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Inner City Riverside Development and Land Use Transformation: in the context of Addis Ababa

MSC Thesis in Urban Settlement Studies /NOMA- SEARCH program/

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Declaration

I, the undersigned, declare that this thesis is my own and original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged, following the scientific guidelines of the Institute.

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Confirmation

The thesis can be submitted for examination with my approval as an Institute's advisor.

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Abstract

Looking at the current trend in the use and appropriation of land adjacent to rivers in the city of Addis Ababa, it becomes difficult to imagine how these areas had been transformed from user-friendly and plausible city-river interaction to degraded and disregarded part of the city where, these areas are characterized as destination points for most of the garbage from households and factories. The main objective of this study is to investigate the physical and spatial transformation of settlements along with existing activities currently taking place along riverside areas within the city. It also identifies different parameters and develops basic principles as well as guidelines for future river-edge development strategy. Four case study areas located within the inner city, currently undergoing urban renewal program, are selected for investigation. The study is carried out using data obtained through Google earth image, line maps, interviews, observation and mapping of the case study areas. In addition space syntax software "AGRAPH" is used as an important tool in analyzing spatial- program relationships, while providing a scientific backdrop in cross-relating initial assumption with on site observations.

The study found out that, there are significant numbers of built-up structures added, extended and transformed between1995 and 2002 mainly to accommodate shelter mostly for informal inhabitants. Inner city riverside areas of Addis Ababa are characterized as "lost" spaces of the city which do not promote social values and harmonic interaction between people and their natural surroundings. Moreover, these spaces are least accessible and poorly utilized which has resulted in attracting informal activities and informal settlements. In addition, the several transformation and activities happening within the informal environment and their proximity to major access routes show a direct relationship- i.e. the further away from major access routes the more the informality.

Finally, based on the findings of the study, design guidelines and land use strategies are proposed for inner city riverside areas. To show practicality of the recommended guidelines, a schematic land-use design is proposed for one specific case study area.

Key words: River-edge, Watershed, Transformation, Accessibility, Buffer-zone

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Abbreviations

AAEPA _ Addis Ababa Environment Protection Authority

EPA_ Environment Protection Authority

ORAAMP_ Office of the Revision of Addis Ababa Master Plan

SEARCH_ South and Eastern Africa Research Cooperation for Habitats

Local terms

Ato - an Amharic equivalent to Mr

Baltina - collective name for food flavoring spice products

Birr- Ethiopian currency (In March 2012, 1USD is nearly17.30 Birr)

Iddir- a social organization and gathering mainly during death of member families

Kebele - The smallest administrative unit

Kefleketema -Sub-city level administration unit

Mahber- social organization associated with social and religious matters

W/ro - an abbreviation of “woizero” meaning Mrs.

Woreda - an administrative unit composed of several *Kebeles*

Introduction

1. Introduction

Water is one of the most important natural resource which is essential for the survival and health of most living organism. Its extended use for drinking, agriculture, transport, industrial input, electrical power generation and recreational facility shows to what extent water is an integral part of human life. Early human settlements and civilization like Mesopotamia and Egyptian civilization were structured along water bodies. These water bodies provided easy access for transportation and allow food security for its inhabitants. As time goes by the importance of these natural flow of water has been declined in major urban areas. Meanwhile, urban water issues in developing countries are complex and increasingly urgent. According to the United Nations report (2009), one billion people live in slums, largely in Asia (550 million), Africa (187 million), and Latin America and the Caribbean (128 million). The highest slum concentration in the world is situated in Africa with 72% of its urban residents (UN-HABITAT, 2009). One of the biggest challenges for people in slums is getting safe water to drink and clean area to live in. Urban growth in developing countries tends to be rapid and unplanned, characterized by minimal or non-existent sanitation services. According to UN-HABITAT (2009), 83% of the population in 43 African cities lacked toilets connected to sewers.

Like in many developing cities, a rapid population growth and high rural-urban migration poses many environmental problems to the city of Addis Ababa, especially in the old settlement areas. These old and unplanned inner city settlements of Addis Ababa, which only cover less than 15% of the total area(54,000 ha), house 40% of the city's population(ORAAMP 2002 cited in Elias 2008). According to studies majority of housing stock within the inner city are constructed out of "chicka" /mud and majority of the structures are physically deteriorated(Melaku,2011). Deterioration of the structures is not only because of the nature of the material employed, but also, because the houses had not been maintained in many decades. Today, because of population explosion, the banks of Addis Ababa's rivers are becoming suitable hideout areas of informal dwellers and informal activities (Birhanu, 2007). These slow transformations of informality along riverside areas have highly contributed to the pollution of the river water. Moreover, inner city residential neighborhoods are characterized by overcrowding, inadequate services, scarcity of water supply, and lack of toilets and are susceptible to flooding and natural as well as manmade hazards. According to the structural plan of the city (2002), urban renewal strategy is

strongly desired in these inner city areas to overcome the problems and in order to enhance the underutilized inner city land which in turn will transform the image of the city.
Thus, this particular study was intended to investigate existing status of inner city riverside areas of Addis Ababa and also the relationship between its water bodies and their adjacent urban land in order to understand the parameters which will enable to design alternative ways of spatial and land use reconfiguration capable of overcoming the limitations of the latest proposals and future growth scenarios with possible trajectories in developing smart strategies of preserving areas edging the rivers. Ways of effectively reprogramming riverside settlements, reinstating rivers and shores as major urban component, redefining the corresponding public realm and evaluating how these would stimulate and induce change in urban space organization and land use patterns are main interests of investigation of this research.

1.1 Organization of the paper

This paper is structured in to five parts. The introductory part consisting of the objective of the study, research questions, limitations of the study, hypothesis as well as rationale of the study make up the first section. The second section discusses about historical relationship between urban structure and water using various theories along with overview of Addis Ababa planning regulations towards watershed areas. Selected case areas along riversides which are used to investigate the subject matter are discussed on the third section. Cross case analysis and synthesis of the findings take up the fourth section leading to the fifth and last section which point out the conclusion of the paper and illustrates the basic principles and design guidelines. The last section also comprises of schematic land-use design proposal for one of the case area to show the practicality of the recommended guidelines.

1.2 Objective of the study

The study focuses on the physical and spatial transformation of settlements along riversides in Addis Ababa where, the cultural backdrop, the forcing conditions to settlers, conditions of the building stock, advantages and disadvantages of the transformation, public reference of such areas over elsewhere, the existing condition of the river and future prospects as public recreation destination are closely investigated. The major objective of the study is:

- To investigate existing status and existing activities along inner-city riverside areas
- To investigate how vicinities along inner city riverside areas have transformed
- To investigate parameters which influence spatial programs /activities/along inner city riverside area
- To find possible spatial programs along inner city riverside areas and to set guidelines which accommodate habitable as well as suitable spatial programs along these areas.

1.3 Problem Statement

There is a paradox on inner city riverside areas between the informal spatial appropriation and the formal land-use plan. The formal land-use, according to the Master plan of Addis Ababa that was developed in 2002 and is currently at work, a mandatory minimum 15 meters setback, which will act as a buffer zone, is proposed on both sides of the river-edges. Moreover, the environment regulation no: 16/2004 clearly states that the space allocated for green areas should not in any circumstances be used for any purposes other than the intended program and should obtain legal protection (AAEPA,2010). Within this zone, for environmental and ecological reasons, it is expected for no settlement or any other sorts of physical interventions to happen other than green developments. Any sort of physical interventions made along this ecologically sensitive part of the city is illegal. However, the reality explains otherwise, sheltering several settlements along with different informal activities within the river-edge. As a result, the rivers and the river-edges are highly polluted and degraded parts of the city, as these areas become destination points for most of the garbage and sewers from household and factories. Full scale urban renewal strategy, according to the Master plan of the city, is strongly desired in these areas. Accordingly, these riverside areas are currently undergoing massive urban renewal program in order to improve the underutilized situation of the areas. Therefore, it is very crucial to study the existing situation, particularly, the physical transformations as well as the existing activities, which took place along riverside areas, which sustain livelihoods for the low-income inhabitants whom are living or working within the river-edge, while developing riverside areas.

1.4 Research questions

1. How did vicinities along inner city riversides transformed to the existing situation?
    a. How do activities along inner city riverside areas have transformed and to what extent?
    b. How accessible are inner city Rivers to the urban public?
    c. Is there a relationship between inner city riverside areas and the River?
2. What are the parameters influencing spatial programs /activities/ along inner city riversides?
3. a. How can we develop inner city riverside areas with habitable, sustainable and environmentally friendly programs?

    b How can we use the potential of Inner city rivers to shape our urban spatial configuration?

1.5 Significance and rationale of the study

This paper is useful to city planners, designers as well as decision makers in raising awareness of the existing status of densely populated inner city of Addis Ababa. With the estimated population projection of UN-Habitat 2006 and UNFPA 2007 report, cities of the world would posses additional inhabitants in the range of 1.6 to 2.1 billion. With the high level of global urbanization, this would mean cities adding a million residents every five days between now and 2030 (Sevtsuk, 2011). The city of Addis Ababa would not be an exception to this experience. The concern issue would then be to deal with the expansion of the territory as well as inner city densification along with the eventual rise of demand for a better quality of life. With the poor and dilapidated building stocks which mainly populated the inner-city of Addis Ababa, where renewal is strongly desired, a systematic redevelopment schemes should be considered. Accommodating for growth and change in an existing urban areas, often involves radical and disruptive moves. However, such deliberate moves require thoughts on how to preserve urban components with strong potential of serving working parts of future renewed areas. Inner city riverside areas have been the neglected and hidden parts of the city of Addis Ababa for a long time. Moreover, the existence of the paradox between the informal spatial appropriation and the formal land use plan of the city need urgent solution. The formal land use according to the master plan of Addis Ababa that was developed in 2002 and is currently at work suggests a particular and fixed setback of minimum 15 meters on both sides from the river course with an addition of green patch /buffer zone/ along the stream. Within this zone, at least on a

principle basis, it is expected for no settlement or any other sorts of intervention to happen. But the reality explains otherwise, sheltering several settlements along with different activities along the riverside. Moreover, According to AAEPA (2010), Addis Ababa Rivers become destination for most of the garbage and sewers from households and factories causing environmental degradation and pollution. Therefore, it becomes apparent to be critical about types of riverside interventions currently taking place and evaluate their relevance as compared to the structural plan of the city. Studying the existing situation and activities along these riverside areas is crucial in order to understand the development potential of the area which in turn, will help in highlighting possible ways to effectively reprogram and revitalize riverside areas. The result will stimulate as well as induce a change in urban space organization/spatial patterns/.

1.6 Scope and limitations of the study

The scope of the study is limited both by geographical location of riversides (inner city) and by the subject matter. The focus of the study is bound in the layer of spatial attributes leaving other factors like the social and economic conditions, environment impact, river water pollutants, etc for future study. The study is also limited by:

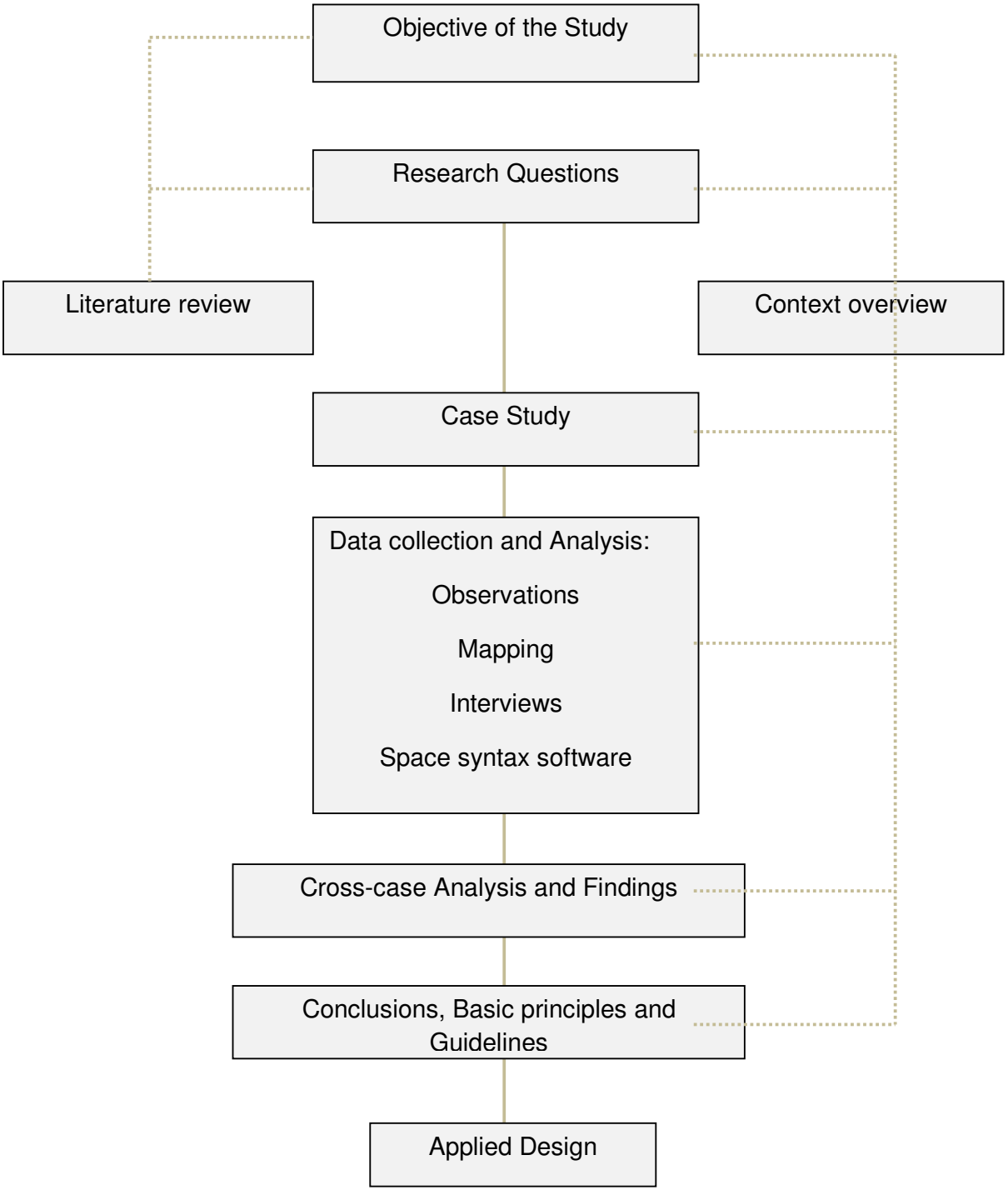
- Inaccessibility of recent line maps. Only two available line maps of 1996 and 2002 are used along with Google earth images of 2002, 2005 and 2009.
- Inadequate information on related theories on water urbanism
- Inaccessibility of basic maps and information from different government agencies (e.g. Ownership map)
- Unwillingness response from residents fearing the current renewal practice and its relocation consequence while conducting field study.

1.7 Research method

The research is carried out using the only two available line maps drawn from GIS /Ortho-photo/ which were conducted on 1995 and 2002 and Google earth developed images of 2002, 2005 and 2009. The bigger scale transformation was first conducted using Google earth images in analyzing the extent of transformation in the riverside areas. The morphologic transformation analysis of the case areas is bounded by the two line maps of 1995 and 2002. Recent phenomena are added while field study making up the recent 2011 map. Comparison of the built up morphology is used to understand the specific units which

had transformed over the given years. Different activities along the riverside are also mapped and analyzed to examine the usability of the river and also the relationship between the river and adjacent activities. Direct interviews are also conducted in the selected case areas after identifying the transformed units in order to understand the reasons to do so. Space syntax analysis software AGRAPH, which is developed by B. Manum, E. Rusten and P. Benze (http://www.ntnu.no/ab/spacesyntax), is also used in analyzing the spatial aspects of the case areas.

1.8 Research Strategy



Theoretical Frame work

II. Theoretical Framework and overview of Addis Ababa planning regulations

2.0 Introduction

Cities are incredibly complex and textured. They are shaped in many ways. Economics, politics, society, culture and nature all play crucial part in this process. Cities often seem disordered created by spontaneity and almost infinite variety of place, people and practices. Whatever the forces and practices are cities are always the result of design (El-Khoury, 2004). Design may be conscious and formal, undertaken by architects and planners. On the other hand, city is made and remade through daily activity of its inhabitant's every day. It is the result of informal cultural, social and economic practices. The Informal practices also create new form of urbanism in cyberspace. According to Gandy (2004), there is a mutual conception of relations between nature and culture in urban space. Nature is not conceived as an external blueprint or template but as an integral dimension to the urban process which is itself transformed in the process to produce a hybridized and historically contingent interaction between social and bio-physical systems.

In history, man and nature has been complementary to each other. The human survival within nature is closely related to living with water in a way which tied urbanization and built-up patterns of cultural as well as urban landscape in close relation to the logics of watershed areas (stockman, 2008). The flow of water in the natural landscape became one of the most important visual and spatial components in structuring and organizing early human settlements (van Buuren, 1993; Picon, 2005; Shannon, 2007 cited in Stokman, 2008).

Recently, cities are facing huge challenges concerning environmental issues. They are disconnected from their ecology for various reasons. This point is emphasized by Gandy (2004) thus "…the relationship between water and urban space can be understood by features such as new moral geographies and modes of social discipline based upon ideologies of cleanliness". Most modern cities have centrally controlled drainage system. This invisible water infrastructure system disconnects urban land-use from the logic of the watershed as well as people's experience from the ecological processes of the landscape (Stokman, 2008). While in others case, water bodies have become so polluted that they are becoming problematic part of the urban fabric.

To revitalize and develop riverside areas which are polluted and degraded, needs an understanding of historic relationship between water and adjacent land use patterns. Thus, relationship between water and cities and how water as element of urban morphology structures a city are discussed below using various theories. Then the discussion flows to the settlement evolution pattern of the city of Addis Ababa and its planning regulation towards watershed areas.

2.1 Relationship between City's morphology and Water Bodies

Relationship between cities and their urban components is conducted through the use of urban morphology as a tool. Urban morphology is the study of the form of human settlements and the process of their formation and transformation. The study seeks to understand the spatial structure and character of a metropolitan area, city, town or village by examining the patterns of its component parts and the process of its development. This can involve the analysis of physical structures at different scales as well as patterns of movement, land use, ownership or control and occupation (Wikipedia, 2003). The study examines how the physical form of a city changes over time and how different cities compare to each other. Moreover, the field deals with the study of social forms which are expressed in the physical layout of a city and conversely, how physical form produces or reproduces various social forms. The emphasis is on the relationship between components of the city rather than object-centered study (Bosselmann, 2008). Urban morphology is not defined simply by act of urban designer and nor is it limited to the formal act of urban intervention taken by government and individual developers. It is also a result of action taken by individual and community in their attempt to create healthy and supportive physical and social environment (ibid).

Cities are shaped by the way of seeing and understanding them which is brought depending on experience and view point. Even the same site can be seen through different lenses and experienced through different mindset. These differences play crucial roles in the physical structure of cities and the mentality through which they are experienced.

More often we are unaware of the historical processes through which the city has come to be shaped. Time and history play important roles in setting the stage for our action. What appears as a rigid plan provides a context for its mutation. What we see as an unstructured process for shaping the city is rather a highly determined result of the laws of capital; lack of structure is mostly problem of representation (El-Khoury and Robbins, 2004).

The fluidly nature of water has a great impact in our social and economic relationships be it with our physical surroundings or human contacts. Many early cities and great civilizations were erected /built along this water systems or coastal planes. These cities played major roles in human history as they were centers of trade and commerce. In fact, cities along water bodies were cradle of civilizations (Eckbo in Gand, 2004). Early major cities of

Mesopotamia such as Ur and Uruk, took root and built on tributaries of Tigris and Euphrates River. The reach water supply as well as the flat and fertile topography has encourages large-scale farming for the settlers. The rivers provided further benefits of reach supply of fish and waterfowl (Encarta premium, 2007). Although the rivers sustain life and insure food security, they had also destroyed riverside settlements by its frequent and irregular flood patterns. Flood controlling mechanisms of dams, high defensive walls and use of aqueducts were later employed to overcome the unexpected flood. Moreover, a system of segmented rice fields was planned as an integral part of the urban tissue, which did not only provide food to inhabitants, but also performed as a system of preventing floods and irrigations (Yokohari 2000, citied in Huda 2010).

Figure 2.1_ early settlement patterns and medieval town structures
(Source_ http://www.google.be/images; Morris, 1994)

In the middle ages, small villages were transmuted in to towns and township was acquired either through commercial activities or as the area become military bases. Fortified defensive walls were also used deliberately with integration of moat system in the medieval towns in order to defend the settlements from outside invasions (Morris, 1994). The presence of the water system has also provided a defensive mechanism. Presence of the water system allows easy transportation access to connect different settlements located along water bodies. The morphologies of the medieval cities were highly shaped by the tangled patterns of roads and water systems (De- Meulder and Shannon, 2008).

Figure 2.2_Cultural landscape patterns resulting from the adaptation to the characteristics of the watershed (source. Stockman, 2008)

Authors like De Meulder and Shannon(2008) argue that early urban structures like that of Dinocrates of Alexandria (331 BC), plan of St. Peterburg (18th century) and plan of L'Enfant for Washington were also constructed using water bodies and water structures as a keystone. In those periods, water had become one of the focal points to revive relationship between the human body and nature since water played a pivotal role in this reconstruction of urban space to produce a city which integrates intersection between technology, society and nature creating a well situated urban space within a city (ibid). The water systems with the underlying natural physical landscape were a major visual and spatial component of structuring and organizing settlements. Both linear and winding water systems have strong relation to the resulting patterns of land-use and urbanization.

Owing to the increase concentration of human activities and settlement, the performance of water systems had to be used for various functions during the development of cities and urban landscape. In addition to settling along the banks of natural rivers, the process of cultivation and urbanization has call for the introduction of man-made system of canals, ditches, ponds, dams and reservoirs in order to use the best of natural water resource.

But in recent centuries 19th and 20th, water systems were remarkably disappeared from the urban structure neglecting the importance and relation of water with urban fabric. The first industrial revolution, according to De Meulder and Shannon (2008), was to blame for the disappearance of the water systems. In 19th and 20th century, the water bodies were subject to dirt with garbage and the sewage systems resulted in skyrocketing pollution causing vast cholera epidemics in large settlement areas of European cities (ibid). As population increase and city periphery expands, land transport system informs of rail-way and vehicles

were widely used in urban areas, where watershed areas of the city are reserved for industries. Water lost its natural attraction due to the belief that the link of water with public health and water sanitation was supper important in the mid of 19th century. Hence, the new era of **clean urbanism** emerged with the help of high engineering mechanisms to deliberately canalized, piped out the water, covering the dirty water, clean the city by means of hiding the water sources out of sight, resulting in the visual banishment of water and water structures in urban areas (De- Meulder and Shannon, 2008). The emergency of the "hygienist city" or clean urbanism in nineteenth century which began as public health movement promoted urban space as an identifiable assemblage of organs. The connection between water infrastructure and the hygienist city was minimized so much as water infrastructure lay hidden either beneath the city streets or located to those marginal spaces on the urban periphery. The absence of water in modern urbanism is evident ever since.

Figure 2.3_ Networks of invisible water infrastructure replacing open water systems (Source: Stockman, 2008)

However, the hydrological transformation of the nineteenth-century city posed a fundamental dilemma for emerging forms of urban governance. Meanwhile, the provision of an improved water supply system could be achieved relatively easily than handling waste water. The waste water drainage caused huge technical and economical challenge (Gandy, 2004). The implementation of centralized water systems in cities such as Paris in 1802, London in 1808 and Berlin in 1856, took many decades to resolve. The understanding of technological networks and the "hidden water" had been largely left to engineers and at the same time, other visible aspects of urban design were widely perceived as the traditional domain of architects and urban planners (Gandy, 2004). Stockman(2008) disagree the widely use and acceptance of high-tech and autonomous technical water infrastructure

systems designed by engineering specialists as prevention and solution for problems related to flood and water pollution related to urbanization.

