on cars
- Density is an important consideration in reducing people’s reliance on the private car, reflecting the desirability of using land efficiently, linked to the impacts on the natural environment and climate change.

3.11.3 Walkable connected urban area

“Traditional streets and highways have discouraged pedestrian movement, disrupted water, wildlife patterns and divide natural environments and society (Heister 2006, 52). Street design that encourages pedestrian and social interaction can have the opposite effect. Pedestrian and bicycle routes are important toward achieving sustainability, quality of life, and connected communities.

3.11.4 Outdoor activities need greenway

An ordinary day on an ordinary street shows, waking, playing, and sitting on benches and steps. Conversations between peoples, working and greet during walking occur naturally (Jan Gehl, 2007). This mix of outdoor activities is influenced by a number of conditions. The physical environment is one of the factors: a factor that influences the activities to varying degree and in many different ways. Outdoor activities and a number of physical conditions influence them (Jan Gehl, 2007).

3.11.5 Types of activities

Outdoor activities in public spaces can be divided into three categories; each of the outdoor activates demands on the physical environment: necessary activities, optional activities, and social activities (Jan Gehl, 2007).

Necessary activities include those that are more or less compulsory like going to school or to work, shopping, waiting for a bus or a person, running errands. In general, everyday tasks and pastimes belong to this group among other activities; this group includes the great majority of those related to walking because the activities in this group are necessary, their incidence is influenced only slightly by the physical framework. These activities take place throughout the year, under nearly all condition; either the condition is comfortable or uncomfortable.

The second types of outdoor activities are optional activities that happen in, if there is a wish to do so and if time and place make it possible, include a walk to get fresh air, standing around enjoying life/nature, sitting and sunbathing. These activities take place only when the outdoor external physical environment is optimal to accommodate the needs of the users, which are highly dependent on the exterior physical environment. In street and city spaces of poor quality, an only the bare minimum of

activity takes place. People hurry home, in a good environment, a completely different broad spectrum of human activities are possible (Jan Gehl, 2007).

The third types of outdoor activities are social activities. These types of activities depend on the presence of others in public spaces, children playing, greetings and conversation activities, communal activities and passive contacts that is simply seeing and hearing other people. Social activities occur spontaneously, as a direct consequence of people in connection with the other activities because people are in the same space, meet, pass by one another, or are merely within view (Jan Gehl, 2007).

In general, activities happening depend on the presence of people which proportionally affects the number of activities. Greenways have benefits of such social values in urban fabrics and can be used to accommodate these outdoor activities and to design outdoor environment as activity enhancer.

3.11.6 Qualities of the public realm and flexibility of greenways

Physical planning is highly influenced by the boundary and character of outdoor activities, social activities (Jan Gehl, 2007), the physical realm of the public influence patterns of activities to design better or worse conditions for events outdoor, and to create lively or lifeless cities.

Low, closely spaced building masses are, accommodation for foot traffic, and good areas for outdoor stays along the streets and in direct relation to residences, public buildings, places of work, and market, and so forth. It is possible to see buildings, people coming and going and people stopping in outdoor areas near the buildings because the outdoor spaces are easy and inviting to use. This city is a living city, on in which spaces inside the building are supplemented with usable outdoor areas, and where public spaces are allowed to function, outdoor activities are highly dependent on the quality of the exterior physical environment , attractive activities appear when the external physical environment are favorable (Jan Gehl, 2007). To keep the city or part of the city safe is a fundamental task of a city street and pedestrian environment. (Jane, Jacobs, 2007)

When establishing the pedestrian street or traffic free zones start to improve daily and social activities. Cities with pedestrian streets and automobile-free public spaces exhibit outdoor activities than the car-oriented cities, even though the climate is the same.

3.12 Functions of a greenway along lake shore /riparian corridor

Among functions of greenways, defining water quality , Hydrologic regulations ,sediment, and nutrient filtration ,sediment and erosion control, invasive plant species and erosion , removal of nutrient and pollutants , regulations of water temperature , protect aquatic habitat (Paul Cawood & Daniel, 2006)

3.13 Effects of human activities on riparian corridors/lake shoreline

Lakes and riparian ecosystems have been critical resources for nearly every culture in the world. Fair as expectable as the location of human activity along rivers, lakes and other such resources have been the effects of this activity on aquatic ecosystems (Paul Cawood & Daniel, 2006). The major human activities that affect the water environment, quality and the ecological integrity of riparian corridors are agriculture, urbanization, and channelization of stormwater, transportation, recreation, flood control and withdrawals of water supply. Each of the activities near the water resources has a characteristic set of a negative consequence (Paul Cawood & Daniel, 2006). Some mentioned activities may be ameliorated by maintaining or restoring natural riparian vegetation (Donald, Alan, & Robert , 2003).

3.14 Effects of recreational activities on riparian corridor

In timeline of history water bodies and riparian corridors were the most attractive recreational resources and locations. This attraction brings diverse recreational opportunities and settings that riparian corridors provide and of the affinity of people have for water and natural setting around (Paul Cawood & Daniel, 2006). Effects of recreational activities on riparian corridors can include the loss of vegetation and litter layer from crushing, compaction, and reduced soil permeability and subsequent increases in runoff, erosion, siltation, and sedimentation. The presence of human beings and their pets disturbs animals that use the corridor.

3.15 Effects of channelization on riparian corridor

Channelization started as flood control programs. The main goals of channelization are facilitating runoff and lowering groundwater levels as a result of low infiltration of the built environment imperviousness. Channelization has yielded flood control benefits, though controversial, the consensus among biologists is that channelization is an ecological disaster (Hellmund et. al., Paul, & Daniel et. al., 2006). The effects of up area channelization can affect the water resources in the lowest area causing erosion, polluting, sedimentation and siltation. For this mechanism, other studies set a direction controlling the stormwater locally on that specific area to minimize the effects of the lowest area of cities like water bodies, wet areas, and floodplain.

Urbanization is a process of being urbanized for human need. Urbanization covers the landscape with impermeable surfaces; water cannot infiltrate the soil and so runs off much more rapidly than it would otherwise (Sandstrom, 2002). Drainage is altered, and contaminants enter streams readily and in more concentrated forms (Hellmund et. al., Paul, & Daniel et. al., 2006). This situation is especially likely during construction because freshly disturbed and de-vegetated soils are highly susceptible to erosion (R.

H. G. Jongman, 2004). Much of the runoff from urban systems goes into storm drains, through storm sewers, and then into receiving streams found at lower elevation point.

Storm sewer effluent contains high concentrations of sediment, nutrients, and toxic materials that are washed off roads and parking lots. Sometimes, storm runoff is conducted through on-site retention of detention basins, which permit sedimentation. Riparian vegetation usually has little influence on these sources. In some cases, however, point sources have been diverted to constructed wetlands where filtration can occur.

3.16 Corridor design of greenway

When designing greenway for a portion of the whole network at local scale, understanding how that portion/segment functions within the network is essential. The location of the corridor, for instance, in the sensitive area like a lake, wet area or near a floodplain or in an urban area and its condition in comparison with the other location should be factors in design practice. (Hellmund et. al., Paul, & Daniel et. al., 2006)

Greenway has many different intended uses, protection of natural resources, environmental integrity and connectivity should always be the primary goal. Specially greenways along riparian corridor, lakeshore, wetlands and like. In designing a greenway, determining the width and including critical spots for the different objective is an essential procedure.

Along with a greenway, variable widths will often be needed to hold different functions of a greenway; to help maintain natural flow regimes, and to protect significant natural features, to facilitate transport, and accommodate the social and cultural activities.

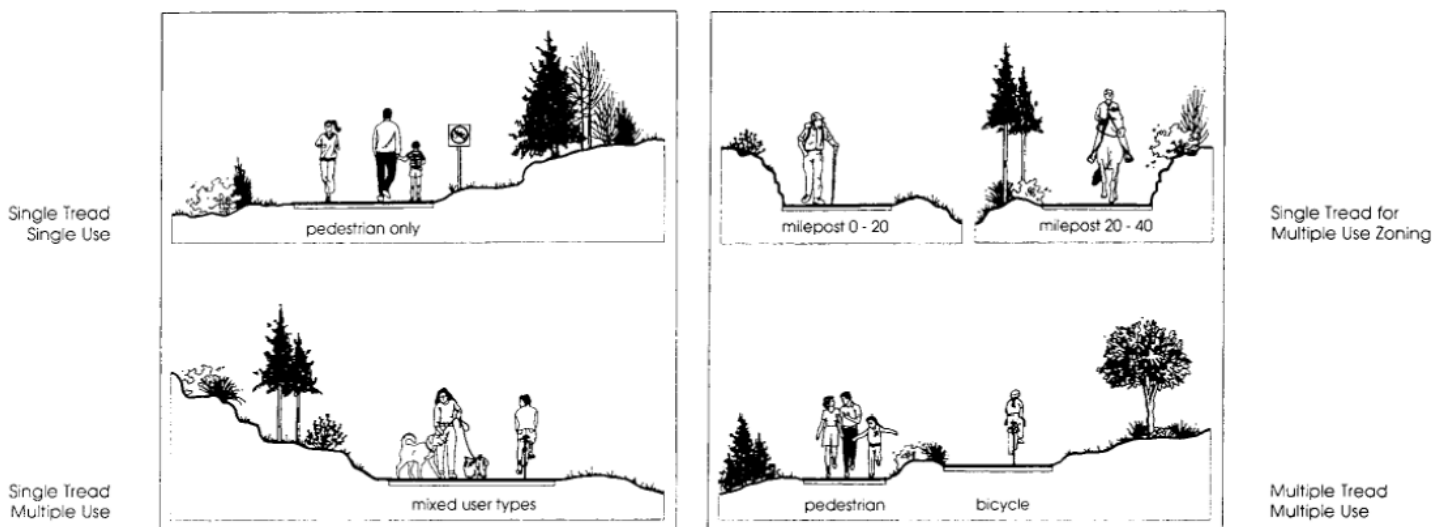


Figure 5: Types of Trail and Corridor (Time-Saver Standards for Urban Design, P-506)

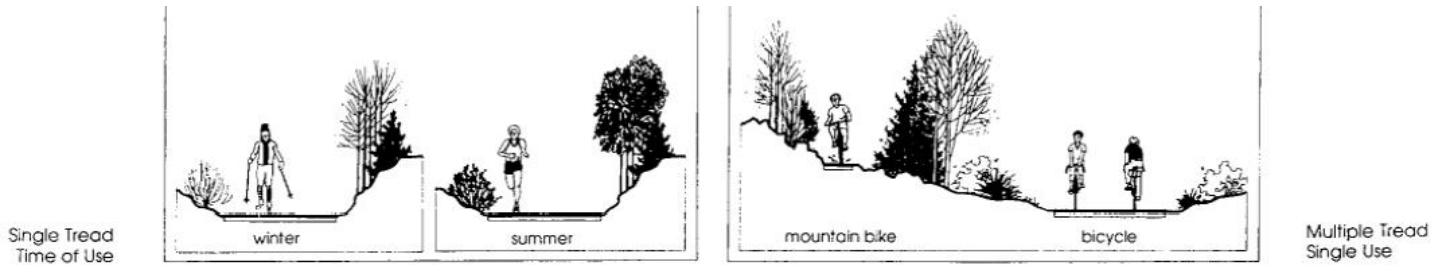


Figure 6: Types of Trail and Corridor (Time-Saver Standards for Urban Design, P-506)

Table 4: Corridor feature and tread width (Time-Saver Standards for Urban Design, P-513)

Corridor Type	Urban/City center (meter)	Sub-urban/ periphery of the city
One-way bicycle, single lane	1.5	1.5
Two-way bicycle travel, dual lanes	3	3
Three lanes of bicycle travel	12.5	12.5
Pedestrian	3.5	3
Pedestrian/ saddle and pack animal	5	3.5
Hiking , low movement density	1.5	-
Hiking , moderate movement density	2.5	-
Multiple uses biking walking and tree lines	6.7	5

Table 5: Environmental suitability of uses and activities within sensitive environments (Time-Saver Standards for Urban Design, P-513).

Ecological Environmental Sensitivity	Types of use			
	No access	Walking	Bicycling	Horse-riding
Low (upland terrace, stable-rocky soils and mature forests)	NS	MS	MS	S
Moderate(lowland terrace, river valley, suitable soils, successional forests)	S	MS	S	S
High (Wetlands, primary dunes, pocosins, steep slopes , hydric soil	MS	S	NS	NS

MS =Most Suitable ; S= Suitable ; NS = Not Suitable

3.17 A vision for community design

Just as important definitions and purpose, the origin of greenways contribute to an understanding of why they are important considerations if the planning and development of surrounding communities and adjacent landscapes. The role of early greenways primarily focused on social benefits and promoting human nature connectivity. In contemporary greenway movement, environmental and ecological features are more central (Hellmund et. al., Paul, & Daniel et. al., 2006). The pressure of development on preservation and conservation efforts common dilemmas in contemporary greenway planning and design, all of which need a concentration of valuable resources to stand. Urban development should consider strategies that broaden the idea of environmental protection and emphasize the greenway framework in it's entirely (Alliance(STA), 2012). This framework includes the social and cultural considerations that were recognized by historical landscape architects, as well as transportation (Chataway, E.S. et al., 2014).

Together, sustainable growth and development strategies that can be used to guide growth and development based on the framework of greenway (Donald, Alan, & Robert , 2003).They emphasize the social/cultural, ecological and transportation attributes of the landscape and can be applied to areas surrounding greenways (Britt, 2015). As foundational and unifying elements within community design, greenways serve as environments for integrating these strategies and their goals towards the realizations of the sustainable urban area.

Derived from these strategies, the remainder of this review outlines core principles that address the socio-cultural, environmental/ecological objectives for development collected with greenway landscape. And finally, these principles form the basis for further discussions of formulating and applying the thesis design criteria.

3.18 Case studies

The examples described herein provide real-world models of community designs that are in line with this thesis'. Each case reflect design based upon the core strategies important to community development within greenway setting that are documented

3.18.1 Serenbe, Atlanta Georgia

In this case have common transportation and ecological features that are inherent to it be a greenway community, what makes sense particularly inspiring as a model, is how it balances growth and conservation of natural landscape, as well as, emphasizes the social and cultural resources of the site. Located on a 1000 acre community on the fringe of Atlanta, it is an example of a greenway design that integrates the contemporary new urbanism and conservation strategies. Serenbe is a model for Atlanta of

an ecologically sound, sustainable community design that blends conservation, high density, mixed uses, cluster development and pedestrian-oriented strategies within natural environments.

This design emphasizes a mix of uses with smart growth objectives for a sustainable live, work, and play environment within the site. As an important example of a community that integrates the cultural framework, based upon the local heritage of the area and interconnected by a pedestrian-oriented network (Serenbe community, 2013). The serenbe features design elements- such as porches along streets that foster a sense of community and social atmosphere. It characterizes options that promote a socially diverse environment including apartments above commercial establishments in mixed-use buildings (Serenbe community, 2013).

The design taking advantages of the site vistas and minimizing disturbance of natural landscape form, as well incorporate natural trails to promote walkability and connectivity while preserving a sense of place within the natural setting.

3.18.2 Garnet oaks, Pennsylvania

Garnet oak was a prototype for many greenway designs that followed by its preservation and conservation of the valuable natural environment and of landscape form and character. It includes connected open spaces with a mile long. The site 30-hectare conservation is developed. The other features in this were pedestrian-oriented transportation advantages of its trail system, and also a model for ecological aspects of greenway design. Garnet oaks designed not only for preservation but also for natural stormwater management based upon LID solution and techniques. Short streets and compact block layout are major advantages for filtrations, significantly reducing impervious in the landscape.

The design tried to eliminate engineered curb and gutter storm water treatment along streets to capture further run-off and infiltration using LID solutions.

Over fifty percent of preserved open space and conservation area highlighted diverse recreational and environmental education features included through its trails system.

Generally, these precedents reveal conservation design with combinations of socio-cultural and ecological features.







-  Acquired Park Land
-  Private Open Space Conserved in Conservation Subdivision
-  Conservation Subdivision Open Space Donated to Township by Developer
-  Trails

Figure 8: Garnet oaks, preservation and recreational greenway.

3.19 Summary of Review and Case Analysis

In this chapter, several definitions of greenways have been laid out and the review has given insights on greenway definitions, types, function, and benefits, planning and designing fundamentals. On the other hand physical, environmental benefits and social aspects of greenway design has been reflected. Although, the case studies well reflected the driving strategy, design criteria and Design guideline for this thesis to designing the segment of greenway on actual urban fabric.

3.19.1 Strategies to plan and design greenway

Walkable connected urban area

Pedestrian and bicycle routes are important towards achieving sustainability, quality of life, and connected communities. Street design that encourages pedestrian and social interaction; for achieving a pedestrian-oriented community through integration with the trail networks and natural resources of greenways to facilitate walking, jogging, cycling as well as promote important social connections.

A connected network of open space and conservation lands

A greenway system of networked open space and conservation natural environments address multiple social and ecological objectives. They also provide recreational amenities and desirable green space. Natural resources are valuable when networked, for maintaining the ecological conditions, while also creating a sense of place and identity. So, connected open spaces and conservation landscapes are critical in order to protect and regenerate ecosystem, wildlife corridors, and natural balance.

Sense of place

Compatibility between the community and greenway is ultimately achieved by a sense of place, character, and identity. The sense of place for a design is sensitive to and provides a perceptible link to the distinct physical environment, cultural, historical context of the greenway will contribute to foster a sense of place and image of the community.

Conservation development

Buildings are situated in compact areas to minimize footprint, which is a critical consideration within the context of valuable greenway landscape. Mixed use and compact design strategies, clustering development also reduces infrastructure for saving more natural lands.

Mixed land uses and Compact Design

Mixed-use development of different functions within the city creates characters that promote quality of place, allowing diverse people to live, work and interact. Mixed-use communities become more

pedestrian and bicycle access and further expand access to the natural experience of the greenway to a wider range of the population.

Implementation criteria, goals and guiding line

Table 6: Summary of review findings; sustainability factors and greenway framework, features, and strategies

Sustainability Factor/Greenway framework	Greenway corridor Features/Strategies/Guidelines
Environmental/ Ecological	<ul style="list-style-type: none"> • Flood Hazard reduction • Reduction of erosion and downstream • Riparian habitat enhancement and biodiversity • Protect the natural environment • Preservation habitat • Provide wildlife habitat corridor and wildlife migration • Micro-climate enhancement • Increase in air quality • Enhance environmental quality
Socio-economic and Recreational	<ul style="list-style-type: none"> • Provide a connection between divided communities • Attract tourism • Provide scenic routes for walking, cycling etc. • Increase learning about the natural environment • Provide opportunities for outdoor activities • Free to use and easy to access • Social benefits improve leisure time • Increase active frontage • Decrease the car related family budget • Provide direct employment opportunities • Enable well-being through contact with nature • Induce a healthier lifestyle • Facilitate social equity • Help to reduce crime and enhance safety • Decrease the health problems
Transportation	<ul style="list-style-type: none"> • Provide an alternative transportation route for the journey to work-home and leisure activities <ul style="list-style-type: none"> • Provide non-motorized transportation • Provide a sustainable connection between communities and urban-rural <ul style="list-style-type: none"> • Provide sustainable access and linkage between historical and cultural heritage

4. CHAPTER FOUR- DATA PRESENTATION AND ANALYSIS

4.1 Data Presentation and Analysis

This chapter presents the data and analysis of the study structure. First, it presents demand area, identified in the assessment of location phase and categorized in respective functions; service, manufacturing, recreational, retail, and scenic. The second step is a suitability assessment of landscape. For this step, seven factors were prepared to assess the landscape of Hawassa. These factors are land availability, road type, attractiveness, environmental protection, protected area, demands for connectivity and topography. After weighing the factors, each factor is an overlay over another (see Diagram 2). Finally, greenway route delineation is conducted using LCP tools, then evaluating and adjusting steps were conducted to generate greenway network.

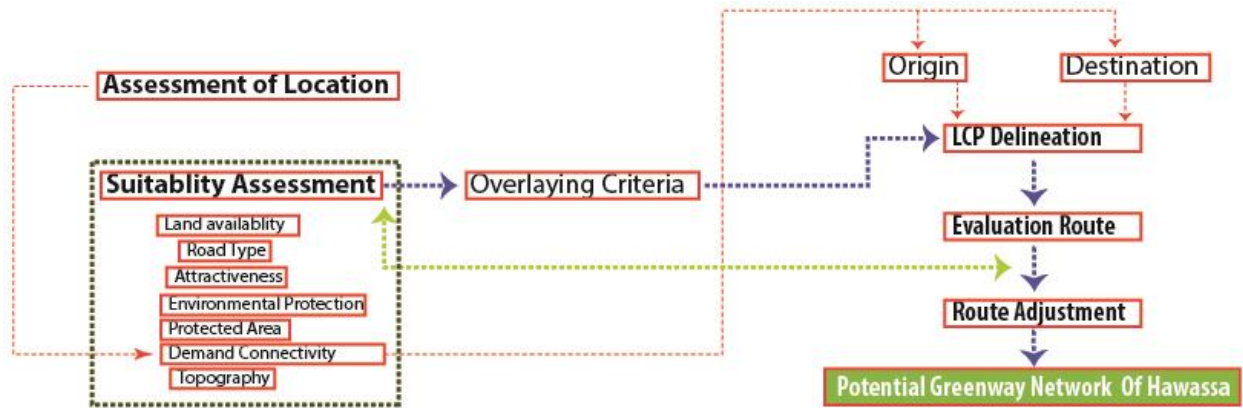
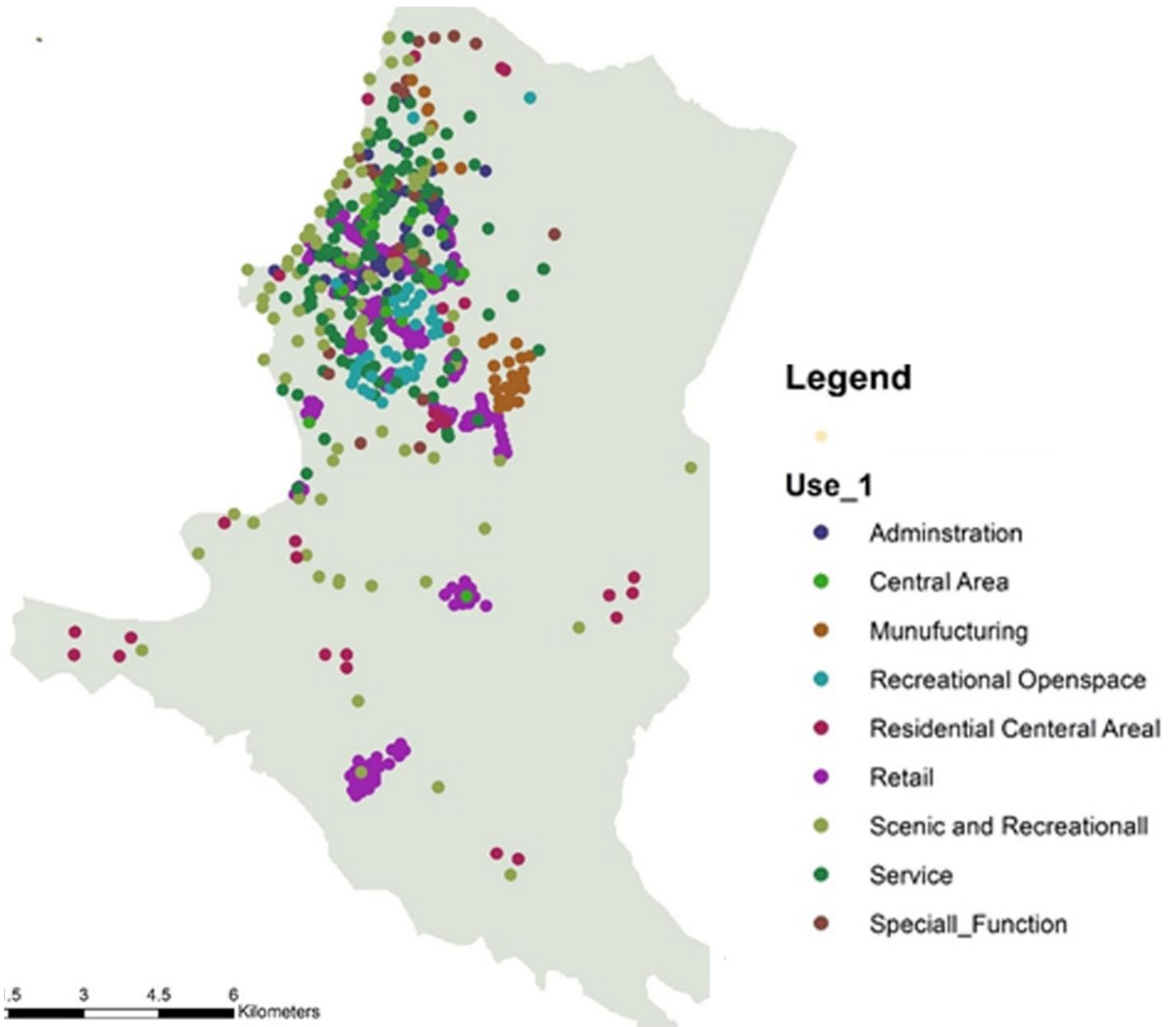


Diagram 2: Process flow diagram (Author).

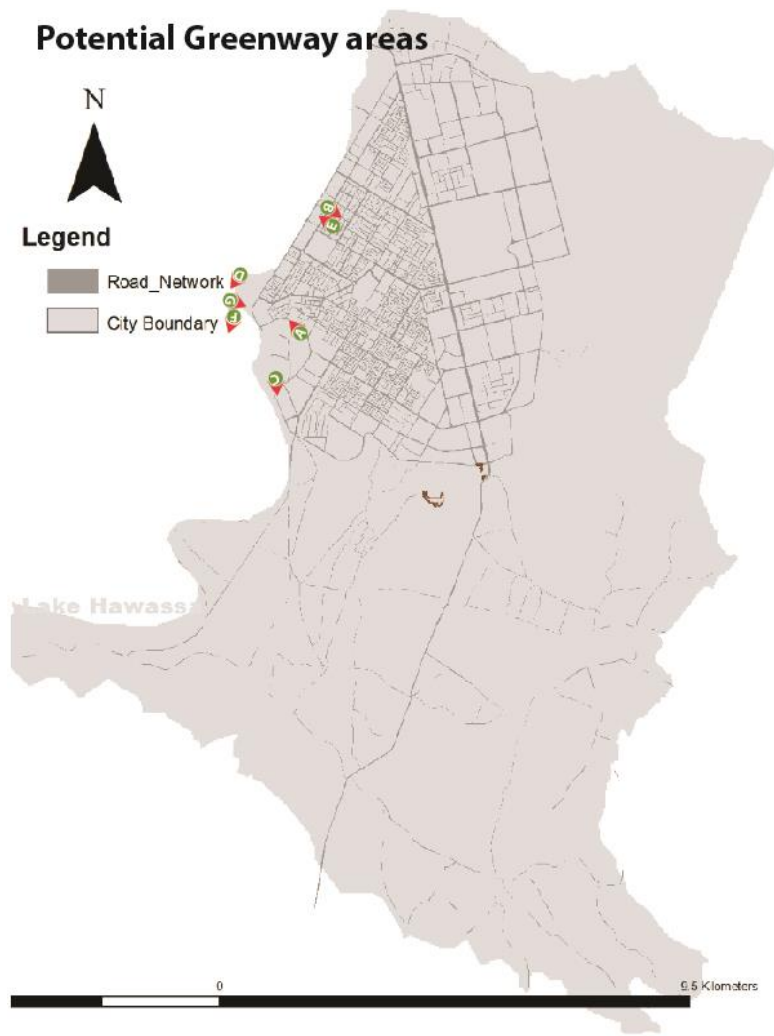
4.2 Assessment of Demand Area

To assess and identify the demand areas in the city of Hawassa, the spatial data of urban functions, like main urban activities and residential areas were drawn mainly on-site survey maps. Hawassa administration, municipality of Hawassa, biodiversity conservation office of the city administration has provided the data of spatial information for the study. Demand locations were studied in their categories; manufacturing, services, retails, administration functions, recreational, residential, historical, city centers and scenic. The first category, manufacturing includes Hawassa industrial park, industrial areas, and factories. Services category includes health facilities (hospital, clinics, health post and like) schools, institutions, public library, transportation terminal, stations, and religious place. Retails include shops, restaurant, and markets. Administration functions include sub-city office, and city administration offices. Recreational includes parks, square, natural resources and green spaces. Scenic

locations include highest viewpoints. City center includes the location of centers from the main city center to the smallest kebele level centers. The historical and cultural location includes monuments, public square, manmade heritage, natural heritage. To provide a clear overview 984 locations were identified. Map 1 shows the city's demand areas and the known locations of the city's destinations.



Map 1: Map showing the location and their concentration of demands of connectivity across Hawassa city (Source: Field Work 2017).



Potentials loaction in the city of hawassa , tabour mountain view to the lake and trails



Hawassa old Markets



View from Tabour Mountain to Kuyuwata Mountain and Referral Hospital



Amoredel Recreational Public Park



Hawassa Old Market popular Vegetable and Fruit place

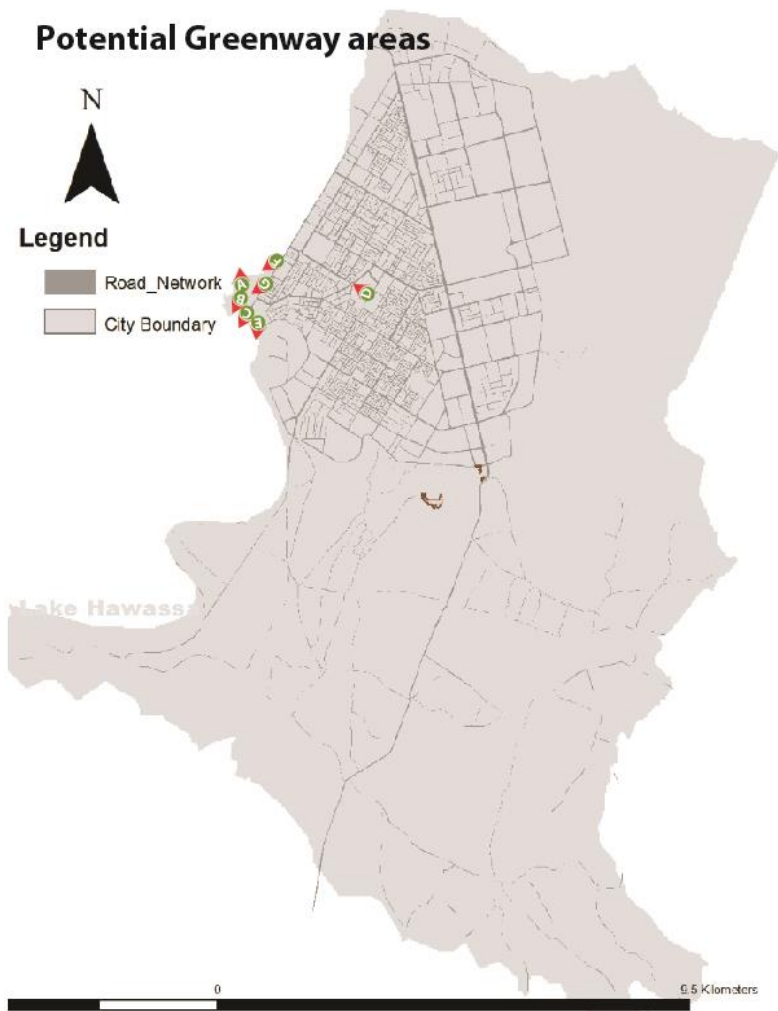


View to Mount Tabour and Kuyuwata Bio-diversity Conservation Park



Amoredel Recreational Park Wedding Place

Figure 9: Natural Features and Retails among the identified location (Source: Field Work 2017).