Despite the fact that the great majority of cities owe their very origin to the presence of rivers or watersheds, water infrastructure has almost disappeared; it is there but not visible, not accessible. It is no more part of the collective conscious of our urban structure (Stokman, 2008). Therefore, in the modern city, this created emergence of new forms of social and cultural hybridity where people's experience is disconnected from the water-related processes of the landscape.

One of such new emerged forms is the concepts and inception of eco-city. Different instruments like local agenda 21 and agenda's pertaining to sustainable developments where introduced in different countries after the first introduction of Eco-city concept in 1992 at the"Earth Summit" the UN conference. After the conference, the concern for sustainable development of cities become critical issue and more emphasis was given for the relationship between cities and nature as well sustainable development of cities through involvement of various groups and sections of society. The first eco-city projects were believed to be implemented in Denmark and USA-California both on the theme of Green city were emphasis is placed on beautification, pollution prevention measures, recycling and efficient use of energy, targeting selected neighborhood centers (City Manager's Office, 2003). Even though, the general guideline, strategies, approaches and methods of the Eco-city concept are similar, each country has developed its own modified version/ focal point/ to fit the concept to their own specific context (Ibid).

At the present time, city relates itself with its constituent and / or adjacent water bodies, according to Mello and Hollanda (2009), in two distinct and mutually exclusive aspects. Firstly, the city considers the water bodies as an element of urban design and as seamlessly interweaved into the urban landscape. This becomes a case in which the city actively promotes and uses its water bodies and infuses a multiplicity of programs into it. The integration would surpass the usual notion of the environmental advantage attained through enhanced natural resources and reach up to a raised status where the urban fabrics of such cities would become practically defective without their very basic component- the water bodies. The second case is where in urban areas where water bodies are disregarded with their shore spaces degraded, adjoining buildings are at risk of flooded or washed away and facing elsewhere but the water body, which has been the destination for most of the garbage and filthy injected sewers from households and

factories(ibid). Such areas would host much crime and are leftover spaces of the city. This category typically represents the current status of most riverside situations of the current developing countries and early 19th and 20th century industrial cities (De Meulder and Shannon 2008). The first trend in the use of water bodies in urban areas qualifies urban life and promotes social values as well as harmonic interaction between people, built up structures and nature (Hollanda and Mello, 2009).

In general, the land use adjacent to water shed areas has been remarkably changed and transformed from the beginning of early settlements to current urban settlement structure. The direct use of water bodies for agriculture, irrigation, transportation and use of moat systems are transformed as world population increase dramatically. The 'warp and woof' intertwined connection of road and river which has once played major role in giving most medieval towns their own unique structure is barely exist today (Morris, 1994; De- Meulder and Shannon, 2008). Moreover, the rivers and streams were banished from human settlement areas after they are associated with the born of epidemic disease in 19th century. However, in recent decades owning to ecological concerns, water is brought back on to our urban scene (De- Meulder and Shannon, 2008). City beatification and integration of recreational parks in urban neighborhood, as part of eco-city model, has been implemented and easily achieved through the presence and uncovering of the hidden rivers, usually with integration of adjacent pathways, biking trails and play grounds along river corridors.

2.3 Overview of Addis Ababa settlement Pattern

The rapid growth of African cities with urbanizing rate of 4% (UN-HABITAT, 2008) is accompanied over the use and expansion of urban spaces. Addis Ababa being one of the urban cities of Africa, is exhibiting a high rate of urbanization and urban transformation.

Since its foundation in1980's the city has grown from sparse and scattered settlements to an expansive and highly populated metropolis with an estimated current population of 4 million. (UN-HABITAT, 2008).The spontaneous and unplanned origin and growth pattern of the city character is driven by the then politico-military response (Wubshet, 2002).

The three important nodes namely, religious center (St. George church), political center (*Gibi*/palace) and market areas (*Arada*) were used as a starting settlement nodes which latter filled with residential units forming the different neighborhoods (*Sefers*). Rivers, gorges, rugged terrain with deep valleys stretching from North to South as well as other natural landscapes played major role as a division mechanisms or physical boundary for the early neighborhoods (Destalem, 2005). The vast vacant land and natural landscapes which used to separate early neighborhoods latter on was filled with residential houses (Destalem, 2005, cited in Addisalem, 2010). Major water source for the residence of the city was from the near-by streams and rivers. The proximity of settlements around streams and rivers in Addis Ababa could be argued to have evolved from its original intention of using its clean water for drinking, washing and use for agricultural purposes which were plausible and user-friendly city-river interaction. The scale of access routes and the city's morphology has greatly been affected in traditional neighborhoods, since animals were used as a mode of transport at the time (Berhanu, 2007).

Following the establishment of Djibouti- Addis rail way line in 1917, Addis Ababa open its door for western civilization. Meanwhile, the ruling regimes with their different ideologies and national policy initiated different studies and several revision of Master plan for the city in order to tune its urban pattern (Destalem, 2005). The master plans were implemented in few selected neighborhoods which lead to the dual nature of the city: the local traditional settlement and the planned neighborhoods (Destalem, 2005). The Declaration of nationalization of land by the socialist era in 1975 has encouraged hastily built unplanned settlements which were poorly constructed in order to coup- up with rapid urban population growth (Addisalem, 2010).

Most of these settlements are residential units located in the southern, southwestern, and northeastern peripheries of the city on lands planned and reserved for public parks, green areas, sport fields, and industries in the 1986 master plan (Teshome, 2008 cited in Addisalem 2009). Moreover, the increase population demand and the intense development have claimed more urban space forcing the city to grow spatially pushing agricultural lands away from the city. The city which had once vast and diverse green and ecological spaces along and around water bodies are currently struggling to survive as a result of the non-friendly spatial development approach of the city which is consuming most of the green areas (Eyob, 2010). Furthermore, land adjacent to water bodies have become unattended areas of the city despised by many and discordant with the formal proceedings of the city as a result of informal land occupation.

2.4 Addis Ababa's Planning Regulations towards water bodies

Global report on Human settlements declares that world's urban population is increasing in alarming rate and urbanization is expected to reach 70% by 2050 and currently the number has cross the 50% cross line (Global Report on Human Settlements, 2009). The majority of this growth is expected to be experience in developing nation of South-America, Asia and Africa.

A sample data gathered around the world's cities projects that total urban land use is increasing at an annual rate of 2.56% (UN-Habitat, 2006). With this rate the urban cover on earth is expected to double within 27 years (Jenks & Burgess, 2000). Addis Ababa which accommodates 26% of the national urban population is not exceptional to this phenomenon expecting 120,000 new residents every year (UN-Habitat, 2006, sited in Eyob, 2010). Moreover, as cities experience demographic growth, they tend to expand spatially forcing, among other factors, residents for possible ways to respond to the needs and demands of the limited and scarce resource- space/land.

Land is an important factor of production which plays a vital role in production of goods and services in urban as well as rural areas/settings. Hence, it become prime important to carry out planning regulations and land valuation in urban areas. Different planning methods including Land valuation techniques, local development plan and other measurements had been applied in Addis Ababa at different political periods to guide the city's development depending on the then political situation and development goal (Land valuation document, 2011).

If we look at the existing structural plan of Addis Ababa, planning regulation regarding natural water bodies are categorized under green concepts of the city. The provision of the green frame within the city is intended to provide dual benefits for local communities and the environmental ecology of the city with the benefit of watershed protection mechanisms for air pollution as well as biodiversity conservation (Master plan evaluation document, 2011). This green concept of the city is also divided in to four categories, namely;

1. Urban forest,
2. green buffer along river course,
3. public parks and
4. Urban agriculture (ORAAMP, 2002).

Out of the 21,046 hectare of green areas planed for the city in the master plan, the green buffer along the river banks are expected to cover 4,193 hectare which is 19.9% out of total area designated for green areas and 7.7% of the city's proportion (AA planning & information institute, 2009)

Seven major and medium rivers within the city of Addis Ababa along with their 75 seasonal Tributaries drain the city south wards originating from *Entoto* Mountain. But these rivers receive sewages and wastes from the residential areas located along the course of the river as well as from industries which are located along the river banks (AAEPA, 2010). Furthermore, the master plan of the city that was developed in2002 and is currently at work has put a particular setback of a minimum of 15 meters buffer zone in both sides of the river course for areas located in the inner city and developed areas of the city. The 15 meter setback should also incorporate 2-5 meters width walk way/circulation along the river corridor. The delineation of the buffer zones along the rivers is expected to stretches to 50 -100 meters in the peripheries (ORAAMP, 2002). Within this zone at least on a principal basis, for environmental and ecological reasons, it is expected for no settlement or any other sort of physical interventions to happen other than green development. Moreover, the environment regulation no, 16/2004 clearly states that the space allocated for green areas should not be in any circumstance be used for any purposes other than the intended program and should obtain legal protection ,since the existence of ample green spaces in urban areas is vital in attaining quality of urban life(EPA,2009). In these sense, any sort of physical interventions made along this ecologically sensitive site is illegal.

However, according to Eyob (2010), 90% of buffer of rivers crossing the major east-west axis are encroached by illegal settlers. 50% of the built up structures, which are located along the area reserved for buffer zone, acquire permission from their respective local administration*/kebele/* by violating the master plan without their mandate (ibid). He also noted that controlling prohibited activities along river-buffer zone areas is becoming extremely difficult as most of the structures and activities acquire legal permission to be exercised (ibid). Furthermore, new multi story structures are being constructed on top of the rivers located along major access streets. Existing buildings are also using the buffer-zone area by diverting the river course in order to allocate more space for car parking (Ibid).

Alsam Building (Mexico square area)

H&M Building (Hayahulet area)

Figure 2.4_ Buildings constructed on top of rivers and their buffer zone area (Source: Eyob, 2010; picture by author)

According to Environment Protection Authority (2010), the buffer delineation is further classified in to three zones. The first zone consists at edge of the river were the water flows. In this zone planting of shrubs and indigenous trees is necessary so as to prevent landslide as well as to protect and sustain flora and fauna of the city (AAEPA, 2010). The second zone is delineated for vegetations which purifies and protect underground water while small size vegetations and lawn planted at the end of the bank to allow rain water infiltration and to sieve aggregates from the water representing the third zone (AAEPA, 2010).

Apart from being aesthetic value for our cityscape, trees and green areas play vital role in protecting our urban environment (Green Frame; master plan document, 2010). But the desired buffer zones areas along the river corridor are not implemented in any rivers within the city. The master plan evaluation document criticizes the absence of urban green policy for the city of Addis Ababa for not implementing the environment component of the master plan which was; according to the document is a result of ambitious planning concept. Moreover, as a result of the lack of environment policy and regulatory body, most of the rivers draining the city are polluted as a result of inappropriate practice and uses, mainly by unplanned settlements as toxic waste disposal sites from industries located along river banks (AAEPA, 2010). Fragile area of the city like Riversides, hillsides, gorges and flood plains are mostly occupied by unplanned squatter settlements. The availability of vacant land which can be easily squatted without any sort of payment is the main reason for the expansion of squatter settlements on these fragile slopes and hazardous areas. And there is less possibility of eviction from such sites (Hardoy, 2001, quoted by Minwuyelet, 2005)

With the plan of bring balanced development and to improve the livability of the city, currently, the city administration is undergoing large scale re-development schemes that intend to efficiently utilize urban land and to allocate land for new developments. According to some scholars, for redevelopment of an existing site to occur, the net value of land if developed at a new density must exceed the gross value of land and building that currently exist on the site plus the cost of replacing the old building stock. This tipping point is typically reached first at the most accessible areas of the city, where land is of highest value due to convenient access from all parts of the expanding metropolis. The advantage of having effective land valuation system which is transparent, sustainable and flexible would enable among other things:

- The development of appropriate standard benchmark prices on the lease of land; Transparent and clear taxation systems on the use of land;
- A viable and effective land marketing system that will facilitate investment ;
- Helps the City Government to capture the value it has created on the land through the provision of infrastructure services;
- Helps the city government to facilitate the relocation process, and improve the level of acceptance by concerned parties. (Land valuation document, EiABC, 2011).

Though different scholars around the globe have put different parameters to valuate urban land, the key attributes which determine value or grade of land in Addis Ababa, according to recent study conducted at the Ethiopian Institute of Architecture Building Construction and City Development /EiABC/, are:

1. Infrastructure weighting the 45% of total value given to urban land which have:
    - Public Transportation (10%)
    - Road (25%)
    - Water (5%)
    - Electricity (5%)
2. The intended Land -use of the area acquire 30% of the value given to urban lands.
    - Centrality accounts 7.5%
    - Mixed land use- 3.75%
    - Nodes and development corridors -6.25%
    - Industrial areas – 2.5%

- Urban parks- 5%
- Urban agriculture – 5% *(land grade document, EiABC, 2011)*

3. Developmental factors of the city account 10%
    - Plan and implementation 4%
    - Allowable building height 3%
    - Housing condition 2%
    - Housing density 1%
4. Sensitive physical properties of the city located with land have only 5% value.
    - Water shed areas 1% *
    - Geological factors 1%
    - Soil type 1%
    - Slope-ness of the area 2%

*Here according to the land-value document the weight given to water shed areas is only 1%. The documents argument is that this water shed areas (streams/ river) located within the city are neither used for transportation, recreation nor as inputs for any kind of production. Furthermore, it also argues that watershed areas have no influence in our context on land acquisition decision. Moreover, the maximum value of 1% is given for areas which are located 70meter and more offset distance away from the watershed edge. As the offset distance decreases from the edge line of the watershed, the value will fall accordingly ending at 0 point for urban areas with less than 30 meter offset distance from the watershed edge. Thus, discriminatory land price is reflected in urban land near rivers and watershed areas. (*Land grade document, EiABC, 2011)*

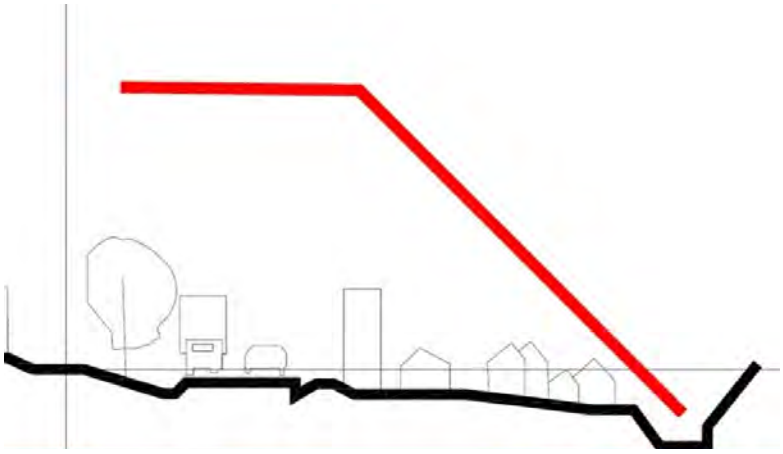


Figure 2.5 Current land value (own construct)

Addis Eco-city concept

Eco –city model is an organic approach to town planning towards sustainable development, which mainly emphasize on decreasing pollution effect, devising alternative energy sources, recycling and reutilizing byproducts and wastes, changing consumption behavior and reducing wastes from the source (City manager's Office, 2003). It is the next step in the evolution of our urban environment: built to fit its place in cooperation with nature rather than in conflict designed for people to live whilst keeping the cycles of atmosphere water nutrients and biology in healthy balance, empowering the powerless, getting food to the hungry and shelter to the homeless creating a place for everyone in every land.

The inception of the eco-city program was in line with the time of the city's administrative transition in to decentralized 10 sub-cities /*kifleketema*/ along with the preparation of local development plan for identified strategic investment areas of the city (ibid). The Eco-city concept was initiated and adopted for the city of Addis Ababa in 2003 by the previous city manager Ato Tesfamickael Nahusenay (City manager's Office, 2003). The project was launched as a pilot project in 10 *kebeles* with the assumption of replicating the positive aspects (Melaku, 2011). The key development concern of the city government is in improving the living environment of residents, improving image of the city and exploiting economic potentials of the deteriorated inner city areas in a sustainable way. The eco-city concept of Addis Ababa is mainly focused on sustainable development and integrative intervention/ strategies/, where it emphasize the balance between environment, social and economic objectives through community, private and public partnership (Elias,2008; cited in Melaku,2011). But according to Melaku (2011), the project was expert driven run by Administration steering committee. As a result the desired objective and expected outcome is less observed even in transforming the pilot area (ibid).

Part III

Case Studies

3.1 Case Studies

The study is conducted on inner city riverside areas mainly through on site observation and mapping on selected case areas.

3.2 Case area selection criteria

There are seven major and medium rivers within Addis Ababa along with their 75 seasonal tributaries draining the city southwards. Out of these seven major rivers crossing the city, the first selection criteria is looking for rivers which cross inner/main center of the city according to the city's centrality delineation used on recent government documents. Rivers located on urban areas which are subjected to the massive ongoing urban renewal/upgrading program, make up the second selection criteria.

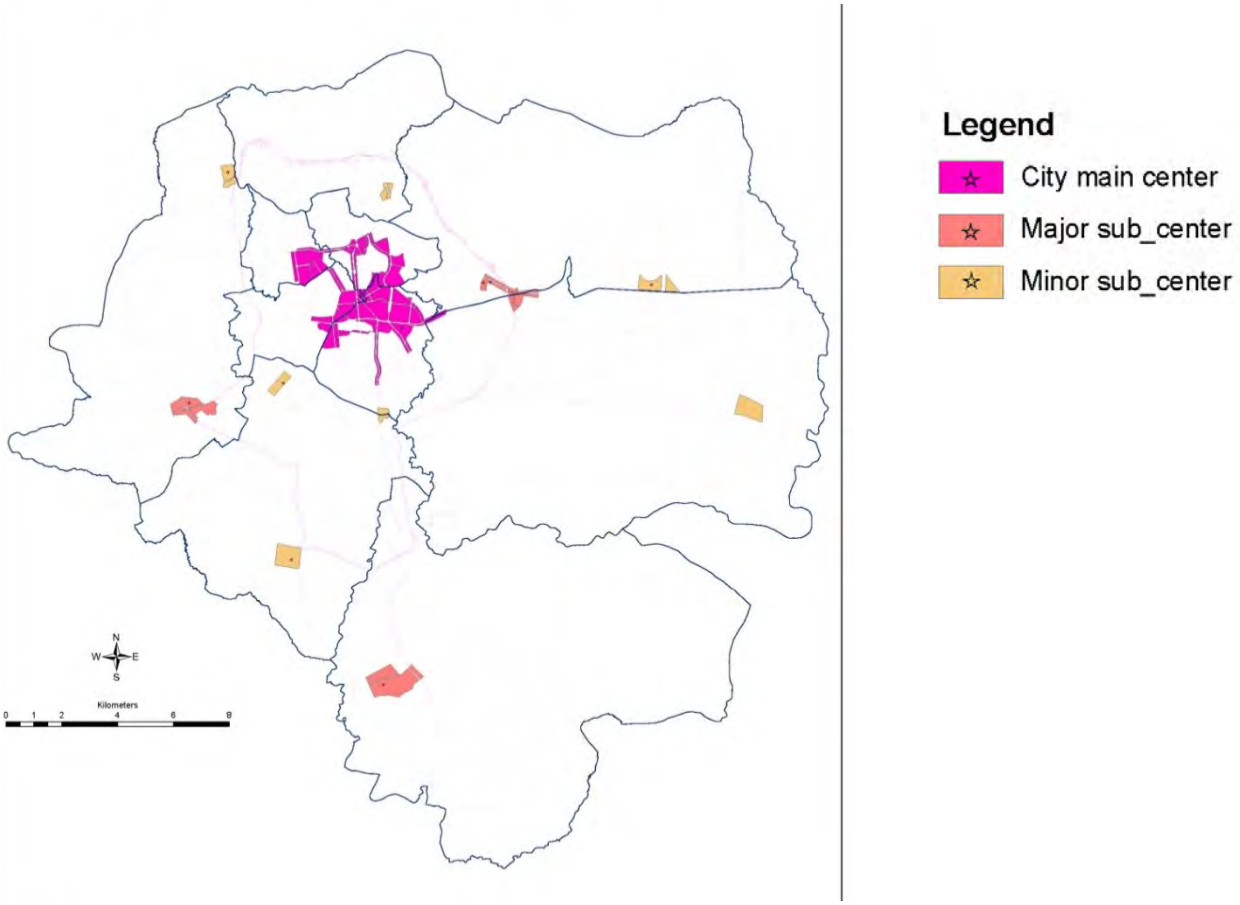


Figure 3.0 Centrality location (source: AA building height regulation document, 2011)

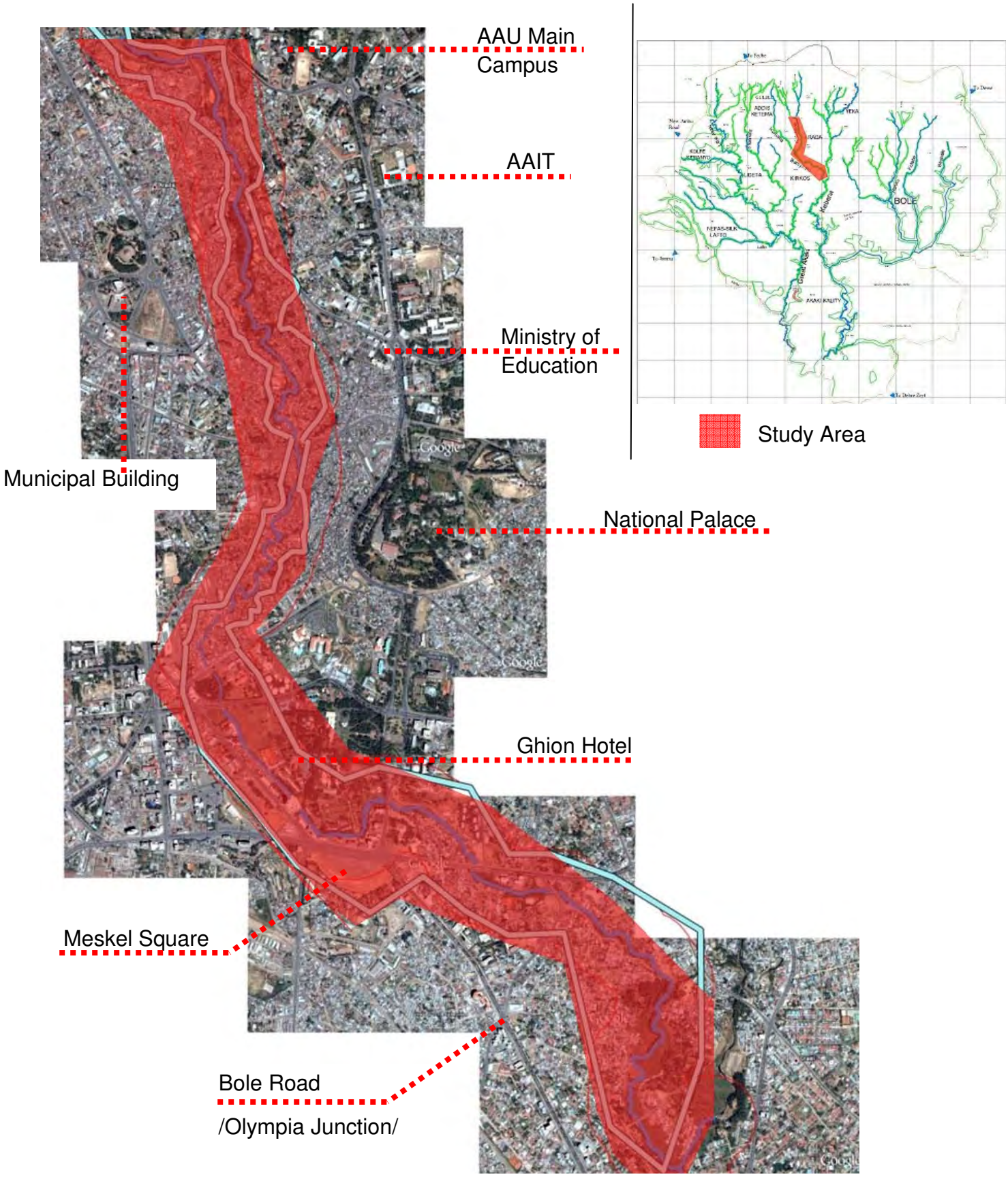


Figure 3.1.0_location map of selected case study area

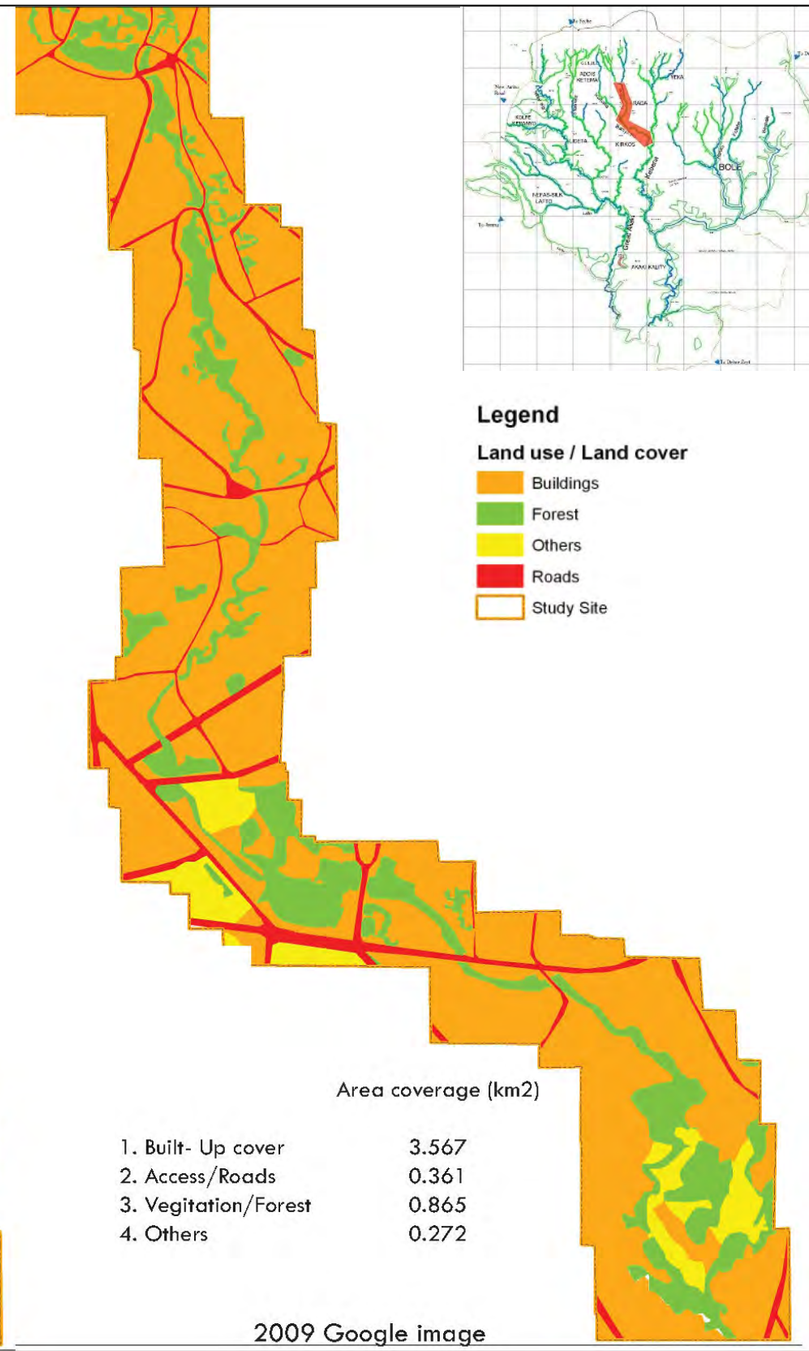


Figure 3.1.1_ GIS analyzed map of the case study area_ showing the general spatial transformation

Finding

Google earth image of 2002, 2005 and 2009 are used to analyze the general transformation of the selected area within the given years using GIS remote sensing software as a tool to analyze the transformation. The software combines and reads the same color notations of the Google images as one category. The images are classified in to built-up structures, access roads, vegetations and others/open vacant lands/.

After acquiring and analyzing the 2002, 2005 and 2009 Google earth image, illustrated in figure 3.1.1, the results of the findings are discussed as follows.

The built –up coverage of 2002 read 3.16km2, the roads and access accounts 0.32 km2 while vegetation coverage is 1.15km2. In the year 2005 images the area coverage of built up structures as well as roads/access show an increment with 3.422 km2 and 0.338 km2 respectively. In other hand, the vegetation coverage in that same year has reduced to 0.820 km2. This phenomenon is also reflected in the 2009 image analysis. The built-up structure land coverage shows 3.567km2, access and roads 0.361km2 while the vegetation cover shows an increase reading 0.865km2.

According to the remote sensing analysis, it is observed that there is a clear expansion of area coverage in built-ups as well as access roads and where as the vegetation coverage area has shown a significance reduction between the year 2002 and 2005 and increase by 0.045km2 in the year 2009.

The general spatial transformation of the case area suggests for further in depth study in order to understand what kind of interventions are taking place in river side areas as well as the buffer-zone area. Four major zones are selected with high level of spatial transformation within this case for further study.

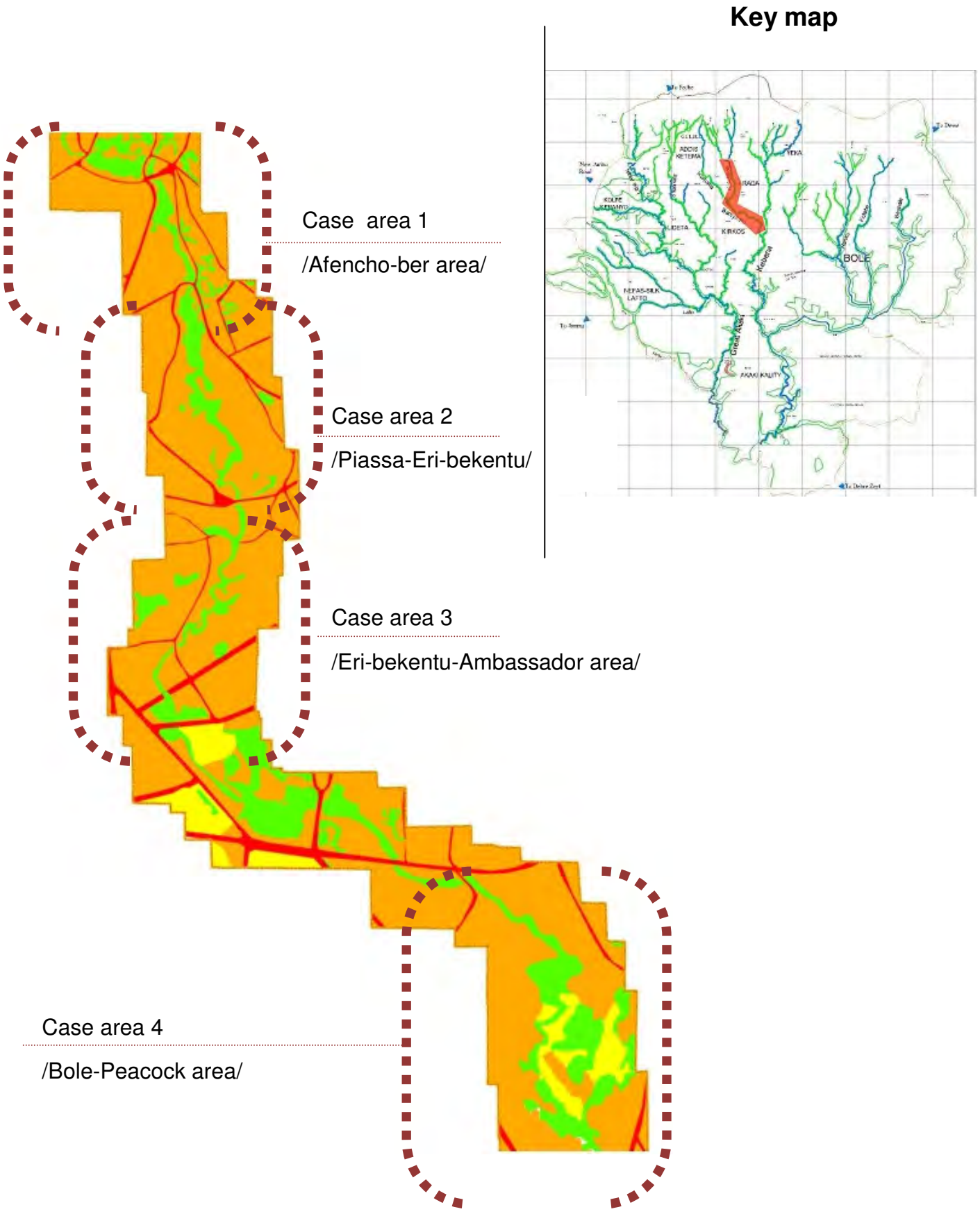


Figure 3.1.2_ Zoomed to specific case study areas

3.3 Case area _1

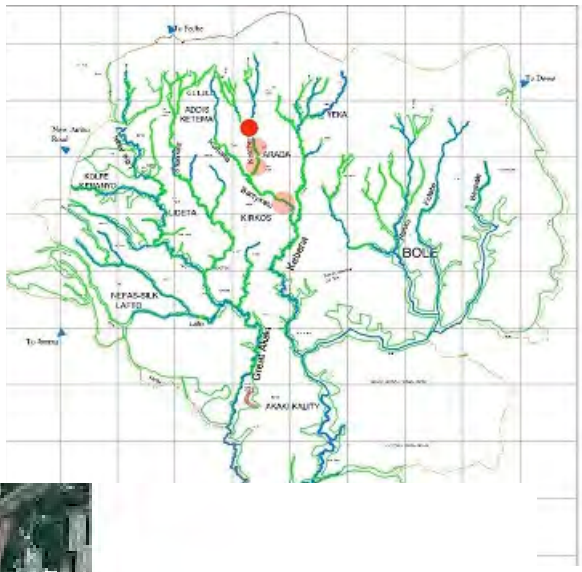


Figure 3.1.2b_ Case area 1 /Afencho-ber area/ location map

Figure 3.1.3_ Transformed units of case area 1 within the year 1995, 2002 and 2011

As seen from the above figure 3.1.3 there are a significant number of built up transformations in the area in year 2002. Sample cases are selected for structured interviews to understand the process of transformation and to identify types of transformation as well as involved actors.

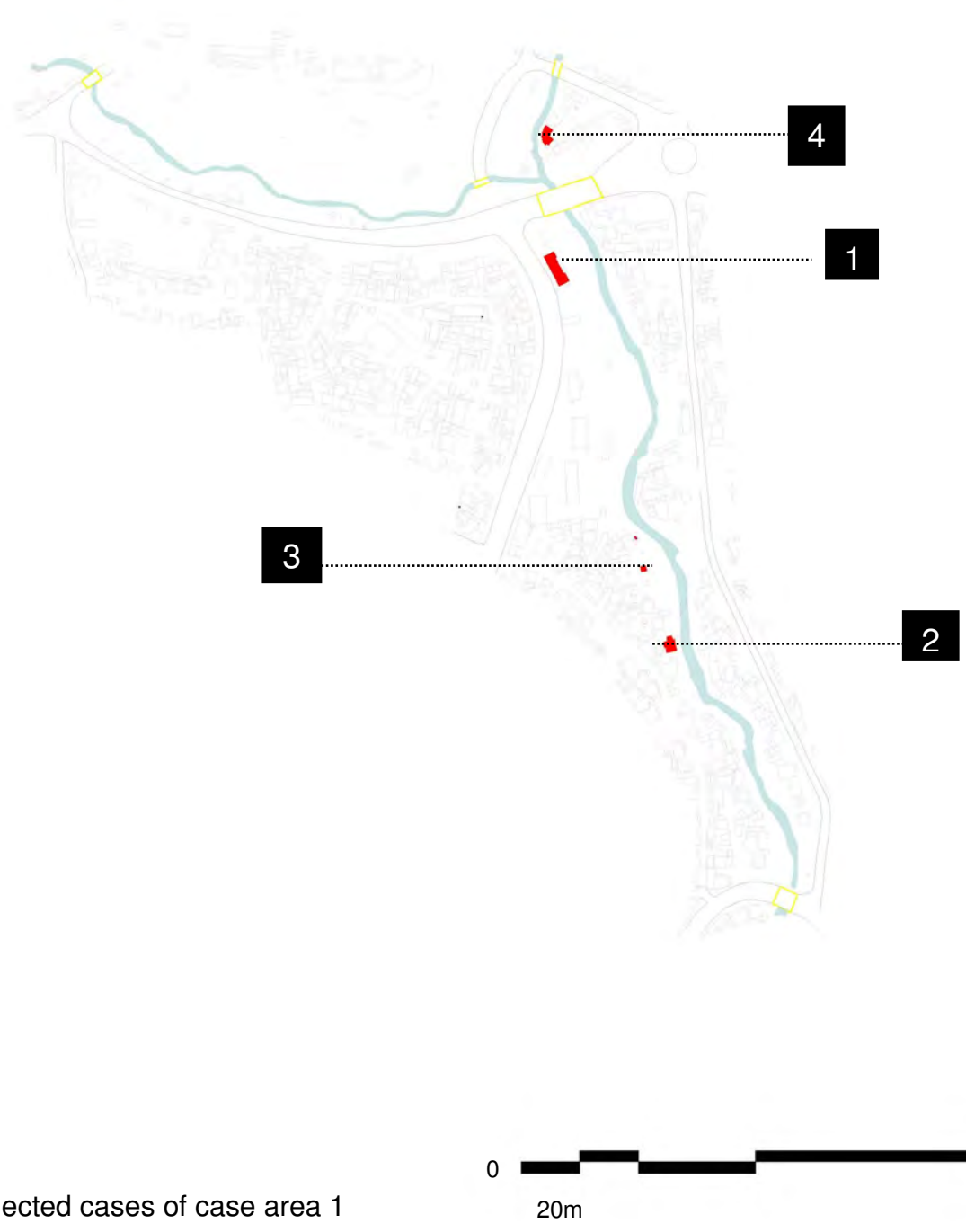


Figure 3.1.4_selected cases of case area 1

Transformation (see figure 3.1.4

Transformed unit Type 1

A group of young cooperatives within the umbrella of Small and micro enterprise have established a workshop after acquiring a temporary permit from the sub city.

Ownership: The cooperative (temporary structure)

Activity; workshop

Area: 12m2

Wall material: EGA sheet

Roof material: EGA sheet

Floor material: earth

Box.1 Transformed units in case area 1

Transformed unit Type_2

A family who has lived in the area for 26years had added a semi-detached unit on the existing *kebele* house.

Ownership: *Kebele house*

Activity: kitchen

Area: 8.25 m2 No of people living: 7

Wall material: “cheka” mud construction

Roof material: corrugated iron sheet

Floor material: cement screed

Box.2 Transformed unit in case area 1

Transformed unit Type_3

A communal toilet constructed either by NGO donors or with cooperation between the *kebele* and community living in the neighborhoods since the settlement lacks toilet facilities even within the compound.

Ownership: community

Activity: common toilet

Area: 3 m2

No of people served: ranges between 10 to 20 family

Wall material: HCB wall

Roof material: corrugated iron sheet

Floor material: cement screed

Box.3- Transformed units in case area 1

Transformed unit Type_4

A family who lived in the area for over 40 years had constructed detached housing unit to meet the family number demand within their compound. Another additional unit has also been added for rental purpose

Ownership: *kebele house*

Activity: Bed room

Area: 16 m2 No of people living: 10

Wall material: “cheka” mud construction

Roof material: corrugated iron sheet

Floor material: cement screed

Box. 4- Transformed units in case area 1

Analysis and Findings

Majority of the transformed built up units within the case area, as observed while field work, are under the ownership of local state known as *kebele* houses. Within this house, the study exhibits three types of transformed units. The first and second types are either additions to the already existing structures or new structures erected within the compound of *kebele* houses. Units extended either horizontally or to back from the existing structures make up the first cases as illustrated in Box 2. While the new additions to the *kebele* owned compound are group under type 2. Both types of transformed units have similarities looking at the purpose of the shelter. The units are built either as a solution to house the increasing number of their family /to overcome over-crowding/or to rent-out part of the shelter for other tenants as a source of income. Meanwhile, the third types of transformed units are structures erected on vacant land located along the buffer zone and along the main access roads. These structures are constructed either with temporary structures of corrugated iron sheet wall cladding as illustrated in Box 1 or with hollow-concrete-block wall construction as illustrated in Box 3. The temporary structure units like that of Box 1 are constructed after acquiring a temporary license for the service they are rendering from the *kebele* micro and small enterprises.

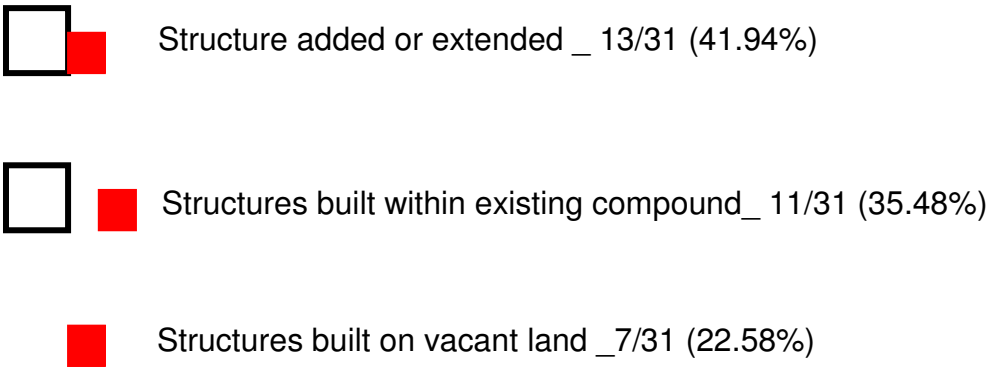


Figure 3.1.5_ Types of transformation in case area 1

Out of 31 observed structures which have transformed, 13 are structures extended from existing structure, 11 are new units added within existing compound and the remaining 7 are new structures built on vacant land.

Legend

Main/major Street

Access /local/ Streets

Pedestrian streets

Figure 3.1.6 _ General access map of case area 1

0 180m

Legend

Area used by private

Area used by public

North Direction

0 180m

Figure 3.1.7_ Domain map of case area 1

There is only one public area/park/ marked as p1 (green colored) located to the north of the case area. This public park is accessed through local street/represented by orange lines/as seen from figure 3.1.6 above. Direct access from the public park is prevented by the compound fence. There is a shorter riverfront avenue where the river is visible but in the majority of the case area, there is neither any longer riverfront avenue nor a continuous pedestrian way as seen from figure 3.1.6 making the river invisible and physically inaccessible. Urban river frontage referring to water body visibility is composed, according to Bruno and Kelly Shannon (2008), in two basic types of space _ blocked views and partially blocked views. The first type is predominant in the case area due to existence of barriers like buildings, compound fence and unintended vegetations which hinder water visibility. The inaccessibility of the river front is mainly due to absence of public space along the riverside. As illustrated from the domain map in figure 3.1.7, which represents the open public areas in white and space which are claimed by private or government ownership/enclosed units/ are represented in black. The map demonstrates that the majority of the riverside spaces have a private domain which is either occupied informally or formally. As explained by Hollanda and Mello (2009) that urbanity/public usability/ occurs in riverside spaces which have vast public domain coverage, high physical as well as visual accessibility with clear destination that are constituted by surrounding building entrance. The riverside in case area 1 is characterized by non-constituted space since majority of surrounding premises turn their back to the river as seen in figure 3.1.8 Moreover, the public area/public park/ and riverside surrounding quarters are not bound for activities which promote public attraction as well social or community useable area. The majority of the activities along riverside are exclusively bounded by residential quarters, machine workshops and small scale business activities. These minor activities are mapped and investigated whether if they are encouraged by nearby streets and investigate whether these activities take the river as input source or drainage output.