Remnants of Ras Mengesha Seyoum Historical Palace



Edge of the Lake Hawassa in between Amora Gedel and Mount Tabour



Fish Market



Monument of Sidama Sumuda



Fish Market with wildlife

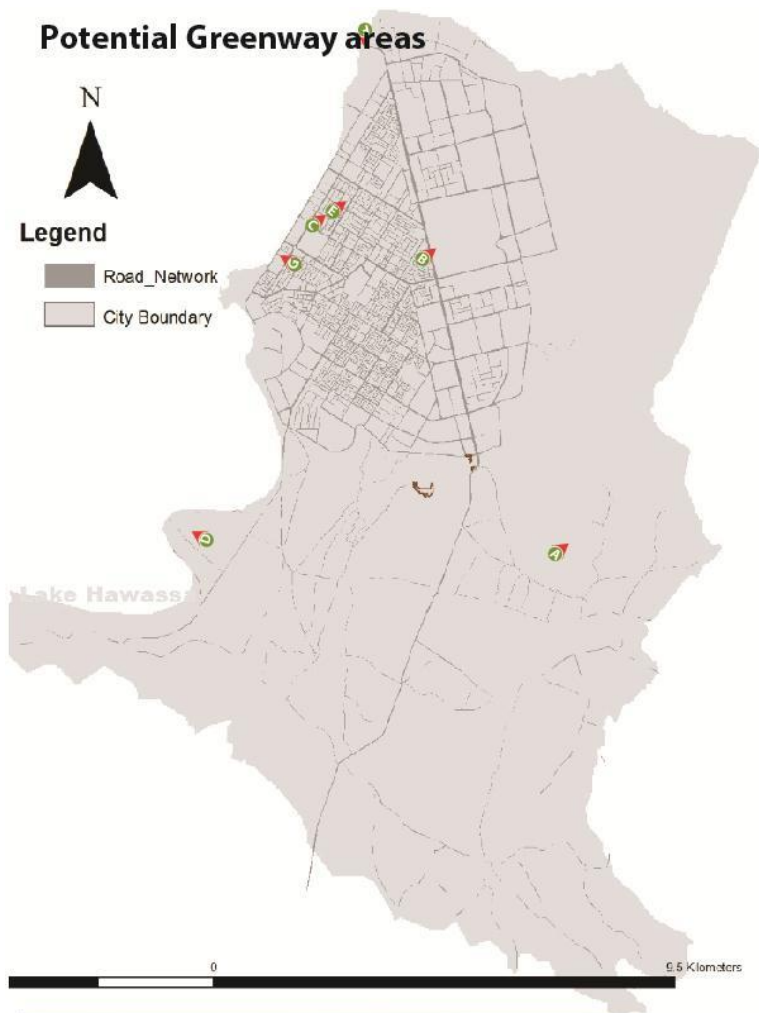


The end of Gudumale Square with Lake Hawassa



Gudumale Square during Fiche Chemelala Celebration

Figure 10: Historical, recreational and cultural features among identified locations (Source: Field Work 2017)



Burkita Hot Spring



Hawassa Industrial Park



Old Market locally known "Shenkora Tera"



Millinim Protected Bio-Diversity and Wildlife forest



Kuyuwata Protected Bio-Diversity and Lake View From Mount Kuyuwata

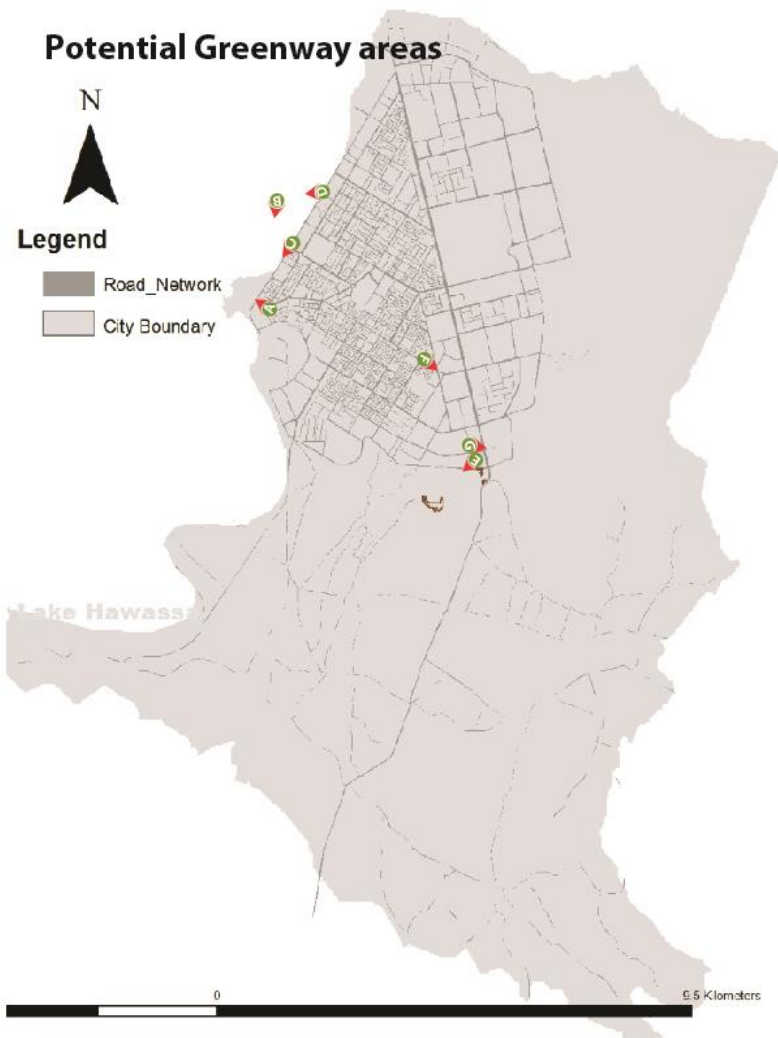


Routes to Lake Hawassa



Zero Hulet Multi-Purpose Public Space

Figure 11: Natural, Protected, retail and service features among identified location (Source: Field Work 2017)



Gudumale Square



Fikire Hayik the most popular edges and Public space of Lake Hawassa for recreation



Trail along the Lake Hawassa Shoreline



Osis Bridge the most Known and historical Access to Lake Hawassa



Monument of Wolde Amanuel



View to Qiqe Mountain from Tumbaho Monopol Multi-Purpose Filed



Mount Alamoura View from Tumbaho Monopol Multi-Purpose Field

Figure 12: Recreational, scenic, natural and public features among identified location (Source: Field Work 2017)

Pictures shown above were destinations in the city of Hawassa which are among locations identified for their potential use in greenway planning and design later on.

4.3 Assessment of Suitability of Location in Hawassa for Greenways

After attaining the first task of phase one, assessment of the demand areas that need to be included in the greenway network, areas suitable to be delineated as the routes that fulfill the objective and goal was the second task of this study. The following land suitability factors were considered, land availability, road types (road hierarchy, road density, and road surfacing), attractiveness, topography, demand for connectivity, protected area, and environmental protection were the main factors. These factors for suitability choice are based on factors set by (Conine A. et, 2004) and (Miller ,W. et al., 1998) , and adapted to the greenway objectives specified for this study. A labeling pattern was prepared to assess the study area by each factor (Table 7). Based on the Conine and Miller suitability factors have seven layers. Of each factor in which all the landscape patch in the city of Hawassa is ranked to delineate the greenway route to which they are suitable and unsuitable. The landscape patches were weighed and overlaid based on their cost (Table 7) using the GIS tool RASTER FILED CALCULATOR model and MAP ALGEBRA in Calculator use 10-meter cell size raster. Each factor of suitability and their attribution to the greenway are further illustrated in detail as shown in Table 7.

Table 7: Suitability factor scheme adapted from (Conine A. et, 2004) , (Miller ,W. et al., 1998) , (Blob, 2016) and (Donald, Alan, & Robert , 2003) and (Teng, M. et al., 2011)

Suitability Factor	Category Definition	Suitability Rank	Cost Value	Factor Weight (%)
Land Availability	Open green spaces , Urban parks, forested areas , other vegetated areas	Very High	0	14.28
	Open spaces ,wastelands	High	0.25	
	Lentic water bodies , private lands , built-up areas , agricultural areas	No	1	
Road Type	Footpaths, Car-free pathways , forest tracks	Very high	0	14.28
	Existing cycle routes, separate bicycle lanes ,residential roads	High	0.25	
	Collecting roads	Moderate	0.5	
	Access roads , secondary roads	Low	0.75	
	Primary roads ,steps ,Private roads	No	1	

Attractiveness	Entirely green or natural spaces: Forests ,swamps ,lotic and lentic water bodies	Very high	0	14.28
	High proportion of green spaces >50% :urban parks , Gardens	High	0.25	
	Low proportion of green spaces < 50% : urban semi-built up areas	Low	0.75	
	Lack of green spaces , urban built-up areas , primary and secondary roads	No	1	
Environmental Protection	Entirely green or natural surfaces: forests, wetlands, lotic	Very high	0	14.28
	A high proportion of green space, urban parks, gardens	High	0.25	
	The low proportion of natural space , urban, semi-built areas	Low	0.5	
	Lack of green space and natural spaces, urban built-up areas, main roads	No	1	
Protected areas	Areas outside conservation areas, Existing roads , existing trails in the area	Very high	0	14.28
	Existing green space , vegetated areas	High	0.25	
	Conservation areas , protected biotopes	Low	0.75	
	High priority conservation areas	No	1	
Demand Areas	Demand areas : Urban activity centers and residential areas : the main central in 200m buffers	Very High	0	14.28
	All other areas	No	1	
Topography (Slope) for movement	Slopes with 0-3%	Very high	0	14.28
	Slopes 3-8 %	High	0.25	
	Slopes 8-15%	Low	0.5	
	Slopes greater than 15 %	No	1000	

4.3.1 Land availability

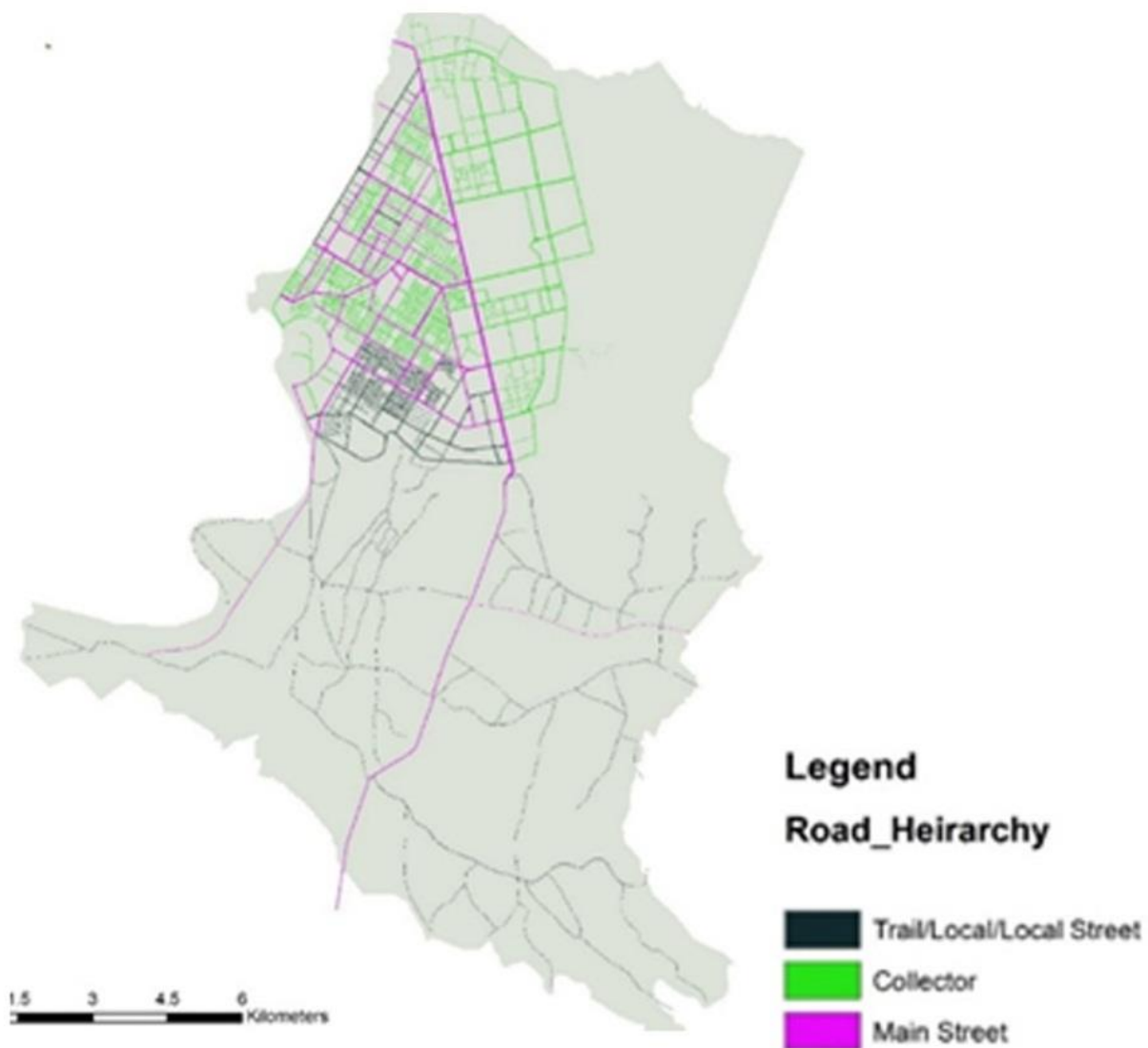
This factor aim is to indicate whether a land patch in the city is potentially available to be included as part of the greenway. The assessment is mainly identifying land patches as built up, privately owned or other function. This analysis takes the city land use as an input. Weighing each land patches and ranking them as very high, high or low suitability was necessary. Greenways should be located in existing parks and other green spaces in order to secure natural environments in urban areas. Thus, green spaces such as community playing area, parks, forests, and natural features like water bodies were categorized as highly suitable areas for the intervening greenway in the city. In terms of considering the

availability of lands in the city it should be measured in terms of their natural green contents to attain the objective of a greenway. Open spaces are also considered the highly suitable area for greenway but it should be vegetated open space to fit in as highly suitable for the greenway. As discussed above greenway by its nature is closely related with areas of high contents of a natural resource than manmade landscape patches. On the other hand unsuitable area for greenways include, built-up areas, areas with a dense network of the vehicular path, private lands. This assessment phase uses mainly land use, the density of roads and road hierarchy as potential lands because all the land parts of the city should be considered. The area with high traffic implies high road density. The populated area with the highly built up ratio is taken as low suitable in terms of land availability. Regarding the hierarchy of roads, main streets are most of the time motor dependent than other active modes on the local streets highly interactive with nature. Main streets took, as low suitable and local street is highly suitable, while collector streets are moderate suitable in terms of availability as part of the landscape patches.

4.3.2 Road Type

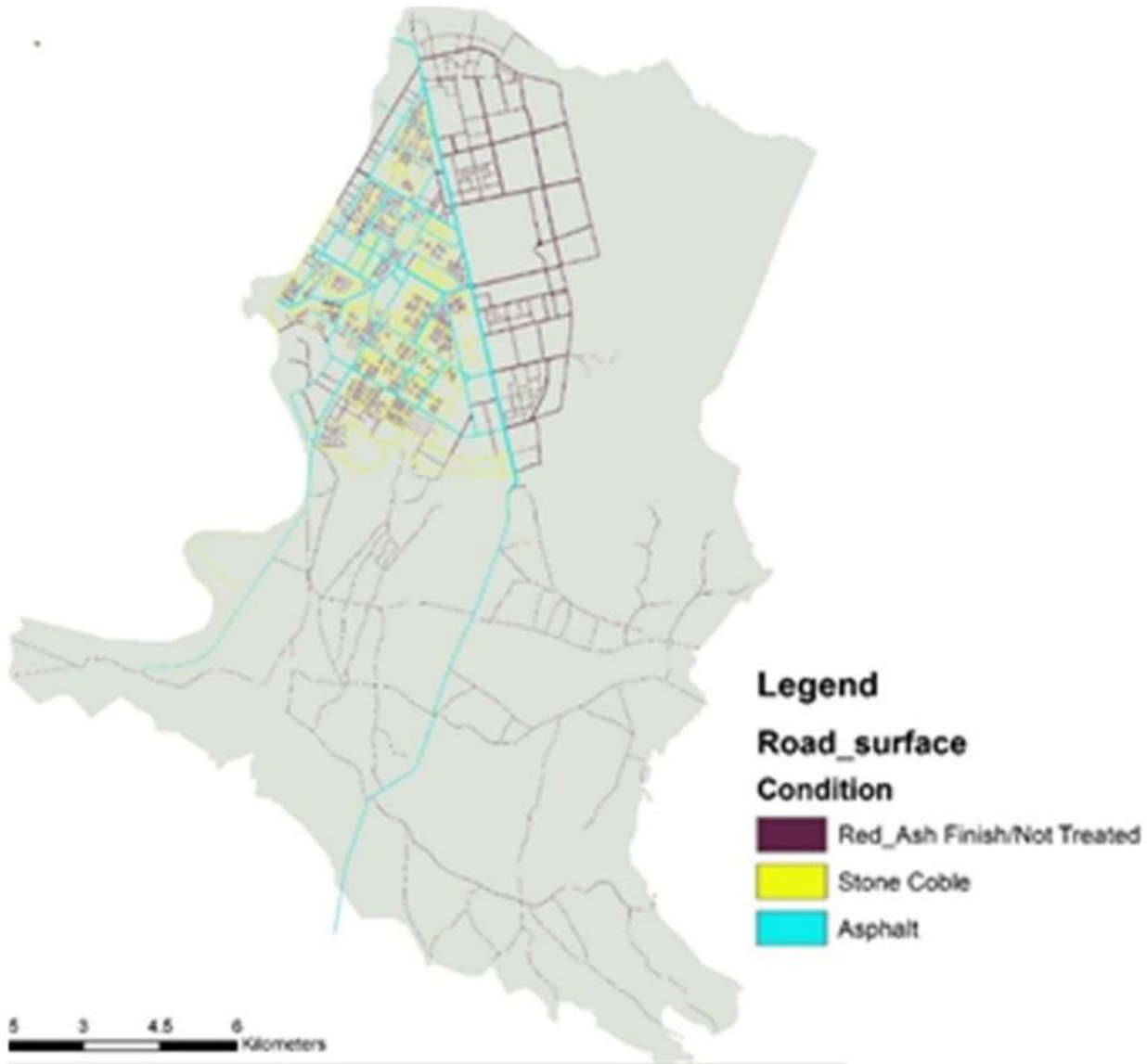
Moving from one part of the cities to the other for different reasons is an increasingly important topic with regard to the human and wildlife dimensions of urban ecosystems. Identifying suitable route of Hawassa roads to be part of the greenway was essential. The existing recent road network plan of Hawassa and digitalizing potential trails from Google map and on-site observation of potential routes for greenway were employed. Digitalizing the observed routes especially along the lake Hawassa, mountains and rivers should take as high suitable routes. In this phase of the assessment, suitability was analyzed based on road hierarchy, road surfacing, and road density. Higher road density, higher vehicular traffic, and very hard surface hold lower value for suitability. So, roads at central areas of Hawassa which are characterized by higher road density, higher vehicular traffic and asphalted surface these conditions make the area unsuitable to plan greenways.

i. Hierarchy of roads



Map 2: Map showing the hierarchy of roads in Hawassa city (Source: Structural plan of Hawassa).

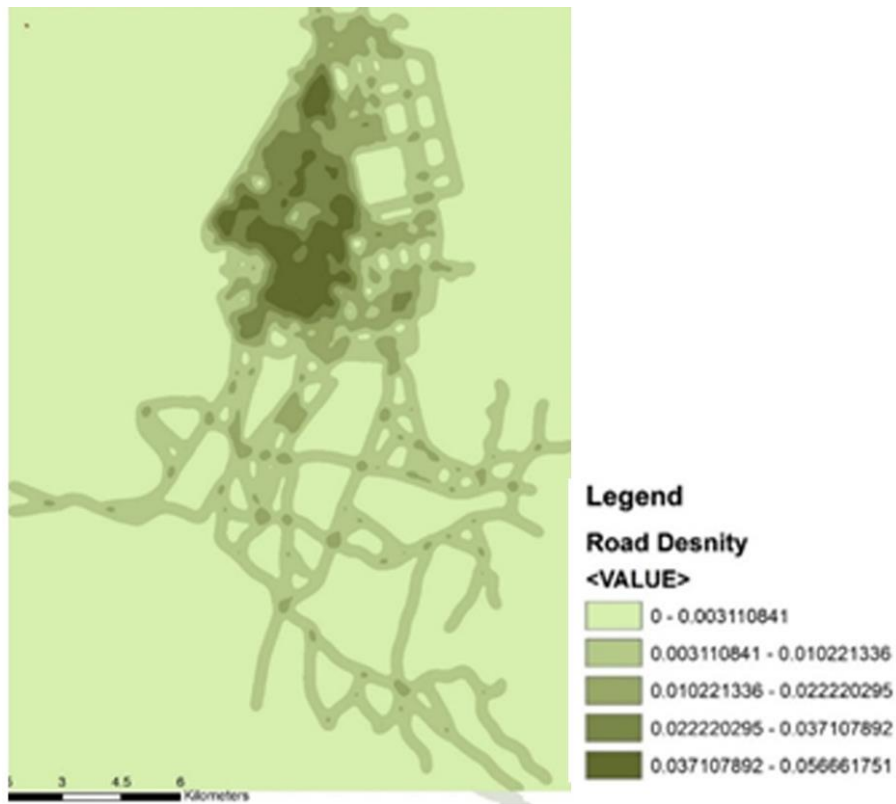
ii. Road Surfacing



Map 3: Map showing Road Surface in the city of Hawassa (Source: Hawassa city Recent Base Map and Field Survey).

iii. Roads Density

This sub-task indicates areas of the city with relative length of streets within a square kilometer. Areas of the high density of road indicate the higher length of roads per kilometer square. This condition minimizes the option of integrating greenway and thus is ranked area of lower suitability.



Map 4: Road density in the city of Hawassa (GIS – Density analysis).

Based on this parameter the suitable areas are those with less road density and lower traffic zones, but there are suitable segments that are found in dense roads and high traffic zones during fieldwork.

4.3.3 Attractiveness

Attractiveness is included as a factor to ensure the appeal of greenways as a daily travel or recreation option, and thus to promote human health and wellbeing. This is the third suitability factor, mainly analyses landscapes attractiveness or degree of naturalness. Naturalness is a key dimension that people relate to in any ecosystem, no matter how urban it is, in most remote sections of the greenway corridor, people saw wild nature as a key resource and mentioned nearby natural areas and ecosystems that should be protected and restored. Hawassa has diverse attractive locations, but the degree of attractiveness for this assessment factor is identified.

Recreational landscapes in Hawassa with a higher degree of naturalness are ranked highly suitable. Among these natural locations, mountains, lake, river, parks, forests, open spaces, and street with good vegetation coverage found higher suitability, and on the other hand, the land with high interventions, the central area, most streets, and commercial zones are ranked as areas of low suitability.

4.3.4 Environmental Protection

These factors of suitability assessment identify natural systems and landscapes resources to protected and incorporated into planning and design. These features make a place more comfortable, interesting and efficient, as well as a protection mechanism for resources to be incorporated in greenway corridor. More than half area of Hawassa is found in its natural state, but simultaneously rapid expansions urban change is a threat. Forests, lakes and, rivers edges, sensitive areas were identified and ranked highly suitability. The built-up part of Hawassa is considered as an area of lower suitability.

4.3.5 Protected areas

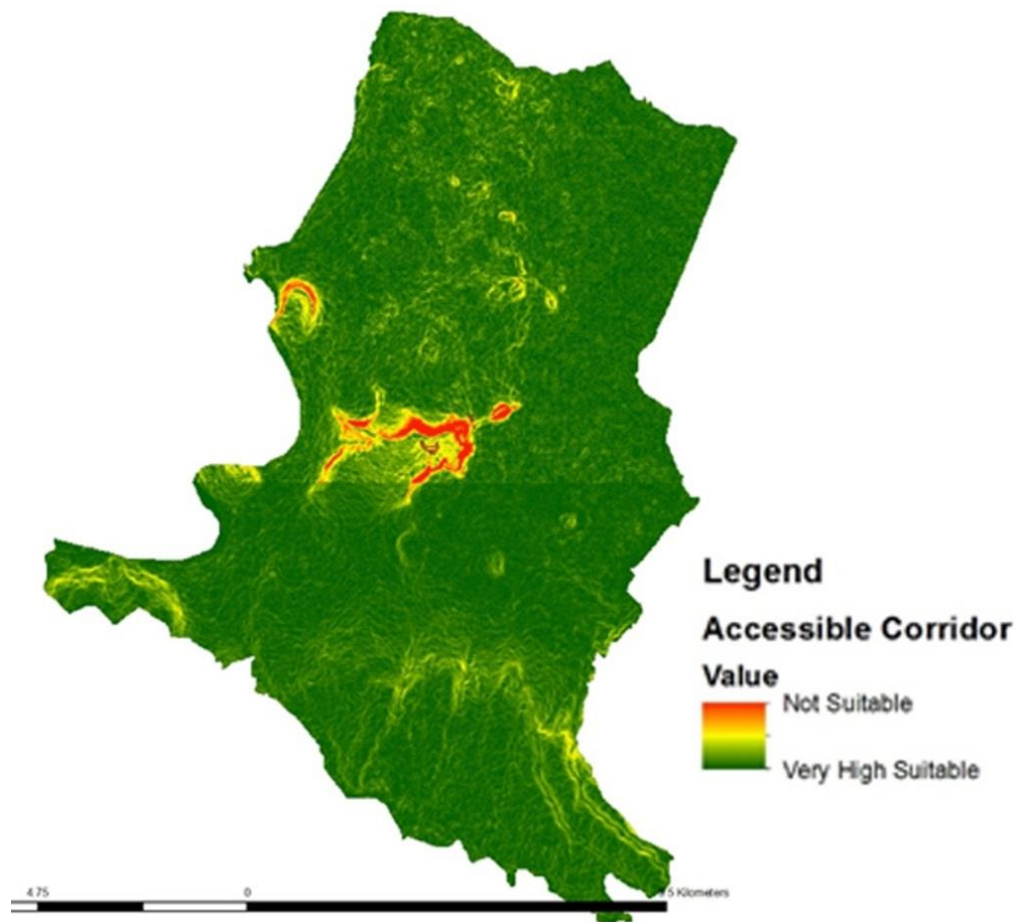
In this factor, sensitive habitat area should always be identified and ranked as highly suitable in terms of natural content, but some protected areas need more consideration. Encouraging wildlife to remain close to human activity visually enhances the visitor experience. Physical access to these areas may disturb other lives in this place. This can be achieved by maintaining as much original habitat as possible. Forested areas specially located by the municipality, like Millennium Park, need to be avoided. This location, in terms of the protection benefits of the greenway, weights high cost avoid routing in the protected area, but holds the lowest suitability to go far or adjacent to this sensitive area.

4.3.6 Demand for Connectivity

On this assessment of suitability activity concentrations with areas of high demand need to be included in the greenway network. In this factor of suitability, only two ranks *high suitable* and *not suitable* are classified. Locations of the different category were identified in the previous tasks. Based on this data looking for the relative degree of concentration, central areas of Hawassa are ranked as highly suitable and residential areas are the origin for most trips in the city and thus ranked higher. Areas between those locations are not suitable.

4.3.7 Topography

In history and in many areas, flat land is a premium and should be set aside for placing different functions. Topography plays a considerable role in people's and animal movement from one location to other and higher role in the choice of destiny to live and work. Topography is used as a factor in determining a greenway corridor. Based on this identifying suitable topography for movement and scenic points is analyzed. In this factor of suitability two cases were identified; suitability for movement and suitability for scenic spots. Four ranks of suitability considering movement were formulated; very *high suitable* the areas less than 3% slope, *Highly Suitable* areas with slopes 3-8%, *Low Suitable* with 8-15% slope; this location in greenways is selected for hiking and similar activities and finally *Not Suitable locations* with slopes greater than 15%(see, Table 7).



Map 1: Map showing accessible topography for greenway corridor (NASA USGS- DEM)

4.3.8 Weighting and combining suitability factors

The study area was assessed for its suitability; the suitability is classified into seven factors. Each of suitability factor layers was assessed in seven different spatial layers as specified by Miller and Conine. The seven factors assessed in the study were land availability, road types, attractiveness, environmental protection, protected area, demand for connectivity and the topography. For each of the suitability factors, spatial features or landscape patches were weighted and classified in previous tasks in terms of suitability assessment as determined in Table 7 of factor weight.

All weighed and classified spatial features for each factor were combined using Table 7 of factor weight in field calculator toolbox. The 518 sq. km. area of the city was divided into 10m by 10m square cell size for weighing the factors in raster media for raster based LCP delineation process. In this study, all the seven factors were weighted equally during combining the whole factors. This means all the factors attribute equal importance for attaining the goals, as comprehensive greenway framework. Finally, in combining all the factors the GIS RASTER CALCULATOR was used. The cost surface embodies the

overall sum of cost value for each 10m by 10m cell in all seven factors of assessment. The final weighted cost surface served as the base for the LCP delineation in the following step.

4.4 Defining Greenway Path using the LCP

In the process of delineating greenways totally, fifteen least cost routes were generated by using cost surface overlaid from the previous seven suitability assessment criteria and on-site identification of potential existing routes and the least cost path tools of GIS. Route delineation sub-task needed to assign a point of origin and destinations. Origin and destination point dataset were taken from demand for connectivity assessment step. Final overlaid cost surface was used as an input in LCP. To generate the routes on the GIS platform these various steps. Finally, using LCP identifying the best possible route from start_1 to destination _2 was done based on the cost surface/Suitability result map. Therefore, fifteen similar steps were repeated for delineating the possible routes in Hawassa that connect the demand areas.