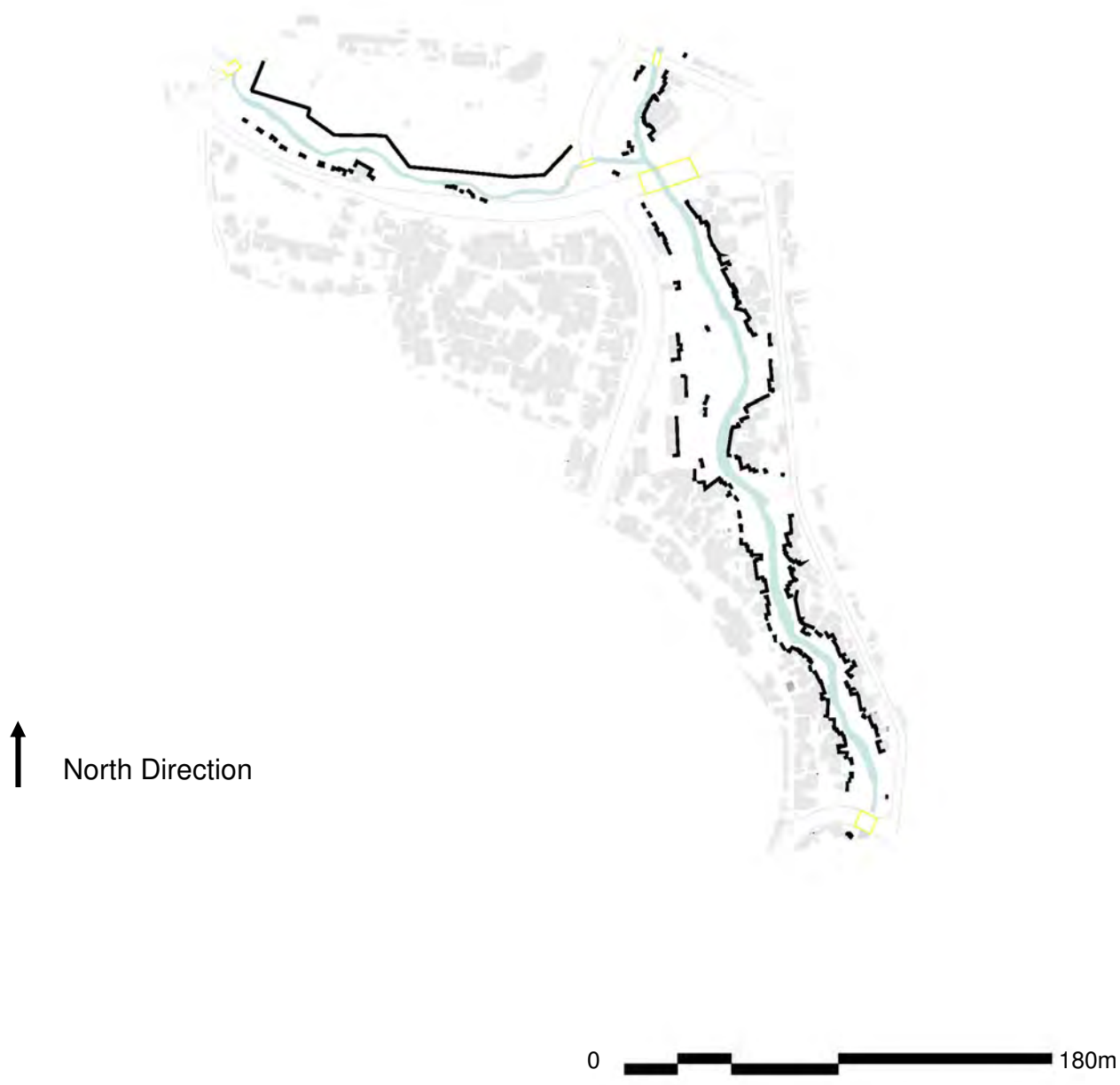


Figure 3.1.8_ river edge definition of case area 1

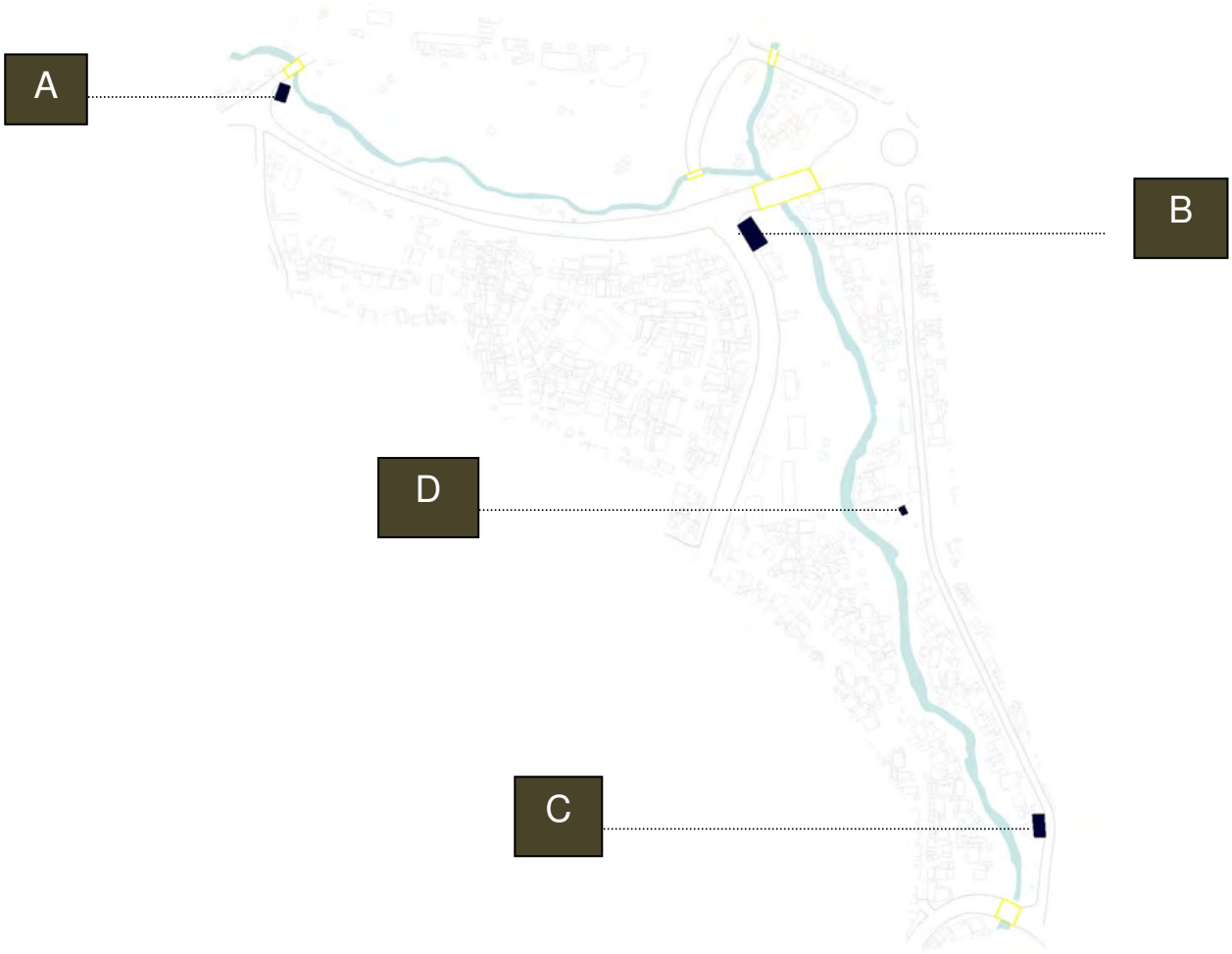


Figure 3.1.9_ Selected activities in case area 1

Activity, Livelihood and accessibility

A_ Activity & livelihood

Selam car wash cooperatives

16 young members of the *selam* car washing cooperatives are engaged in car washing service after acquiring temporary license to use the river edge as a working area from the sub city. The business runs seven days per week from 8:00am to 18:30. Minimum of 20 cars are washed per day and the number exceeds 40 on weekends.

Working area: 108 meter square

Lease condition: 3,000 birr per annual tax

Water source: purchased from neighboring house

Relation with the river: drainage output

Work in the area since: 2009 GC

Box 5. Activity in afencho ber area

B_ Activity & livelihood

Ye-ain marefiya seedling sellers' cooperatives

32 members of the cooperatives are engaged in the production and selling of the seedling in the case area (see figure 3.1.9). On average 120 seedlings are produced per day. The business has expanded towards the river edge after getting temporary approval from the AAEPA according to w/ro Birkinesh Kassa member of the cooperative.

Working area: 160 meter square

Lease condition: temporary

Fertile soil source: purchased from ***Debrezeit***

Water source: own direct pipe line

Work in the area since: 2003 GC

Relation with the river: none

The soil condition: vulnerable to land slide

Box 6. Activity in afencho ber area

C_ Activity & livelihood

Unregistered car washing service

Unlike the cooperatives, in this activity is performed without any form of legal procedure. This activity is also observed every week but with less intensity.

Working area: along access street

Lease condition: informal

Water source: from a spring near by

Relation with the river: none

Work in the area since: before 2000 GC (estimated)

Box. 7. Activity in aftencho ber area

D_ Activity & livelihood

Individual shop

An individual unit within a compound is used as a shopping unit.

Working area: 3 meter square

Ownership: within kebele compound

Lease condition: informal

Relation with the river: none

Work in the area since: 2000GC

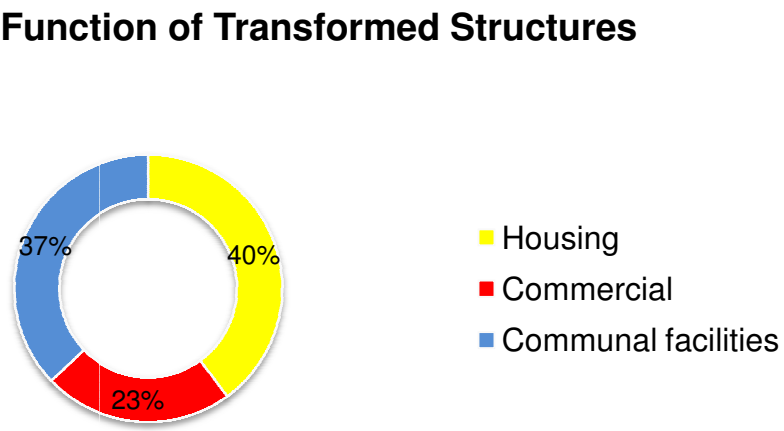
Box.8. activity in affencho ber area

Activities

Almost all of the activities conducted along the riverside do not have direct access with the river. They don't use the river as a source of input. Rather the river is receiving waste/drainage output from the car washing services. The map in figure 3.1.10 showing axial map of the area with a result from the space syntax software analysis match with the study's assumption that access is encouraging income generating activities in urban areas. The type of programs along the riverside are determined by the proximity of the activity to the main or local access streets.

The axial map developed from AGRAPH software (presented in figure 3.10) illustrates the axial integration of major and minor access streets along the riverside as well as the public park. The warm color (red) represents the most integrated access while the darker tones (dark Blue) represent the list integrated access. The only public space/public park/ is access by street with low degree of integration (cool colors) illustrating that the public park is less accessible to the public. The more the program is based on income generating activity, the program tend to come close to access streets. The findings from the software match the initial assumption that, programs are encouraged by access streets which is seen as a resource for the users. As the proximity to the access streets is farthest, the activities tend to be informal and hidden since access are terminated making it difficult for surveillance.

After interviewing and observing 35 sample cases which have transformed, 14 (40%) are under housing category, 8 (22.86%) are commercial and the remaining 13 (37.14%) are communal facilities.



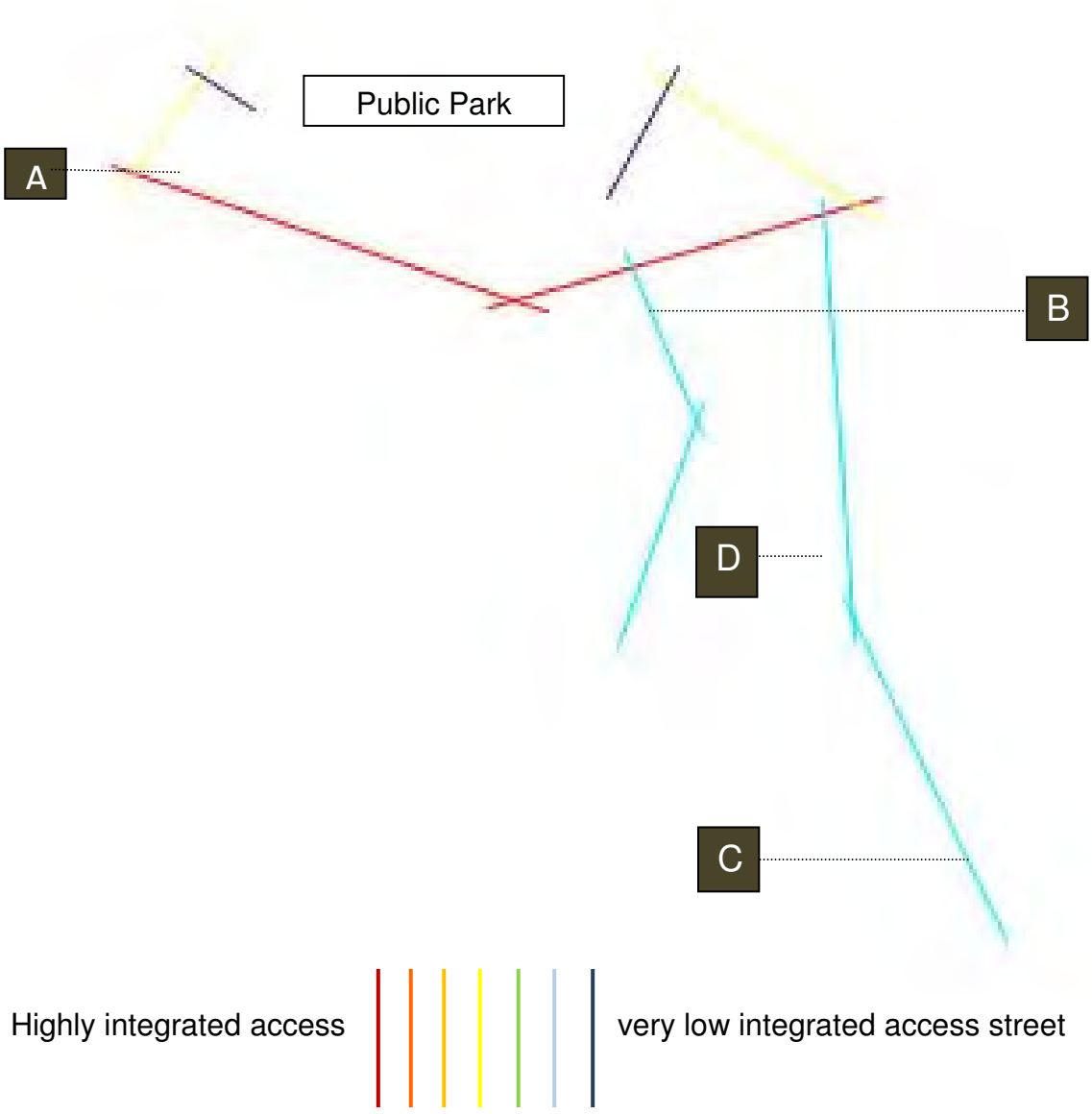
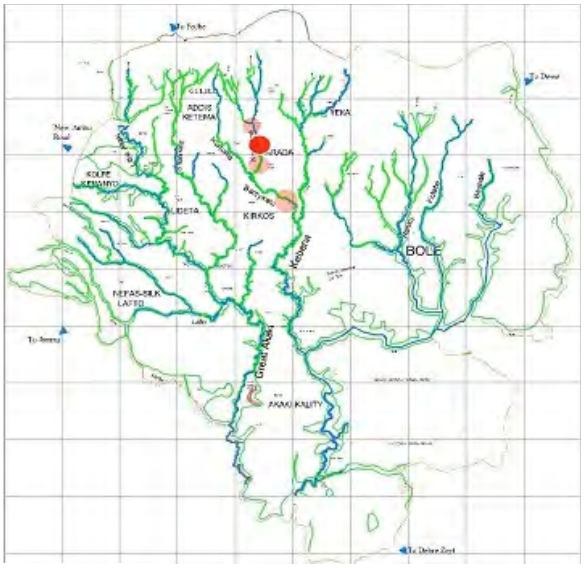


Figure 3.1.10_ Axial map of case area 1 (Source: AGRAPH space syntax software output)

3.4 Case area 2_ Piassa area



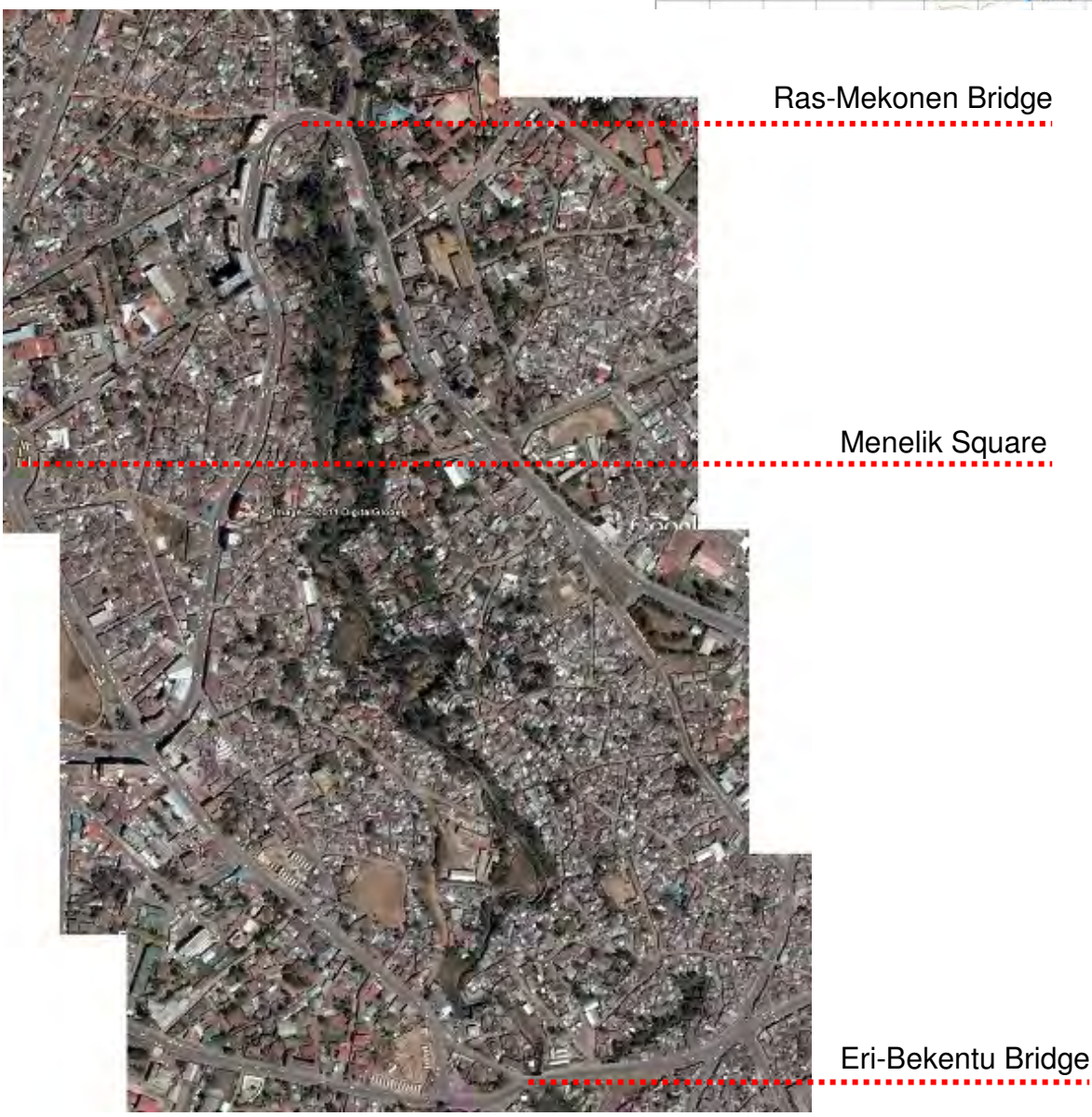


Figure 3.2.0_ Case area 2/Piassa –Eri-bekentu area/ location map

Figure 3.2.1_ transformed units in case area 2

As seen from figure 3.2.1, there are significant amount of units which have transformed over the year between 1995 and 2002. These units (colored in red) are categorized and presented in Boxes below.

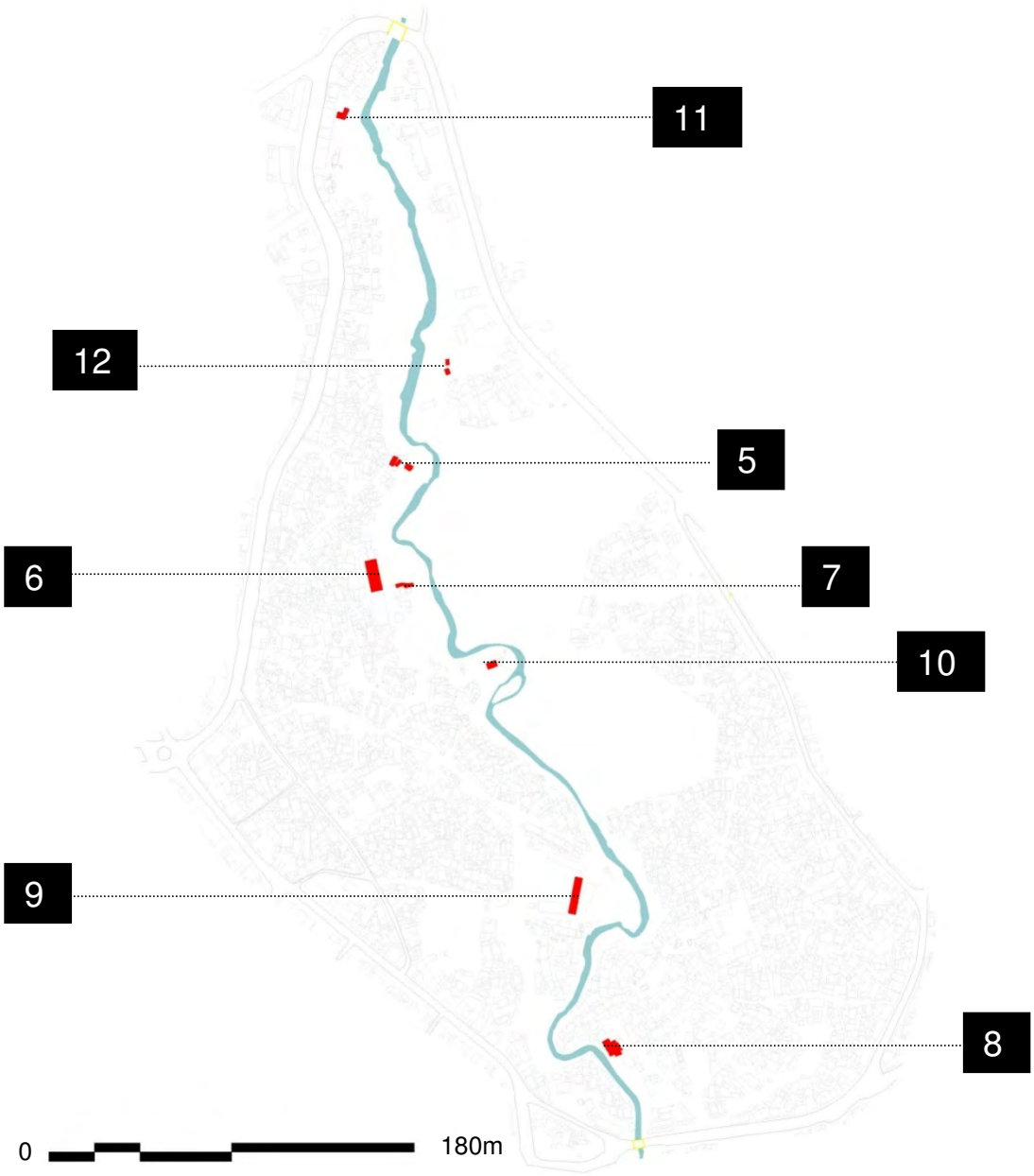
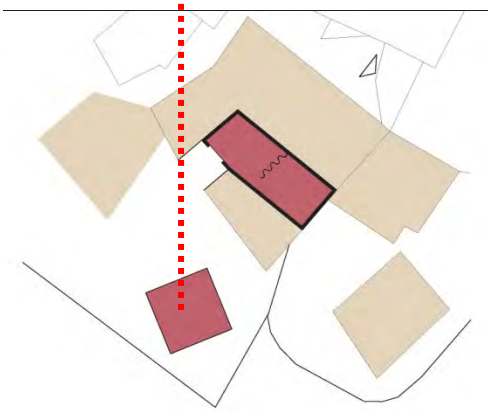


Figure 3.2.2_ Selected transformed units of case area 2

Transformed unit_5

A shelter rented out by second tenants for slaughtering service. The sheep barn is located in other household and is brought to the location to be slaughtered.



Ownership: squatted individual units

Activity: residential + sheep slaughtering

Area: 9.6 m2 residence + 4.5 m2 shade

No of people living: 10

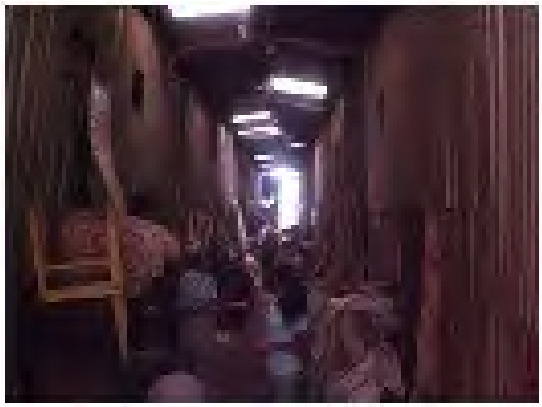
Wall material: plastic cover + CIS

Roof material: plastic sheet + CIS

Floor material: earth

Box 9_ Selected transformed unit

Transformed unit_6



Different families are sheltered in these temporary structures whom were evicted from their neighborhood as a result of urban renewal program.

Ownership: *kebele* (temporary shelter)

Activity: residential

Area: 26m2 per one family

No of people living: 6 per family

Wall material: Corrugated iron sheet

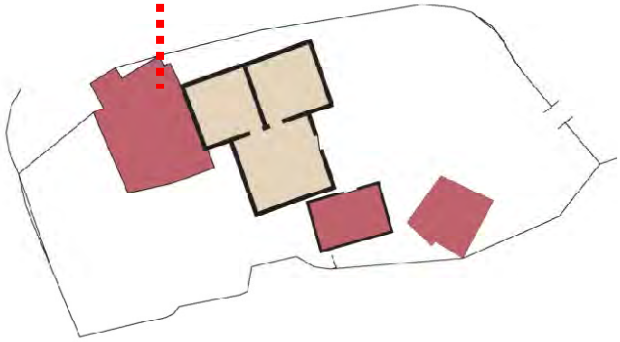
Roof material: corrugated iron sheet

Floor material: earth

Box 10_ Selected transformed unit

Transformed unit_7

Extended unit is used to house sheep.



Ownership: rented *kebele* house

Activity: kitchen + sheep barn

Area: 30 m2 _ No of people living: 10

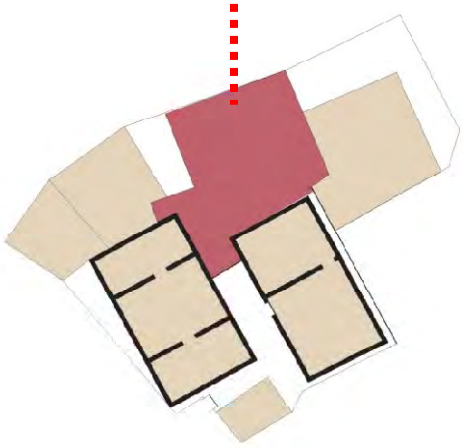
Wall material: plastic cover + CIS

Roof material: plastic sheet + CIS

Floor material: earth

Box 11_ Selected transformed unit

Transformed unit_8



Ownership: privately owned

Activity: cattle barn

Plot Area: 49 m2 _ No of people living: 16

Wall material: plastic cover + CIS

Roof material: plastic sheet + CIS

Floor material: earth

Box 12_ Selected transformed unit

Transformed unit_9

Yekatit 66 elementary and secondary school

Ownership: government school

Activity: elementary & secondary school

Area:

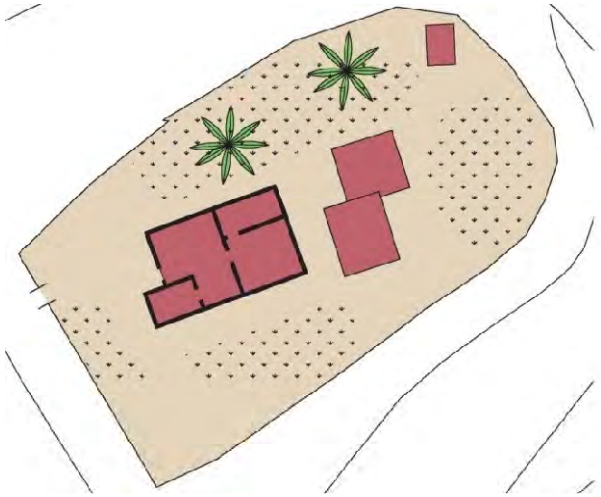
Wall material: HCB wall

Roof material: EGA sheet

Floor material: terrazzo tile

Box 13_ Selected transformed unit

Transformed unit_10



Ownership: squatted private unit/informal/

Activity: housing + Bee hives

Area: 16.65 m2

No of people living: 6

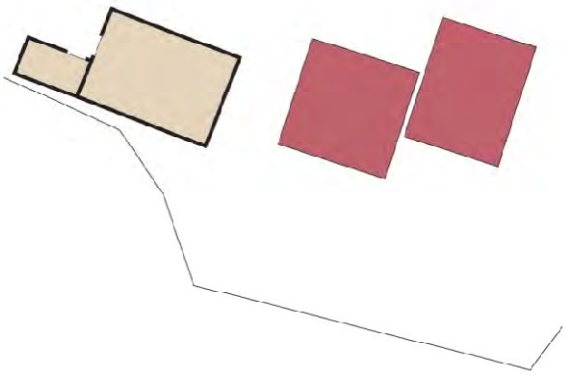
Wall material: mud construction

Roof material: GIS sheet

Floor material: cement screed

Box 14_ Selected transformed unit

Transformed unit_11



Ownership: *kebele* house

Activity: housing_ kitchen + storage

Area:

No of people living:4

Wall material: GIS sheet + plastic sheet

Roof material: GIS sheet

Floor material: earth

Box 15_ Selected transformed unit

Transformed unit_12

Ownership: community

Activity: communal toilet

Area:

No of people using:

Wall material: HCB wall

Roof material: GIS sheet

Floor material: cement screed

Box 16_ Selected transformed unit

Analysis and Findings

The spatial transformation of this case area as seen from figure 3.2.1 is vast in year 2002. The local state/*kebele* / owned houses are dominant in this case area. Just like the previous case area1, three categories of transformation are also observed. With average number of people living in the housing units being varied from 8-10, shows high density and sign of over-crowding which is the main cause of additions and extension of room to the existing structures which were owned by *kebele* as well privately owned. The construction material used for the extended structures is similar in most cases to the original material, in this case mud /*chika*/or HCB wall. The dominant type of transformation is the second where, the units are added near the original unit. In both cases, the transformed units are used for household activities like cooking and additional sleeping room in response to privacy demand by the family heads. Squatted compounds and units without any form of title deed are also observed along fragile areas and vacant lands of the buffer-zone area. 79 transformed structures were identified on line map which shows the boundary and fence lines. Out of those units 20 were extended structures, 38 were structures constructed next to existing structure within the same compound and the remaining 21 were structures built on vacant land.

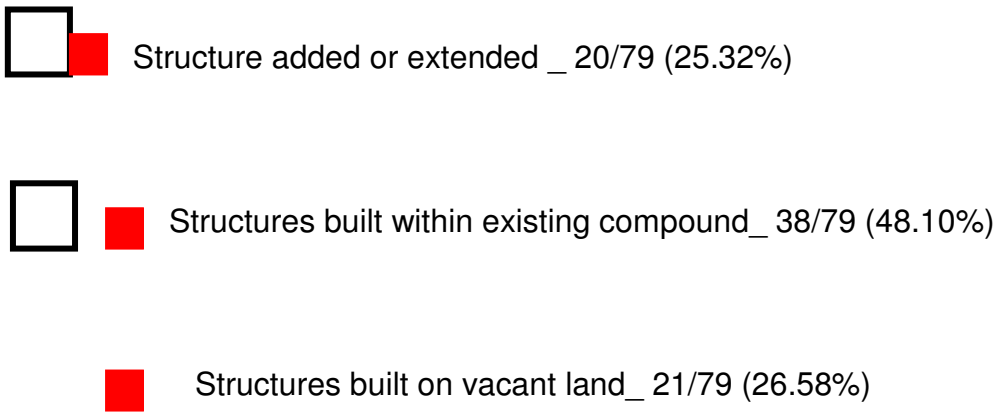


Figure 3.2.3_ Types of transformation in case area 2

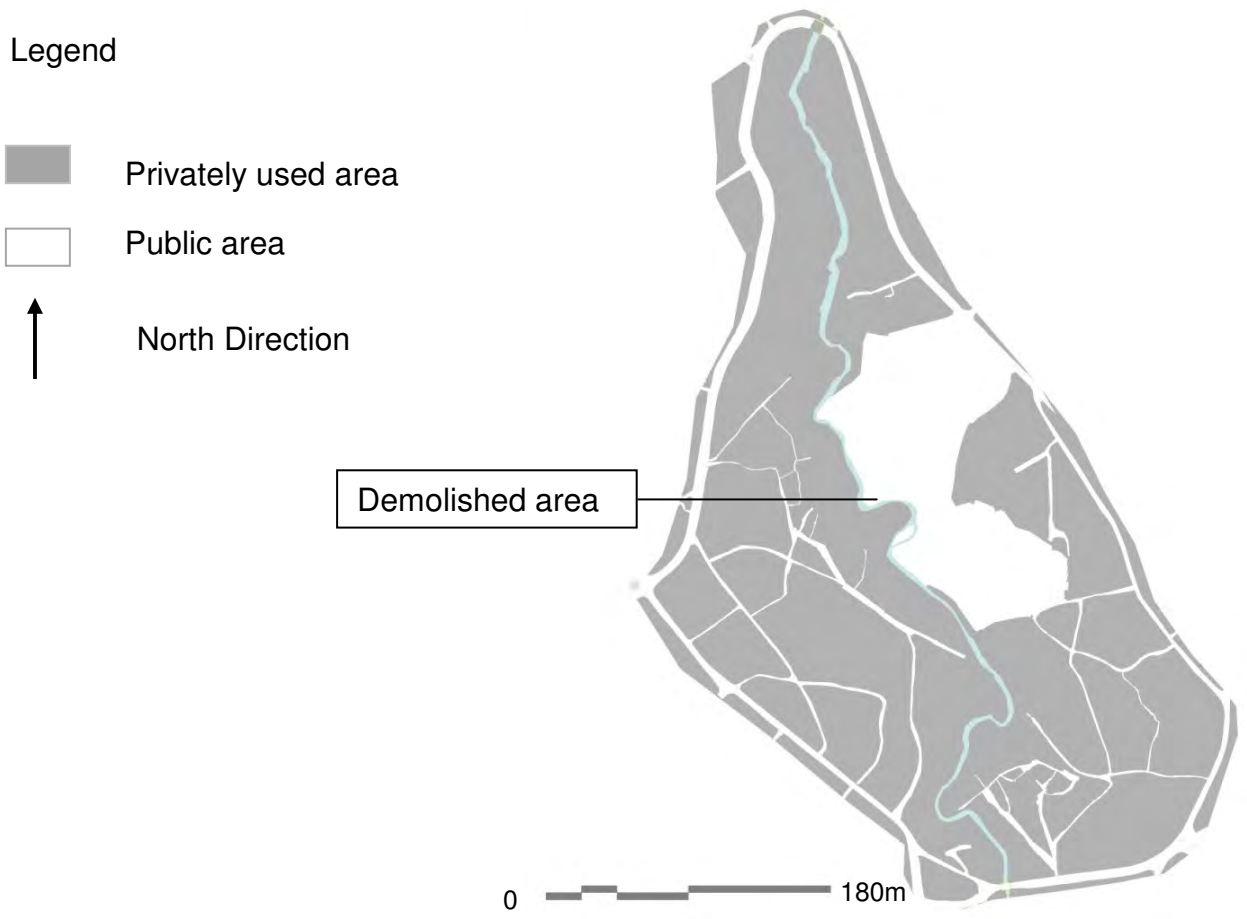


Figure 3.2.4_ Dominance map of case area 2

There is no ample public space in this case area as see in the domain map (figure 3.2.4).The map also shows that the area is highly dominated by private uses / residential quarters/. The only open field existed is the recently demolished area for urban renewal purpose. The river is inaccessible for the public as there is no any public space along the riverside and the river is not feed by any major as well as local streets (Major Street is represented by red lines in figure 3.2.5) absence of pedestrian walk ways along the riverfront also made the riverfront visually and physically inaccessible. Just like case area1, the surrounding blocks along the riverside are looking elsewhere but the riverfront.

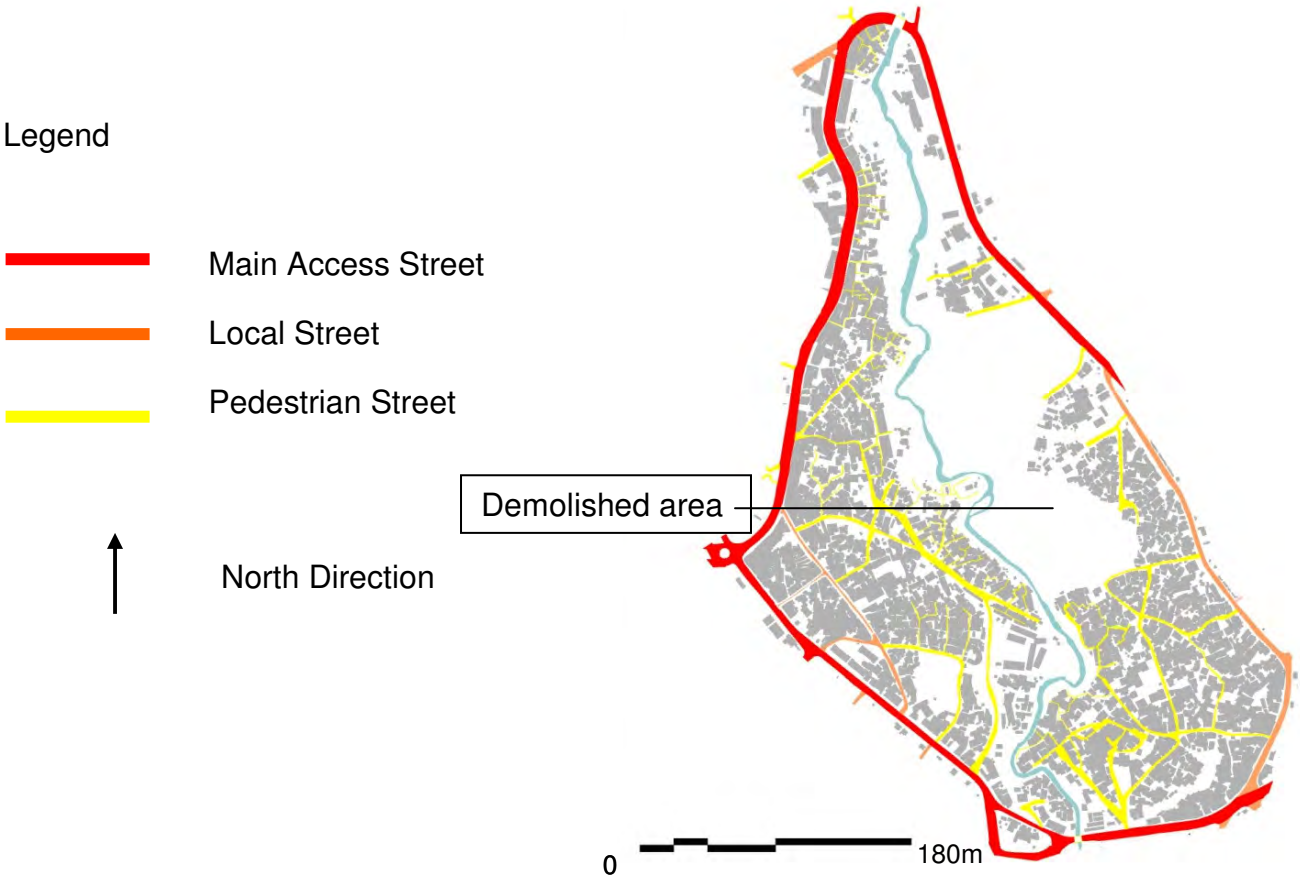


Figure 3.2.5_ General accessibility map of case area 2

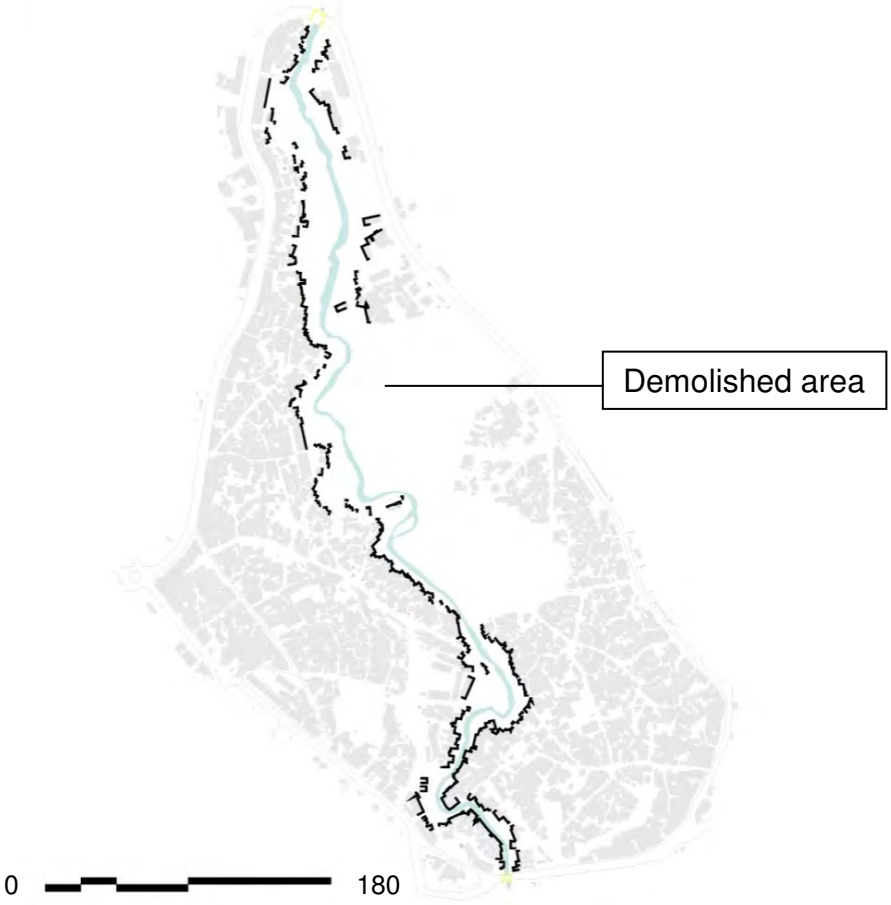


Figure 3.2.6_ River- edge definition map of case area 2

It can be concluded that this case area also lacks public usability as it is characterized by residential area/private/ coverage without any sort of public open space and programs which attract public use along with difficulty of access as a result of topography accessibility.

Activities along the riverfronts are selected and presented below in order to investigate the relation of the activities in relation to the major access streets with the same assumption made as case area 1.

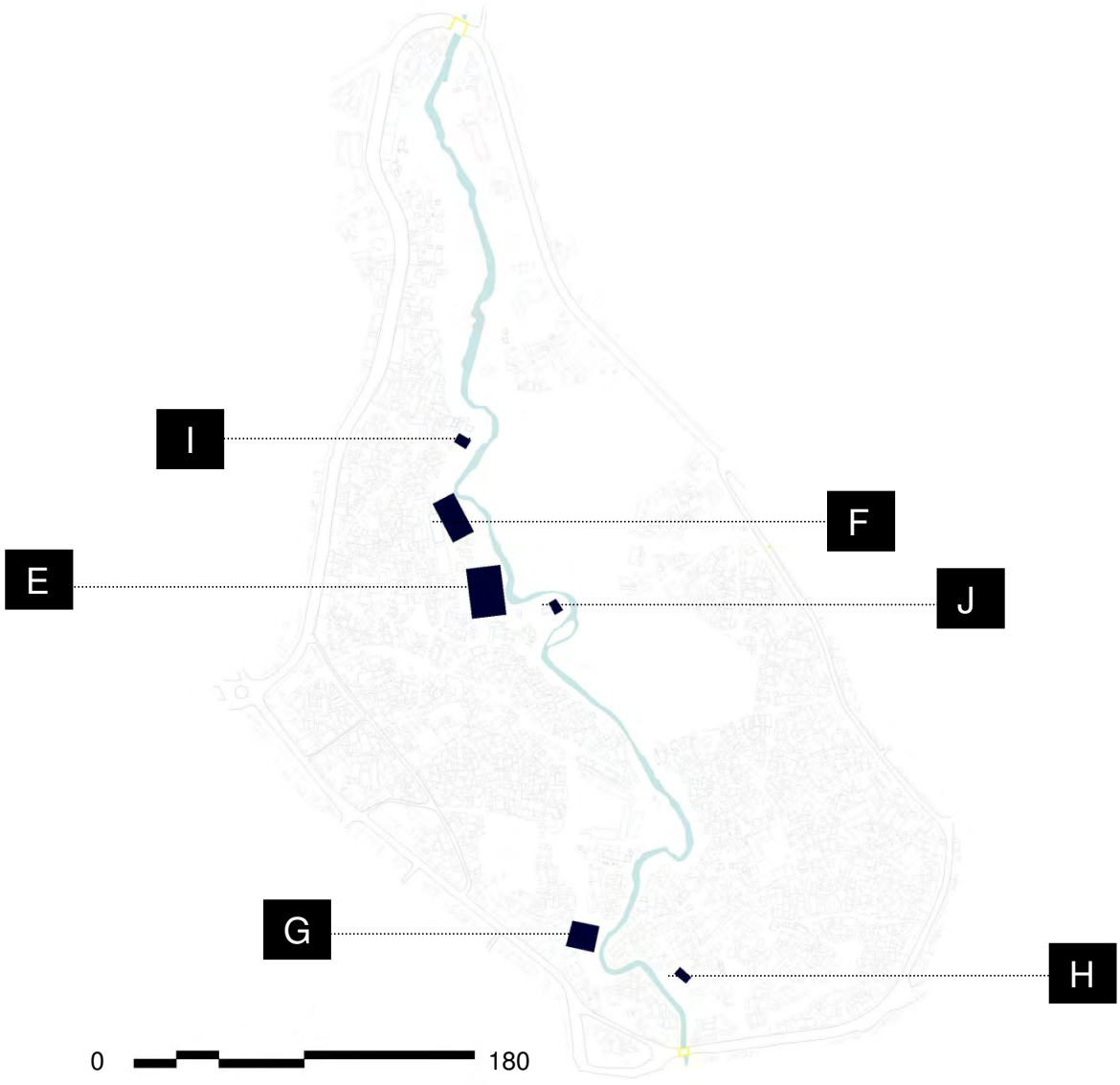


Figure 3.2.7_ selected activities in case area 2

Activities along the riverside in case area 2 / *piassa/*

E_ Activity & Livelihood

Domestic use food production

Wooden strip/sticks is used to delineate 27 families plot area for domestic use urban cultivation/vegetation

Working area: ___ meter square

Lease condition: informal

Water source: purchased or from own house

Relation with the river: none

Work in the area since: 2005GC

Box 17_ Selected activities in case area 2

F_ Activity & Livelihood

Grazing area

Used as grazing area for neighborhood cattle's and sheep which was used to be a vacant vegetation (shrub)

Working area:___ meter square

Lease condition: informal

Choice of location: vacant land availability

Relation with the river: none

Work in the area since: before 1997 GC

Box 18_ Selected activities in case area 2

G_ Activity & Livelihood

Solid waste collection

A youth cooperatives of 16 are engaged in solid garbage collection under the sub city Environment protection Authority

Working area: ___meter square

Lease condition: none (unknown)

Choice of location: vacant land availability

Relation with the river: none

Work in the area since: 2010 GC

Box 19_ Selected activities in case area 2

H_ Activity & Livelihood

Good selling units/kiosk/

A common phenomenon within the case area is the existence of shopping/selling activity inside a portion of a living unit_ in this case in a *kebele* house

Working area: 6 meter square

Lease condition: informal

Choice of location: close-by access route

Relation with the river: none

Work in the area since: before 2000 GC

Box 20_ Selected activities in case area 2

I_ Activity & Livelihood

Slaughtering activity

A space rented out for a slaughtering purpose by households living in the compound.