4.5 Evaluation

This step mainly inspects the final delineated routes strength and seeking its weakness based on different criteria. The final greenway routes were evaluated at different levels. First, the resulting greenway routes are inspected by overlaying all single routes together on one map then conflicts and overlay are found. Second, the resulting greenway route was inspected by overlaying on the existing roadmap. In this process, the final delineating routes were examined against the existing spatial context of Hawassa. Each route was examined for conflicts, trade-offs, and compliance with existing roads, especially conflicts with high traffic volumes, roads passing through dense areas then identifying and delineating other possible routes and evaluating conflicts and compliance with the existing land features of each route according to greenways goals and objectives were carried out. Third, evaluating the resulting fifteen routes relating to one another, and the alignment was checked. In this process inspecting layout design and connections, based on buffering using PROXIMITY BUFFER toolbox in GIS and manipulating manually is done. Fourth and finally, evaluating the generated and merged network of greenway with the city different uses and spatial components is done. In this process identifying the misalignments of routes, with private property and protected areas, with unsuitable land patches within the city of Hawassa is observed. Finally, the inspected issues during these steps are adjusted.

4.6 Adjustments

This is the final step of the whole corridor identification processes, as discussed above. To improve the greenway results, adjustments were made to the models in the steps of the site suitability assessment and the LCP delineation (see Diagram 1).

5. CHAPTER FIVE: RESULTS AND DISCUSSION

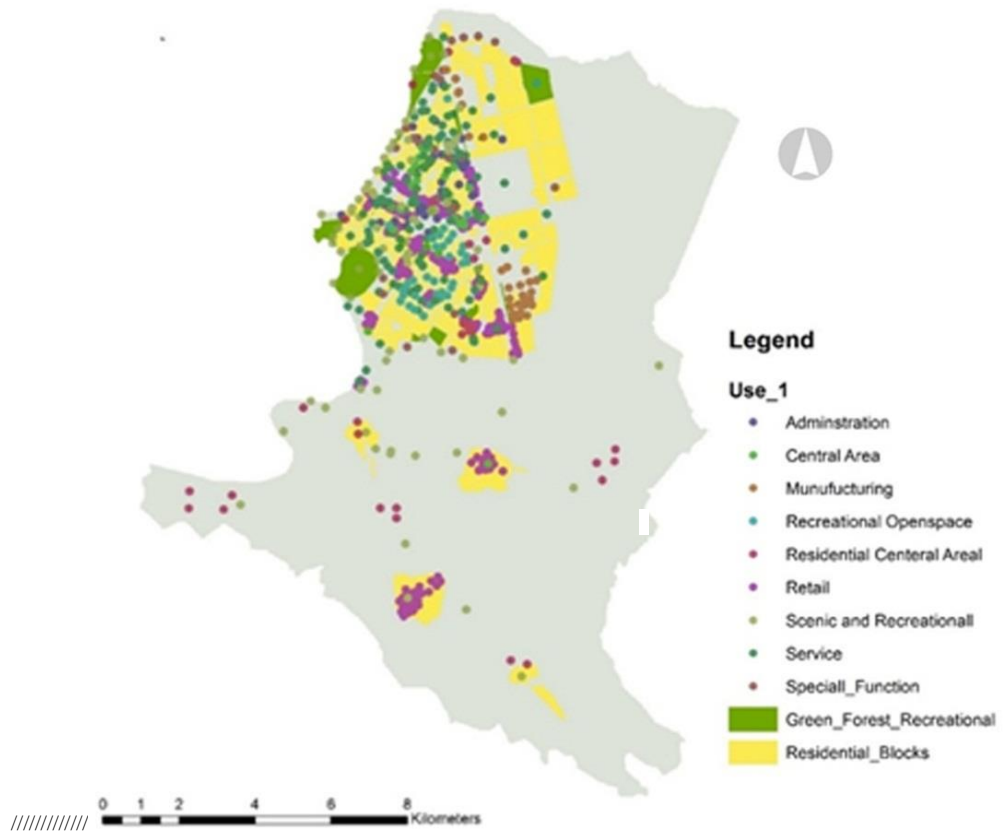
After the implementation of the selected approach and methods, the following maps are generated and presented. (See Diagram 2)

5.1 Results

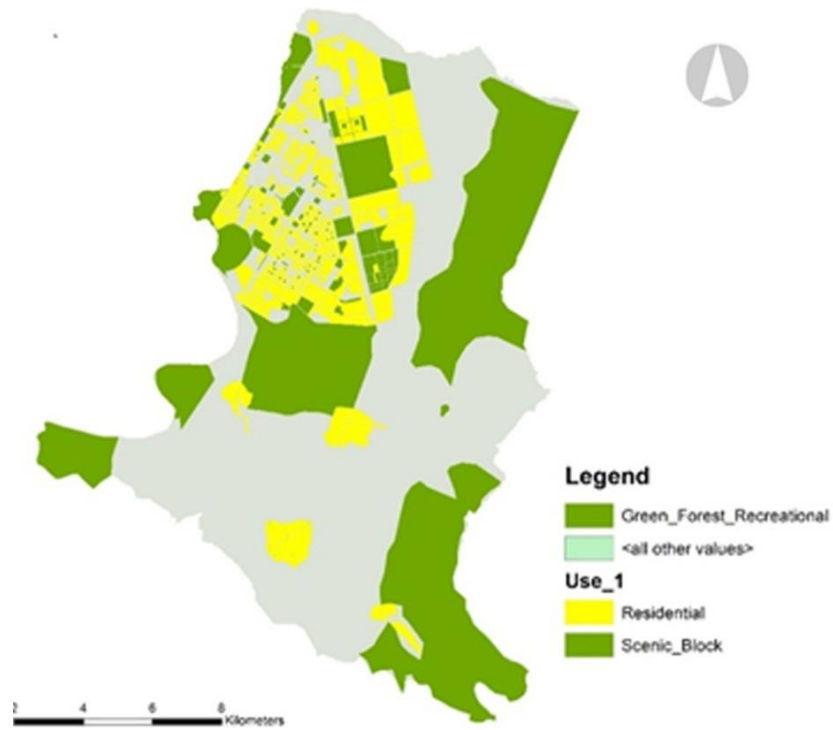
The following subsections summarize the results thematically as areas of high demands and suitability of land. Based on these results validity is discussed.

5.1.1 Areas of High Demand

In the assessment of landscape for identifying locations and spots to be connected in the greenway network distinguishing several processes in the overall landscape cover of Hawassa city by on-site physical assessment, registering locations then digitalizing based on the map found from the municipality was necessary. The result from these steps is shown in Map 5 and Map 6. Residential areas are originators of people in the city. So these areas, as seen in the map in yellow color are dominant on the maps because it is taken as a polygon. The other location, like scenic potential locations, urban parks, forests, mountains, and open markets are also taken as a polygon. Other urban activities and main hot spots taken are displayed as points, like administration, schools, and health facilities. Depending on the above expressing techniques the generated maps describe that many spot and activities are concentrated mainly at the North Eastern part of city administration boundaries and at the Southern part of the city. A total of 984 urban activity spots in entire city were identified, among 984 locations retails have taken the most frequent locations in the city of Hawassa with 516 locations, recreational and scenic including monuments found 148 locations, 163 services, 38 administrations, 25 locations of city with central/nodal character and lower center one hierarchically and 28 manufacturing including the oldest manufacturing locations like Hawassa ceramics and Hawassa flour factory. The industry zones at the southern main entry and exit point of the city and the newly opened Hawassa industrial park with estimated 60,000 employers from different parts of the city also take up a huge land use share. From the listed locations industrial zones and some retails are found at the periphery. The administration is found almost all within the city centers. Generally, the occurrence of activities is high at the city center and at the Northern Eastern part of the entire Hawassa city boundary.



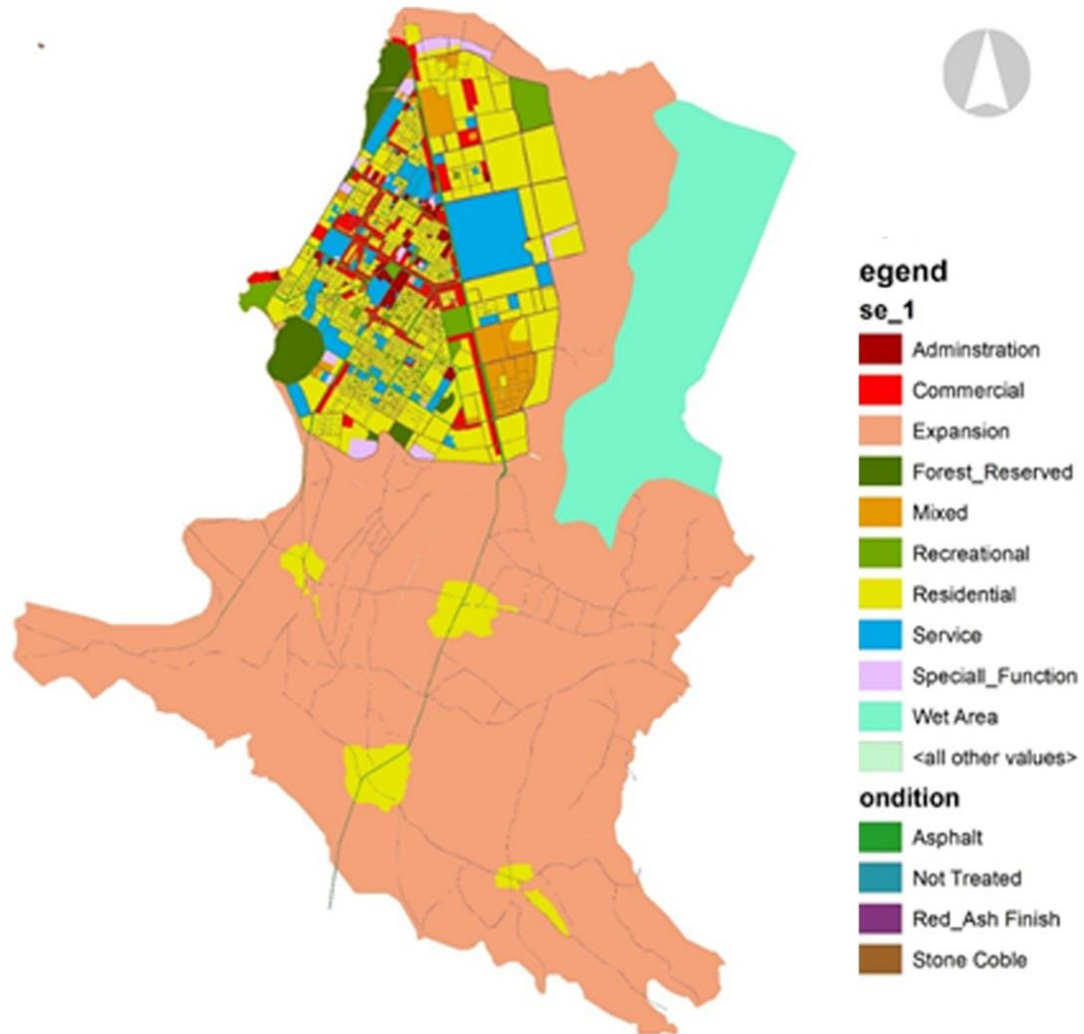
Map 5: Area of residential and urban activity centers in Hawassa (Source: Filed work, 2017).



Map 6: Potential locations by their natural content and residential zones (source: Fieldwork and a base map of Hawassa).

5.1.2 Suitability of land in Hawassa

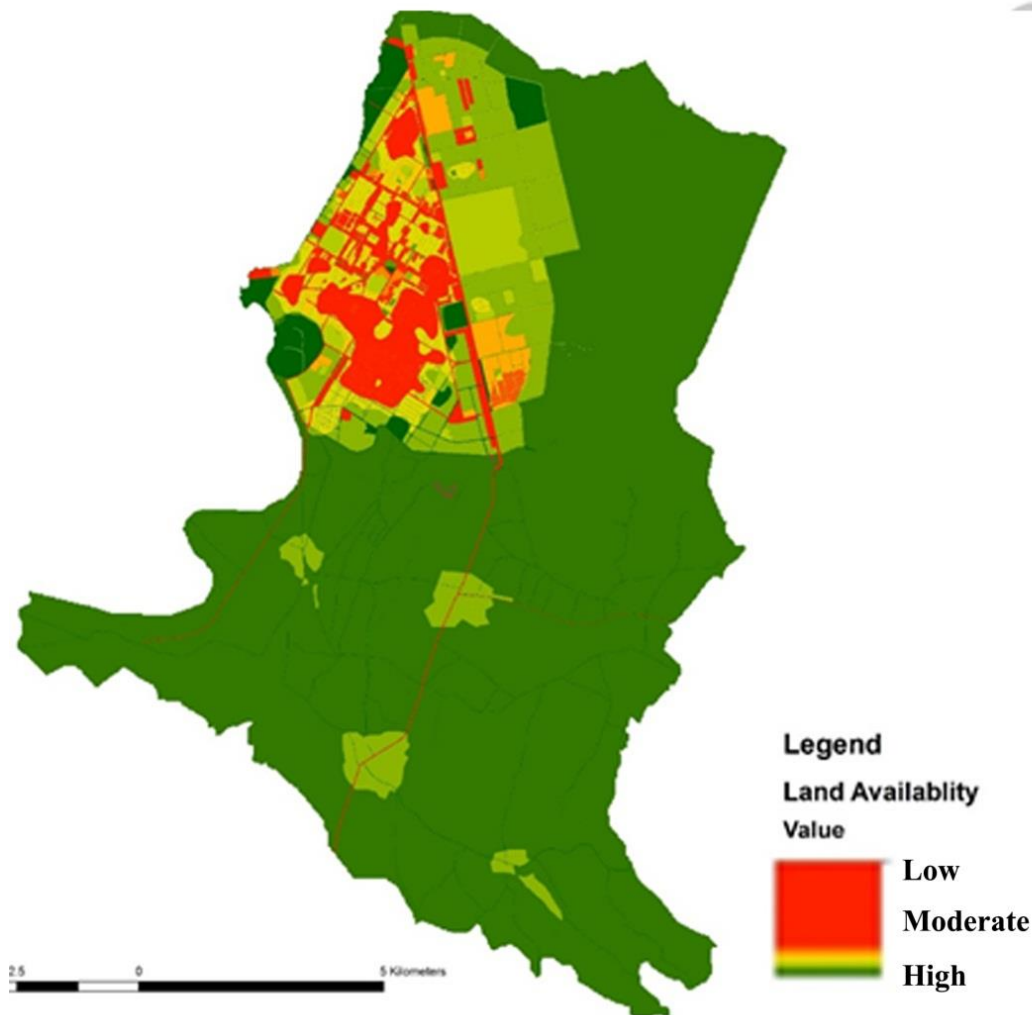
In the analysis phases of identifying suitable land patches from existing land use (Map 7) and route, the delineation process has passed through several steps and techniques. Among the method set to conduct the land suitability of the entire Hawassa is one and main task in this study. Suitability categorized in seven parts as factor of suitability assessment settled as suitability factors, land availability, road types, attractiveness of land patches, attractiveness of their naturalness, environmental protection, protected area identification, patches demand for connectivity, potential routes, and lands suitable for greenway and topographic factors of suitability are categories to take suitability assessment of the entire landscape of Hawassa. Finally, the suitability assessment task ends by creating maps for every category of factors to assess suitability then all the result of suitability maps are combined by weighting each factor depending on advantages for the greenway route and route delineations. The whole suitability maps created are discussed below in the following subchapters.



Map 7: Map showing the current land use of Hawassa (Source: Administration of Hawassa city Planning Department, 2017).

5.1.3 Land Availability for Greenway

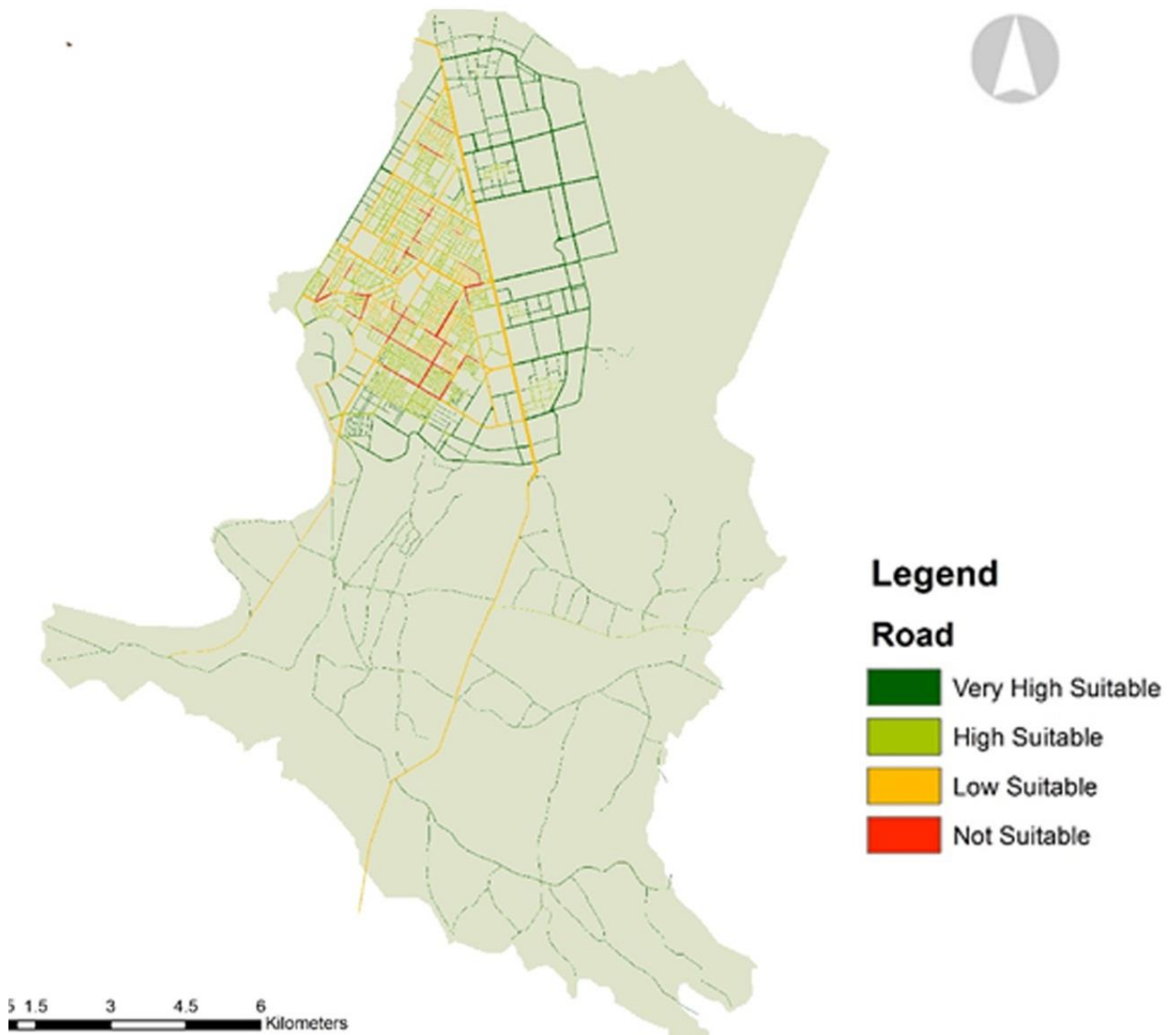
Inland availability suitability assessment of the city, created maps illustrate suitability in terms of land availability for greenway ranks ranging from not suitable to very highly suitable. Map 8 shows unsuitable areas. These are the landscape patches in the city's densely developed area, populated and intense activities. This implies that the central area of Hawassa that is marked in red color with dense buildings, high traffic volume of movement compared with the rest area as we have seen on the map below. Suitability in terms of land availability increases when we move far from the central developed zone. When we focus on the entire map of land suitability factor, areas located at the Southern, Eastern and the North East of the city boundary are highly suitable for greenway network. The Southern part is unbuilt with agricultural activities mainly. Land at the North East and East part of the city is covered with wetland extending from Lake Catchment and extension of Cheleleka Lake which is the main water source for Lake Hawassa through Tikur Wuha River. However, there are small and isolated land patches located in and near unsuitable areas with very high suitability rank. Areas like Amoragedel Park, Millennium Conserved Forest, Tabour and Alamoura Mountains, linear buffer land along Hawassa lake shoreline take the rank of very high suitability though found in unsuitable areas. The rest scenic locations and blocks containing those scenic natural potential, open spaces bounded with residential areas used for playing and gathering space for neighborhoods in various part of the city are visibly ranked as moderately suitable because they are found in the totally bounded urban area. The planning provision of the city need a consideration to regulate the development influence on the natural landscape; the central area loss its natural landscape its totally covered with buildings, in the expansion of Hawassa the planning provision must consider natural landscape and green space network.



Map 8: Map showing land availability for the greenway in the city of Hawassa.

5.1.4 Road Type Suitability

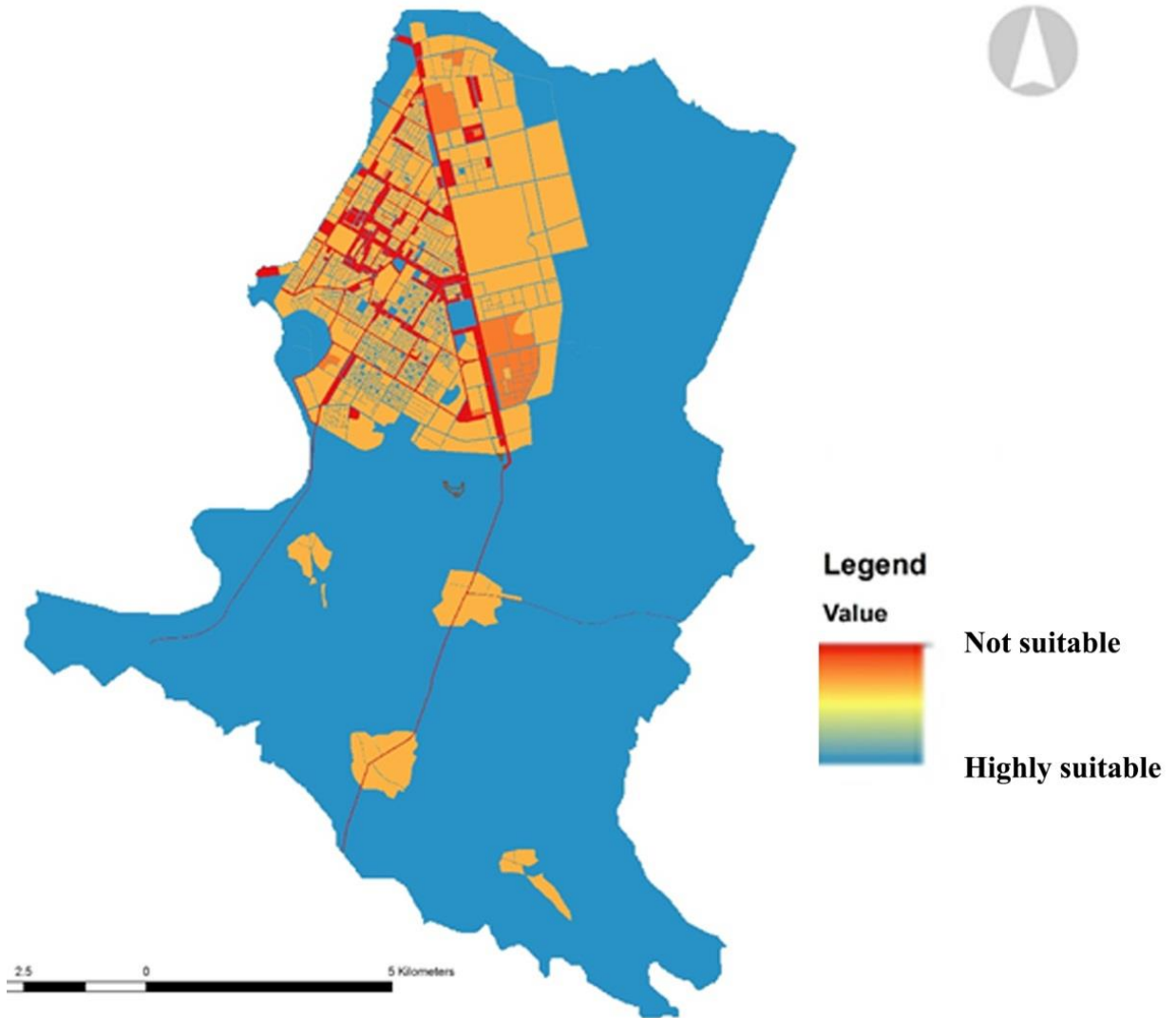
For the road types suitability assessment ranks of suitability for greenway network ranges from *not suitable* to *very highly suitable*. For this assessment, the factors taken are *road density*, *road surfacing* and *road hierarchy* as a defining the component. The denser (relative concentration of street length in the square of km) street tends to be less suitable at the central part of the city. Main streets characterized by high vehicular traffic volume tend to be less suitable. Main streets by their surface character of asphalt located at the central part of the city are less suitable. Map 9 shows higher density and a higher concentration of main streets at the central part of Hawassa. These types of streets and areas found are *not suitable for the greenway*. The generated map illustrates *highly suitable* roads for locating greenway surrounding the main central areas, which are connecting small villages on the periphery of the city boundary and along the Lake Shoreline and routes around mountains.



Map 9: Map showing availability of roads for the greenway in Hawassa city.

5.1.5 Attractiveness

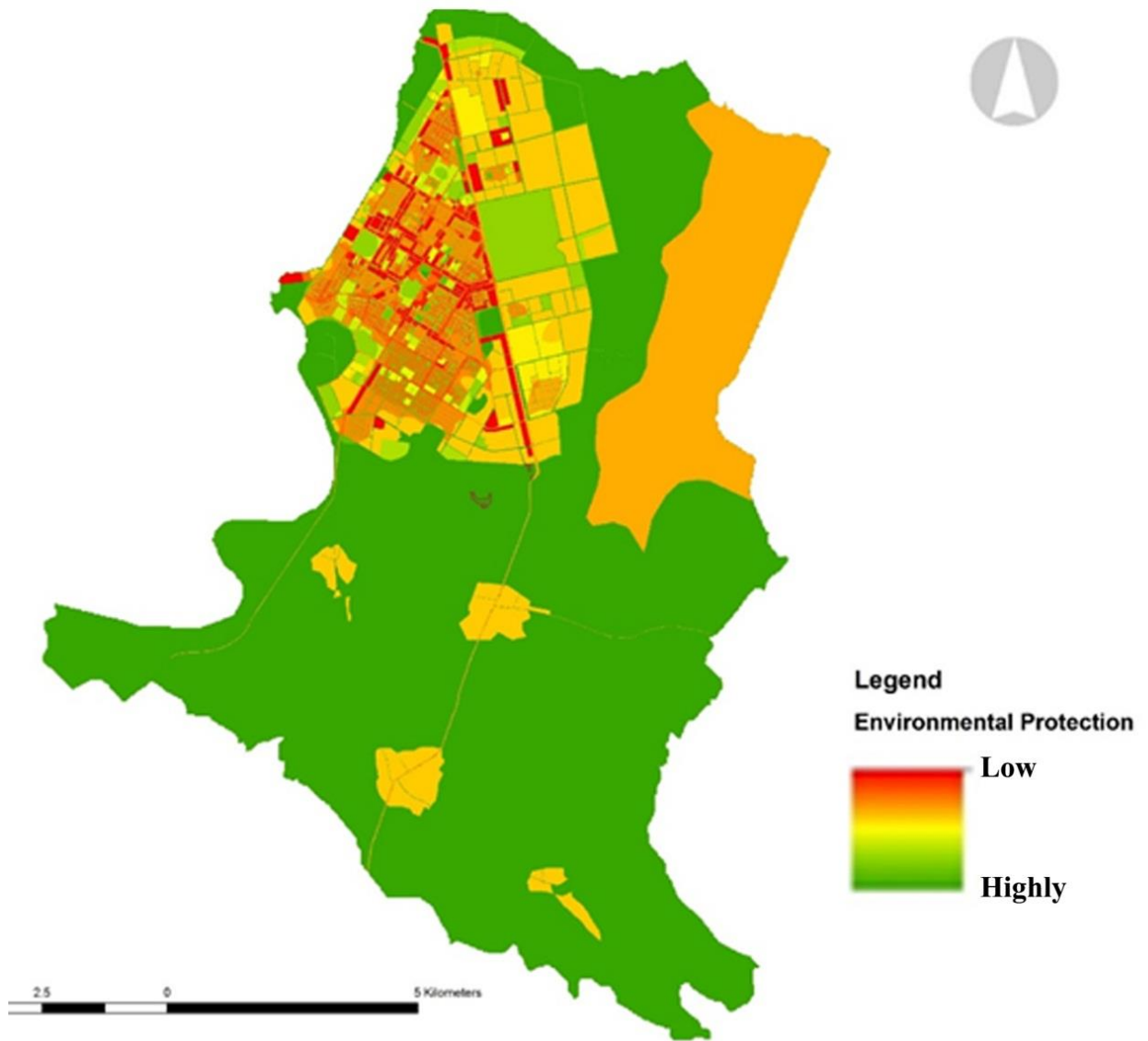
Due to wide area coverage of natural potential features in Hawassa, scenic potential, parks, forests, recreational locations, mountains, wetlands, and springs have made Hawassa have more attractive landscape patches in it. Landscape features made it attractive by their natural content and ranked it *highly suitable* in terms of attractiveness as a factor. On a map of attractiveness (Map 10) below, areas following the main axes of movement by their loss of natural features become less attractive and become *not suitable* which are marked by red color. However, the majority of Hawassa landscapes are attractive and green



Map 10: Map showing the relative attractiveness of land patch for the greenway in the city of Hawassa (Source: the result of Analysis from Land use).

5.1.6 Environmental Protection

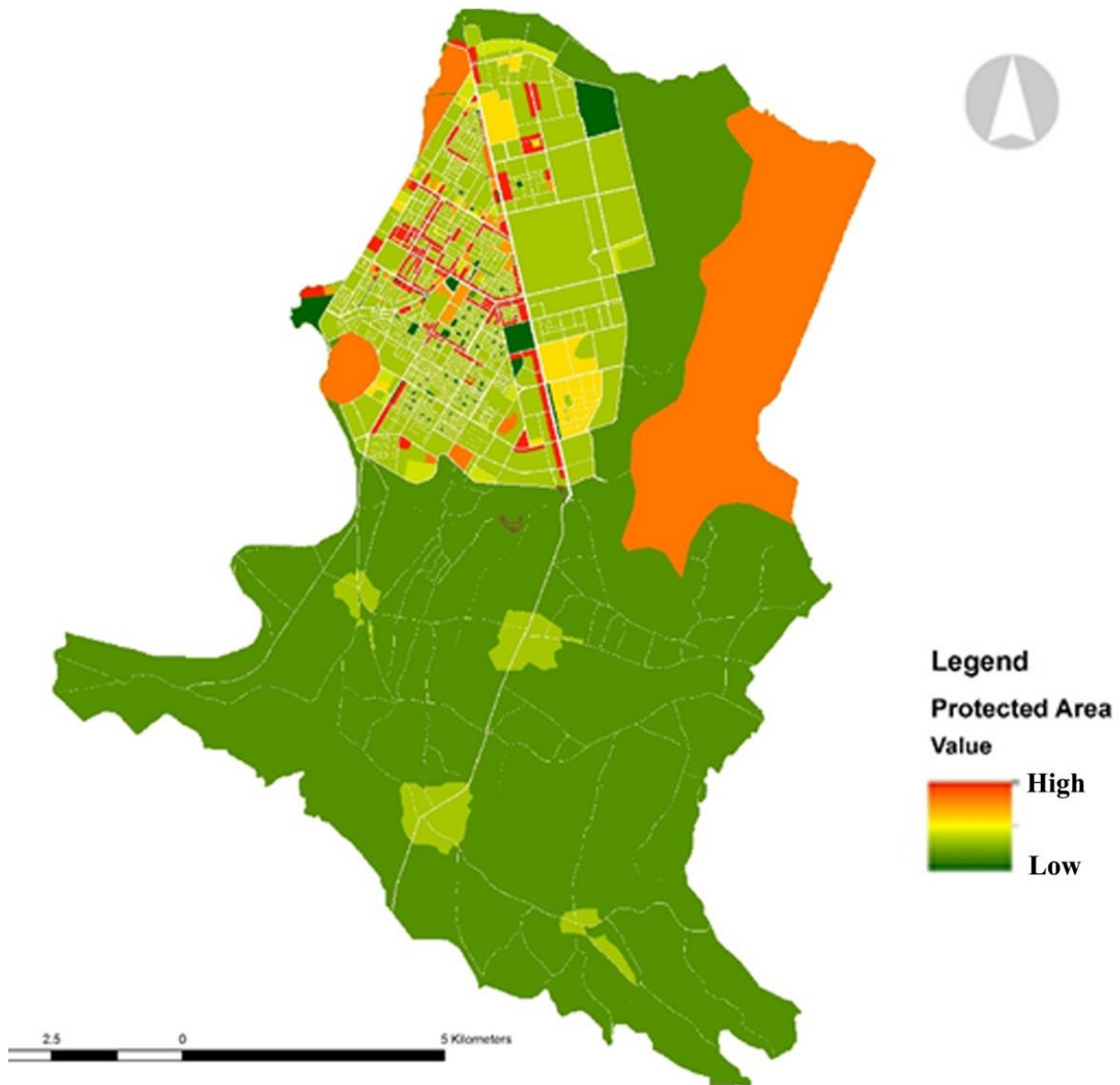
This factor of suitability has taken landscape patches level of contribution to protect and enhance natural ecosystem and the environment as a whole. Forest, vegetated open spaces, potential places to rehabilitate mountains ranked *highly suitable* in terms of environmental protection advantage. The generated environmental protection factor map (Map 11) shows that the central areas, specially marked with red, developed environment with less advantage are *ranked not suitable* in terms of this factor. Majority of land patches as seen on the map below have potential in terms of environmental protection and are marked in light green color are ranked *very highly suitable*.



Map 11: Map showing the suitability of areas based on their protection status for the city environment.

5.1.7 Protected Area

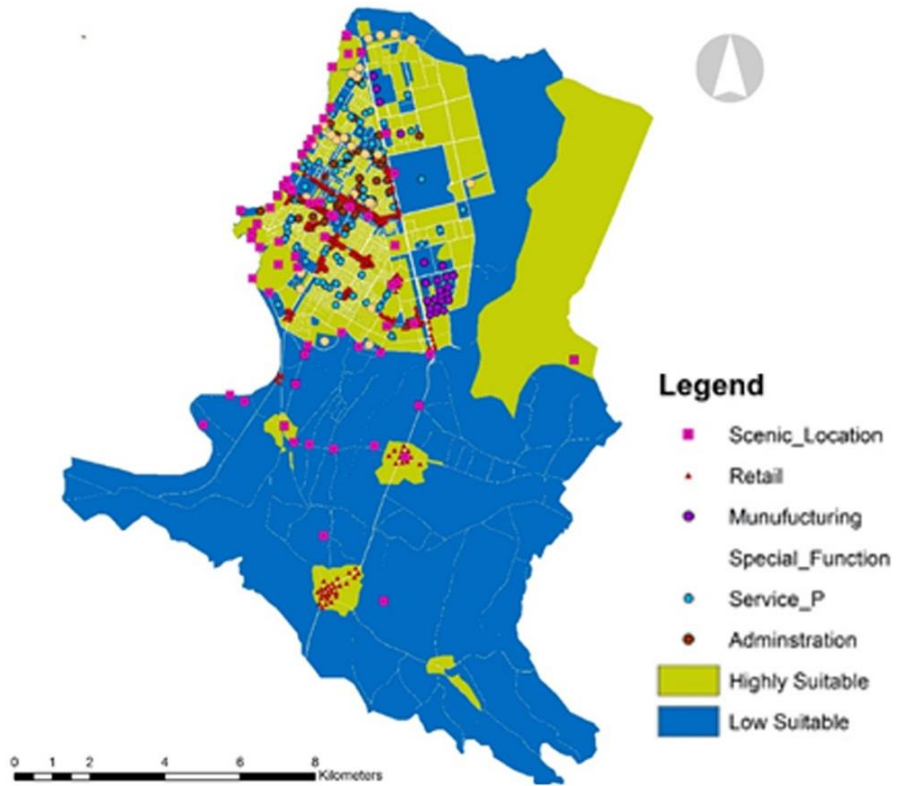
Sensitive areas conserved for wildlife were ranked with low suitability by considering interruption of wildlife habitat by human intervention. Human pathways do not interrupt wildlife. Map 12 shows densely vegetated and close forests rank *not suitable* in terms of a specified factor, millennium conserved park is one example conserved to protect wildlife and plant species. Delineating routes in the sensitive area will face conflicts of human and wildlife. In terms of this factor developed lands ranked *very highly suitable* to reduce the tendency of routing in sensitive boundaries.



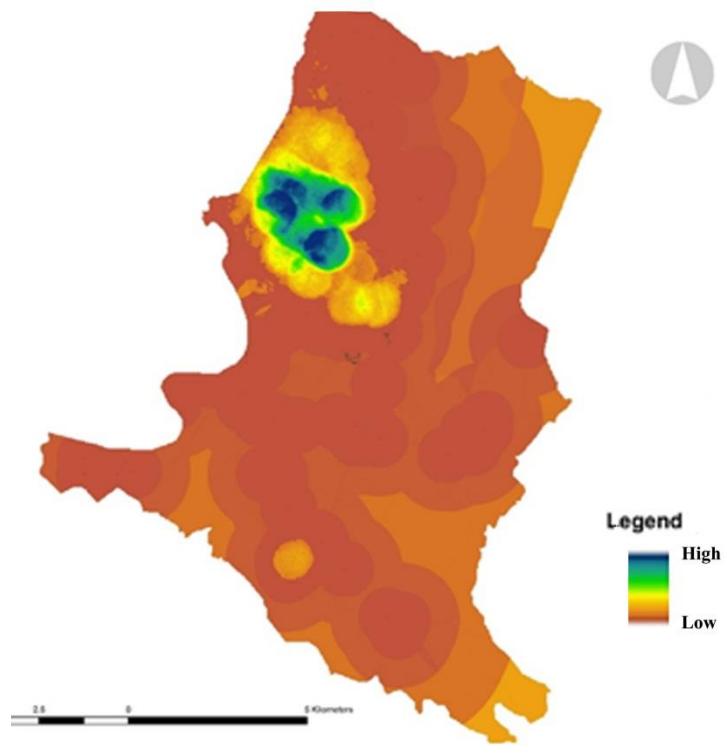
Map 12: Map showing protected area suitability of Hawassa city.

5.1.8 Areas That Demand Connectivity

On this factor of suitability, only two categories of rank are given, *very highly suitable and not suitable*. Areas identified as origin and destinations locations and boundaries ranked *very highly suitable* because these locations are identified as points that need to be included in the greenway network. The rest of the land is ranked *not suitable*. Map 13 shows the location of origin and destinations of the city and Map 14 shows concentrations of nodes and demand areas in the city. The central areas are locations of higher concentration points. According to the generated map using *Kernel Density* in GIS, high demand for connectivity is located at the center of Hawassa.



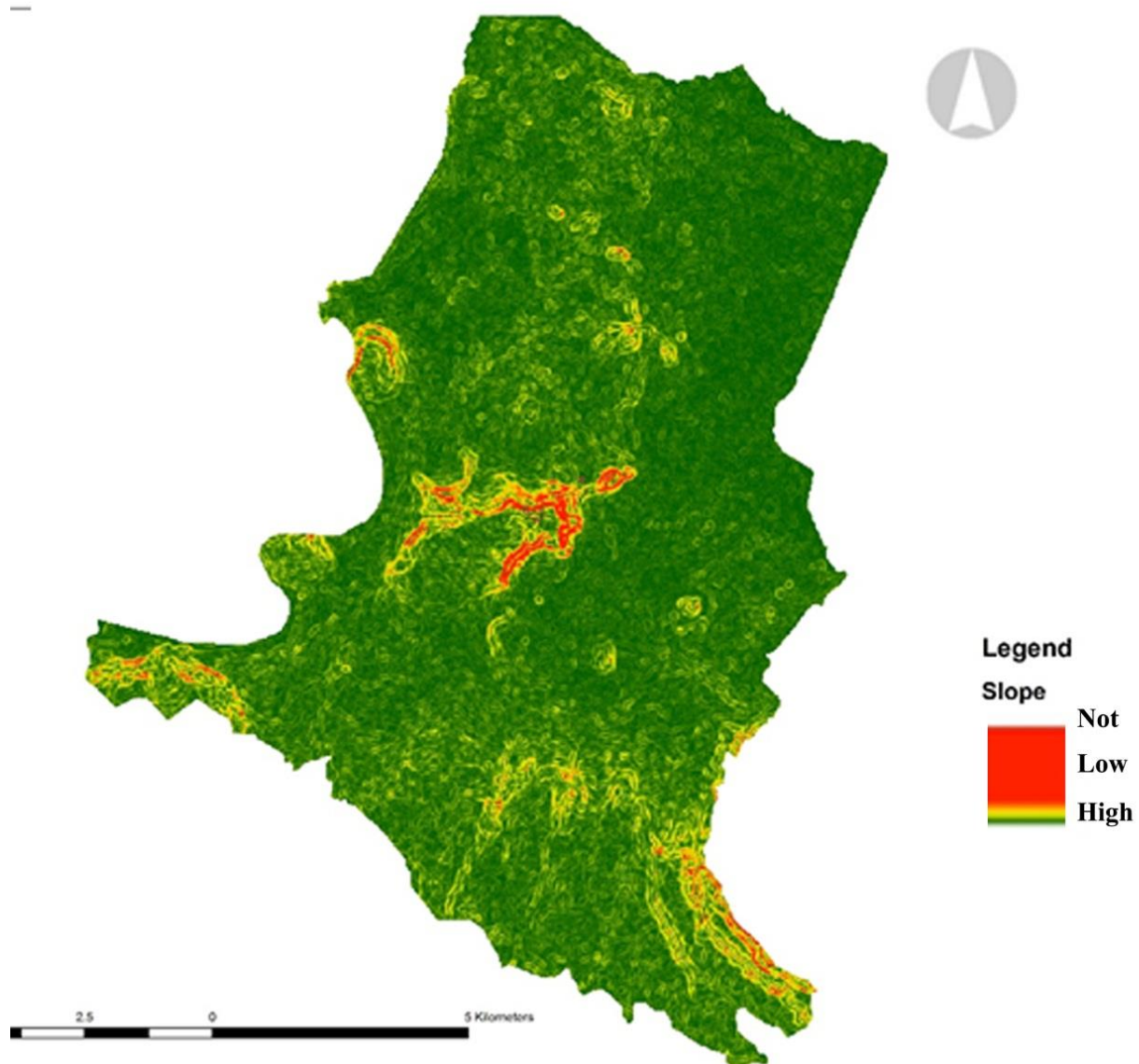
Map 13: Location of demand connectivity by greenways in Hawassa .



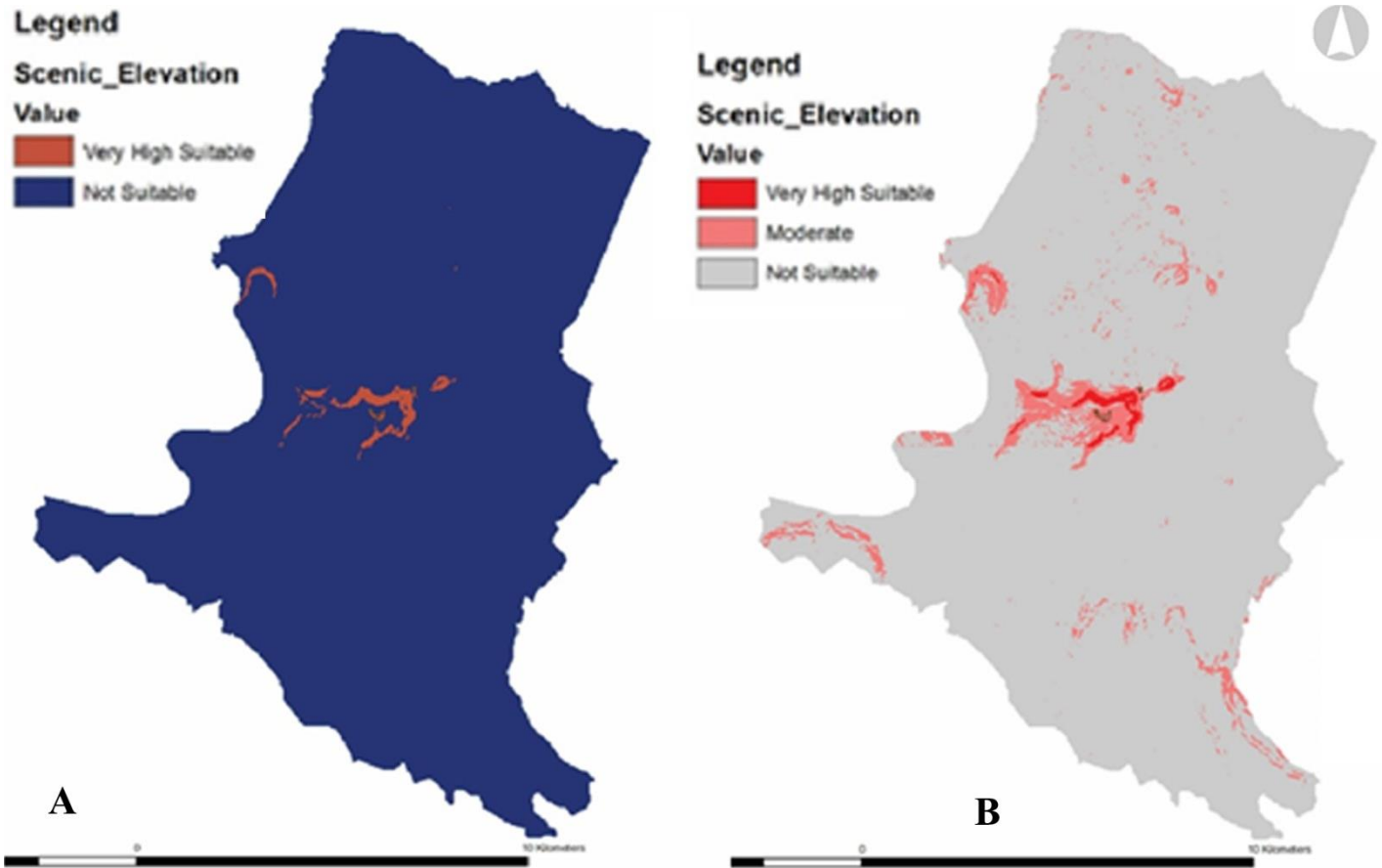
Map 14: Map showing the density of locations to be included in the greenways.

5.1.9 Topography

Accessible topography and scenic height are the main factors considered in this category. In delineating greenway route outside the existing public right-of-way must conform to slope requirement. Pathways used by pedestrians are very accessible when the slope is less than 3%. This patches of land ranked *very highly suitable in terms of topography as a factor*, 3-8% are *highly suitable rank and slope greater than 8% is ranked low*. Land patches between 8-15% slopes can become accessible for hiking but not for all greenway users and are ranked *least suitable*. Finally, land patches greater than 15% are ranked *unsuitable* for greenway network. On the generated map of this factor (Map 15) areas ranked as *not suitable* were parts of mountains like Alamoura, Tabour, Qiqe and Kiyuwata Mountains in the city but not all parts of the mountains. The uppermost part of the mountain is suitable for Scenic importance (Map 16).



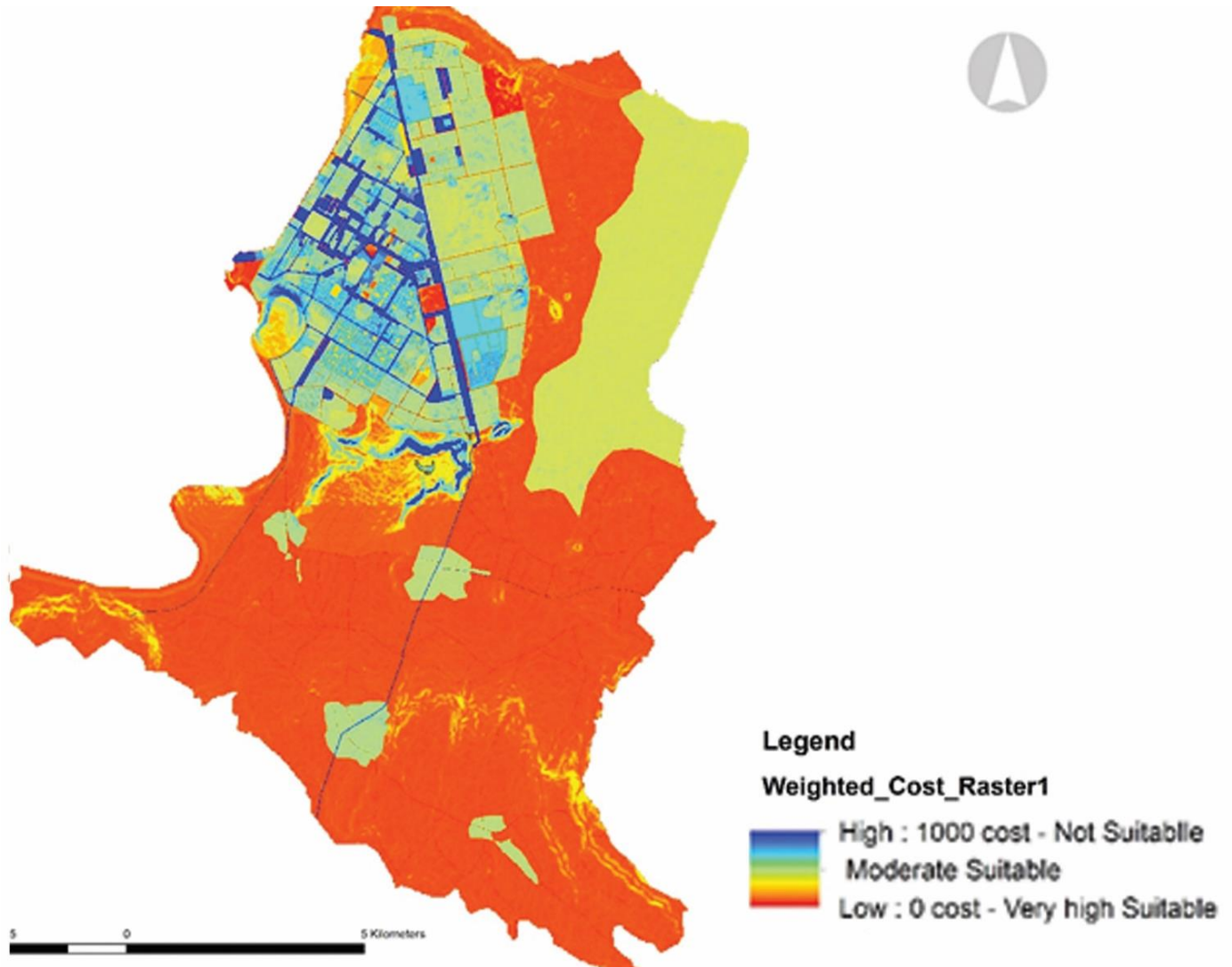
Map 15: Map shows topography suitability as a factor for greenway network.



Map 16: Map showing, Suitability of topography for movement (A) and scenic potential location in terms of Height (B).

5.1.10 Cost Raster / Map of combined factors of suitability

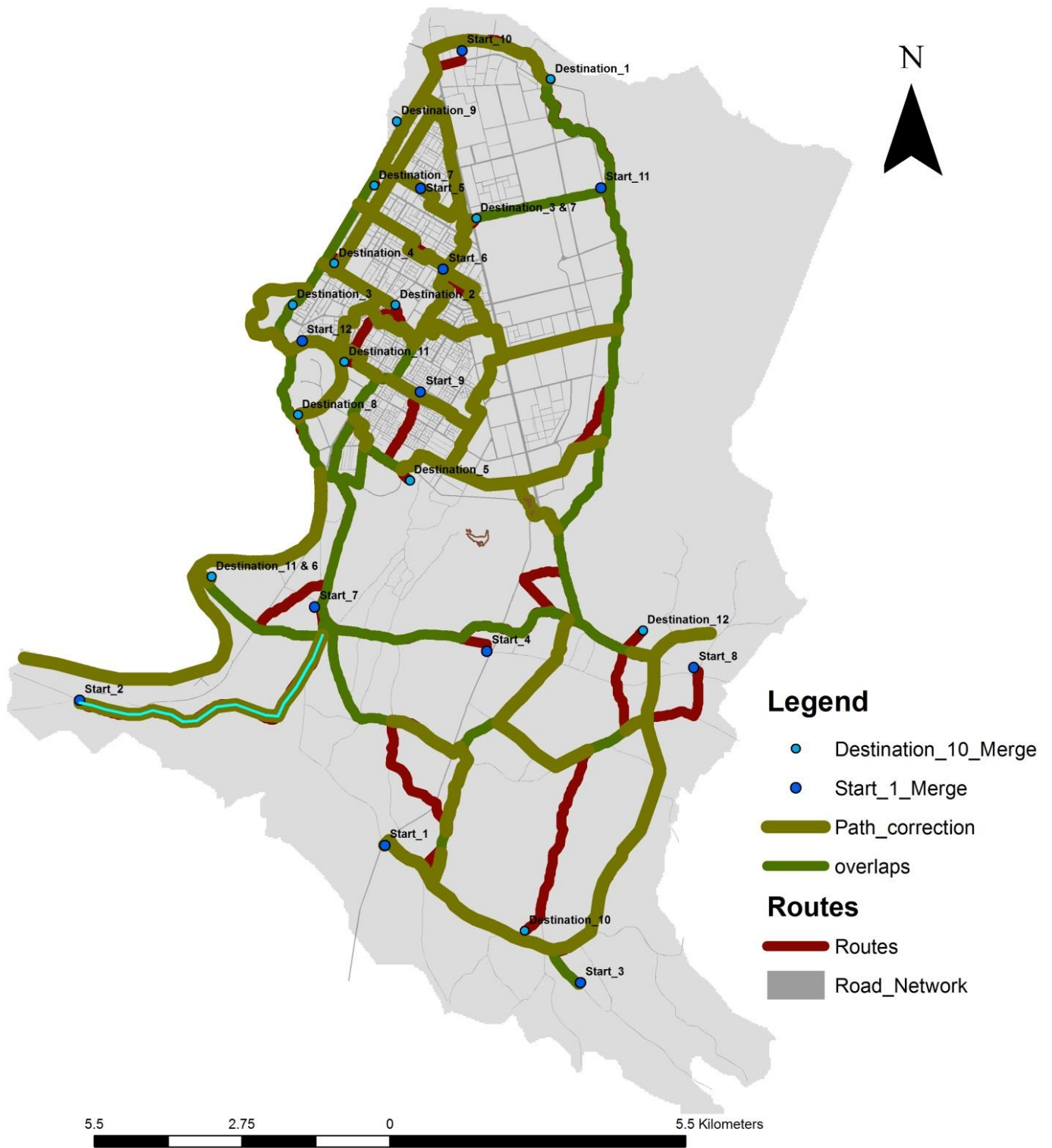
Map generated for combined factors of suitability (Map 17) illustrates which area is *very highly suitable*, which area is *moderate* and which area is *not suitable* in the entire boundary of Hawassa. On this map which combined all the factors of suitability in equal importance for greenway network in MAP ALGEBRA of GIS RASTER CALCULATOR, for route delineation of greenway path is outlined. The central part of the Hawassa almost tends to *low and not suitable rank* and the other parts of Hawassa ranked *high and very highly suitable*. Locations following highly developed area and main streets are not suitable for the greenway.



Map 17: Weighted and overlay of all analysis, cost raster of Hawassa for the greenway.

5.1.11 LCP Delineations of Greenway Corridor

Routes of potential greenway are generated based on the combined factors of suitability in the LCP model of GIS. The generated greenway network consists of fifteen single routes, which connect residential areas, villages at the periphery with each other and populated destinations by intersecting the central part of Hawassa. It also connects residential areas with each other that are located at opposite ends by intersecting them to the central area. Totally 251 km greenway network is formed by interconnecting of routes without excluding overlaps and adjustments. The final length of the greenway network formed is determined after the evaluation and adjustment of the generated map (Map 18).



Map 18: First run greenway route generated of the LCP model.

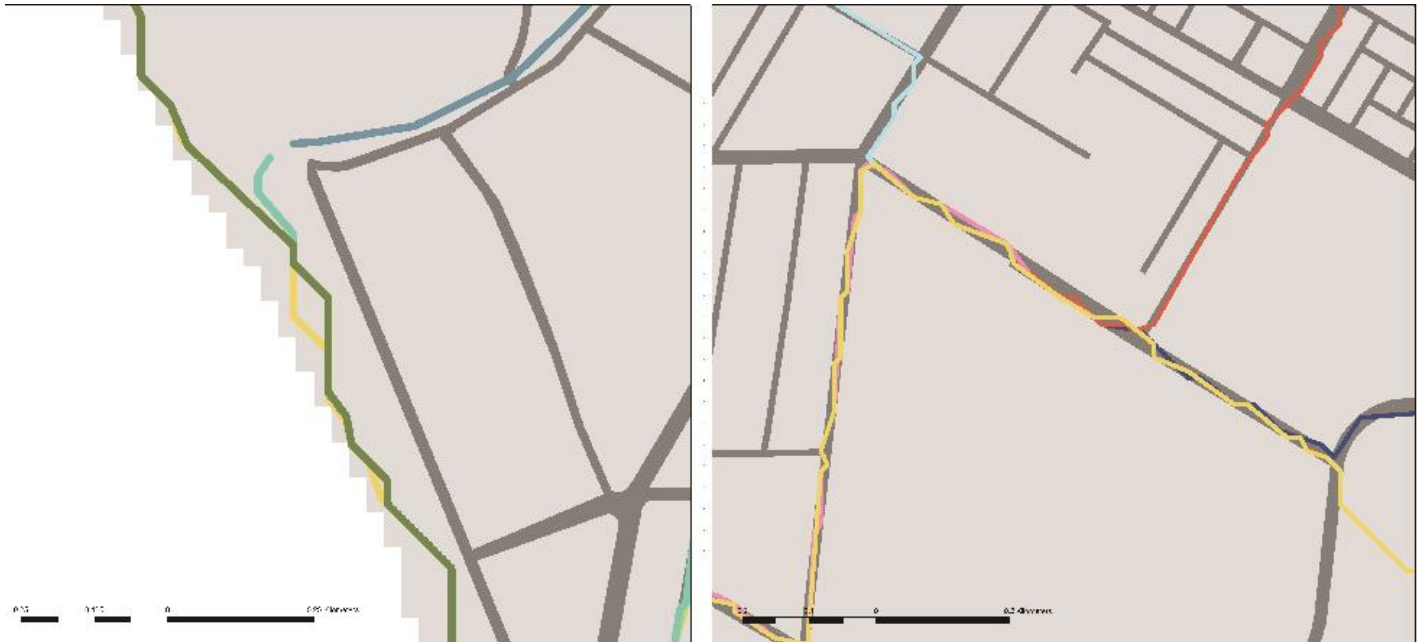
5.1.12 Evaluation of greenway

Evaluate and try to find the weakness of generated greenway was based on different criteria. The final greenway routes were evaluated at different stages. First, the resulting greenway routes were

inspected by overlaying all single routes together on one map then conflicts and overlay are found. Second, the resulting greenway routes were inspected by overlaying on the existing roadmap. Third, alignment is checked evaluating the resulting fifteen routes relating to one another alignment is checked. After identifying major issues adjustment was done.

Identifying conflicts between generated route

The result greenway routes are inspected by overlaying all single routes together on one map in order to find out conflicts and overlay. The locations where many routes are overlapped are in the most suitable landscape of the city.



Map 19: Conflicts of the first run generated greenway routes one another.