Working area: 4.5 meter square

Lease condition: informal

Choice of place/space: land availability

Relation with the river: waste disposal

Work in the area since: before 2000 GC

Box 21_ Selected activities in case area 2

J_ Activity & Livelihood

Honey harvesting

A bee hives located within a private compound for the use of commercial honey harvesting. Different plantations are also cultivated for the bee's to collect nectar

Working area: 25 meter square

Lease condition: informal

Choice of place/space: land availability

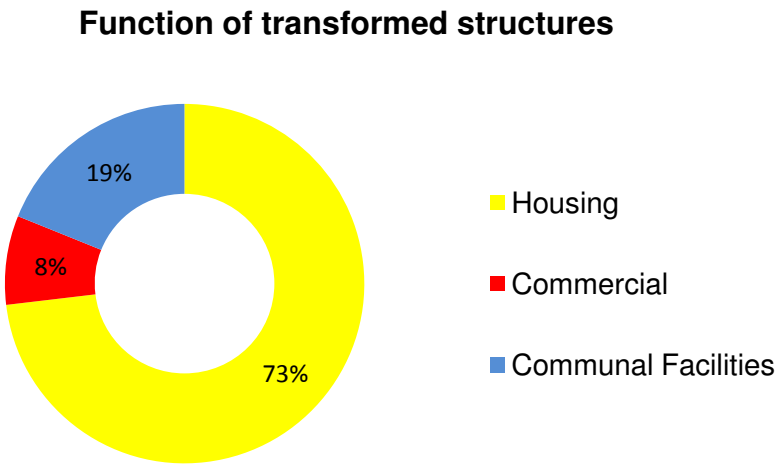
Relation with the river: available vacant land

Work in the area since: 1993 GC

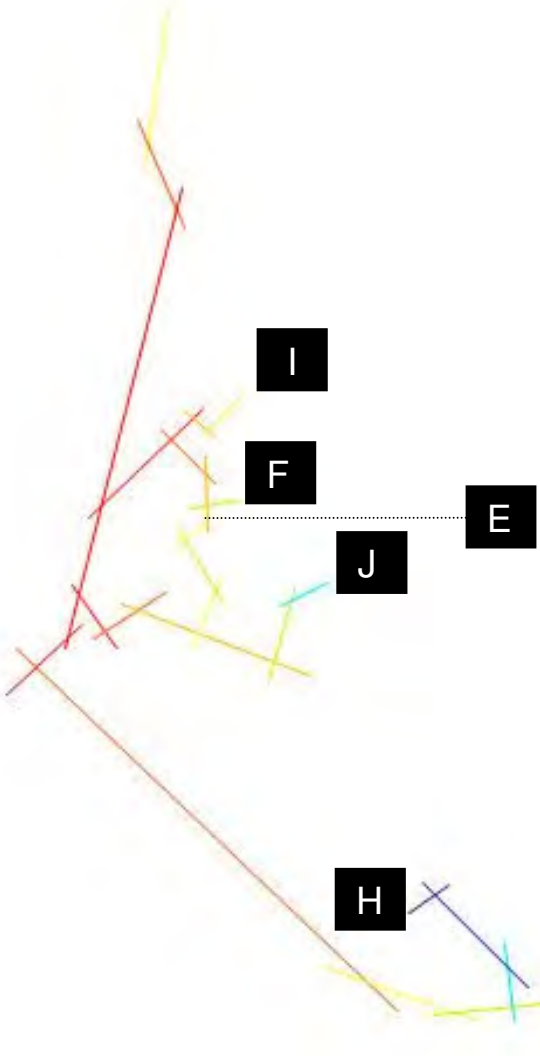
Box 22_ Selected activities in case area 2

Activities

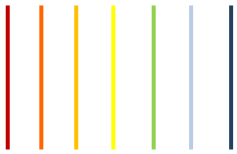
Only activity listed in Box I use the river as sewage output. The rest have no relation with river neither as input resource to the activity nor as use it as output. The only activities located along major pedestrian route are the shopping unit in Box H and solid waste collection area (Box G). The rest of the activities have difficult access. But all of the activities, except the solid waste collection (Box G), are categorized under informal activities since the activities are not legal registered. As seen from the axial map in figure 3.2.8 (AGRAPH software output), most of the activities are accessed from less integrated access routes. This informality is encouraged in areas which are furthest away from major access routes where surveillance is difficult. As areas in urban space are far from major accesses with difficult access and when the destination is not visible, it encourages informal activities. Meanwhile, the functions of the transformed units were identified using open ended interviews and observation. Out of 37 transformed units, 27 were units added or extended for housing purposes while, 3 were commercial and the remaining 7 were constructed for commercial purposes.



Majority of the added or extended units (27/37) are under housing category showing the dominance of the function in the case area. Commercial function is discouraged in case area 2 riverside space since the area is less visible and inaccessible.



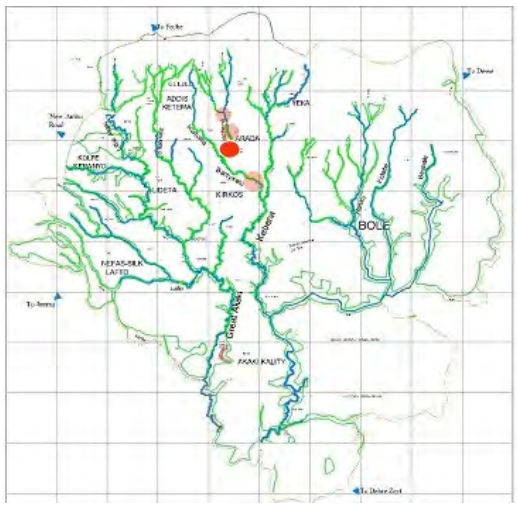
Highly integrated access



low integrated access street

Figure 3.2.8_ Axial /integration /map of case area 2 (Source: AGRAPH space syntax software output)

3.5 Case area 3_Eribekentu- Ambassador area



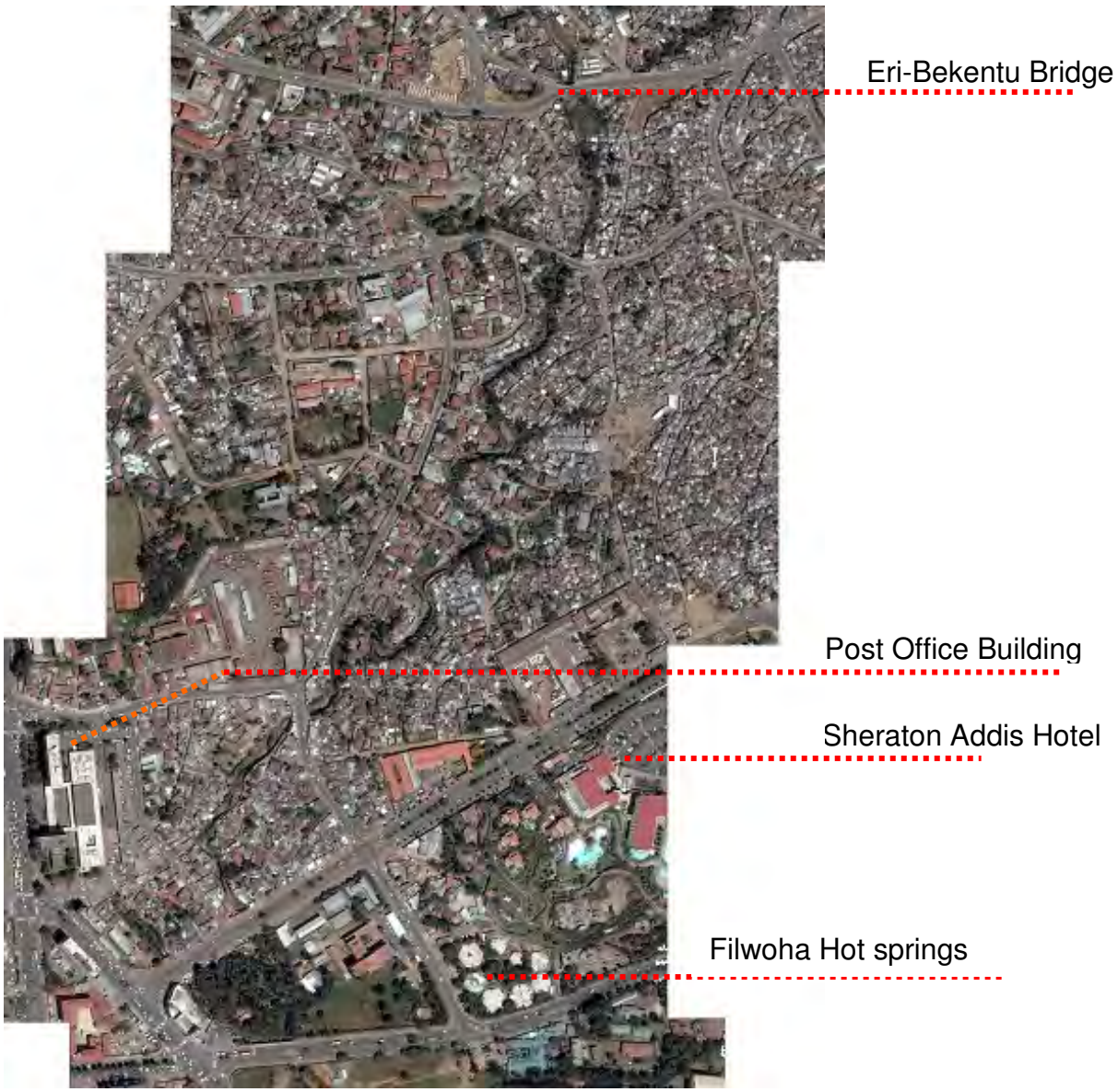


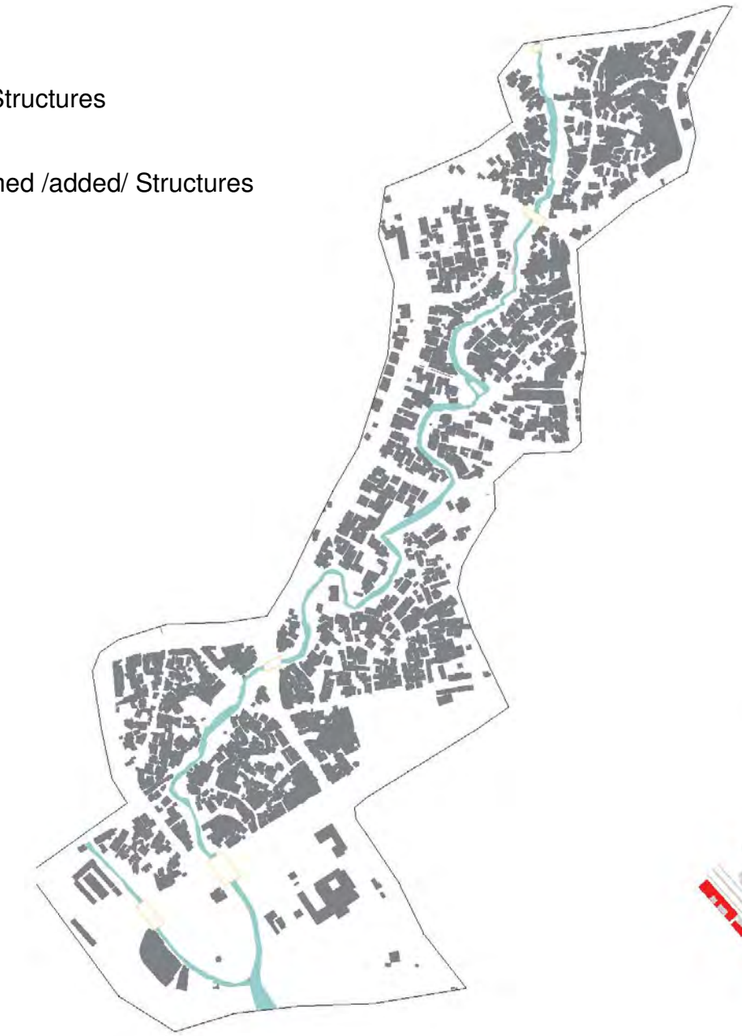
Figure 3.3.1_ Case area 3 /Eri-bekentu area/ location map

Legend

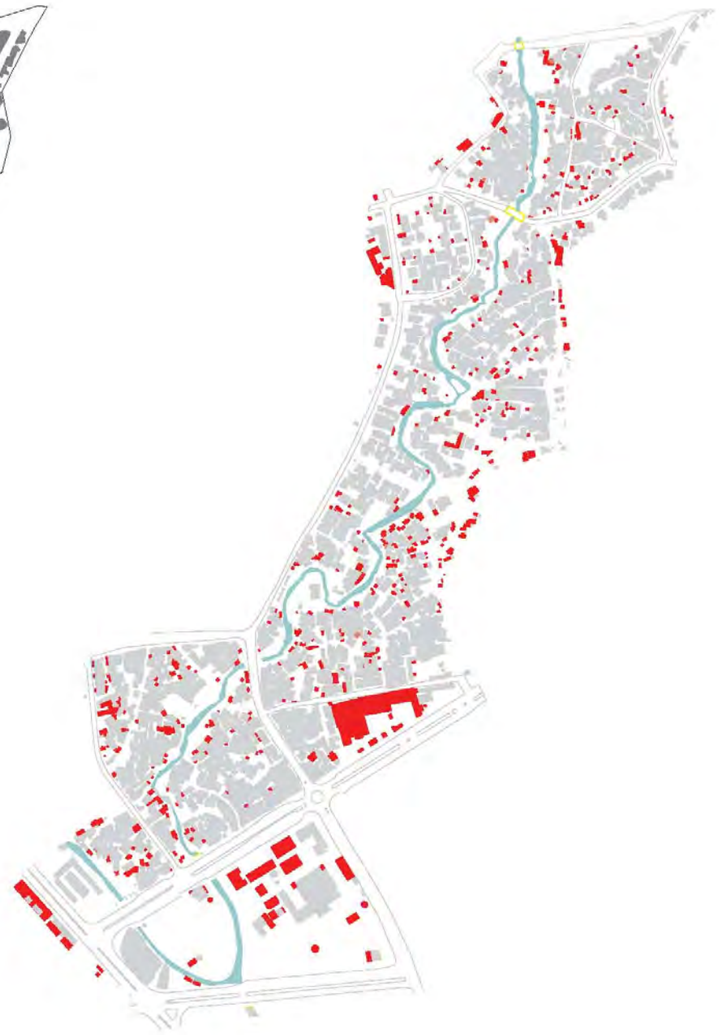
Existing Structures

Transformed /added/ Structures

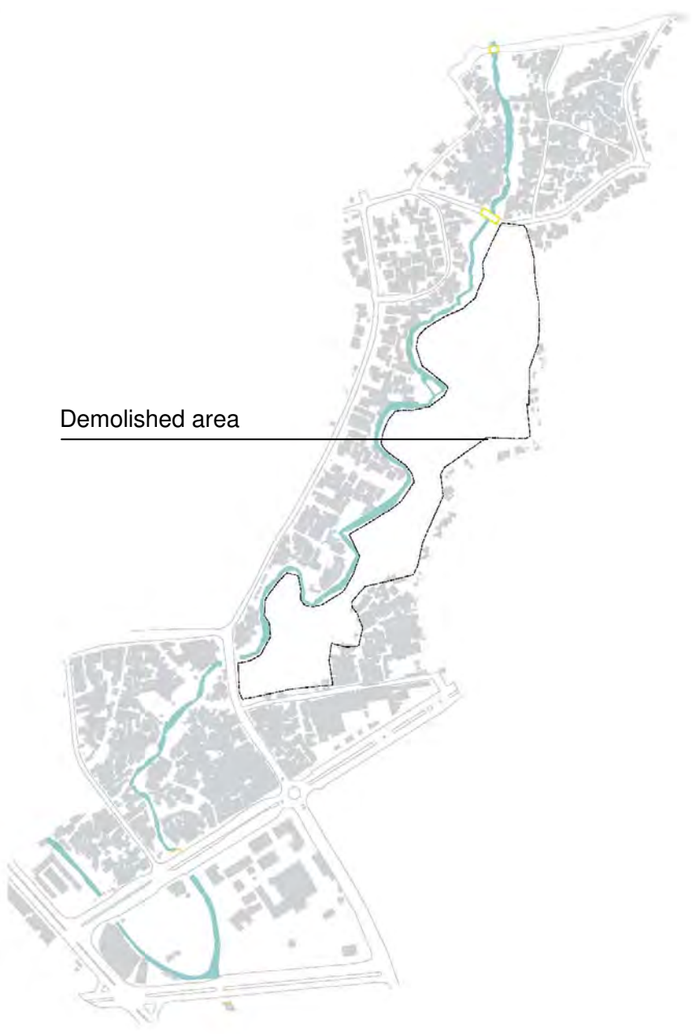
North Direction



Morphology in 1995



Morphology in 2002



Morphology in 2011

0 180m

Figure 3.3.2_ Transformed units in case area 3 (See figure 3.3.1)

The transformed units are mapped in red colors and the existing structures are mapped in gray tone (see figure 3.3.2). The spatial transformation is highly noticed between the year 1995 and 2002. The spatially transformed units are analyzed in the boxes below to investigate for what purpose they are transformed and to identify the type of transformation as well as involved actors.

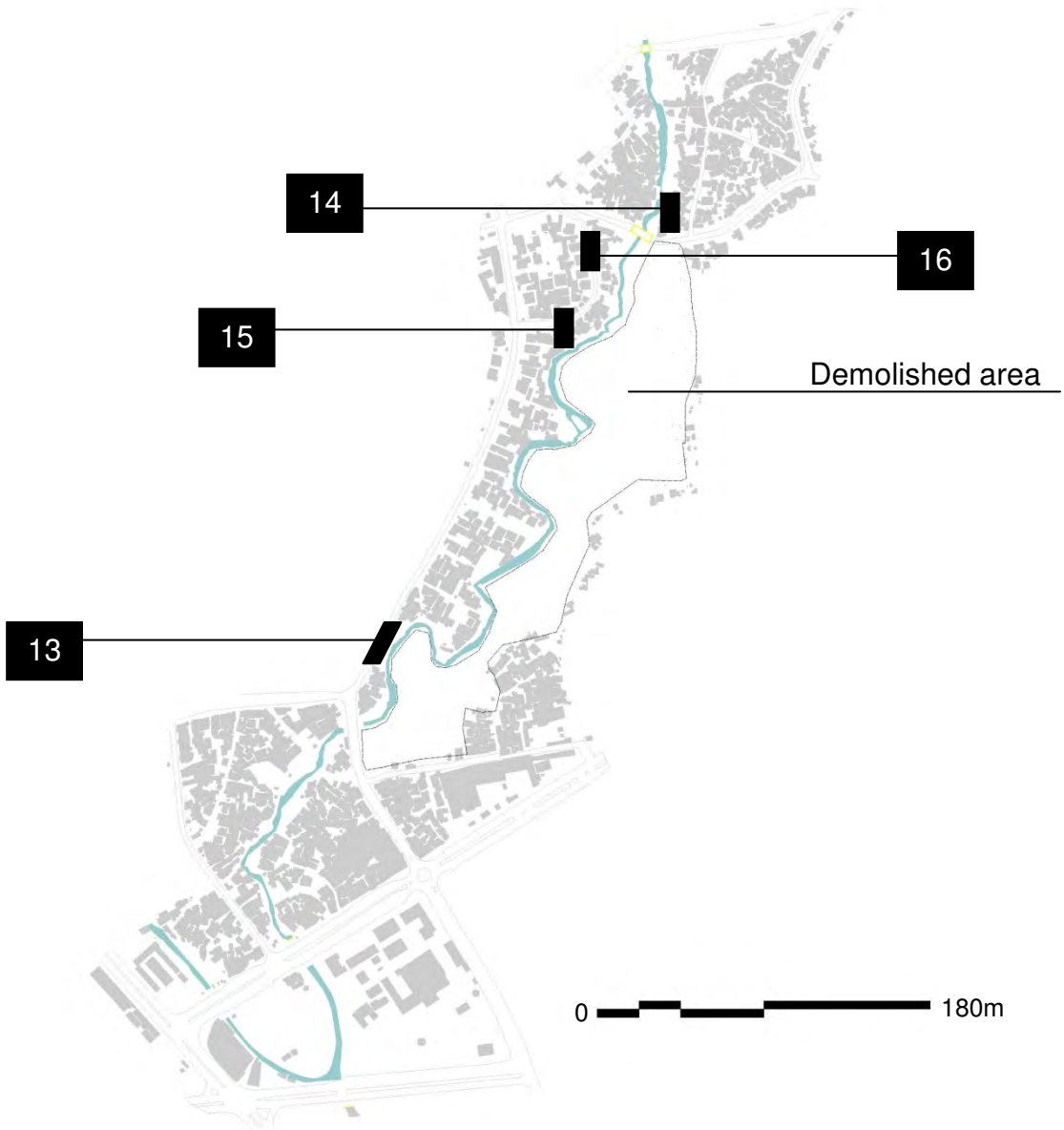


Figure 3.3.3_ Selected cases of transformed units in case area 3

13_ Transformed unit

Arkebe/Teletafi/ shops

It is believed that there are close to 6,000 units all around Addis-Ababa. These types of units are launched with the intention of empowerment strategy to support physically challenged people, urban poor's, women and street vendors (Addisalem, 2011).

Tenure: government owned

Activity: commercial

Area:

No of people using:

Wall material: metal sheet

Roof material: GIS sheet

Floor material: metal sheet

Box 23_ Transformed unit in case area 3

14_ Transformed unit

Communal kitchen

The family settled in this area before 2000. The unit is extended on existing *kebele* house for rental purpose.

Tenure: *kebele* owned housing

Activity: rented out sleeping room

Area: no of rooms: 4

No of people using:5

Wall material: GIS sheet

Roof material: GIS sheet

Floor material: cement screed

Box 24_ Transformed unit in case area 3

15_ Transformed unit

A semi detached unit is added initially as a store and rented out 6 years ago/2005/

Tenure: privately owned

Activity: living unit

Area: no of rooms: 1

No of people using: 4

Wall material: mud/*chika/* wall

Roof material: GIS sheet

Floor material: earth

Box 25_ Transformed unit in case area 3

16_ Transformed unit

A new structure constructed near existing structure within the same compound. The family earn additional income from the rented structure.

Tenure: privately owned / rented/

Activity: living unit

Area: no of rooms: 4

No of people using: 8

Wall material: mud/*chika/* wall

Roof material: GIS sheet

Floor material: earth

Box 26_ Transformed unit in case area 3

Analysis and Findings

This case area also exhibits similarities as the two previous cases, that there are significant numbers of housing units transformed in the year 2002 map. The units are transformed either by adding in the existing structure or they are new constructions within the existing compounds. Mud construction is mainly employed in the transformation process both in keble owned house and privately owned housing units. The added housing units illustrated in Box 15 and Box 16 are rented-out for other families. The extended unit in Box 14 is in the *kebele* house which is rented out in response to the demand to earn income. The third type of transformation is occurred on vacant space located between the streets and housing fence for commercial purpose with or without formal license. Metal sheet is mainly used to construct these temporary shelters.

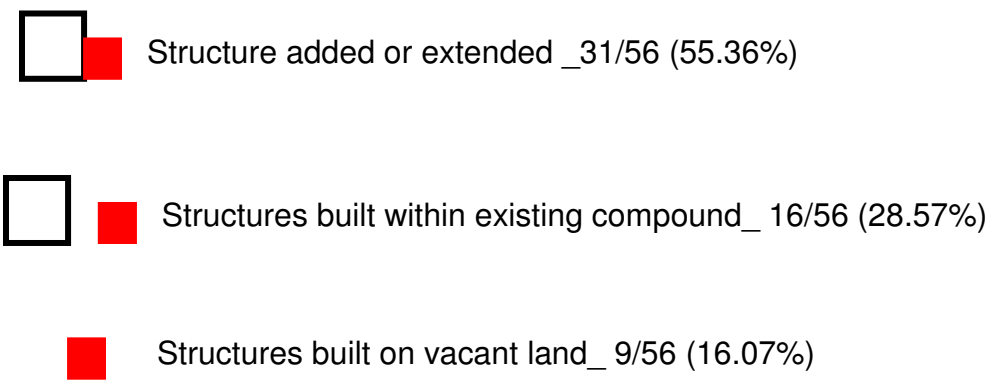


Figure 3.3.4_ Types of transformation in case area 3

Out of 56 observed and identified transformed units, 31 units were extended structures, 16 were structures built next to existing building within the same compound and the remaining 9 were new structures constructed on vacant land.