Overlay with a street network of Hawassa

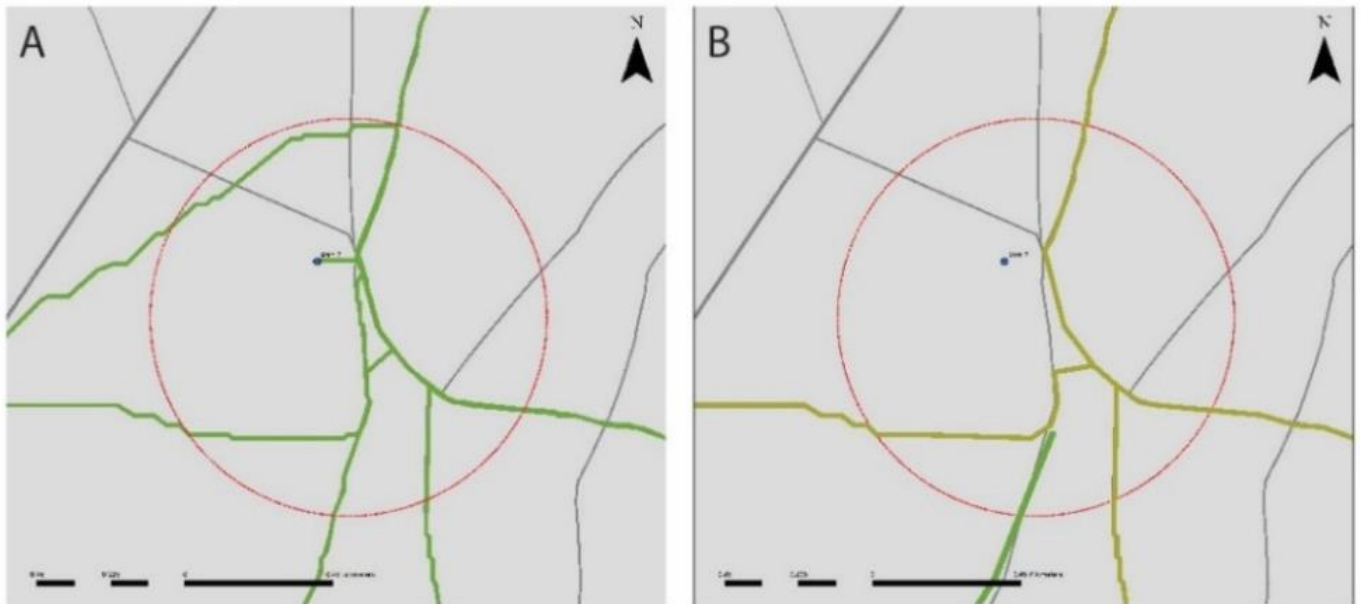
Second, the resulting greenway route was inspected by overlaying on the existing roadmap. In this process, the final delineated routes were examined against the existing spatial context of Hawassa. Each route was examined for conflicts, trade-off, and compliance with existing roads especially conflicts with high traffic volumes. Roads passing through dense areas are then adjusted. Evaluating conflicts and compliance with the existing land features of each route according to greenways goals and objectives have been conducted.



Map 20: Shows the overlay of the proposed greenway network and Hawassa city existing network.

Route Alignments

In this step of evaluation how far routes cross one another is observed and alignment is checked. In this process inspecting layout design and connections, based on buffering using PROXIMITY BUFFER toolbox in GIS and manipulating manually is done. As seen on Map 21, map A routes are aligned near to one another. When it is adjusted as seen on the map (B) they are merged to one route by using manual inspection of the most suitable surface the route passes through.



Map 21: Identifying and correcting route alignment (A) First run model of LCP and (B) After adjustment of alignment.

5.1.13 Adjusted Routes

In the evaluation of the first run result of LCP model, there were some difficulties of routes conflicting with each other and with the existing street network. After adjustment of routes shown in

(Map 22) 44.3 km of overlaps between routes and 81.9 km run on different routes in the city totally 125.2km path is determined after adjustment.



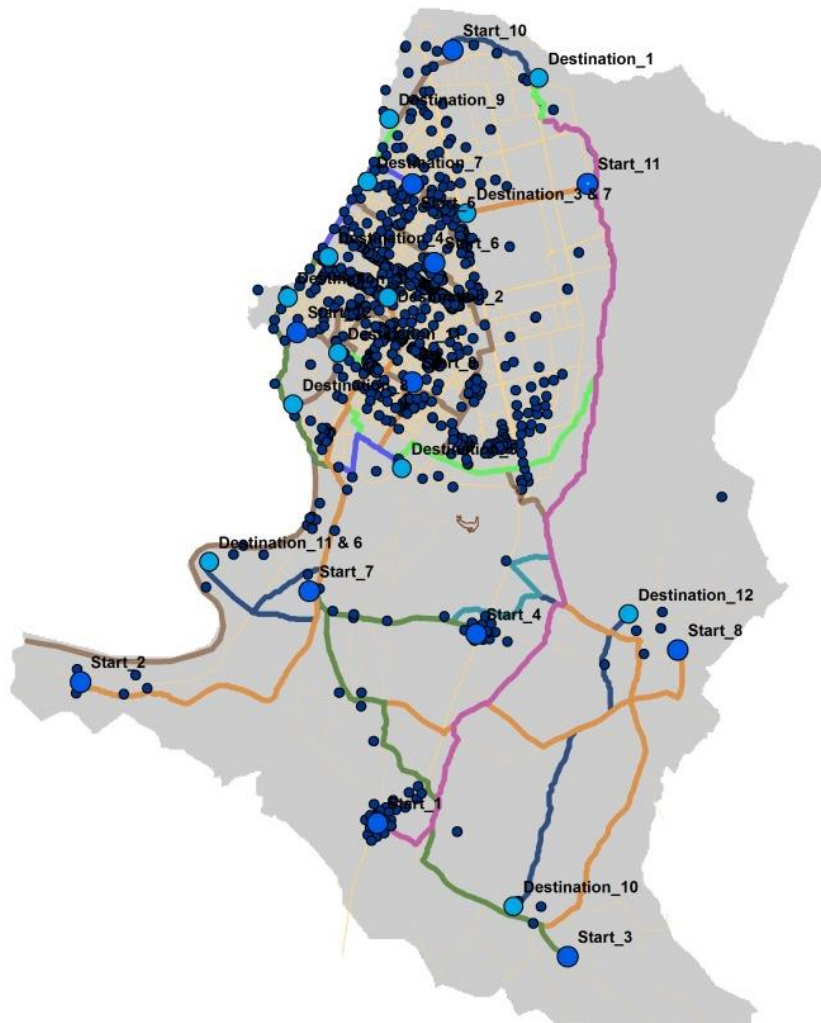
Map 22: Adjusted routes.

5.2 Discussion

All the results of the previous chapter from identifying the demand areas, assessing the suitability and delineation of the greenway, to the inspection of the generated routes with the existing spatial features have exposed, the conflicts, trade-offs, and overlaps. This reveals whether the greenway routes generated by the GIS model are realistic, attainable; fit to the objectives and goals of the study namely identifying and designing of a potential greenway of Hawassa. The generated greenway network is inspected based on the points raised in the evaluation, and inspection process that lead to possible alternative solutions.

5.2.1 Validity Coverage of the Demand locations by the greenway networks

To validate the proposed greenway network needs to compare the object of the study. Identifying and designing potential greenways of Hawassa depends on proper identification of the cities potential and its suitable landscape. Therefore, validation of the resulting greenway network is done based on potential locations and greenway network coverage to link identified locations.



Map 23: Map showing the proposed greenway network and the need coverage (Source: Field survey).

Table 8: Coverage of Proposed Greenway network with Demand locations (Generated from GIS Multi-Ring Buffer tool)

Walking time t near route(minutes)	Distance From Route (meter)	Coverage of Locations	Coverage i Percentage
5	400	777 location out of 984 within 400m distance from the Proposed route	78.9%
8	800	967 locations out of 984 within 800 from the proposed route	98.3%

As shown in Table 8 above almost all the identified greenway potentials are found concentrated in a walking distance from the proposed potential greenway network of Hawassa. This implies that the proposed greenway network is appropriate for the city.

5.2.2 Use of potential existing trials

The generated routes and their network cover all the potential walking, natural, and social landscapes of Hawassa in near proximity (Figure 13 & Map 24). This result implies that using the city’s potential to attain the presented objective of the study is attained.



Map 24: Potential existing vehicular free trail included in adjusted greenway network.

Existing City Wide Potential Trails

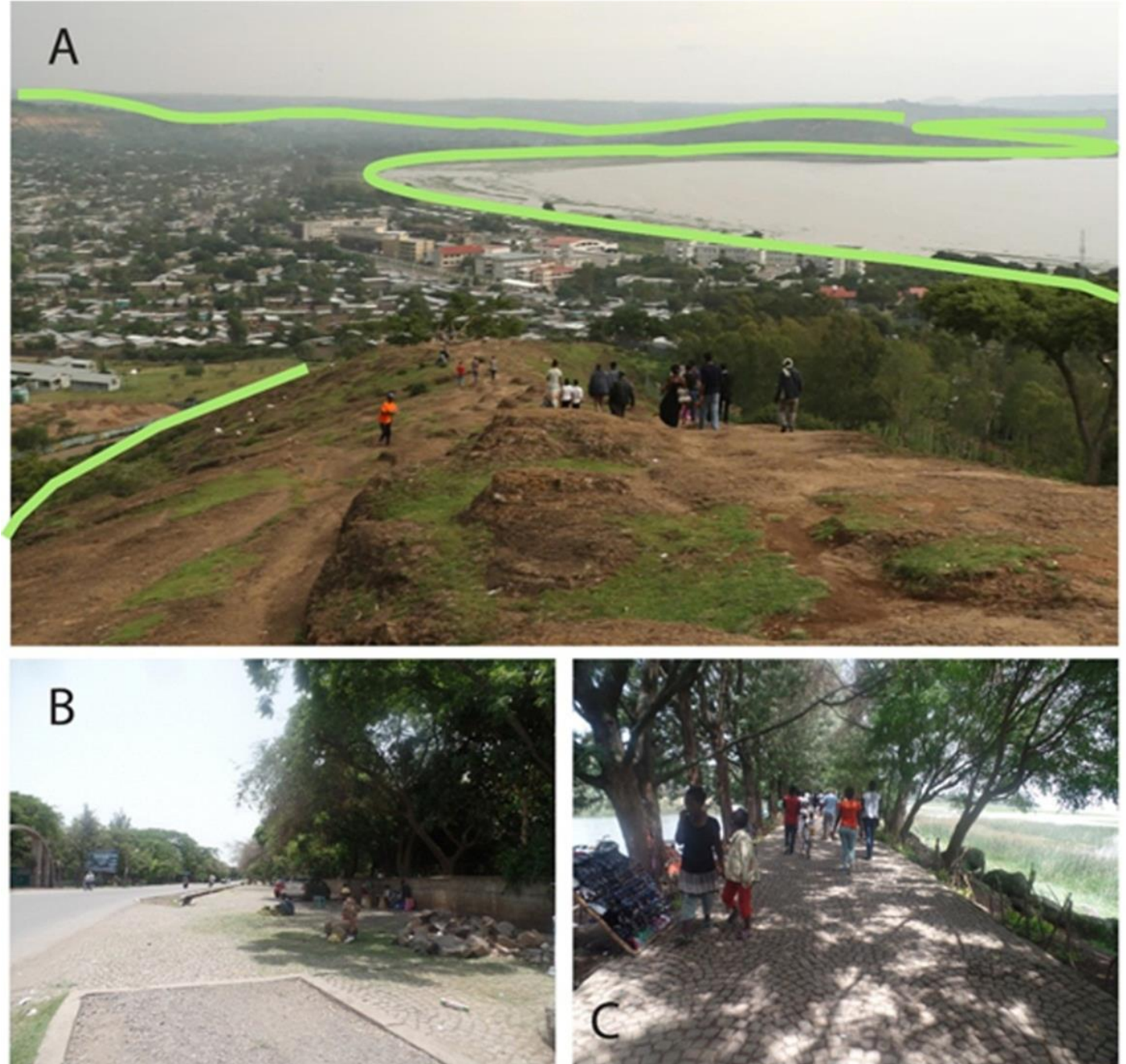


Figure 13: Some of the Potential greenway areas and natural corridor; the Potential walking path along the lake shoreline (picture taken from Tabour Mountain) (A), potential linear space along the street from St' George Church to Fikir Hayek, and Popular trails used for a long time along the lakeshore. (C) Were included in the greenway network. (Source: Field survey 2017).

5.2.3 Categories potential greenways in Hawassa

According to the need and intended functions of greenway different categories of corridor identified in Hawassa city.

Table 9: Types of greenway projected for Hawassa

Type of greenway	Function	Location
Riparian	Protecting the lake and wetland; buffering built to natural sensitive landscape and wildlife corridor.	Along the lake
Urban/scenic/historic route	Pedestrian access and provision of natural component	Developed urban area
Urban shared route	Cultural resources protection/enhancement, good pedestrian environment and provision of urban linear natural route	The greenway along main roads
Environmental and Recreational	The opportunistic assemblage of greenways and open space of various kinds to integrate green infrastructure and creating a livable urban environment	Connecting one neighborhood open space to other
Active recreational linear park	Connecting different public space, parks, and squares	Example, the connection between Amorage del and Fikir Hayek
Ecological significant natural	Provide significant natural corridor to provide migration of wildlife and species interchange	Near protected area and lake shoreline, trails around the conserved mountain like Kiyuwata and millennium reserved park

5.2.4 Strengths and limitations of the LCP model

This study demonstrated that greenway identification based of GIS/LCP model can be effectively applied to the urban area that is characterized by limited available open spaces and also enough open space to develop greenway, especially in the urban core. In addition, the input of factors and criteria is highly flexible and can be adjusted to any local context as well as available data (Teng, M. et al., 2011). The key strength of the LCP model is that algorithm provides a structured approach to greenway planning that automates the identifications of the most suitable greenway routes while taking into account and combining multiple contextual factors((Miller ,W. et al., 1998). The GIS-based LCP model makes possible to analyze numerous datasets simultaneously over a large area and in a relatively short time frame. The model is transferable to various other urban study areas and routing applications. Applicability is the strength of the method. The major limitation of the LCP model is comparing the result on the actual landscape especially when the study area comparatively larger. And lack of data availability and accuracy can limit factor and distort the result.

5.2.5 Applicability of the model to other areas

The GIS-based LCP model is capable of identifying suitable urban greenway routes drawing entirely from digital data sets and local background information, without relying on on-site assessment after digitalizing the raw data. The provided data sets of good quality and time are available the model is widely applicable for greenway and other route delineation projects in an urban setting. Availability, accuracy, and recentness of the data required for the greenway delineation are perhaps the most fundamental criteria for its applicability (Miller ,W. et al., 1998). If the factors mentioned above are considered, the model can be used to a variety of other study areas in urban settings.

5.3 Summary of analysis tasks and findings

Table 10: Summary of analysis and findings

Tasks	Findings
Potential locations	<ul style="list-style-type: none"> • Open green spaces, parks, forested areas and other vegetated areas found along the lake and at the edge of the city. • The developed area of Hawassa is the most destinations where collected • The most trip attractor locations found at the center • At the periphery of Hawassa new emerging settlements observed as a potential location for this study and for the future connectivity through the greenway
Land availability	<ul style="list-style-type: none"> • Most part of Hawassa is a suitable item of lands, but the developed area mostly unsuitable. • No consideration or regulations is taken in most parts of the developed area to protect natural environments. • The planning provision of the city should consider regulating the development influence on the natural landscape; the central area loss its natural landscape; it's totally covered with buildings; in the expansion of Hawassa the planning provision must consider natural landscape and green space network. • A rapid development like hotels are emerging, especially along the lakeshore made the natural environment in risk.
Road type	<ul style="list-style-type: none"> • The central part of Hawassa mostly unsuitable taken road as a factor • The densest, surfaced with an impervious and high traffic volume of vehicle and motorbike use the streets of developed center. • But areas surround the central part and periphery of the city suitable.
Attractiveness	<ul style="list-style-type: none"> • The result shows suitability in terms of attractiveness based very high on most parts of Hawassa. • Due to the existence of vegetation coverage in the surrounding of the urban center increase attractiveness. • Area of low and no suitability, such as roads, areas of little or no vegetation, occur in residential areas and especially in the urban center.

	<ul style="list-style-type: none"> • Entirely green /natural spaces highly concentrated at the periphery and area near the lake
Environmental protection	<ul style="list-style-type: none"> • This factor has taken landscapes patches level of contribution to protect and enhance natural ecosystem and the environment as a whole. • The central/developed parts of Hawassa less advantage in the contribution of protecting and enhancing natural ecosystem. • Need improvement.
Protected area	<ul style="list-style-type: none"> • Protected/sensitive areas considered low suitable because it is conserved for wildlife by considering interruption of wildlife habitat by human interventions. • Densely vegetated and closed forests rank not suitable for protection factor. • Route delineations through this area face conflicts of human and wildlife, like Hawassa millennium park
Demand for connectivity	<ul style="list-style-type: none"> • Residential and urban activity centers very highly suitable. • The rest parts of the city not suitable in demand to be connected in greenway in terms of this factors • The developed city parts were more tendencies in need of connectivity.
Topography	<ul style="list-style-type: none"> • Accessible and scenic height is determined in this factor of suitability. • The uppermost parts of mountains in Hawassa are suitable for scenic, but not accessible. • Inters of accessibility, almost all of the city parts are highly suitable.
Merging/Overlaying factor	<ul style="list-style-type: none"> • On the result of combined factors map the central developed area is unsuitable, especially the most developed commercial corridor. • Some improvement needed in the developed area to integrate the greenway and improve the natural environment.
Route Delineation/LCP	<ul style="list-style-type: none"> • The generated network consists of fifteen single routes, which connect residential areas with each other and with urban centers. • By interconnecting several routes, the greenways form a network of 125km delineated with 44 km overlaps on the most highly suitable part of Hawassa.
Evaluation	<ul style="list-style-type: none"> • The first generated greenway network evaluated with an overlaid map to check how the greenway network and suitable landscape is related; almost the whole generated network passed over the suitable landscape of Hawassa. • Second, compare and contrast with the city movement network. In this time some conflicts were happened especially crossing over the main road. This issue solved manually by comparing of relative suitability of the area • Third, evaluate the greenway network with spatial features, like, conflicts with private property. This issue also solved manually by comparing landscape patches of the area with their suitability level.

	<ul style="list-style-type: none"> • Finally overlooked the layout design; overlapping, geometric layout, and connection type. These issues also solved with manually checking and re-routing depends on relative suitability rank of the landscape.
Adjustment	<ul style="list-style-type: none"> • On this stage, adjusting the issues raised above during evaluation of the greenway network.
Overall	<ul style="list-style-type: none"> • The planning provision should consider strategies for sustainable growth. • Land should be preserved for strategies like, provision of the greenway to recover the natural system • Infrastructure planning should consider effects on the natural environment and its network during, planning and construction time.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

5.4 Conclusion

All parts of the study process enabled the planning and design to achieve a more sustainable synergy between the natural environment and infrastructural development using greenway corridor as a strategy to repair the gap; Improving natural environment, wildlife habitat, biodiversity, and development together using Greenway as a strategy for Hawassa. The greenway framework was inclusive for all the city aspects, social, transportation and ecological services that provide sustainable connections between natural landscapes and social built infrastructural development of Hawassa. In planning and designing parts of the study were different criteria's for assessment, delineation, and design applied. In this process, seven factors were determined and weighed to indicate the suitability of all landscape patches in the city based on the seven suitability factors.

This greenway network put goals to connect activity centers in the city, to provide alternative travel options, to enhance recreational, socio-cultural character and to boost urban environmental protection. Finally, greenway networks were produced, in the potential routes in the city of Hawassa, the generated city scale corridor need to be designed on the actual ground as realized on the next part of the study. Overall all greenway corridor identification and local area design were effective in addressing sustainability, socio-cultural transportation and ecological components for Hawassa.

5.5 Recommendation

This study recommends greenway planning as a valuable strategy in the interventions for ecological/environmental protection, increased sustainable transport and improved livability in cities, As a result, it considered applicable planning and design tools. Proposing new greenway connections should be taken as an integral component for environmental protection and ecological service, recreational opportunities, and transportation infrastructure for sustainability, and should be considered side by side with city expansion and land use planning as well as road planning. But should participate users and explore the way they interact when using greenway networks. And follow up with proposed strategies, criteria and guidelines of greenways and trails serve to implement.

5.5.1 General recommendation

The general recommendation presented based on reviewed strategies and cases to ease the integration of the delineated city scale network on the actual landscape of Hawassa. For the realization of the greenway network, some design and guiding considerations are proposed in compliance with the

literature on greenways, urban design, and landscape design. The recommendation is given based on the framework of greenway; socio-cultural, ecological, and alternative transportation, although considering urban design standards. The recommended criteria, strategies, and guidelines are suggested to create an urban design with a greenway segment that meets human needs while improving ecological performance within the Greenway landscape. Based upon the context of a greenway landscape the respective body headed for implementation essentially focuses on:

Ecological strategies

- Preserving and extending the greenway at Hawassa landscape within the community to enhance habitat protection, vegetation provision to increase natural environment, promote tree canopy to provide shade, filter the air, and help recharge water aquifer, reduce the volume of run-off , use LID solutions.
- Smaller building footprints and compact design to preserve more vegetative land.
- Street trees in planting buffers and along the greenway as well as along streets can greatly enhance and support goals of greenway provision.
- Landscaping in the developed area should consider LID solution to manage stormwater.

Socio-cultural strategies

- A greenway system of networked open space and conservation natural environments address multiple social-ecological objectives. So thinking the greenway in a connected and networked manner for its best function. They also provide recreational amenities and desirable green space in communities.
- To promote a quality of place on greenway landscape should interpret from the mix of diverse functions. Allowing diverse people to live work and interact
- Compatibility between the community/corridor and greenway is ultimately achieved by sense, character, and identity of place. Greenway design, in this case, should be sensitive to and provide a perceptible link to the physical environment, cultural, and historical context of the greenway will contribute to foster a sense of place and image of the community.
- Street facing, frontage, and entrances of buildings in the study area and along greenway corridors, mixed-use buildings are encouraged to provide needed housing and desirable retail conveniences, blank walls should not face the street or trails at city scale as well in a specific site.
- The city of Hawassa should pursue a citywide program of tree planting along the greenway to participate the peoples in the vision of greenway provision. Today and for the future.

- Architectural heritage in all improvements encourages a sense of place that is rooted in Hawassa unique heritage and cultural traditions.
- Space between buildings should be minimized as much as possible, the more they closer they begin to form a defined street edge for the pedestrian. Building along the street should be built as closely together as possible in order to create a more perceptible street edge.
- Integrate site amenities include trash receptacles, dumpsters, benches, tables' fountains, bike racks and shelters for good pedestrian and socio-cultural environment.

Alternative transportation strategies

- Walkable connected urban area, Pedestrian, and bicycle routes are important towards achieving sustainability, quality of life, and connected community as well connected different urban blocks using the natural approach, greenway.
 - Buildings should be oriented to the greenway, trails, and street. This help to create an inviting public-private oriented space.
 - Pedestrian-oriented streets arranged in a connected, grid-like as well shorter block depth pattern to encourage and promote walking and biking.
 - The city should encourage pedestrian circulation networks that provide relatively direct connections between homes and jobs and retail, civil, or other facilitates that can serve them
 - Provide safety from traffic, these elements of the built environment will help provide safe alternative transportation and pedestrian protection from traffic. Although, make the pedestrian setting perceivably safer for the user in order to create a Walkable pedestrian environment.
 - Define the greenway edge using hard as a well soft defining element, like planters, to help the pedestrian and bike realm enhancing the good and safe experience.

5.5.2 Ecological criteria and guidelines

Table 11: Design Criteria and guidelines for ecological aspects of the greenway.

Greenway Framework	Design Criteria	Guide Lines
Ecological preservation/ Protection / Conservation	Integrate green space	Increase vegetative areas in street scape
	A network of open space	A connected network of the open natural landscape, green spaces, and parks
		Extended connections to greenway network at the bigger area and adjacent areas
	Compact and cluster development	Design the lands to build compact and to save more open space
	Spatial connectivity	Linear green spaces that promote open space connectivity to the greenway and adjacent communities
	Minimize fragmentation	Avoid development that perforates and interrupt patches of habitat.
		Avoid continuous barriers between site and greenway that divides habitat.
	Promote Infiltration and minimize impervious cover and reduce run-off	Minimize impervious roads, sidewalks, parking, and building footprints. Providing necessary human functions and needs within the built environment of the site.
		LID solutions, to manage run-off
	Enhance bio-habitat and promote native species	Local natives and planting well suited to the greenway and local conditions of the site.
		Avoid disruption to riparian buffers by development
		Create micro-climates and improve soil conditions with edge boundaries of physical development elements to promote native and biodiversity.
	Natural Resources conservation	Restore key ecological features of conservation areas such as riparian areas and river corridors.
	Width	Minimal width: the wider the corridor the better to serve multi-functionality; sizes have been given for different situations from 15m to 200 varying for urban and sensitive area

5.5.3 Socio-cultural criteria and guidelines

Table 12: Design Criteria and guidelines for socio-cultural aspects of the greenway.

Greenway Framework	Design Criteria	Guide Lines
Socio-cultural	Promotes connections to nature	Buildings should locate with easy access to urban setting and greenway.
		Clusters of trees and understory in visually prominent locations
		Scale and placement of homes, buildings, streets and other design elements should preserve viewsheds to the greenway.
		Multi-functional sidewalks and trails that connect to urban areas, greenway, open space and common areas.
	Permeability and transparency	Placement of buildings blocks, street and other design elements that should enhance and preserve view to cultural, historic and greenway setting.
		Orient common areas in visually prominent locations.
	Promote and reflect the natural condition of greenway within community atmosphere	Green spaces, common areas, and parks linked to each other and the greenway through systems of landscape streets, pedestrian, sidewalks and trails.
		A network of sidewalks and trails that connect buildings and homes to the greenway network and natural settings.
		Buildings and homes should be integrated with common areas
	Orientation	Green space and common areas oriented in visually prominent location.
		The building should face green space, parks, sidewalks, and trails.
	Cultural and historical preservations	Interpretive elements, such as signage, exhibits, and markers
		Landscape material and character
		Conceptual interpretive design elements that produce a perceptible image of cultural cultural greenway heritage.
Design elements that enhance and preserve views to historic and greenway setting		
Balance private and Public space	Define boundaries near buildings through combinations of landscape design elements.	
	Private and public space Should be integrated with the shared common area and use architectural elements to define semi-private transition space like porches.	

5.5.4 Alternative transportation criteria and guidelines

Table 13: Design Criteria and guidelines for alternative transportation aspects of the greenway.

Greenway Framework	Design Criteria	Guide Lines	
Alternative Transportation	Prioritize pedestrian	Less parking on Street and in front of Buildings	
		Create areas where cars can be parked out of the way to minimize the obstacles	
		Hierarchy of roads that create quiet loci neighborhood and smaller access streets on community interior that activate social interactive setting near the building.	
		The designated pedestrian crossing should be marked for greater visibility and direct pedestrian traffic across the street.	
	Safe street zone	Surfacing should be Appropriate to facilitate pedestrian and biking	
		Create a street environment that strives to ensure pedestrian safety sidewalks, pathways and crossing should be designed	
		Minimize the vehicular parking near the pedestrian prioritized environment, which interrupt the pedestrian activities by crossing and parking	
	Accessibility	The pedestrian environment should be free from barriers to minimize conflicts with external factors.	
		Multi-functional sidewalks and trails that connect to urban areas, greenway, open space, and common areas.	
		sidewalk and trail options for different abilities	
		All-inclusive and Walkable pedestrian-oriented streets.	
			Public and social common areas should be connected through a system of landscape streets, pedestrian sidewalks, and trails.
			The pedestrian network should provide continuous direct routes and convenient connection between destinations, including homes, schools, shopping area, public services, recreational opportunities, and transit. These guidelines should be considered for bike user too.
			The mid-block crossing should be used when blocks are greater than 150m in length in order to keep pedestrians from going too far out of their way to cross the street.
	Pedestrian Streetscape		streets designed in a grid layout to promote connectivity when possible
		Walkable pedestrian-oriented streets	
		Narrow streets, short blocks, and inter-connectivity that prioritizes pedestrian and slows traffic	
		Separation/division of street, pedestrian sidewalks and pathway network that include connections to open spaces and to the other part of the city.	
		Tree canopy and vegetative areas in streetscape and open space for more Natural environment coverage as a well livable corridor.	

In the next part of this study, testing this proposed city scale greenway at a local scale for the ease of integration to actual urban fabric through design using the recommended criteria, strategies and guidelines shall be presented.

PART II

6. CHAPTER SEVEN - DESIGN

The action area for the design task covers 75 hectares. This stage of the project was taken for the actualization of the design task that is testing on a specific area by using the procedures of urban design with greenway frameworks.

6.1 Introduction

This stage of the thesis was taken for the actualization of the design task which is testing the whole network by taking segments based on the given recommendation, criteria and guideline. The action area for the design task covers 75 hectares used the procedures of urban design with greenway framework. The following steps entail selecting a site based on selection criteria; the site must include the segment of greenway from the whole greenway network, identifying compatible natural, social resources, and critical issues, then identifying types of greenway intended for specific segment depends on opportunities and traits found on the actual situation. After identifying strategies follow program development as per the recommendation. Finally, the design developed.

6.2 Site selection

The selected site for detail segment test design of the thesis includes criteria to select. The first section criteria are the development potential for greenway and high demand of developers in the current situation for construction of different buildings and infrastructure by the government and private developers. The second selection criteria are the potential of commercial and business created by vitality and pedestrian density in the area. Third, existing development intervention put the lake in risk, minimizing natural patches, cause more pervious surface, high volume of run-off to the lake and wildlife disappearance. The municipality of Hawassa put the site in first priority in terms of risk and needs protection (MWUD,FUPI, 2006).

For the design, 75 hectares site is selected as an action area that includes a portion of the proposed greenway corridor and urban fabric with different functions like, lake protection, recreational area and low-density residential areas in it mainly. To achieve the optimum benefits of the greenway system the specific site opportunities and constraints should be identified and addressed through urban design.

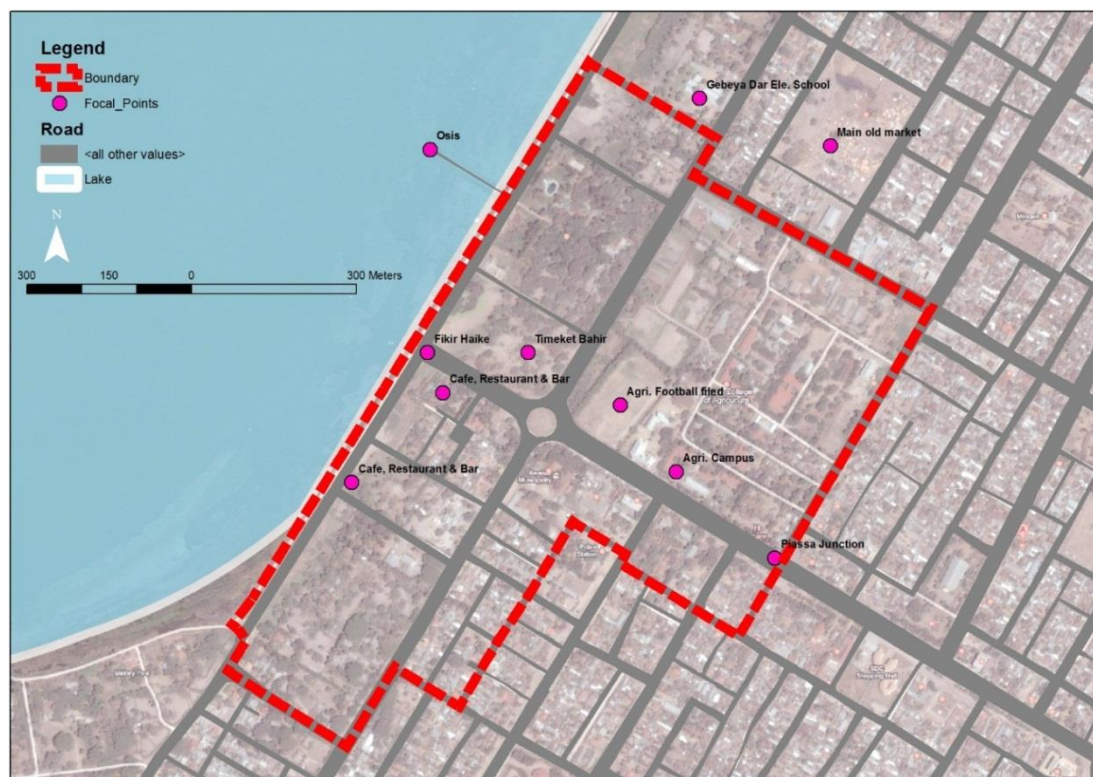


Map 25: Location map (Source: Georeferenced Google map and Greenway network generated on part one of this Studies).

The action area is found on the lakeside defined 75-hectare area with a planning extent of the lake shoreline development that runs along the Northeastern parts of the lake which is directly seen across from city center and is bisected by Fikir Hayik to St. Gabriel Street. The South East part is bounded by Tikur Wuha to Municipal Street. On the South East side, it is bounded by Amoragedel Park and surrounding; on the North Western side by SOS children village. The main market of the city, Hawassa University Agricultural Campus, the old municipality of the city and unmanaged buffer area of the lake (Map 26) are included in the area. On this buffer area, the city administration is trying to develop different land uses in addition to a 20meter wide asphalt road along the lake shore.



Map 26: Action area (source: Georeferenced Google map and Greenway route generated in Part on this study).



Map 27: Public nodes near and around project area (source: Google Map and Field Survey).

6.3 Compatibility of greenway

In this analysis task the existing urban fabric/situation determined, special the area that city scale greenway route aligned (delineated at part one). Analyzing the existing situation and elements, natural and manmade features need to qualify the type and purpose of greenway on the local scale for the actual area. Greenway proposed at part one had four segments as we have seen on Map 28. Segment one passes along the lake Hawassa shoreline characterized by riparian corridor, segment two bounds Fikir Hayek and intersect segment one perpendicularly, segment three is the continuation of Segment two after the roundabout connecting it with main city center of the city and segment four delineated parallel with segment one pass along the long fence of Hawassa University Agricultural Campus and passes nearby the old market to the industrial park.



Map 28: Segments proposed greenway network defined in the action area (Source: Part one of the study).

6.3.1 Segment 1/ Corridor segment along Lake Hawassa

Longtime observation, photography and various data have been made on this segment of the action area. The elements of the area are the intense activity of commerce with small temporary shades and narrow trails move along the lake shoreline. There are short segments of the undersigned and unmanaged trail which bring people to this segment and Lake Hawassa. This segment is the end of any movement of the journey to the lake. The continuity of specified segment creates a great opportunity for the project

site to be connected at city scale network for diverse function, recreational, wildlife habitat and as movement corridor, buffering the effects of urban landscape on the lake and keeping the natural environment.

There are active nodes all along this segment where two routes from different direction connect. All activities take place in temporary shades and extended space of the public realm. No permanent building constructed along this path to accommodate these activities. The activities near the edge of the lake create litter on the lake and have caused migration of wildlife. Missed component of this segment was the existence of permanent uses and activator of the public realm to secure the area, as shown in Figure 14, the trails connecting the city part and the segment are a silent edge, between the lake and urban environment. The other missed elements are stormwater management and usage mechanism. Because of this all the runoff comes to this area and increase inaccessibility and quality of the lake during high rain.



Figure 14: Actual situation along the segment one (Source: Field Survey).

The type of greenway to integrate on specific area depends on various factors, such as the location of the area, size of the area, and needs of the area. Greenway is a design and planning strategy used to address multiple environmental, economic and social functions. According to Jack Ahern, there are four principles and strategy to define types of greenway based on protective, defensive, offensive, and opportunistic. These strategies applied individually or in combination, depending on the goals of the greenway plan on each segment.



Figure 15: Actual situation around segment one (Source: Field Survey)

This segment needs a holistic strategy because its natural resource dominance and rapid urbanization are fragmenting its natural landscape. Integrating the holistic approach means protecting, defending, offending and use the opportunity on the site. Protecting the natural environment from encroaching development, defining the buffering distance, defending to stop the fragmentation, offensive what is today on the site and thinking about the future by reconnecting the fragmented landscape and

enhancing the opportunities: will fulfill, recreational needs and protect natural, vegetation and different wildlife around. Existing landscape features are optimal for greenway development (See Figure 16, Figure 17 and Table 14).



Figure 16: Actually started action to protect and beatification of the corridor (Source: Field survey)

Segment one acts like riparian corridor along Lake Hawassa shore. The city administration already has placed some level of regulatory protection to control overflow like constructing dike along the shore.

Human activities

Lakeshore and ecosystem around riparian corridor have been critical resources for nearly every culture in the world. Just as predictable as the location of human activities along the lake has been the effects of this activity on aquatic ecosystems. The major human activities that affect water quality and the ecological integrity of riparian corridors are urbanization, recreation, flood and withdrawal of water

supply. Some of the issues are listed below which happened as a result of human activities on the edge of the lake.

- Riparian corridors have become magnets for recreation use. Their attractions are the result of the variety of recreational opportunities and setting that riparian corridors provide and the affinity people have for water. Effects of recreation on the riparian corridors can include loss of vegetation and litter layer from the walk over, compactions and reduced soil permeability and increase in runoff volume, erosion, and sedimentation.

- Recently rapid urbanization covers the landscape of this riparian corridor with impermeable surfaces for different function including asphalted road extended from the city, water cannot infiltrate the soil. In the city of Hawassa much runoff from the urban system goes into this riparian corridor along the lake through channelization.

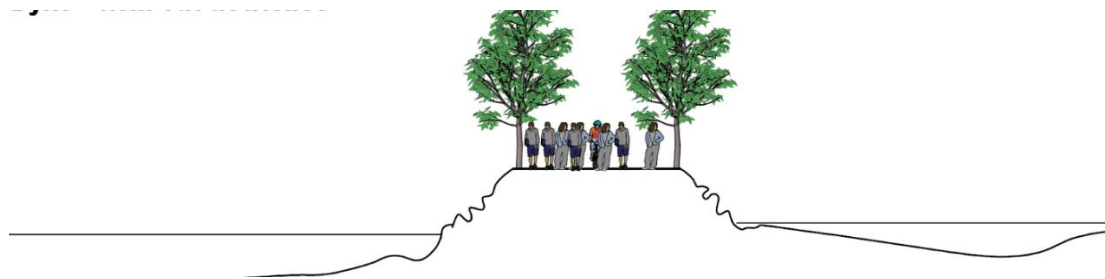


Figure 17: 6-meter wide trail along lakeshore facilitating all the activities along the lake (Source: Filed Survey)

Table 14: Resources, issues and key functions defined for segment one. (Source: Field Survey)

Natural resources	Social landscape	Critical issues	Started action	Key uses of the greenway
<ul style="list-style-type: none"> • Lake and Lakeshore • Floodplain • Wildlife • Wetland 	<ul style="list-style-type: none"> • Walking trails • Bars and restaurants • Small shops • Public space/plaza • Public spots 	<ul style="list-style-type: none"> • Sedimentation • Erosion • The connection of outlets nearby the lake • No buffer that maintains the lake water quality • Conflicts between wildlife and human activities • Lake protections and the effects of human activities. • Channelization of stormwater to the lake/floodplain • The need for more recreational possibilities with more capacity of all-inclusiveness of uses ,land areas and types 	<ul style="list-style-type: none"> • Retaining the existing soil started to build the gabion wall at the edge of the lake • Dike maintenance to control flood into the lake • Greening some segments along the lake but its objective was the only beautification. 	<ul style="list-style-type: none"> • Conservation, • Protection , • Wildlife corridor , • Recreational , • Biking ,walking , horseback ride trails, • Public amenities, plazas, public space and buffering the built and the natural environment • Comfortable, outdoor, Connectivity, public gathering/social nodes and multi-functional corridors to minimize the conflicts between wildlife and human needs.

According to the recommendation given in part one; an urban separator in between the lake and the built environment is a necessary element to protect the natural environment from impacts of human interventions, especially for water resources. But recent scenarios of Hawassa land leasing scheme brings more competitions on this sensitive area of the city for human needs. The government has not given enough attention to this fact compared to the attention given to commerce and trade.

6.3.2 Segment 2

The segment extends from Fikir Hayek to the intersection of the Main Street in the project area. This segment is the most popular and known location used as the main entry point to the lake, especially for the visitors. The main issues raised and identified are listed in Table 15 and Figure 18.



Figure 18: On the actual situation of segment two (Source: Filed Survey).

Table 15: Resources, issues and key functions defined for segment two (Source: Field Survey).

Natural resources	Social landscape	Critical issues	Started action	Key uses of the greenway
<ul style="list-style-type: none"> • Lake and lake ,shore • Floodplain , • Wildlife, • Wetland 	<ul style="list-style-type: none"> • Walking , Timeket Bahir , the circle of life green park, • Bars and restaurants • Connector plaza the main city center and the lake , Public 	<ul style="list-style-type: none"> • The connection of the constructed asphalt directly ends on the lake. Increase the chance of any nutrient wash off and runoff directly to the lake. • No buffer that maintains/Filter • Direct vehicular access to the lake. 	<p>No measure is taken</p>	<ul style="list-style-type: none"> •Conservation, •Protection , •Wildlife corridor , •Recreational , •Biking ,walking , horseback ride trails,

	space/plaza ,public spots	<ul style="list-style-type: none"> • Conflicts between wildlife and human activities • Lake protection and effects of human activities. • Channelization of stormwater to the lake/floodplain • Need for more recreational possibilities with more capacity of all-inclusiveness of uses, land areas and types. 	<ul style="list-style-type: none"> • Public amenities, plazas, public space and buffering the built and the natural environment • The main attractor of users and enhance access to this know plaza • Greening more • Comfortable, outdoor, Connectivity, public gathering/social nodes and multi-functional corridors to minimize the conflicts between wildlife and human needs.
--	---------------------------	---	--

6.3.3 Segment 3

This is an extension of segment 2 and extends from St’ George church to piazza junction. Its analysis is presented in Figure 19 and Table 16.

Table 16: Resources, issues and key functions defined for segment three. (Source: Field Survey)

Natural resources	Social landscape	Critical issues	Started action	Key uses of the greenway
<ul style="list-style-type: none"> • Large vegetation in Hawassa university Agricultural Campus and old Municipal • Good coverage of Vegetation along the street side of the Agricultural campus 	<ul style="list-style-type: none"> • 2m sidewalks • Institution ,banks ,telecommunication ,insurance company • Adare hospitals one and two • Biking path on the vehicle carriageway • University of Hawassa campus of Agriculture. 	<ul style="list-style-type: none"> • Safety , because of the dead fence of banks, old municipality , insurance and long dead fence of Agricultural campus – especially during night time • No coverage of vegetation opposite side of the Agriculture campus all along the street • Totally impervious • Peoples always trying to pass quickly rather stay • Channelization of stormwater to the lake/floodplain • The need for more recreational possibilities with more capacity of all-inclusiveness of uses ,land areas and types • Safety and accident 	<ul style="list-style-type: none"> • Biking path along vehicular • Greening some segments along the lake but its objective was the only beautification. 	<ul style="list-style-type: none"> • Recreational , • Biking ,walking , • Public amenities, plazas, public space and buffering vehicular noise and the built • Active urban area recreational ,social space and route • Comfortable, outdoor, Connectivity, public gathering/social nodes • Bring the chance of more tree canopy coverage • Buffering the walking and biking paths to be safe during using the infrastructure • Safe crossing, a platform for gathering and comfortable environment



Figure 19: On the actual situation of segment three (Source: Filed Survey)

6.3.4 Segment 4

This segment connects the old big city market to the action area. The analysis is presented in Table 17 and Figure 20.



Figure 20: On the actual situation of segment three (Source: Filed Survey).

Table 17: Resources, issues and key functions defined for segment four (Source: Field Survey).

Natural resources	Social landscape	Critical issues	Started action	Key uses of the greenway
<ul style="list-style-type: none"> Plots of land with dense vegetation defining the segment in Agricultural Campus, Wabeshebele Hotel and Timeket Bahir Half-width of the existing segment is given for pedestrian realm Wildlife movement flow from lake though Wabe Shebele Hotel to Hawassa University Agriculture Campus dense vegetation place 	<ul style="list-style-type: none"> Walking trails 15meter safe for pedestrian realm Recently constructed public toilet and shower at the cross junctions 	<ul style="list-style-type: none"> Half the width of the street is left for a pedestrian but not amenities and greening is taken No pedestrian sidewalks at one side of the street on the Shebelle hotel side. No activity attractor and generator except the entry of Wabe Shebele hotel Channelization of stormwater to the lake/floodplain The need for more recreational possibilities with more capacity of all-inclusiveness of uses ,land areas and types 	<ul style="list-style-type: none"> Paving with cobble stone it is a good to start but the technique used and higher compaction minimize infiltration Started planting the non-asphalted zone 	<ul style="list-style-type: none"> Wildlife corridor , Recreational , Biking ,walking, trails, Public amenities, plazas, public space Safe and vibrant pedestrian and social place to stay and pass Mixing the uses by changing the existing fence to activities of capacity to create an all-inclusive environment

For each segment of Greenway of the whole network in the action area situations were analyzed and greenway resources have identified that help to integrate the segments. And some issues were raised and determined which greenway should resolve with key functions. The last step of the above task was identifying the types and functions of greenways for the particular street bounding the segment needed. Next physical and social context of the whole action area is analyzed.

6.4 Physical Context

This site is centrally located in Hawassa that mediate, the city center and lake Hawassa, it is used as the focal point for people near the lake, locally named “Fikir Hayek”. In this specific site there is a linear corridor extending along the city side edge of the lake, initially implemented for overflow of the lake as a dike but now serves as a popular natural scenic corridor of Lake Hawassa. The lake surrounds the Western portion of the specific site and hosts potential activities and government institution, residential plots, services and hotels contained in. The use within each sub-division is primarily low-density residential, and commercial along the main axis. This selected site is one of the main locations visited in Hawassa for, recreational, historical, and cultural and natural values. It is regionally known for its meeting place quality, the trails of Lake Hawassa, scenic potential, access to the popular active and passive recreational activities within Hawassa. The poor management of this location and shortage of amenities put it at environmental risk while considering inclusion of all recreational (see Figure 21).



Figure 21: Existing situation between the lake and the community (source: filed survey)

6.4.1 Existing streetscape

A road can be enhancer and sometimes a barrier for movements of people and wildlife. Vehicular dominated streets are barriers for people to stay and interact comfortably and same for wildlifes. The characters of streets and its network in the project area are some levels of distinction, there are two main streets connected in the city main network crossing each other by making roundabout as seen on the Map 29. There are streets feeding the main streets. Local streets feeding the main street are categorized into two, pedestrian dominated and mixed. All local streets/trails connected with the lakeshore are characterized by pedestrian dominated and local streets which are not connected with the lakeshore are characterized by mixed kind of activities Map 30.



Map 29: Existing Street network.



Map 30: Existing potential trails to interconnect the greenway segment with the actual community. (Source: field trip).

Local streets connected with the lakeshore are advantageous for connecting the greenway segment and the community by creating a network of public/open space, but on the actual site, they are unattractive scenarios. Especially in rainy times, the route is used as a channel for stormwater.

Typical Street Section connecting the main road and the lake shore line

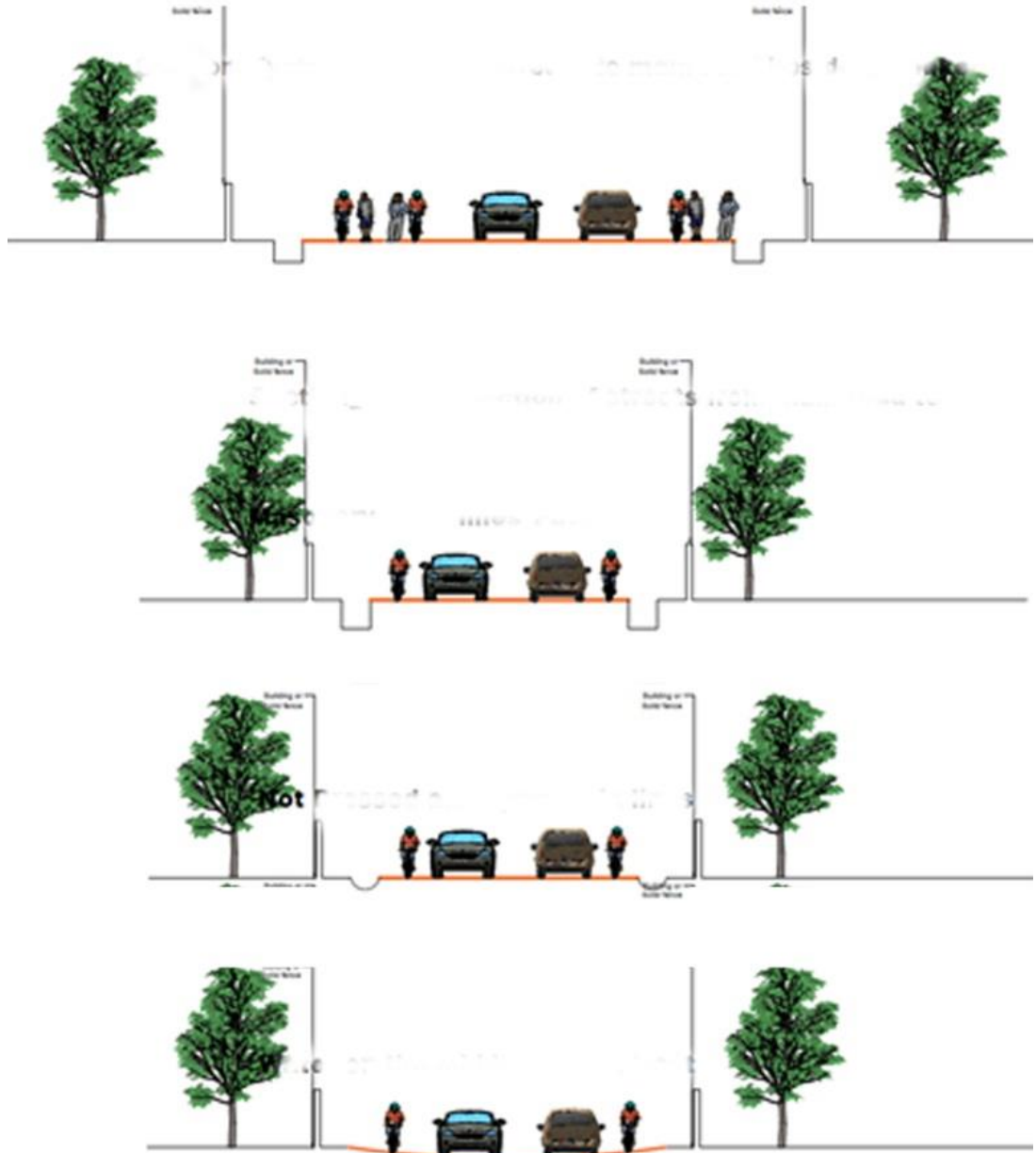


Figure 25: The actual situation on the routes connecting the lake shore to surroundings (Source: Field survey)

The study gauges the street environment from the angle of sustainability, socio-economic, transportation and environmental aspects. The total coverage and surfacing of streets are also identified after using to evaluate porosity to minimize surface runoff (Table 18).

Table 18: Total coverage of street network and surfacing (Source: Filed survey and structural map)

Street pavement type	Coverage(Hectare)
Total coverage	10.647
Asphalt	5.64291
Stone	1.80999
Earth	3.2

The communities along the corridors in the site are accessible by motorized and non-motorized modes. However, there are diverse issues with crossings, travel way and sidewalks, paving, lighting, furniture, open and active spaces, and trees. In terms of safety and comfort, the following challenges are identified.

- The sidewalks are not safe as they are interrupted by access of vehicular entry to plots.
- The presence of fenced administrative functions and services occupying huge blocks have also contributed to an inactive and unattractive definition of streets affecting the quality of the public realm.
- Lack of public amenities along the corridors such as the absence of street furniture, street information, public arts etc. is a constraint.
- Lack of pedestrian ramps which is a hindrance for the usability of sidewalks by the disabled.
- Many facilities and amenities that are placed along the street are not efficiently used, waste receptacles, poles interrupt the pedestrian flow.
- There are no traffic calming measures taken to reduce vehicular speed.
- There is a bike path on the main street from Saint George Church to lake Hawassa but it is used as an extended vehicular lane, for parking, for loading unloading.
- High runoff is observed on the main streets, flowing down to the lake and overflowing over the trails to the lake. During rainy season people do not use these trails.
- There are opportunities to adapt amenities and green infrastructure to solve the mentioned challenges along all the width in the action area to improve functionality.

6.4.2 Land use and local amenities

The land use is primarily residential, social service, and recreation /green space, and also small kind of commercial activities are emerging along main streets within the boundary. The city municipality considers the site as pivotal for development and planning is still ongoing. Considering the site under planning revision, it is an appropriate time for this study to consider the future of the community through the lens of sustainability and the city. In this action area, the dominant use is residential but the surrounding area is partially changing to commercial uses.



Map 31: Existing land use of the project area (Source: Land use map).

6.4.3 Building a pattern and form

The action area is dominantly covered by natural vegetation. More than 90% of the buildings in the area are zero stories. In terms of the pattern the dominant feature in the site is large vegetation and long fences. The site is characterized by low density residential and small commercial activities. The streetscape in the area is defined by vegetation and long inactive fences. All the buildings are detached there is no defined setbacks rather they are bounded by fences. In terms of urban form, buildings are arranged sparsely one from another with very fine grain with dominantly covered and hidden by bog vegetation. The institutions in the action area covered with coarse grain in terms of urban grain.

Almost all of the existing buildings are oriented towards internal private front and backyard. The streets in the project area defined by fenced edges in project area and very few active edges, frontages (see Map 32), and no sense of guarding the lake, because the existing situation of building pattern and plots give their back also use such areas for disposing waste, liquid and solid, this all condition made the area deprived the public realm “eyes on the street”. Where there are a potential edge and open space within the plan area but they are fragmented and not generally usable or accessible for the public at most time in the day for keep guarding the lake and recreational advancement. All the city pattern especially

the study area and its surrounding form and structure are taken by aligning parallel and perpendicular with the lake shoreline.



Map 32: Building pattern of the actual situation of the project area (source: Base map).

6.4.4 Sensitive landscape

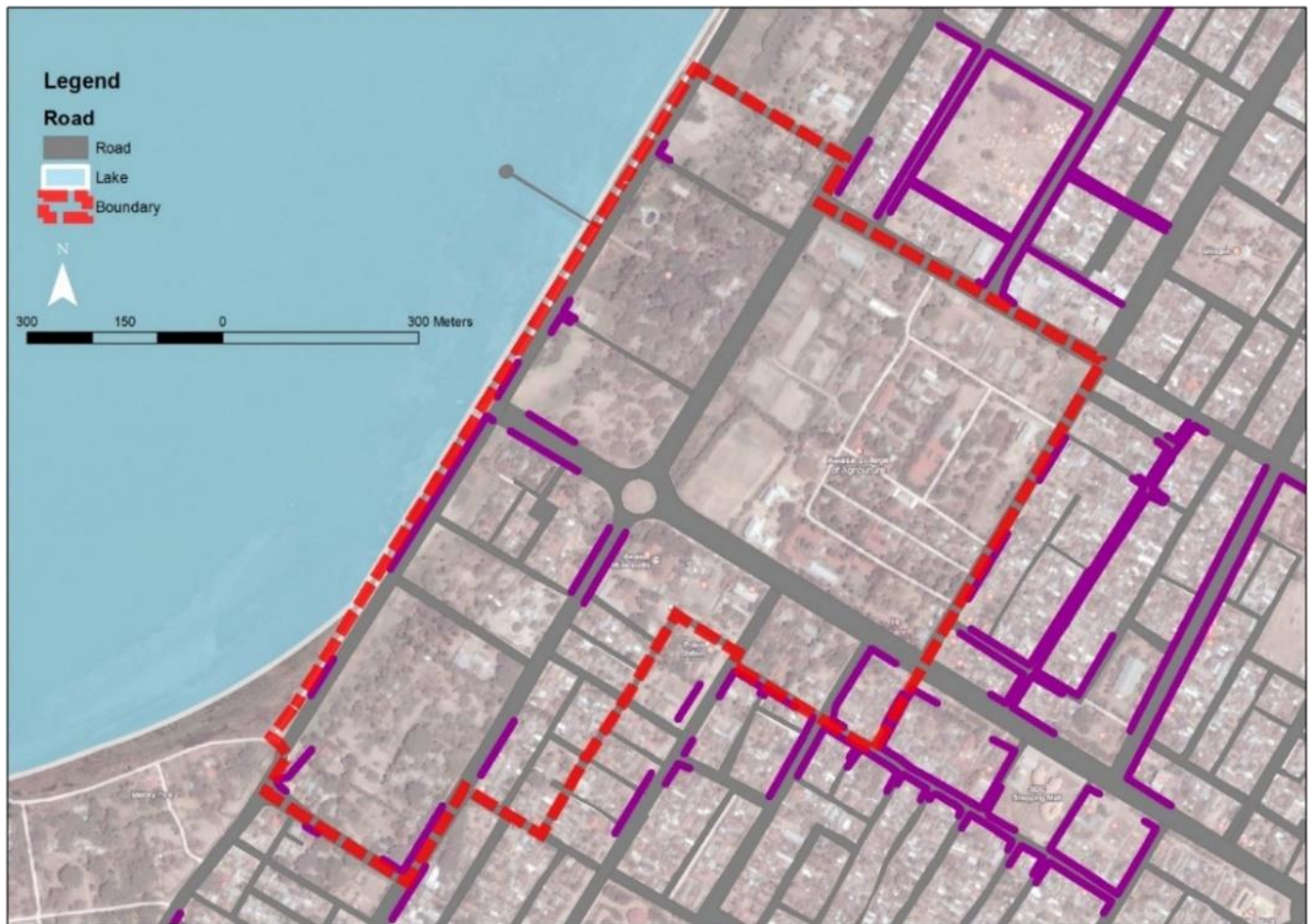
In the site, there are places characterized as floodplain. This is the location of all the stormwater accumulation. The integrity and visibility of this place are unattractive. People use the area as dumping site and for wastewater disposal from their respective owned land. The actual landform and water quality need to be preserved through minimizing the extent of earthworks undertaken in association with development on the actual area. Any development should provide effective buffering from this sensitive area.



Map 33: Sensitive landscape in the project area (source: structural plan and written documents).

6.4.5 Active frontages

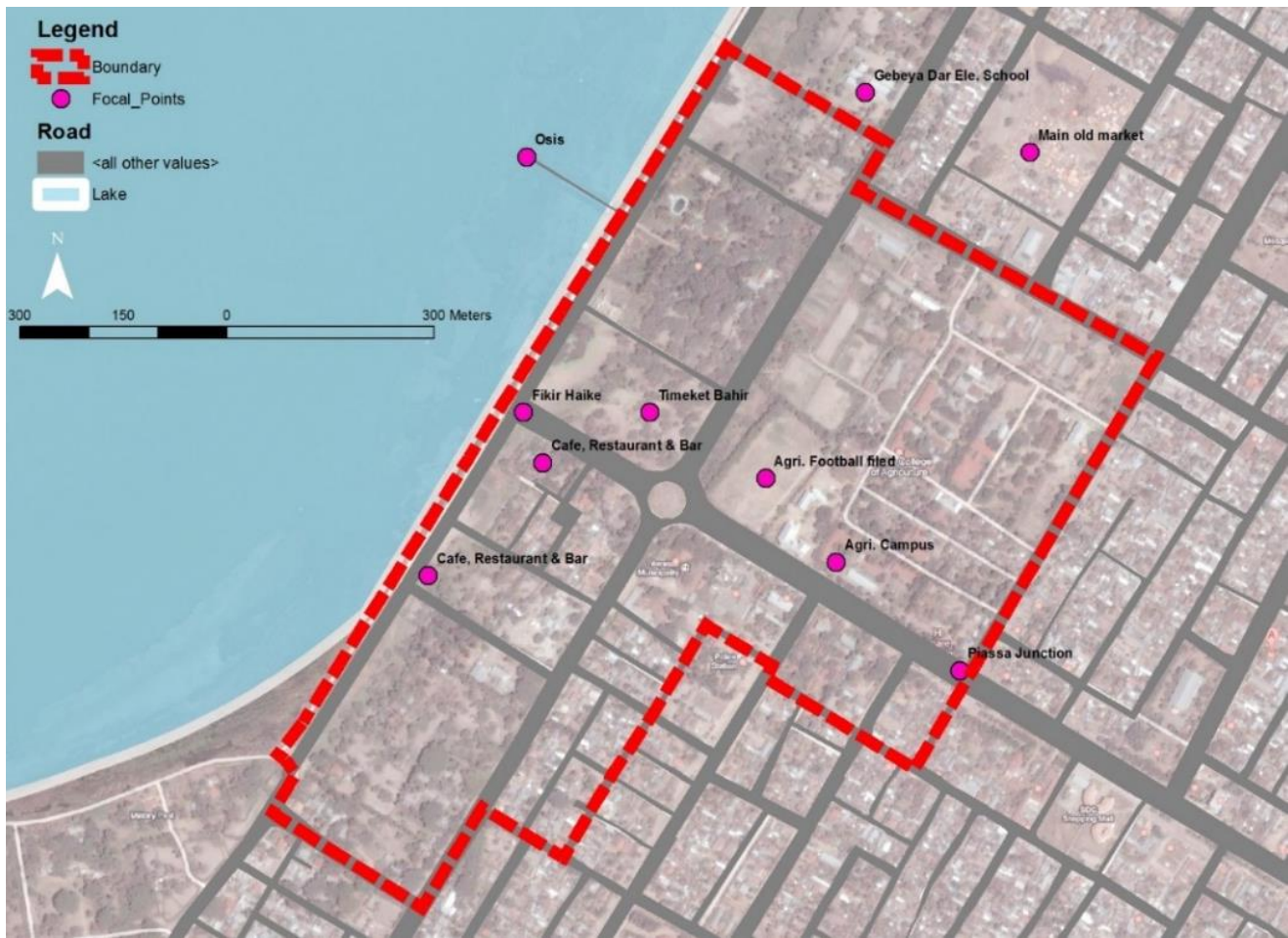
In the action area, most streets are defined by administrative service and institutions. Plots are characterized by big size and long edges, except Fikir Hayek and Lake View hotel area. These scenarios result in less active frontages in the action area. But there are extensions of vibrancy from the neighboring site, the old market, Amoragedel, and the city center. Extending these surrounding opportunities to the action area to make it more vibrant and the safe public realm is essential (Map 34).