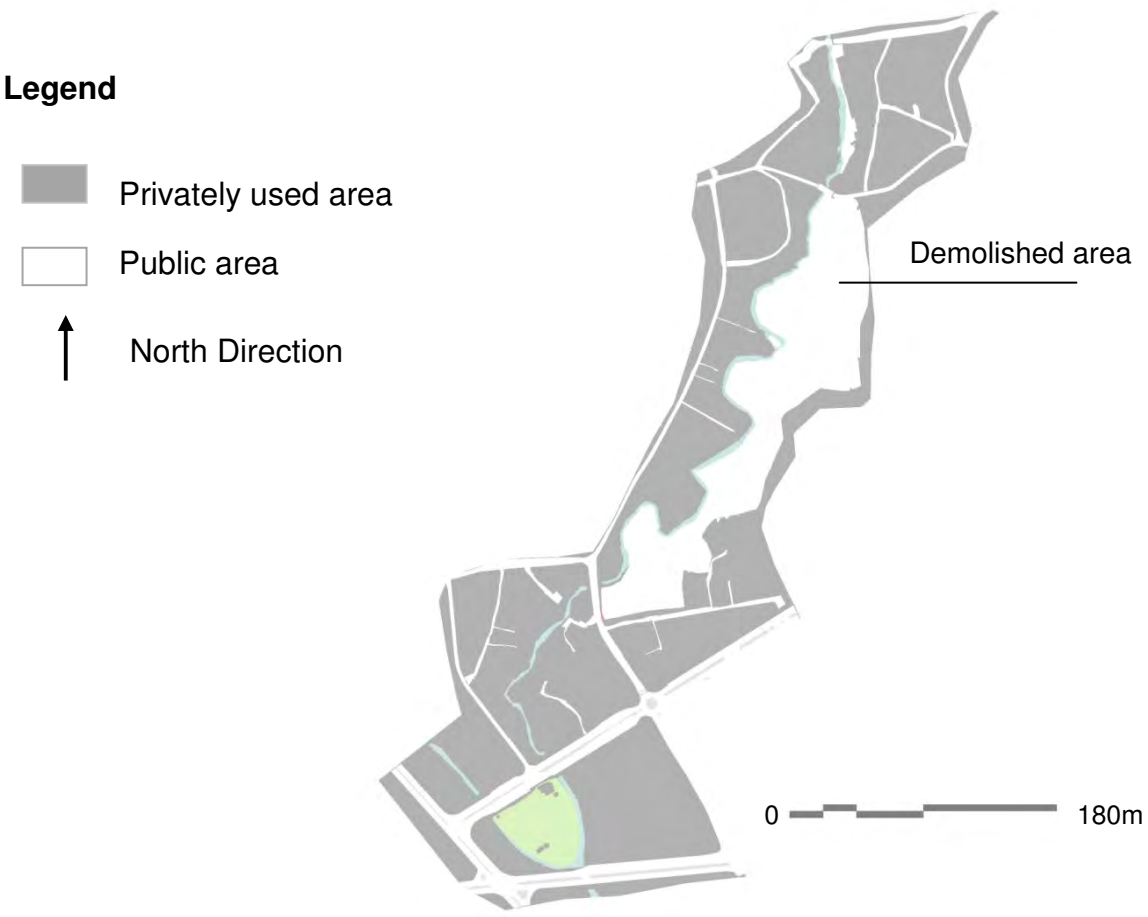


Figure 3.3.5_ Domain map of case area 3

The private space coverage is also dominant in this case area (see figure 3.3.5) with absence of public open space other than access streets. The study area have only one closed-public park/*Ambassador* Park/ (mapped in green). The river is physically and visually in-accessible in majority of the case area as there is no riverfront avenue and continuous pedestrian route (see figure 3.3.6). The visibility of the river is blocked by the existence of manmade barriers. The housing units along the riverfront turned their back to the river as observed in the edge map (figure 3.3.7). Lack of activities which promote public is also evident in most of this case area. The open field which is observed in the map is the demolished area as part of Sheraton Hotel expansion and urban renewal area.

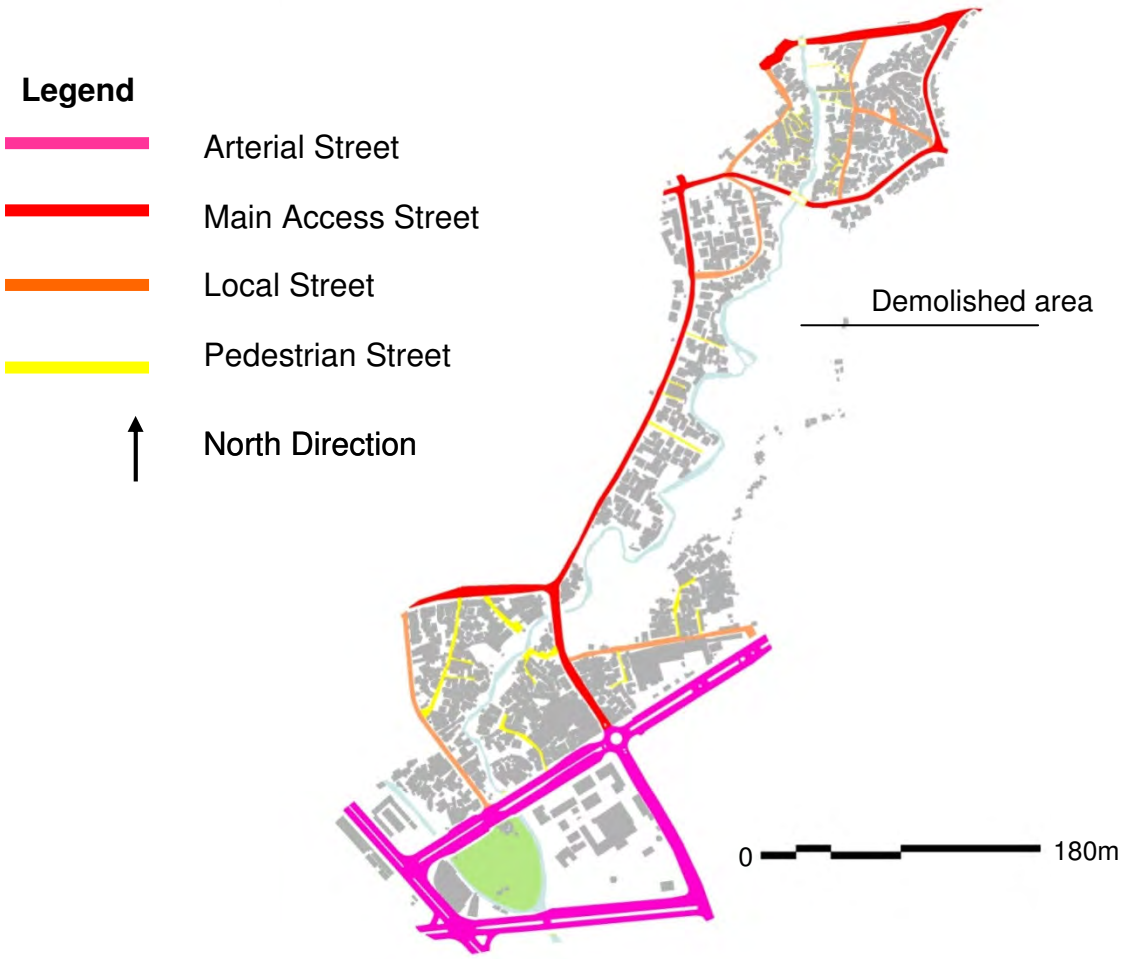


Figure 3.3.6_ General access map of case area 3

But unfortunately, direct access to the river even from the park is also prevented by its fence and the park itself give its back to the river. The park's fence hiders the visibility of the river which flow adjacent to the park and the integration with the near-by buildings. The rest of the urban fabric is detached from the park.

Activities along the riverside in this case area are also investigated using visual observation and syntax software analysis. The selected cases are shown in figure 3.3.8 below.

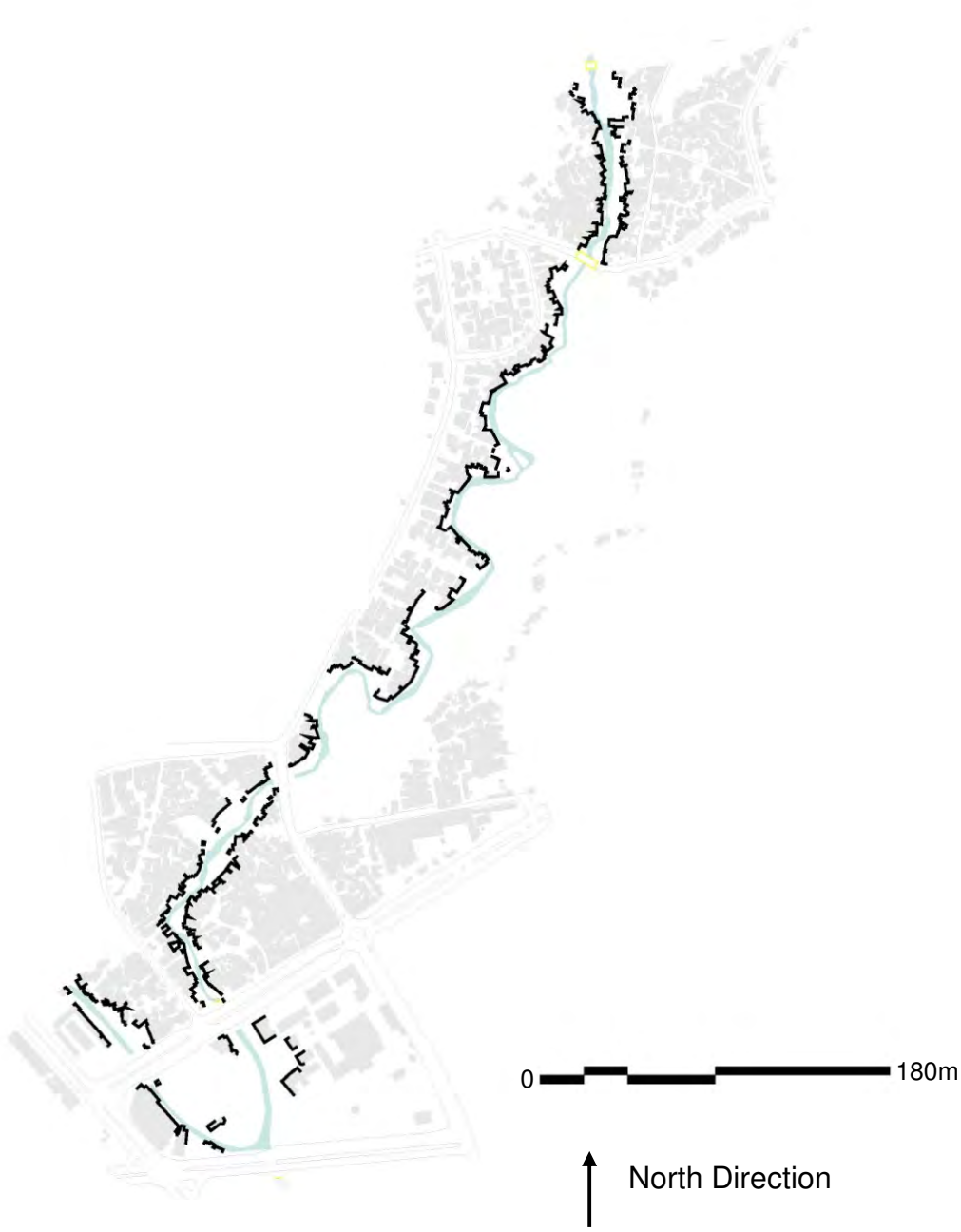


Figure 3.3.7_ River-edge definition map of case area 3

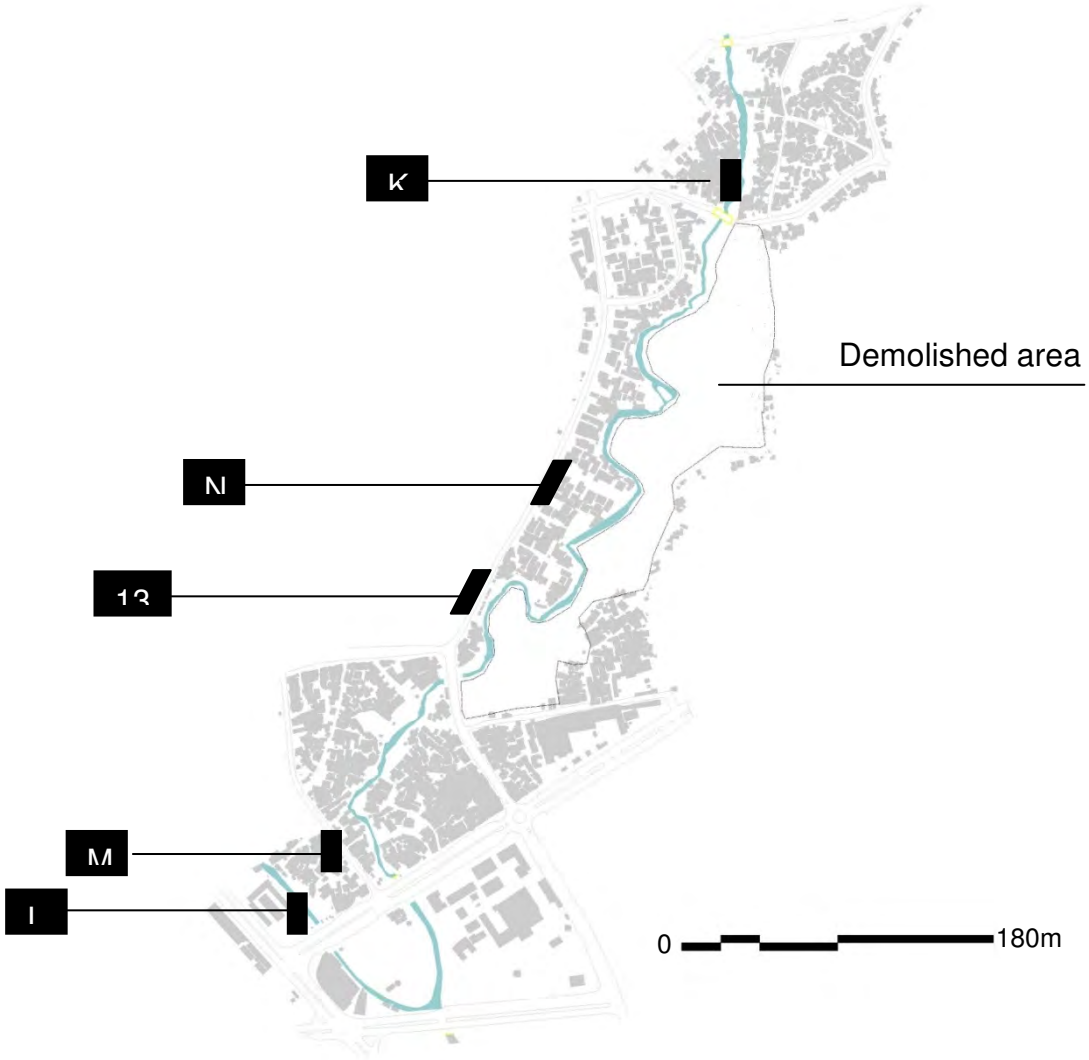


Figure 3.3.8_ Selected activities of case area 3

K_ Activity

Working area: ___meter square

Lease condition: informal

Choice of place/space: available vacant land

Relation with the river: none

Work in the area since: 2005 GC

Gullit /informal open market

Box 27_ Activity in case area 3

L_ Activity

Working area: 52 meter square

Lease condition: privately owned (informal)

Choice of place/space: accessibility & visibility

Relation with the river: none

Work in the area since: 2000 GC

Eucalyptus wood selling

Box 28_ Activity in case area 3

M_ Activity

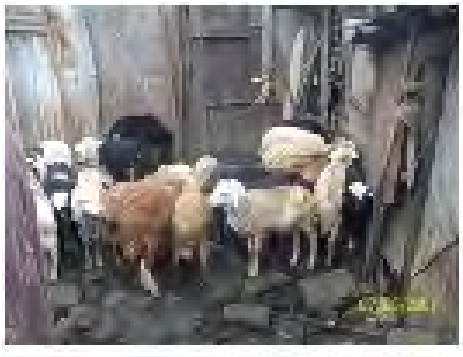
Working area: 6 meter square

Lease condition: rented within privately owned compound

Choice of place/space: family, availability

Relation with the river: none

Work in the area since: 2005 GC



Sheep barn

Box 29_ Activity in case area 3

N_ Activity

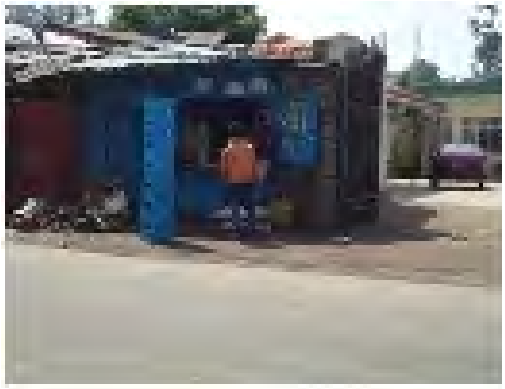
Working area: 4.5 meter square

Lease condition: rented from privately owned unit

Choice of place/space: street side

Relation with the river: none

Work in the area since: 2002 GC



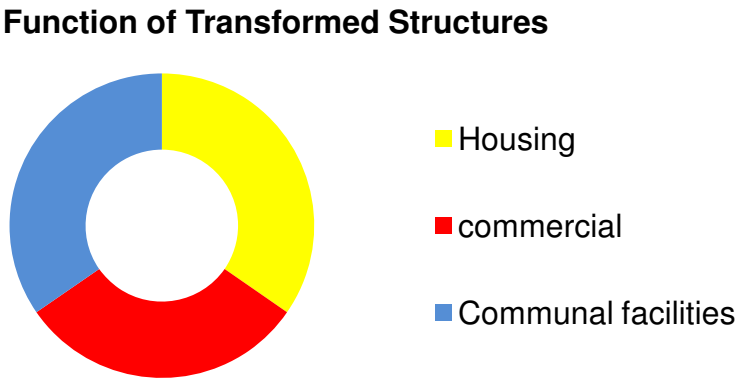
Small scale window shops

Box 30_ Activity in case area 3

Activities

There are significant numbers of small scale window shops (Box 30) along the major streets of the case area which are providing different kind of service targeting street side passer-by. Informal open market is also practiced in a vacant interface between the street and compound fence (Box 27). All of them except activity M are located along major access street targeting the street movement as main resource. The axial map analysis of the case area also reflects the same result as seen from figure 3.3.9 below. Whereas, activity M (sheep barn) is conducted within a residential living unit as it is domestic income source for the family. The only activity located in none- integrated access with less traffic flow is the barn activity M (see figure 3.3.9).

With the help of open-ended interviews the function of the transformed structures was identified. Structures built or extended for housing purpose as well for communal facilities were both 9 each out of 26 and the remaining 8 were constructed for commercial purposes. A balance of function distribution is observed in case area 3. The closeness of the main street to the river-edge is one of the possible reasons for the balance distribution of the functions.



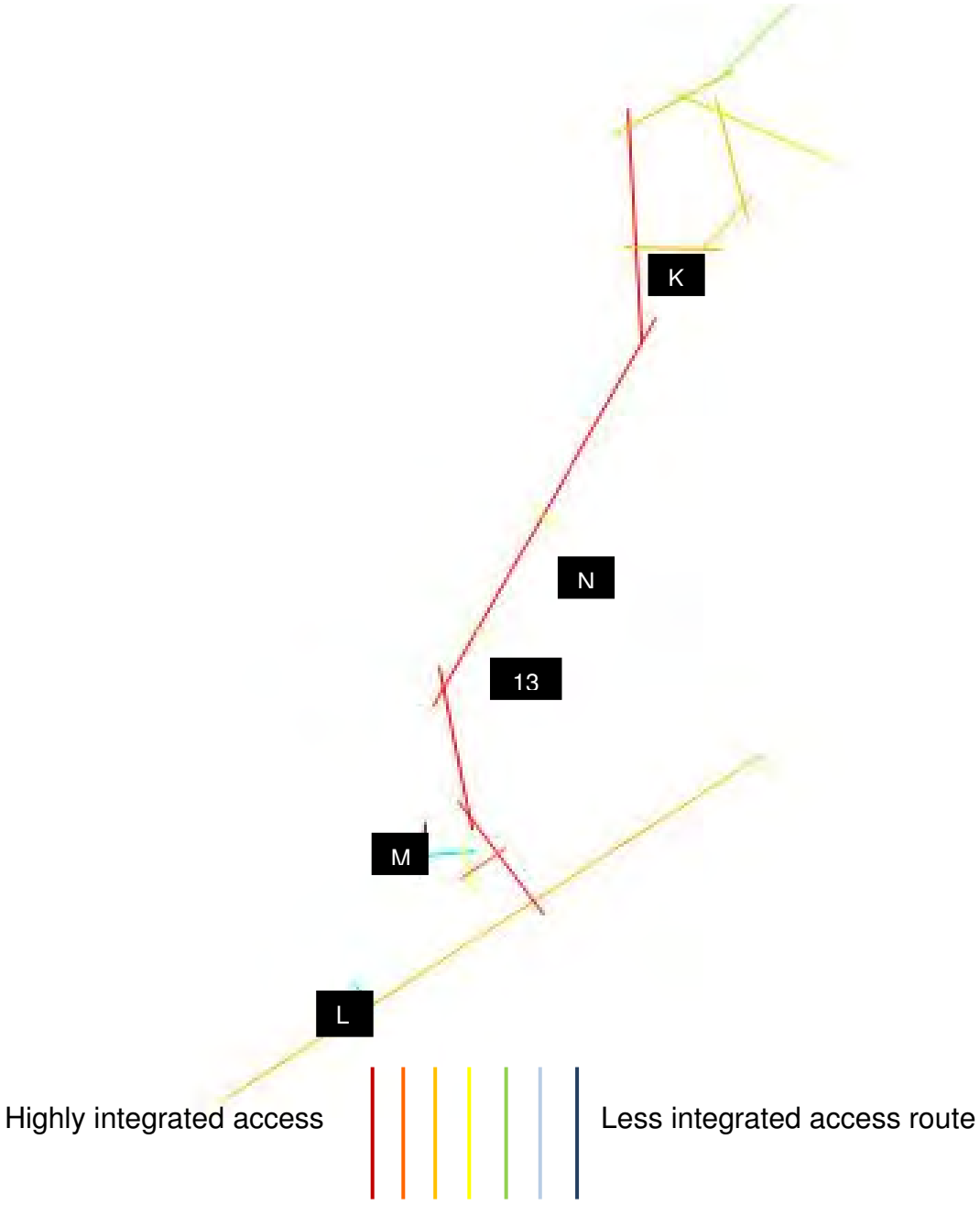
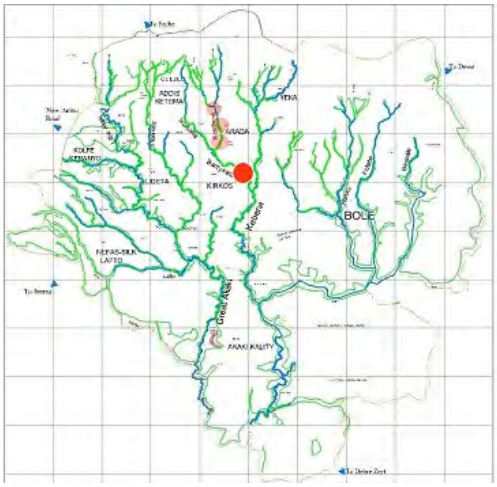