Map 34: Active frontages in and around the action area (Source: Field survey).

6.4.6 Public nodes

The action area is known for public celebration. Public celebration and events are held at different times of the year; such as Timeket, graduation ceremony, Fiche Chemebelala, weddings, and other similar events. These locations were identified and included in the first part of the study during the assessment of demand location as part of the greenway network but are now considered at urban design scale. (Map 35)



Map 35: Public focal points to meet, buy, sell and interact (Source: Field Survey).

6.4.7 Vegetation

Vegetation is an important part of the infrastructure to form a connection between human and nature, achieve an integrated sense of harmony with vegetation and lake setting of the action area. The blocks in the action area are rich in dense vegetation coverage, but less on the public realm, the street sidewalks. The streets median characterized linear plant all along for the aesthetic purpose. For sidewalks and activities reconsideration needed to facilitate comfort and wildlife corridor in the action area. Preserving and restoring vegetation is important to forming those important bonds to the site as well as the city ecosystems.



Figure 26: Sidewalks and the public in the realm and the urban blocks in terms of vegetation (Source: Field Survey)

6.4.8 Topography

For this study topography factors in terms of accessibility, stormwater runoff, erosion, view, and massing. Among factors, the site is accessible topography but affected by runoff because found at the lowest elevation. Considering view in the action area no place taken in terms of the scenic point. For the runoff issues, different greenways are a strategy to minimize similar issues.



Figure 27: the Topographic character of location between the urban landscape and the lake (source: field survey)

The topographic data used to consider the location of floodplain, location affected by erosion and runoff direction mainly in the action area.

6.4.9 Water resource

Characteristics of the sites are downstream catchment, sensitive potential groundwater recharge area, constructed storm water drainage channel. All the city of Hawassa has an average depth of groundwater from seven meters to near the lake shoreline and, maximum of 50meter depth of groundwater, the project area is in the near groundwater depth locations, so implies all the intervention on the site is highly sensitive.

6.4.10 Climate: wind and sun

When we consider climatic factors of sun and wind, elements of the landscape such as tree and water bodies are integral to design and design places and placements of building and public open space throughout the site. Existing tree canopy coverage and additional tree placement can alleviate heat island effect and have significant impacts on indoor temperature, energy usage, and comfortable outdoor environment. As we said in vegetation subparts streets are less vegetated for people's priority planted for aesthetic purpose but the plots inside are the reach of large tree and canopies.

So, planting evergreens and tree varieties along the north and west of buildings should be considered to protect areas of the site from sun rays and heat island effects.

6.4.11 Identifying conservation lands

The features that considered in the analysis include vegetation's, topography, and hydrological conditions inherent in the landscape. Together these features clearly reveal the dense formations of landscape resources, wetlands, and vegetation along the lake Hawassa shore. Trees exist at different locations, hydrological flow and the near groundwater depth (7m is the depth of ground near the lake), so the area between the lake and the built is a portion which is protected and considered as conservation lands.

6.4.12 Natural areas and wildlife

Both of these areas serve as important recreational amenities for Hawassa residents and visitors. Together these areas, along with the city's cultural attractions, represent a significant eco-tourism and cultural tourism opportunity to the site and for the whole Hawassa. So, this area identified in previous sub-chapters of segment analysis and need to managed and included in the design.

6.4.13 Environmental challenges

The site holds high potential to regain from its challenges facing today and in future. Among the environmental issues the area facing are issues related to wildlife, there are species present in the area sensitive to human influence and require wider corridors for adequate protection and shelter as well as movement. The other issues considering the environment are issues related with riparian corridors, the issues aquatic organisms are reduced due to alteration of uplands, runoff, litter, riparian vegetation; extreme changes in water quality caused by urban development see below the picture which showing actual situation on a different season. The picture describes the rapid growth and infrastructural development cause in the reduction of natural surface, implies a reduction in infiltration capacity of the urban land and effects become a high volume of runoff to the lowest elevation and wash the soil also chemical and litter from the urban environment to the riparian corridor.(Figure 28)



Figure 28: Environmental challenges

6.5 SWOT analysis of action area

The following section presents major findings of the situational analysis regarding the action area; strengths and weaknesses, opportunities, and threat; the summary of all the action area situational analysis from the compatibility of the greenway on the intended urban corridor to challenges are presented.

Table 19: Findings/SWOT of action design area

SWOT analysis of action area				
	Strength	Weakness	Opportunities	Threats
Ecological/Environmental	<ul style="list-style-type: none"> • Streets have a linear space along to integrate ecological features • Street width • Potential to storm water management(LID - solution) • Diverse wild life on the area • Potential fenced vegetation • Flexibility to relocate human activities from sensitive landscape and to improve the capacity of recreating opportunity 	<ul style="list-style-type: none"> • Functional conflict between human activities and wildlife • Rapid changing of natural surfaces recently , increase imperviousness • Drainage issue • Increasing surface run off • Intense human activities at the edge of the lake • Fragmented environment/need reconnection 	<ul style="list-style-type: none"> • Ecotourism possibilities when connected the tourism and natural attractions • Active vibrant areas surrounding the action area include Hawassa old market. 	<ul style="list-style-type: none"> • Possible future loss of rich natural environments • Increase in infrastructure provision surrounding site • Increase in imperviousness, the cause for erosion ,siltation and sedimentation • Unmanaged and unplanned natural environments between the lake and the built landscape • Ground water depth in the action area needs high sensitivity
Socio-economical	<ul style="list-style-type: none"> • Existing character of the site; potential public location for different purpose • Existing trails as a passage • Street width 	<ul style="list-style-type: none"> • No pedestrian service at most frontages. • Less inclusive activities; mostly bars • No clear demarcation between public and private resources, mainly land • Privately run commercial services engulf the public realm • Shortage of public open space • Dis-continuity of walkway 	<ul style="list-style-type: none"> • The action area holds a potential to meet the needs of the users, in terms of group activities, biking and more passive form of recreational activities • Potentials of connecting with nature on daily lives 	<ul style="list-style-type: none"> • Rapid developments specially the shore of the lake.

Alternative Transportation	<ul style="list-style-type: none"> • Existing trails as a passage • Street width • Biking and walking culture • Good topographic character • Five pedestrian linkage 	<ul style="list-style-type: none"> • No pedestrian service at most frontages. • The culture of biking and walking are changing • Unsafe infrastructure • Unattractive trails that connect to the lake through the action. • Dis-continuity of walkway 	<ul style="list-style-type: none"> • Good topographic setup for walking and biking in action area as well as at city scale 	
General action area findings	<ul style="list-style-type: none"> • The cross section of streets have potential to integrate multi-purpose greenway • The municipality open for new ideas and change 	<ul style="list-style-type: none"> • Regulation issue to protect the natural environment • Limited signage • Lack of urban standards 	<ul style="list-style-type: none"> • The city administration indicate plans to develop conservation, protection and improve accessibility • Opportunity to reconnect the natural environment 	<ul style="list-style-type: none"> • Land leasing trends along the lake shoreline not considered the sensitivity of the area • The city administration of the master plan proposed asphalt concrete roadway at the edge of the lake

6.6 Program development

Following the discussion on SWOT analysis, strategies and programs that should be prioritized for the greenway and the challenges were listed based on the recommendation. As the main component, the green corridors are the main parts of the greenway system that include alternative transportation, socio-cultural attributes, and ecological service. By merging the site’s strength, weakness, opportunity, and constraints various strategies were formulated according to recommendation is given on the first part of this study.

General strategies

Table 20: Design strategies

Greenway framework	Strategies
Ecological	<ul style="list-style-type: none"> - Protect the natural landscape of the project site. - Promote its wildlife habitat and water quality. - Protect the aquifer recharge/ reduce run-off and floods. - Protect and conserve sensitive areas, of wetlands.

Socio-Cultural	<ul style="list-style-type: none"> - Create a network of public green spaces with greenway segments. - Extend activities to the public realm to activate the pedestrian walkway. - Express the sense of identity and cultural connections by improving the existing natural landscape and character of the site. - Urban mass accommodate Mixity of functions
Alternative transportation	<ul style="list-style-type: none"> - Create a network of sidewalks to improve the connectedness of the pedest walkways. - Create trails and pedestrian environment to improve non-motorized connections - Create a streetscape that prioritizes the pedestrians and safety

Based on these strategies, designing the intended greenway segment, overcome the issues and use opportunities on the project site different, programs, functions, design features and guidelines adopted as per the recommendation is given above.

6.6.1 Programs and Design Features

Table 21: Programs and design features (Source: Study).

	Design Component /Greenway Type	Functions/Criteria	Feature	Guide line used/Action taken
Greenway (Proposed City scale)	<ul style="list-style-type: none"> • Riparian edges 	<ul style="list-style-type: none"> • To protect Lake Hawassa, wildlife corridor, trails, filter pollutant • erosion reduction 	<ul style="list-style-type: none"> • Vegetative area • linear green space 	<ul style="list-style-type: none"> • 30 meter offset from the lakeshore no imperviousness , except seating ,boat deck, temporary sheds ,temporary toilet
	<ul style="list-style-type: none"> • Environmental recreational park 	<ul style="list-style-type: none"> • Protection of sensitive , Stormwater management and reduction of erosion 	<ul style="list-style-type: none"> • Avoid disruption of riparian buffers by development • vegetative, LID practice to reduce run-off and recharge aquifer 	<ul style="list-style-type: none"> • More vegetation
	<ul style="list-style-type: none"> • Urban shared route 	<ul style="list-style-type: none"> • Non-motorized routes with vehicular 	<ul style="list-style-type: none"> • Bike route, sidewalk ,vegetative area ,infiltration , social activity 	<ul style="list-style-type: none"> • Improve street section and intersection
	<ul style="list-style-type: none"> • Active recreational linear park 	<ul style="list-style-type: none"> • Seating ,social gathering ,storm water management 	<ul style="list-style-type: none"> • LID practice ,waking ,vegetative area ,outdoor service, 	<ul style="list-style-type: none"> • Relocation of existing trail with intense activity

<p>Open space system</p>	<ul style="list-style-type: none"> • The greenway ,park ,public street ,square ,plaza and playground 	<ul style="list-style-type: none"> • That promote open space connectivity to the greenway and adjacent communities • Minimize fragmentation • Create a sense of neighborhood and its connectivity to a larger community 	<ul style="list-style-type: none"> • A connected network of open space in the hierarchy , • Vegetative area • LID practice ,Bio-retention , vegetated swales ,pervious pavement ,rain garden 	<ul style="list-style-type: none"> • Linking the entire public realm, green area and the private realm including city scale greenway proposed at the city scale. • Incorporate existing patches of green and corridors of natural resources
<p>Public,</p>	<ul style="list-style-type: none"> • Public pocket 	<ul style="list-style-type: none"> • Social activities ,small market , diverse service 	<ul style="list-style-type: none"> • Keep the existing ,like Fikir Haike 	<ul style="list-style-type: none"> • Expanding and upgrading the existing public space and plaza • Improve the intersections
<p>Active route</p>	<ul style="list-style-type: none"> • Bike routes • Pedestrian-only routes • Shared routes 	<ul style="list-style-type: none"> • Linking the public and the community areas through a system of the pedestrian walkway, bike lanes, and trails • Interactive and activate social values • Promote connection to nature 	<ul style="list-style-type: none"> • Multi-functional sidewalks and trails • Walkable pedestrian-oriented route 	<ul style="list-style-type: none"> • Improving the existing street section aligned with the greenway corridor. • Improve the existing trails and add to the system
<p>Mixed uses development</p>	<ul style="list-style-type: none"> • Housing and retails 	<ul style="list-style-type: none"> • Promote social interaction • Attract diverse people from diverse location and also accommodate diverse needs • Improve safety and security • Serve the public and enhance the vibrancy 	<ul style="list-style-type: none"> • Relatively dense, integrated with greenway by open space system, defining public realm, and arcade. 	<ul style="list-style-type: none"> • Increase the density to attain more space on the ground • Activate the dead frontage of institutions to activate the public realm

6.7 Conceptual development

Based on the table above major components of integrated greenway systems, the ecological, social, and transportation frameworks are to be designed in the project area Hawassa by taking the following points comprehensive action plan (See Map 36).



Map 36: Conceptual map of the action area.

6.8 The master plan of the action area

Following from the concept development process, the proposed layout of the project area reflects the effort to improve the integration between the built environment of the area and the inherent natural landscape. The social and cultural identity, in addition to its transportation mechanism and recreational facilities, give the site a rich character. It’s a pedestrian-oriented community with naturalized open spaces, an interconnected trail network and with an upgrading natural diversity, and corridor connection within the community as well as at a city scale.



Map 37: Proposed layout of design with greenway segments/

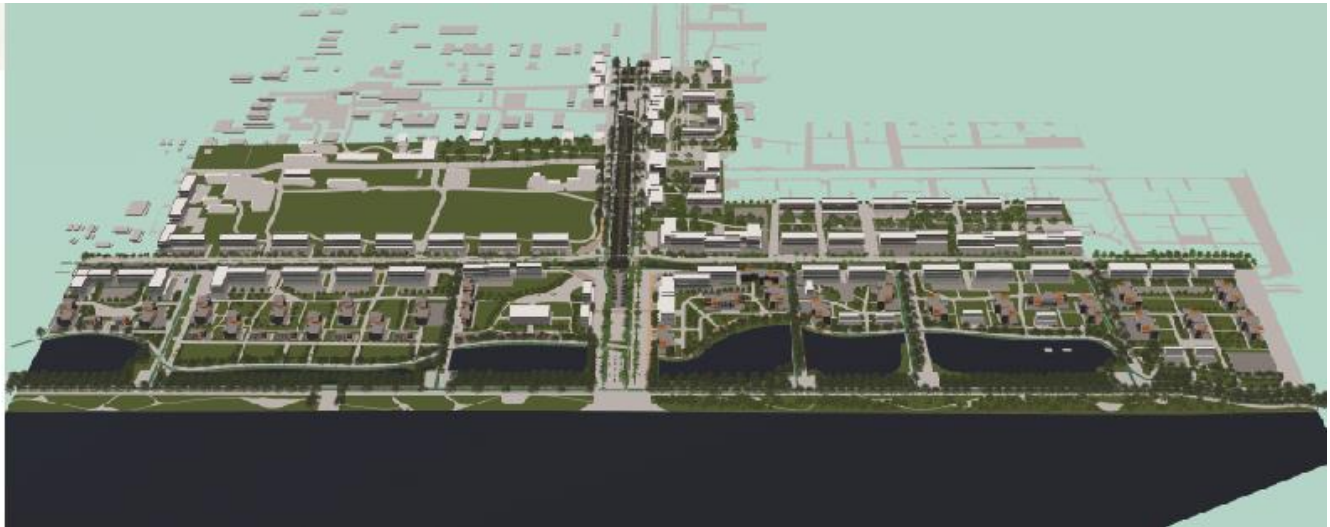


Figure 29: Overall view of the new plan.



Figure 30: Overall view of the new plan.

6.9 Greenway at the local scale

This part presents the proposed city scale greenway network (part one) at the local scale. In the action area, there are four segments of greenways as named before. All the segments of the greenway in the action area are presented specifically below.

6.9.1 Segment one/ riparian corridor

According to the existing situation on this segment, there are diverse natural resources and social capital that need high sensitivity. Wildlife movement corridor, water protection, stormwater management, and social landscape are key functions on the segment. For this situation, riparian greenway type is chosen by its multi-functionality and for serving both the natural and social functions. Greenway corridors adjacent to lake shoreline, trail held scenic, public destination, walking, and biking, which creates opportunities for the recreation and interaction of people and activities like fishing and boating. Between the trail and the lake thirty meters, vegetated lakeshore buffer is proposed to protect the water quality, avoid erosion, to maintain the temperature and siltation.

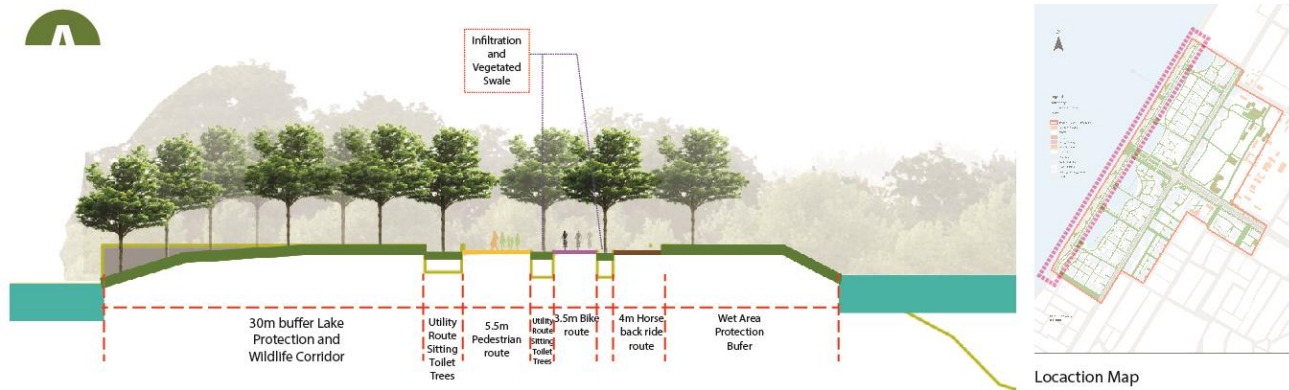


Figure 31: Sectional view of new segment one



Figure 32 Three dimensional views of the new segment one

6.9.2 Segment Two

This segment was the city’s known public node that was used for, social interactions, boating services, bike renting and riding, sitting and used as the main gate to the lake Hawassa. In recent years this location has changed to asphalt concrete and vehicular parking area. The proposed project for this segment is to hold diverse social functions, such as children playing area, café, restaurant, on the street market, public art, and open exhibition, paths for pedestrians and bikers that are connected with other networks with the integration of infiltration measures. The segment eliminates vehicular movement especially at the lakeside but has proposed a parking area near the intersection of two main streets.



Figure 33: Sectional and three-dimensional view of new segment two



Figure 34: Three-dimensional view of new segment two

6.9.3 Segment three

This segment is different in its function and content from greenway segments one and two. This segment here holds the stress both recreational and conservation in the built environment of the action area. Segment three holds programs for the connectivity of social activities including walking and biking, habitat protection, improved safety and comfort for the public as well as environmental protection by adding green infrastructure to stormwater management to minimize runoff. On the existing site, the situation includes wide vehicular, bike paths on the same surface side by side and walkways which was not continuous. On the proposed section segment minimizing the vehicular lane, separating the bike paths, pedestrian and spaces for social activities are buffered then for safe interaction.

The principles of the plan are to improve people's quality of life by helping individuals, families, and society to achieve well-being and happiness. The action is taken to reduce conflict of activities to increase social interaction, taken enhancement of functions, amenities, human scale treatment, and improving the mobility of users.



Figure 35: Sectional and three-dimensional view of new segment three

6.9.4 Segment four

This segment also found the built part of the action area as a key function that contributes to a safe, comfortable social space with attractive natural coverage. It improves the capacity of environmental protection through flood controlling, and enhanced development of greenways can be important mechanisms for helping development coming to the environment (see Figure 36 & Figure 37). Development pressures the natural and social capital in various ways; it affects the biological and attractiveness. Contribute to building environment beauty, visual coherence, sense of place and facilitate social functions while helping the people with wayfinding. Similarly, the extension of this segment in the action area proposes a similar segment but with more carriageways because it holds more vehicle traffic than segment four (see Figure 38 & Figure 39).

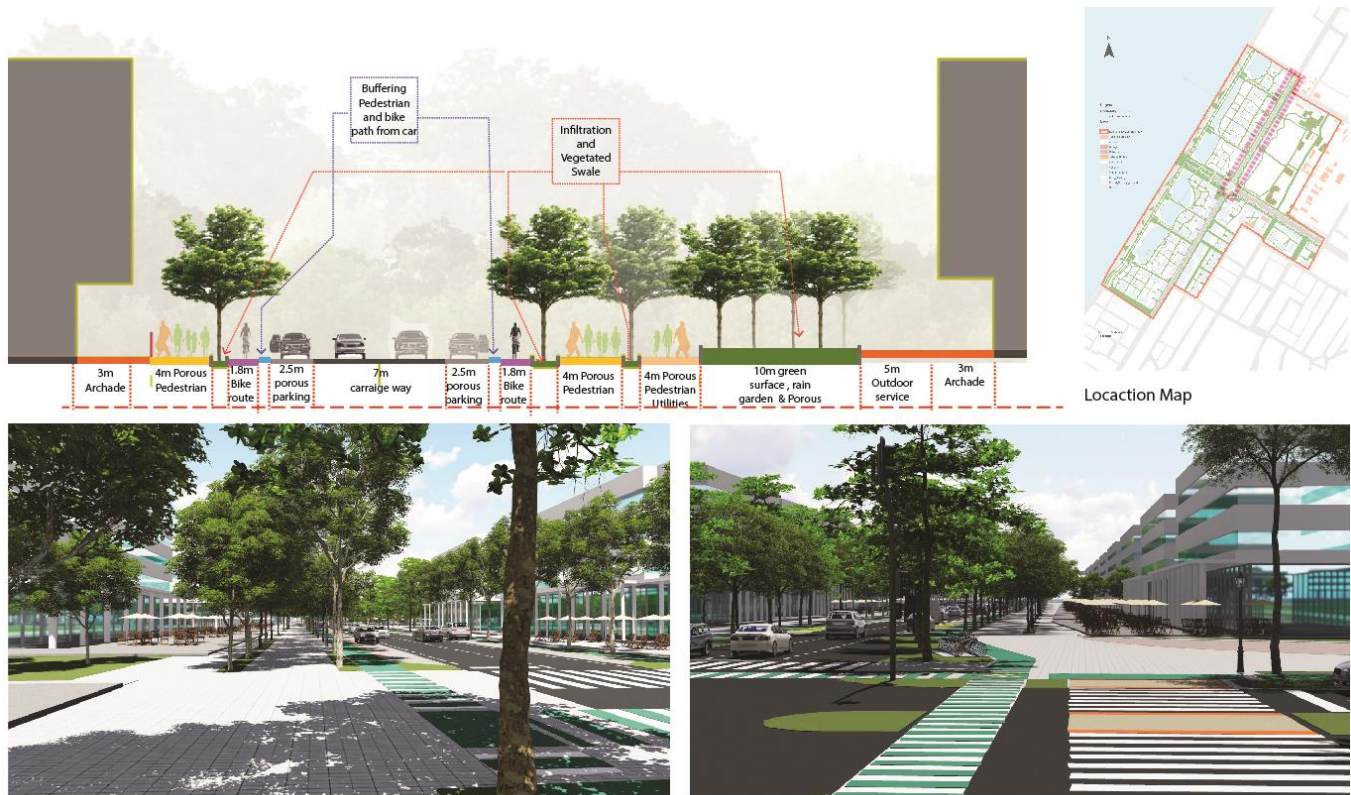


Figure 36: Sectional and three-dimensional view of new segment four

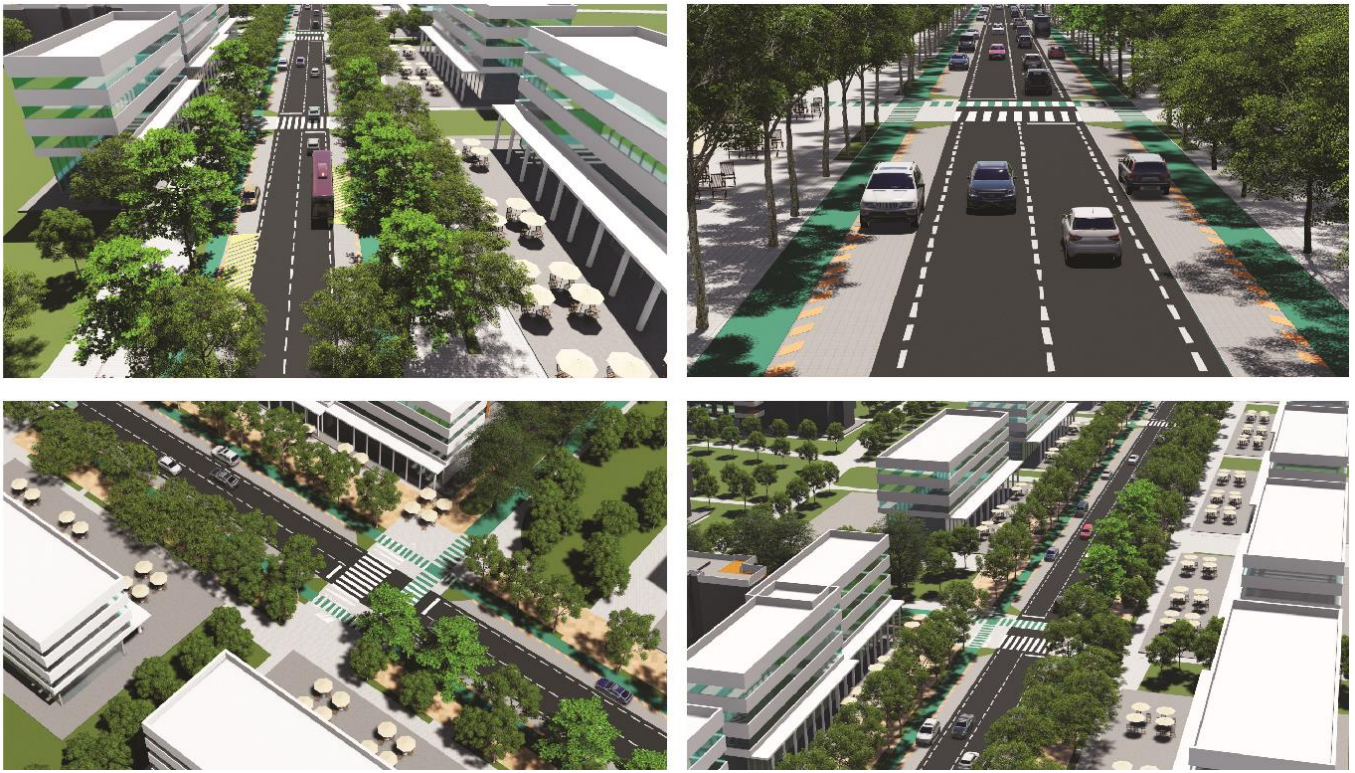


Figure 37: Three dimensional view of new segment four

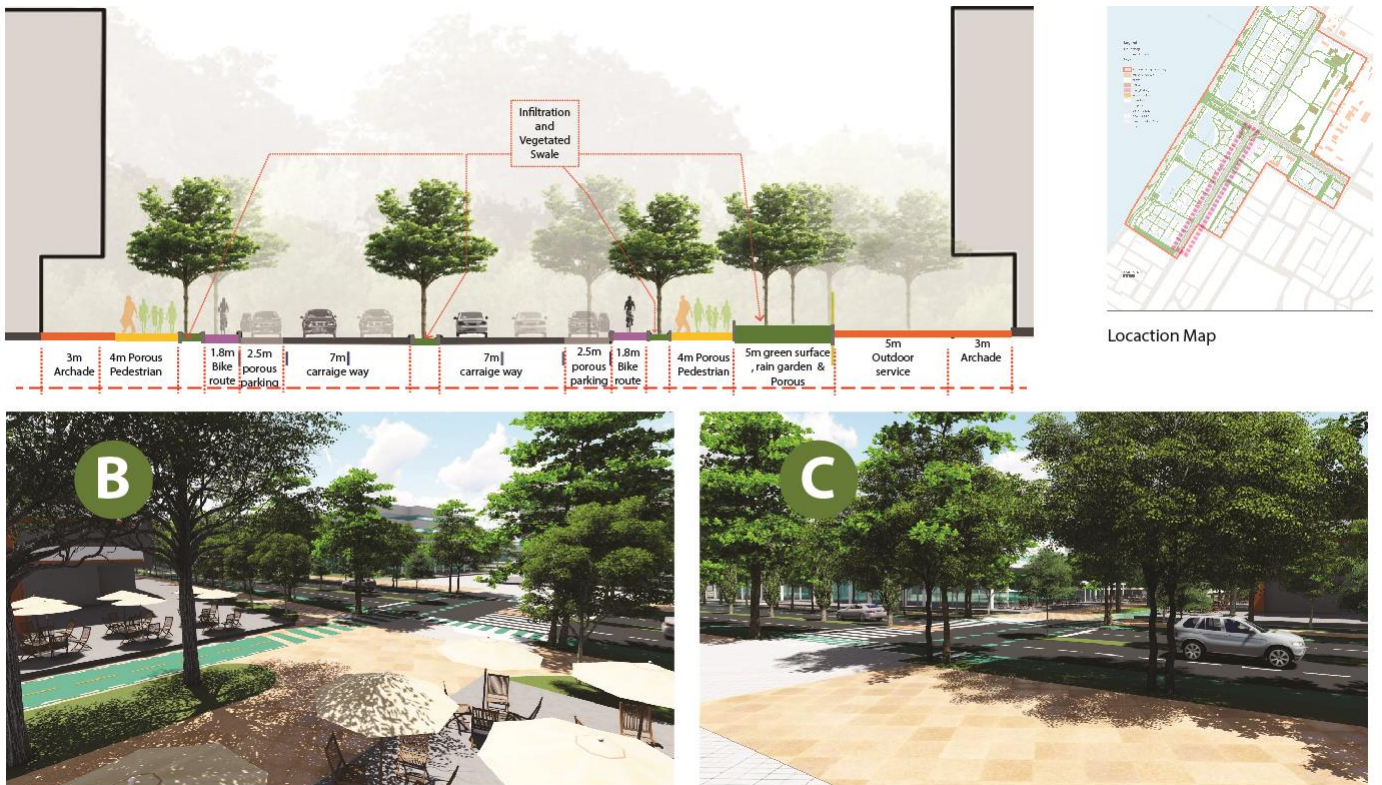


Figure 38: Sectional and three-dimensional view of new segment four extensions to Amoragedel Park.



Figure 39: Three-dimensional view of new segment four extensions to Amorage del Park.

6.10 Ecological features

6.10.1 Greenway and wildlife

The overall aims of greenways in terms of wildlife are keeping their habitat protection and connectivity enhances movement from location to location and fulfills a range of needs. This network helps minimize the extinction of wildlife, migration of species and settle the conflicts of human intervention.



Figure 40: The proposed plan situation of more vegetation and continuity for wildlife.

6.10.2 Greenway and lake protection

The design considers the lake as a natural resource its sensitivity, recreational magnet and wildlife habitat to protecting and uses possibilities to exist together. The action taken in this area, propose 30 meter vegetative buffer zone. This zone softens the edges to serve filtration, minimize temperature, clean and relocating the intense activities behind the buffer at the edge of building line to protect the sensitivity of the area.



Figure 41: Showing buffer zone to protect the lake

6.10.3 Greenway and environmental protection

The proposed greenways consider environmental sustainability designed by connecting natural and social environments with greenway segment. It includes stormwater management techniques in appropriate areas along the street by improving surface impervious to pervious and integrating different stormwater management measures like swales and bio-retention. The design entails the converting of impervious surfaces into green/soft surfaces for stormwater runoff management. 5.2 hectares of impervious asphalt is reduced to 2.43 hectares of asphalt surface designed. A reduction of more than 50% of the impervious surface is designed. Trees are added which will improve the urban tree canopy coverage. Consequently, adding vegetation decreases the amount of carbon dioxide emissions and other greenhouse gases in the air. Native plants should be used for landscaping, improving comfort and to manage stormwater.



Figure 42: The proposed environmental protection scheme.

The environmental sustainability of the site is also restored by providing alternative sustainable transportation like walking and biking instead of driving vehicles. The action area gives an opportunity to utilize the actual right of way for improvement that prioritizes people and environmental protection.

6.10.4 Ecological service

The ecological service enhancement of the site upgrades the sustainability of the site in various ways. Among the mechanisms provided in the study area, were the protection of natural systems, increase the enhancement of vegetation, use of reforested routes, conservation of the natural resource, and defining the wildlife corridor. Stormwater management and green infrastructures improve the ecology and environment while enhancing the sustainability of the action area.

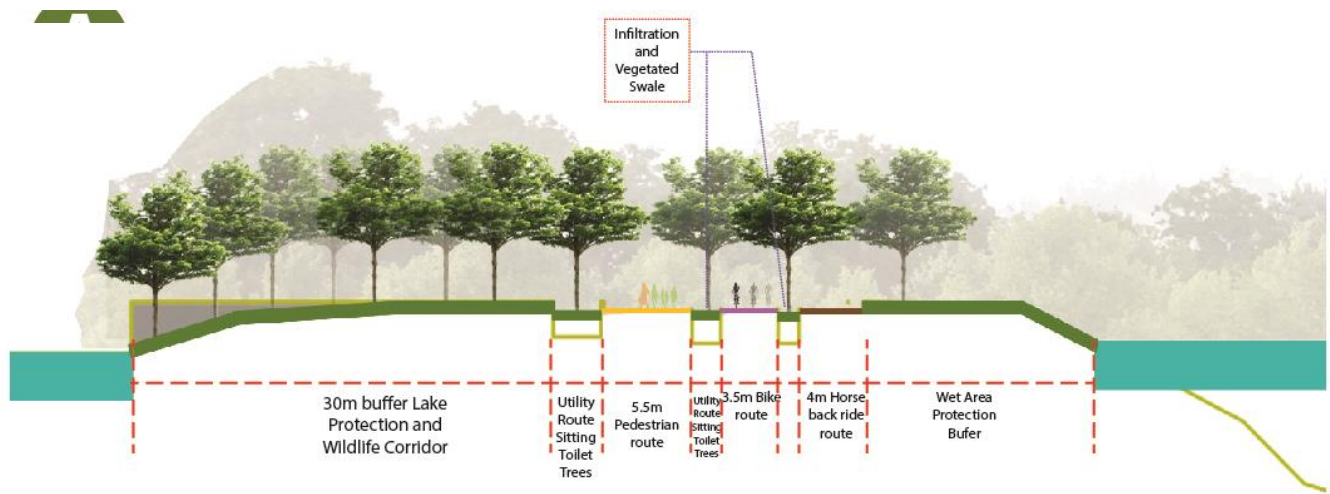


Figure 43: Mechanisms added to improve ecological service of the action area

6.10.5 Protection to natural systems

Providing buffers to protect natural systems is mandatory, maintaining buffers between human activities and adjacent sensitive natural areas is essential to ensure the long-term ecological quality, diversity and habitat value. The study proposed a thirty-meter buffer zone to protect the lake with vegetated native plants with minimum seating interventions for people that need more attachment with the water.

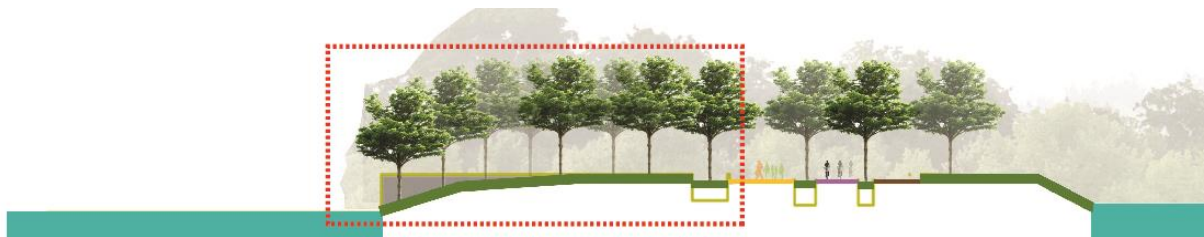


Figure 44: Proposed buffer zone to protect the lake and wildlife

6.10.6 Increase vegetation

The type and availability of vegetation are considered in the design of the action area. Greenway corridors enhance habitat quality, wildlife corridor, ecological sustainability and the aesthetic experience for the greenway user. Greenways are more effective for wildlife habitat and human landscape when they have native trees and shrubs present. Trees and shrubs can also shade users from sun and shelter from the rain. In the proposed plan the seasonal comfort of the user is considered in vegetation. Areas with high volume of runoff should consider high water intake plants.



Figure 45: Before and after view of segment three

6.10.7 Reforested routes

Vegetation along greenways offers enormous benefits, which include character, improving the user experience by providing shade, and maintaining biodiversity and ecological values. In this project site there are primary existing condition with respect to vegetation along trails and surrounding areas. Vegetation along the lake shoreline shades the existing trail adjoining the lake. There is some significant existing urban vegetation along streets. On the proposed plan the approach used is to minimize disturbance and protect existing trees and their roots wherever possible. However, in areas with opportunities for enhancement of vegetation add trees and use native plants in natural areas. Planting along lake buffer and urban areas increase the sites capacity to provide habitat for wildlife and small mammals. The plan recommends large canopy plants, at least 2m from the edge of trails in urban areas but in greenway and sensitive areas plan native trees with larger canopies and dense leaves.



Figure 46: Proposed reforested lake buffer and urban corridors



Figure 47: Proposed reforested social landscape

6.10.8 Conserve natural resource

Ecological form, character, and layout of the action area were a sensitive part of Hawassa. The existing naturally rich character of the area is conserved and enhanced with various decisions. Increasing vegetation, reforesting the corridors and improving the fragmented nature of the natural environment were among decisions taken on the design.

6.10.9 Wildlife corridor

As corridor of wildlife, the design sought the inter-network of natural environment promoting biodiversity and creating connected corridors that provide patches of habitat for native species and wildlife to navigate through.

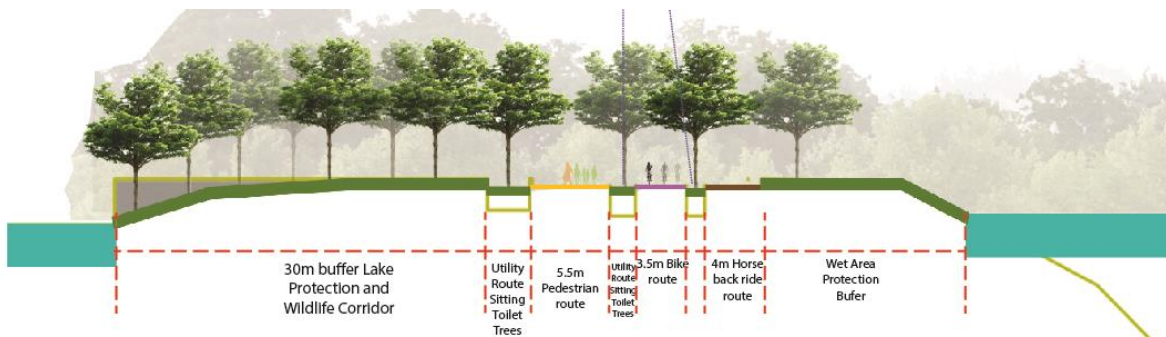


Figure 48: Proposed wildlife corridor along the lake.

6.10.10 Stormwater management

Closely interconnected natural features in the proposed plan bring good opportunities and facilitate ecological functions like stormwater infiltration, detention, and evapotranspiration. The major decisions of the project are buffering the lake from intense human activity, increasing previous surface, integrating the stormwater reduction mechanism along routes and increasing the coverage of tree canopy as

enhancement of evapotranspiration process. Buffering and adding more vegetation along the lake facilitates the reduction of erosion, filtration of water running to the lake and maintaining temperature.

Green infrastructure is necessary to maintain a stable environment safe from erosion. To mitigate issues such as floods and excessive run-offs to the site the design takes water sensitive measures, such as stormwater management systems along with all trails, medians, public spaces, green space, and paved areas. However, the proposed wetland accounts for 40% of the stormwater collected within the project site. Techniques proposed for mitigation include the dispersion of infiltration systems such as vegetated swales and bio-retention systems, pervious pavement along pedestrian routes and parking.

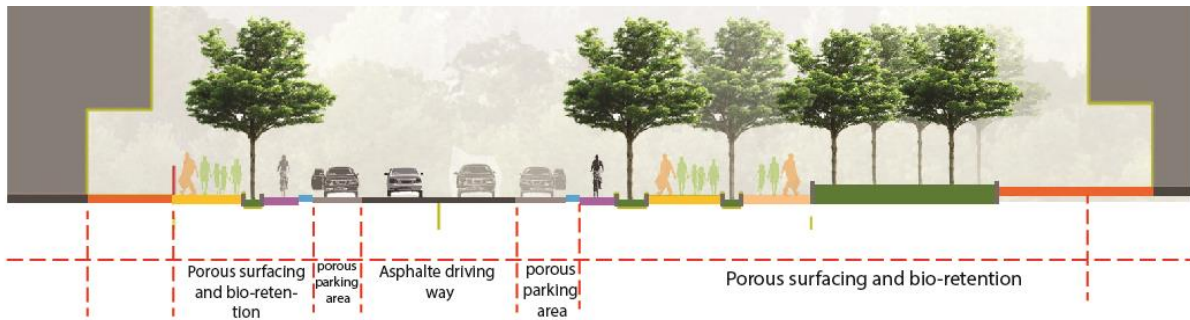


Figure 49: Sample Street section which shows the stormwater controlling techniques

Table 22: Stormwater management systems used in the site

Sensitive Treatment Measure	Water quality function	Water quantity function	The location used on the project
Rainwater tank	low	High	In Blocks integrated with building
Grass and Vegetated Swales	High	Low	Median of streets
Bio-Retention System	High	Medium	Median of the streets
Sedimentation Basin	High	Medium	At the edge of the streets and walking path
Infiltration measure	High	Medium	Green area
Porous pavement	Medium	Low	All paved pedestrian environment and parking area
Constructed wetland	High	Medium	Water bodies in between the lake Hawassa and the built environment

Table 23: Stormwater management evaluation scheme of vehicular carriageway before and after.

Scheme	Pavement	Area coverage	Annual Rainfall(mm)	Coefficient	Runoff Volume
Before	Asphalt	5,2000 m2	956	0.9	44,740,800
After design	Asphalt	2,4300m2	956	0.9	20,907,720

Calculations of stormwater treatment to include the naturalized vegetative open spaces within the design, as well as specific site conditions including slope and soil capacity are presented in Table 23, before and after scheme showing the change in runoff volume by reducing the impervious surface to porous.

6.11 Socio-cultural features

6.11.1 Greenway and urban mass

In the proposed plan, sustainable communities include different types of density and housing types. The plan contains a mix of uses in the action area and on the building level. The mass should facilitate social networks. Greenways and built elements are designed to increase the mix of diverse populations, a mix of social opportunities, connectivity to nature, outdoor recreation, and physical activity. Additionally the security of people on the public realm “eyes on the street”. The mixing of uses promotes compact design and density; it enhances diversity and connectivity. Furthermore, increased natural land coverage provides more comfort for walking and biking, in turn, reducing CO2 emissions.



Figure 50: Proposed greenway and urban mass.

6.11.2 Greenway and community integration

Peoples and natural processes are coexisting more closely when thinking about improving the environment of the community. The contribution of this greenway corridor includes recreational, nature conservation, stormwater management to reduce flood, social equality with the all-inclusive urban setting, scenery enhancement and protection benefits are taken when we improve the integration of greenway.

The integration includes both its natural and social components, interconnected networks of green space that conserve natural ecosystem values and functions and provide associated to the community found in the action area. Generally in this component conducted for the action area enhancement of its

cultural and natural richness by designing greenway with the existing social and natural resources on the site strengthen compatibility of the proposed greenway segment at the local scale.



Figure 51: Connector trails that integrate the city scale segments with the community.

The proposed greenway on the action area could aid community development. Networked recreational and attractive outdoor environment provides areas for people to gather and socialize.

Segments of greenway and trails connector provide an opportunity for people recreating along the greenway to stay, meet and socialize. Children’s play spaces provide chances for interaction among people sharing similar interests.



Figure 52: Connector trails that integrate the city scale segments with the community.

6.11.3 Social capital enhancement

The proposed greenway corridor benefits the people in multiple ways; it creates opportunities for social interaction along its routes. The segments facilitate activities open to the people for diverse individuals engaging actively and passively. This ensures the enhancement of social capital through the greenway corridor, further ensuring the social sustainability of the action area.



Figure 53: New proposed and improved the social place



Figure 54: Streetscape view with different types of social space and massing support social interaction

6.11.4 Economic advantages

The proposed greenway brings more people to the site. The segment, as well as the city scale network of greenway, could add to the efforts that bring more visitors, residents, and business into the project site to make it vibrant. The greenway introduces more frontage, activities and makes safer while upgrading social capital. Trail-based development is utilized in the greenway trails as amenities around which different functions occur. These linear natural corridors with diverse functions that improve the quality of life for residents are an advantageous input for additional residents, to generate new economic development and new job opportunities.



Figure 55: New greenway proposed for more people and more activities.

The whole dimensions of sustainability were considered in the study to improve the quality of life and natural environment protection. The result in the study shows that the proposed greenway plays a great role in multi-dimensional aspects of Hawassa for today and the future.

6.11.5 Public realm and amenities

Issues that pertain to pedestrian and ecological concern were vehicles’ speed, crossing distance, direct crossing, the surface of walking environment, shade, amenities and other social function and safety. Among these issues surfacing is discussed here in this part. To further improve the ecological performance, safety and comfort in the action area the project design continuous walking routes with previous power materials. Parking lots designed off-street and on-street with previous surface to infiltrate of run-off.

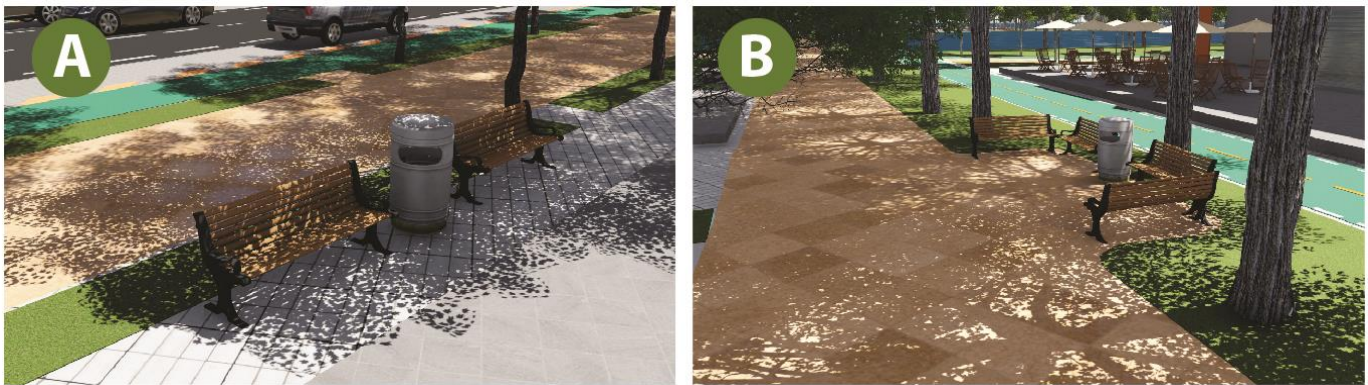


Figure 56: Proposed surfacing and materials

6.12 Alternative transportation features

6.12.1 A connected network of pedestrian environment

The proposed greenway brings an opportunity to the action area by connecting to the larger trail network in Hawassa. Along the proposed greenway corridor, city scale and the local area introduces a network of bike routes and walkways. The corridor converges at different potential locations in the city.

The city scale corridor brings an opportunity of networked walking and biking trails. The connectivity at different scales will increase options of transportation, encourage people to use carbon-free modes of transportations, health, enhance social interactions, and create a new sustainable economic corridor and environmental protection. As a result, in terms of transport connections, the network and segments of greenway conform to the principles of sustainability.



Figure 57: New pedestrian and biking environment

6.12.2 Intersection for pedestrian priority

In the action area, there are intersections which are formed by the crossing of two main streets in the site. The proposed plan changes the circle intersection to direct crossing to improve comfort for pedestrian and biking direct crossing, to appreciate walking, biking and to reduce the vehicles speed. Right angle turning point will minimize turning speed. Minimizing turning radius and providing shorter biking and pedestrian crossings are the major actions taken on the main street intersection. Additional pedestrian and bike refuges for safe crossing are proposed in between two sides when maximum crossing lane is more than crossing two lanes.



Figure 58: The proposed intersection, the first picture (A) Showing the existing circular intersection and the rest three (B, C & D) showing the proposed geometry and contents of right-angle intersection.

6.12.3 Safety and comfort controlled with Greenway

The proposed greenway network at the city scale and designing the segments will help to improve the safety of pedestrians and cyclists by making these transportation options inclusive, by keeping in consideration disables, children and elders. People’s safety and comfort could improve through different measures, by ensuring safe crossing areas, intersections, tree canopy coverage, amenities (lighting, sitting, and signage) and surfacing.

The proposed design considers the situation of crossing the road without proper facilities as one of the biggest challenges for pedestrians. The speed gap between vehicles, pedestrians, and bikers increases the probability of accidents. Taking this situation in consideration the proposal adds facilities in the proper location and improves crossing conditions in the designed streetscape. Among the facilities added are standard zebra stripes and stop lines. Further minimizing the number of lanes pedestrians cross to only two. Crossings are designed at the intermittent distance depending on the concentration of pedestrians. The decision taken to reduce the speed of vehicles prioritizes cyclists and pedestrian (see Figure 59).

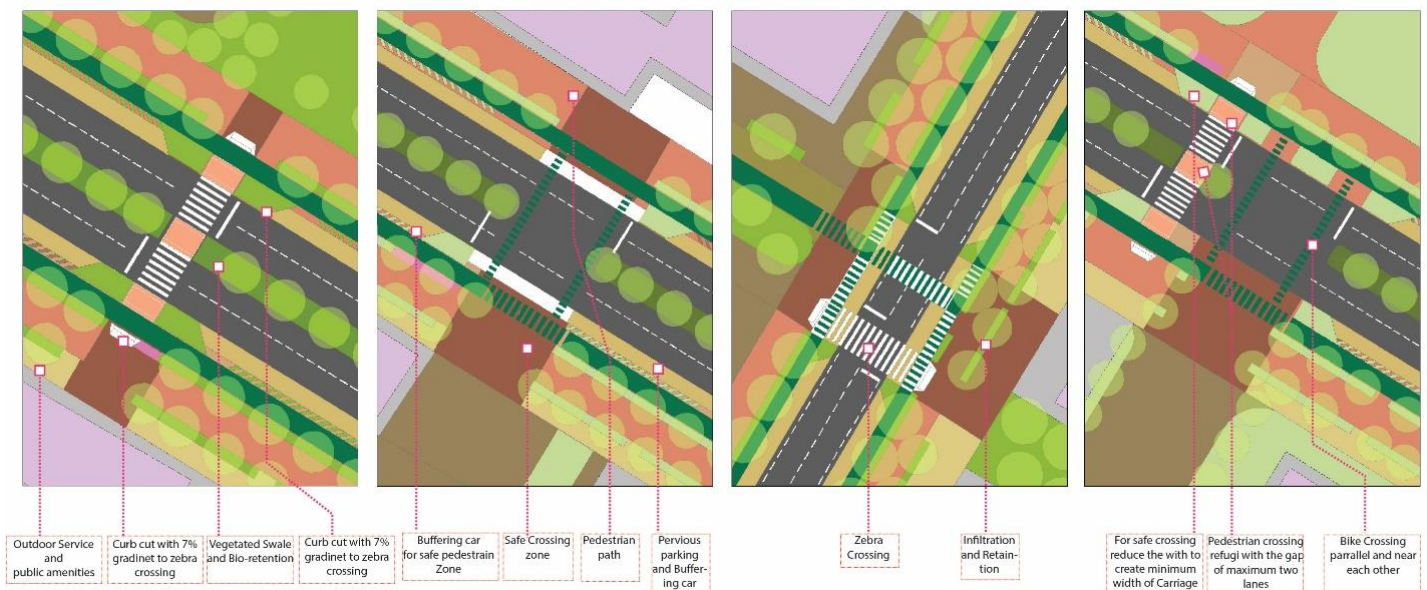


Figure 59: Proposed crossing.

Overall, the results indicate that the proposed outcomes of the design provide a substantial contribution to social, ecological and alternative transportation performance of the action area as well as the whole city while supporting the overall framework of the greenway to attain sustainability and keep safe the natural environments with ongoing rapid development.

Bibliography

Ahern, J. (1995). *Greenway as a planning strategy. Landscape and urban planning*, 33(1-3), pp.131-155.

Ahern, J. (2004). *Greenways in the USA: Theory, Trends, and Prospects.* In R. Jongman, & P. Gloria, *Ecological Networks and Greenways: Concept, Design, Implementation.* (pp. 34-55). Cambridge, UK: New York: Cambridge University Press.

Alliance(STA), S. A. (2012). *Greenway's strategy: "weave it Green". Salmon Arm: Catherine Berris Associates Inc.*

Benedict, M., & McMahon, E. (2002). *Green Infrastructure: smart conservation for the 21st century. The conservation Fund: Sprawl watch clearing house Monograph Series.*

Black, W. (1996). *Sustainable transportation. A US perspective. Journal of Transport Geography*, 151-159. Available at:<http://www.sciencedirect.com/science/article/pii/0966692396000208>.

Blob, L. (2016). *A greenway for sustainable mobility. The potential of developing a greenway network for cyclists and pedestrians in Oranienburg using the least cost path*, 15.

Bowler, D. (2010). *A systematic review of evidence for the added benefits to health of exposure to the natural environment. In Public Health* (pp. 1-10).

Britt, N. F. (2015). *Greenways as the framework for community design on the Patapsco river valley. The University of Maryland, college park.*

Chataway, E.S. et al. (2014). *Safety perceptions and Reported behavior related to cycling in mixed traffic: A comparison between Brisbane and Copenhagen. Transport Research: Traffic Psychology and Behaviour*, 32-43.

Conine A. et. a. (2004). *Planning for multi-purpose greenways in Concord, North Carolina. Landscape and Urban Planning*, 271-287. Available at:<http://www.sciencedirect.com/science/article/pii/S0169204603001592>.

Davies, C. (2012). *Environmental Implications of the Tourism Industry. United State Garet Couch, GISP, GIS for Tourism & Planning, AIANTA.*

Donald, W., Alan, P., & Robert, S. (2003). *Greenways. In Carry (Ed.), Time-Saver Standards for Urban Design (L. L. Schwarz, Trans., pp. 115, 422, 500-517). Massachusetts, USA: McGraw-Hill Companies, Inc.*

EMA, E. M. (2010). *Geographical Data and Boundaries. Hawassa and Ethiopian, Addis Ababa, Ethiopia.*

ENTA. (October 2009). *National Transport Policy 3rd Draft. Addis Ababa: The National Transport Policy Study Committee.*

EPA. (2002). *Environmental pollution control policy of Ethiopia. Addis Ababa/Ethiopia: Environmental Protection Authority.*

Fabos, J. G. (2004). *Greenway planning in the united states: Its origins and recent case studies. In Landscape and urban planning* (pp. 68(2-3), pp.321-342. Available at <http://www.sciencedirect.com/science/article/pii/S0169204603001610>).

Fabos, Julius Gy. (1995). *Introduction and overview : the greenway movement*. (p.5 ed.).

Gedecho, E. K. (2015). *Urban Tourism of Hawassa City, Ethiopia*. 28.

Gloria, P., & Bernardino, R. (2004). *Planning the future landscape*. In J. Rob, & P. Gloria , *Ecological Networks and Greenways; Concept, Design, Implementation* (p. 112). Cambridge: Cambridge University Press.

Gobster, p. H., & Westphal, L. M. (2004). *The human dimensions of urban greenways: planning for recreations and related experience*. *Landscape and urban planning* 68, 153-158.

Hamburger, A. (2016). *Hamburg bekommt Grünzug von der City bis nach Öjendorf*:<http://www.abendblatt.de/hamburg/article206962841/Hamburg-bekommt-Gruenzug-von-der-City-bis-nach-Oejendorf.html>. Retrieved May 13, 2017, from <http://www.sciencedirect.com/science/article/pii/S0169204612001910>

Hankey S. et al., a. (2010). *Estimating use of non-motorized infrastructure: Models of bicycle and pedestrian traffic in Minneapolis*. *Landscape and Urban planning* , 307-316.

Hawassa City Administration. (2014). *Integrated Development Plan of Hawassa*. Hawassa: Hawassa City Administration.

Hellmund, Paul, C., & Daniel , S. S. (2006). *Designing Greenways: Sustainable landscape for nature and people*. Washington : Island Press.

Jan Gehl. (2007). *Outdoor activities and quality of space*. In C. Matthew, & T. Steve, *Urban Design Reader* (p. 152). London: Architectural Press & Elsevier.

Jana, V., & Rogier , P. (2004). *Ecological Functioning of Networks*. In J. Rob, & P. Gloria , *Ecological Networks and Greenways; concept, Design, Implementation* (p. 67). University: Cambridge University Press.

Jane, Jacobs. (2007). *The uses of sidewalks: Safety*. In C. Matthew , & T. Steve, *Urban Design Reader* (p. 156). London: Architectural Press & Elsevier.

Jongman, R., & Pungetti, G. (,2002). *Greenways in the USA: theory, trends, and Prospects*. In J. Ahern, *Ecological Networks and Greenways concept,design ,implementation* (p. 64). Cambridge university press.

Labaree, J. M. (1997, October Updated April 11,2009). *AmericanTrails.org*. Retrieved from *Greenway and Community trails*: <http://www.americantrails.org/resources/greenways/NPSIGrnwy.html>

Little, C. (1990). *Greenways for America*. Baltimore: Johns Hopkins University Press.

M. Bolck et al. (2004). *From Models to reality: Design and Implementation* . In Rob Jongman & Gloria Pungetti, *Ecological Networks and Greenways Concept, Design ,Implementation* (pp. 128-156). Cambridge University Press.

Macdonald, S. H. (2016, December 14). *Greenways and Community Trails*. Retrieved from *www.AmericanTrails.org*: <http://www.americantrails.org/resources/greenways/GrnwyUrbanSHM.html>

Mason, J. (1995). *Designing suburban greenways to provide habitat for forest-breeding birds*. In *Landscape and Urban Planning* (pp. 391-400. Available at <http://www.sciencedirect.com/science/article/pii/016920469402030J>).

Miller, W. et al. (1998). *An Approach for Greenway Suitability Analysis. In Landscape and urban planning* (pp. 91-105).

MWUD, FUPI, M. F. (2006). *Report on the Hawassa Integrated Development Plan. Addis Ababa & Hawassa: Ministry of Works and Urban Development Federal Urban Planning Institute.*

NASA Earth Data. (2016, 08 07). *Earthdata Search. Retrieved from <https://search.earthdata.nasa.gov>: <https://search.earthdata.nasa.gov/data/configure?p=C1214621861-SCIOPS!C1214621861-SCIOPS&m=7.03125!36.5537109375!7!1!0!0%2C2&q=DEM&ok=DEM&sb=38.408203125%2C6.9345703125%2C38.6103515625%2C7.1279296875&fp=GROUND-BASED+OBSERVATIONS!Model!AERIAL+PHOTOGRAPHS&f>*

Paul Cawood, H., & Daniel, S. D. (2006). *Designing Greenways , Sustainable Landscapes for Nature and People. Wahington, DC: ISLAND PRESS.*

R. H. G. Jongman. (2004). *Context and Concept of Ecological networks. In R. J. Pungetti, Ecological Networks and Greenways Concept, Design and Implementation* (pp. 29-32,170,178). Cambridge University Press.

Renato, M., & Luciano, B. (2004). *An Ecological Network for the Milan region. In J. Rob, & P. Gloria , Ecological Networks and Greenways, Concept Design, Implementation* (p. 213). Cambridge: Cambridge University Press.

Robert, R. (2004). *Sustainable Urban Planning. Blackwell Publishing.*

Sandstrom, U. (2002). *Green Infrastructure Planning in Urban Sweden. Planning Practice and Research , 17.*

Searns, R. (1995). *The evolution of greenways as an adaptive urban landscape form. In Landscape and urban planning* (pp. 33(1-3), pp.65–80. Available at <http://www.sciencedirect.com/science/article/pii/0169204694020147>).

Smith, P. C. (2006). *Designing Greenways. In Sustainable Landscapes for nature and people* (pp. 14,15). Washington . USA: Island Press.

Street, G. (2017). *Street for people. Newyork: Nahacto.*

TEEB, T. (2011). *TEEB Manual for cities. Ecosystem services in Urban Managment, 3-4 . Available at : www.teebweb.org.*

Teng, M. et al. (2011). *Multipurpose greenway planning for changing cities: A framework integrating priorities and a least-cost path model. landscape and urban planning , 1-14 , Available at <http://www.sciencedirect.com/science/article/pii/S0169204611002088>.*

Termorshuizen, J. W., & Opdam, (2009). *Landscape Services as a bridge between landscape ecology and Sustainable Development. In Landscape Ecology* (pp. 1037-1052).

Turner, S., Shafer, C., & Lee, B. (2000). *A tale of three greenway trails: users perceptions related to the quality of life. Landscape and Urban Planning, 143-163.*

William, M., Michael, G. C., Frederick, R. S., & Edward, C. (1998). An approach to greenway suitability analysis. Landscape and Urban Planning , 90-98.

WTO, W. (2016). UNWTO Annual Report 2016. Madrid
http://dtxq4w60xq4w60xqpw.cloudfront.net/sites/all/files/pdf/unwto_annual_report_2016_0.pdf.