Figure 3.3.9_ axial map of case area 3 (source: AGRAPH software)

3.6 Case area 4/Bole-peacock area/



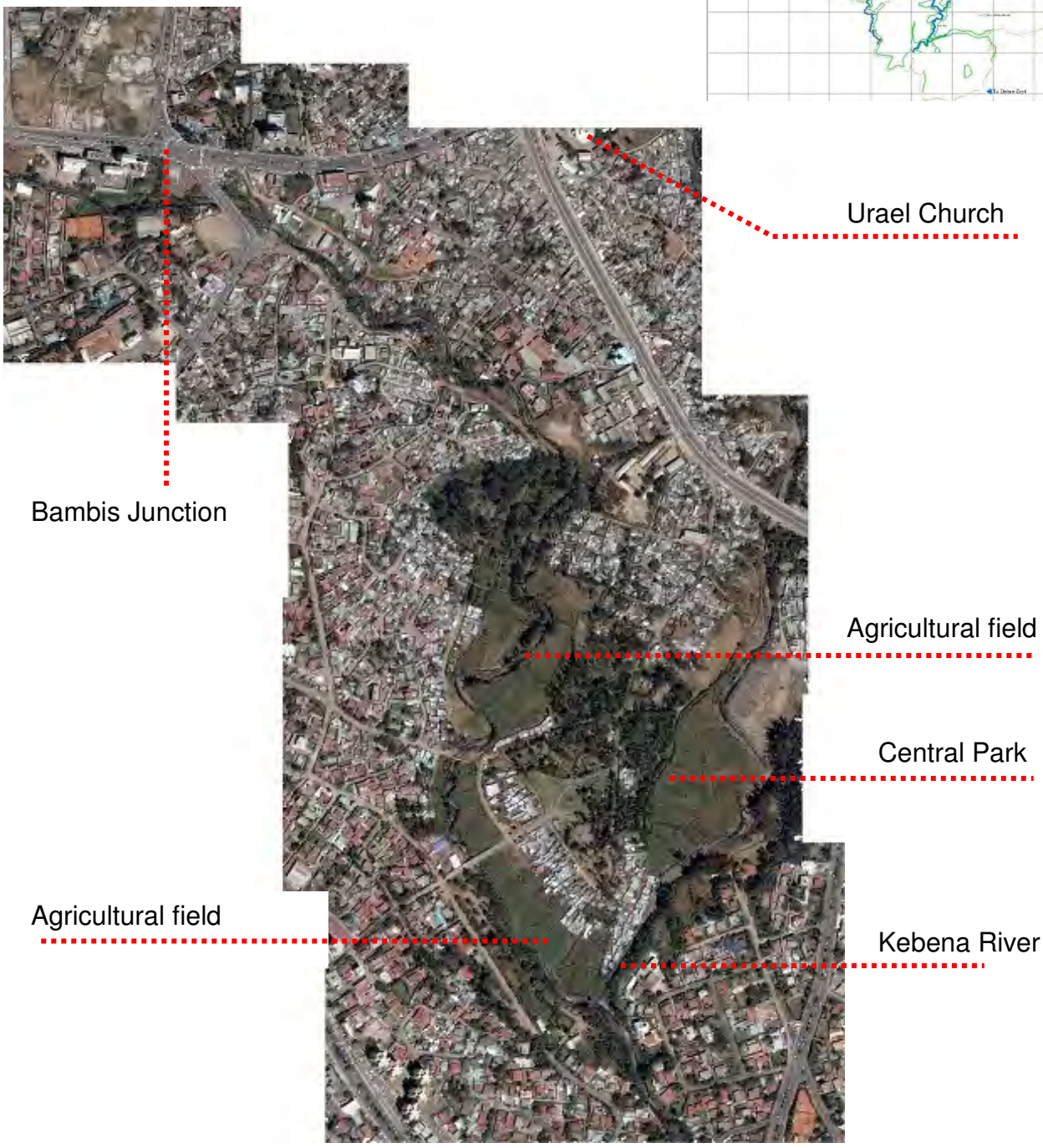
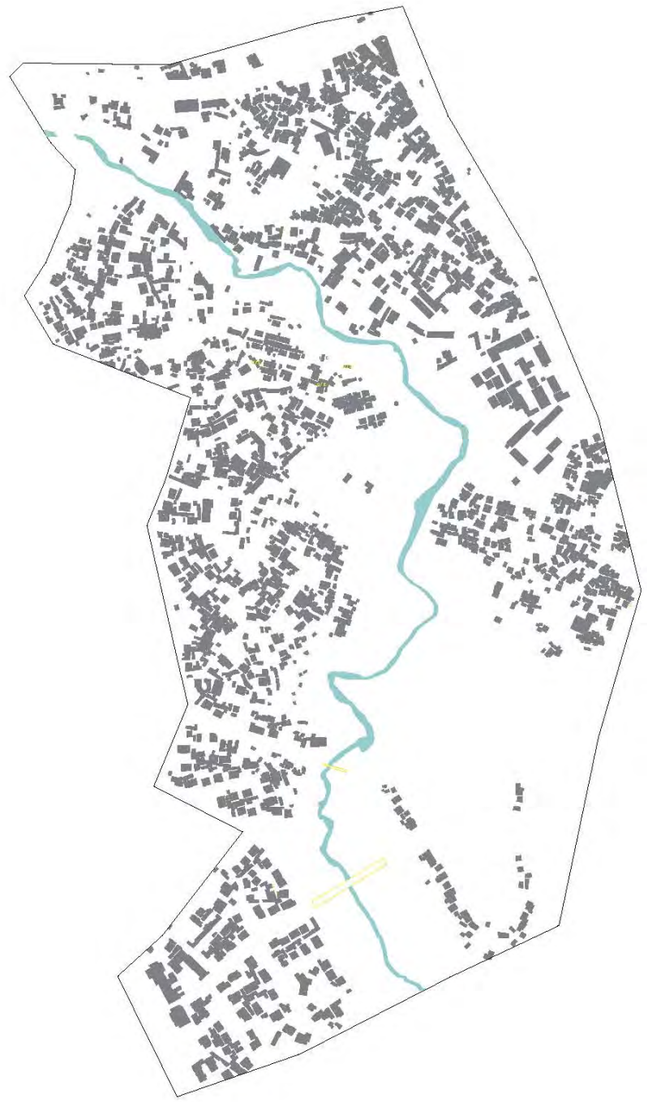
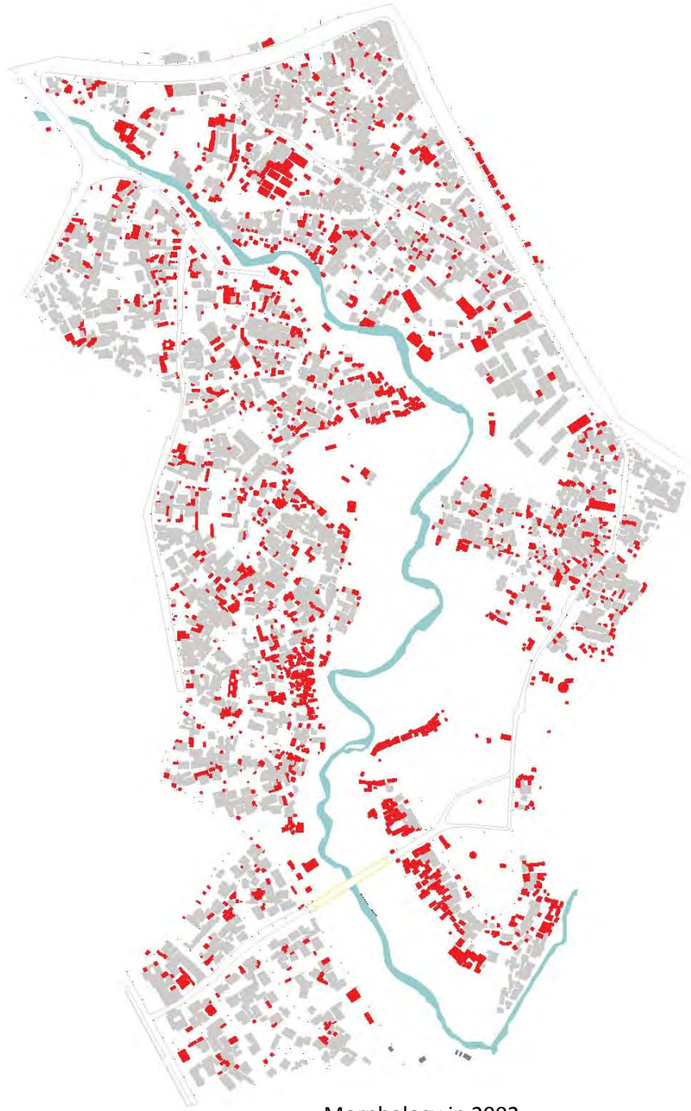


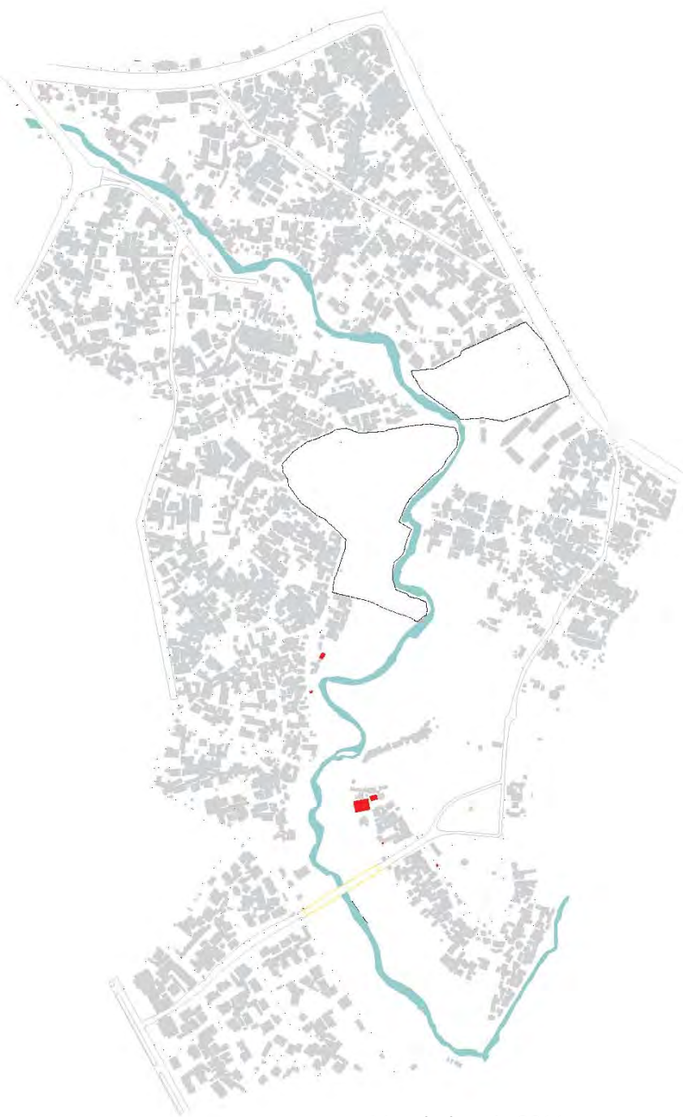
Figure 3.4.1_ case area 4/Bole- Peacock area/ Location map



Morphology in 1995



Morphology in 2002



Morphology in 2011

Legend

Existing Structures

Transformed /added/ Structures

0 180m

North Direction

Figure 3.4.2_ Transformed units in case area 4

This case area similar to earlier cases exhibits spatial transformation as observed from figure 3.4.2 above. The transformed units are marked in red and the existing units are mapped in gray tone. The majority of the transformation is occurred between the year 1997 and 2002. Cases are selected to investigate the type of transformation and activities taking place in the area and illustrated in Box below.

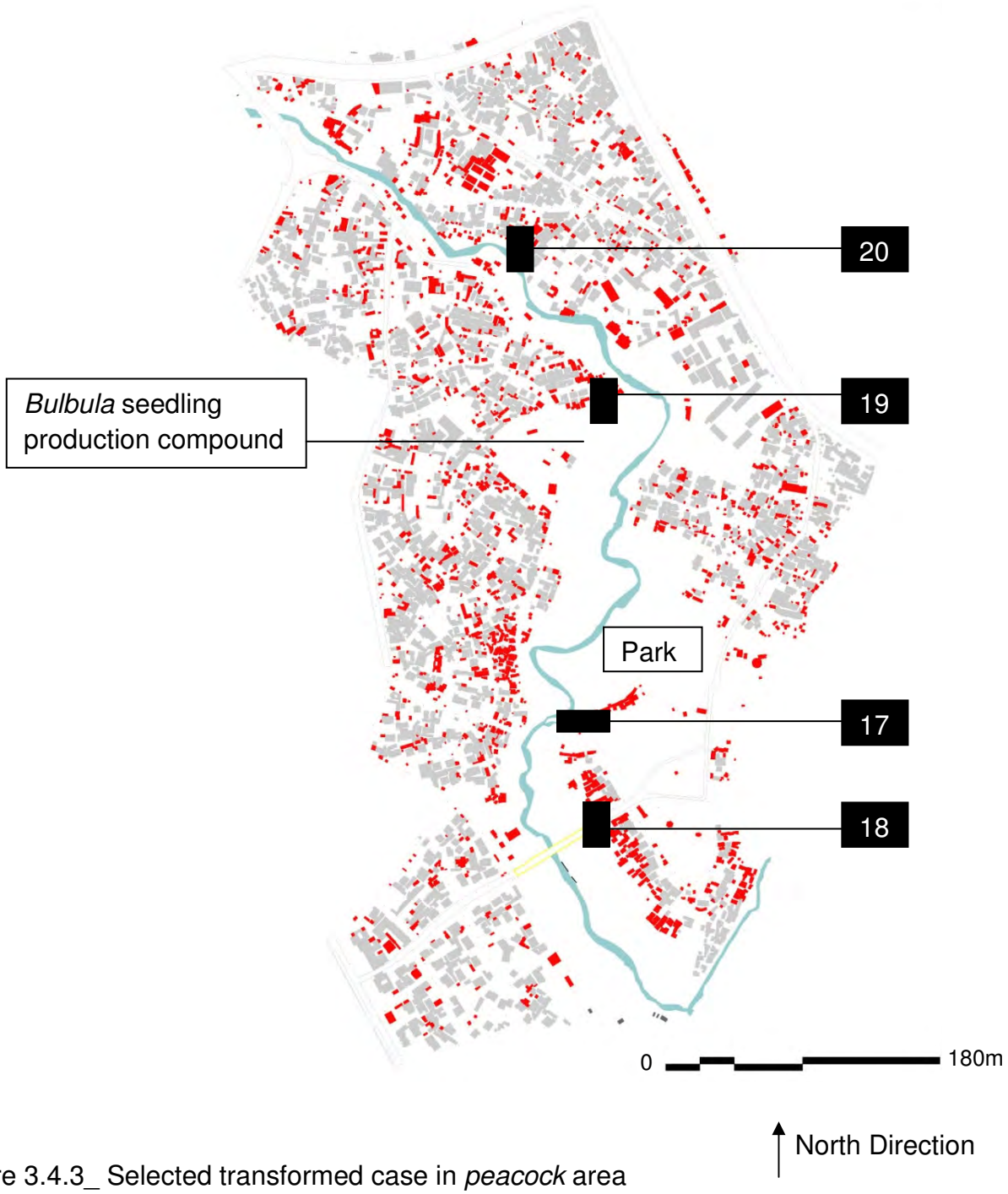


Figure 3.4.3_ Selected transformed case in *peacock* area

Type17_ Transformed unit

Structure constructed on vacant land

Ownership: private /informal/

Activity: living unit

Area: 8 m2 no of rooms: 1

No of people using: 3

Wall material: bamboo+ mud

Roof material: GIS sheet

Floor material: earth

Box 31_ Transformed units in case area 4

Type18_ Transformed unit

Structure constructed with existing private compound

Ownership: private/ informal/

Activity: living unit + cattle barn

Area: 18m2 no of rooms: 2

No of people using:

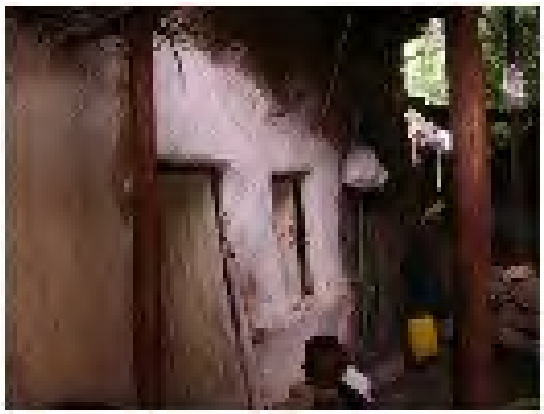
Wall material: mud construction

Roof material: GIS sheet

Floor material: cement screed

Box 32 _ Transformed units in case area 4

Type19_ Transformed unit



Structure constructed within existing private compound

Ownership: private / rented/

Activity: living space

Area: no of rooms: 1

No of people using: 3

Wall material: mud construction

Roof material: GIS sheet

Floor material: earth

Box 33_ Transformed units in case area 4

Type20_ Transformed unit

Extended structure

Ownership: /government

Activity: living space /rented/

Area: no of rooms; 1

No of people using:5

Wall material: mud construction

Roof material: GIS sheet

Floor material: cement screed

Box 34_ Transformed units in case area 4

Analysis and Findings

The intensity of the transformation in this area is mostly along the buffer zone area. The majority of the transformed units in this case area don't have any sort of title deed making them informal. Temporary construction material is employed in constructing the built up structures. These structures are mostly used for rental purpose to earn extra income. In general, two types of built up transformations is observed, the first type of transformation is the additions to the existing units and the new independent structures erected within existing compound fall in the second type of transformation category. The compound development of this area defers from the previous three cases. The compound has a short frontage with longer depth in order to share the water resource especially on the areas near agricultural fields. A second access for pedestrian has also been added as the demand for renting rises.

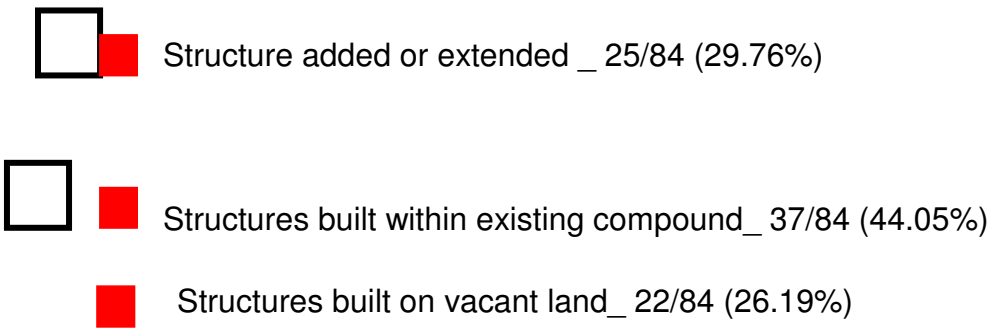


Figure 3.4.4_ Transformation types in case area 4

By using the line map and field observation, 84structures type of transformation were identified. Out of 84 structures, 25 of them were structures which were extended, 37 of them were new structures built near to the existing building within the same compound and the remaining 22 structures were built on vacant lands.

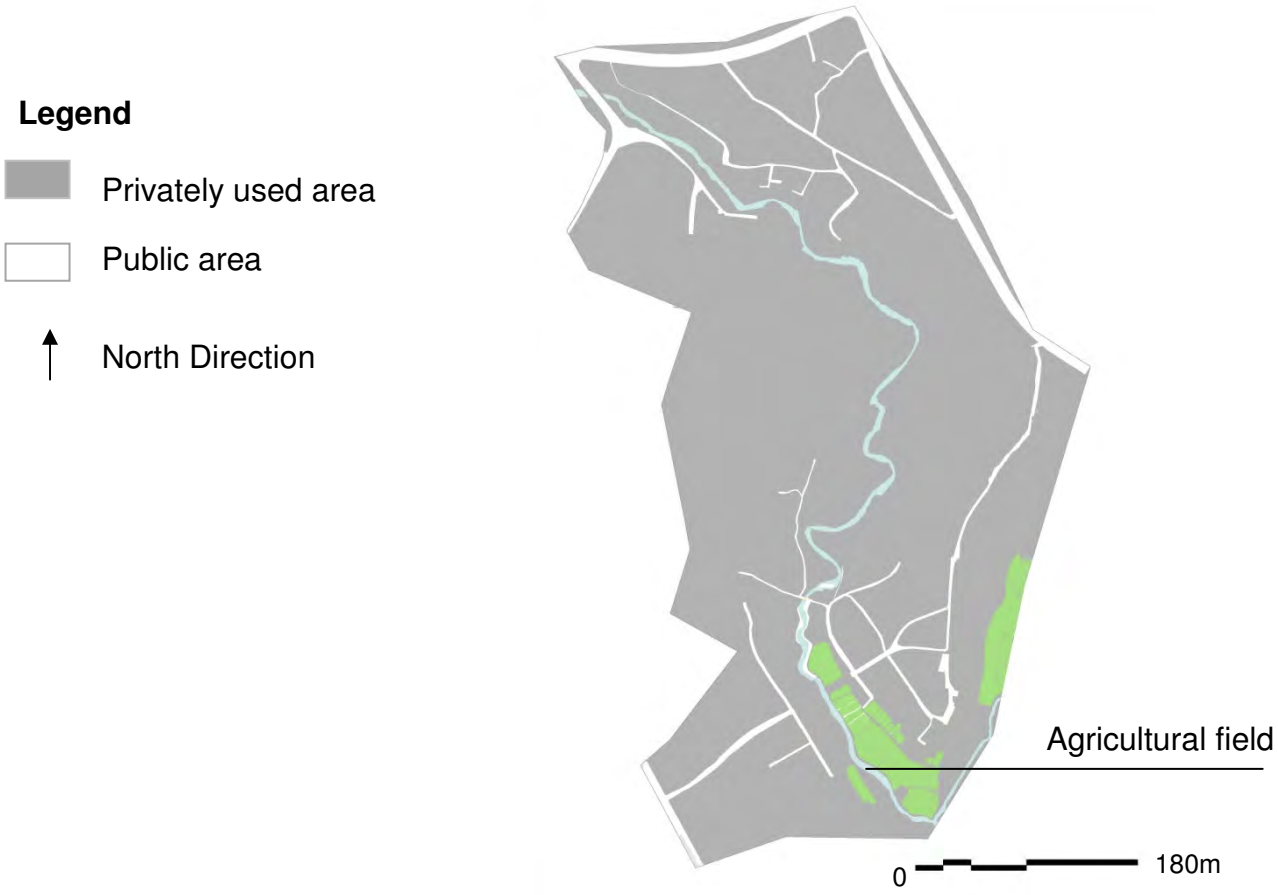


Figure 3.4.5_ Domain map of case area 4/peacock area/

This case area is located very close to one of the highly active urban center of Addis Ababa_ Bole. As one descends down the path towards the public park commonly known as Peacock Park or central park, it is evident to witness a large scale urban agriculture practice. This practice is conducted both individually as well as in a communal manner. These green fields are the major open fields observed in the case area. Flood plain prone area becomes a potential for the agriculture practice. The land coverage of the area is also dominated by private-use quarters (see dominance map figure 3.1.5). Access to the riverfront is possible only through the agricultural fields and through individual compounds as illustrated in figure 3.4.6. Most of the residential units are accessed by pedestrian routes. Looking at figure 3.4.6, it is evident to observe absence of local streets running along the riverfront preventing public usability of the area. As most of the open fields are meanly for domestic and communal uses, absence of urbanity is also evident in the area.

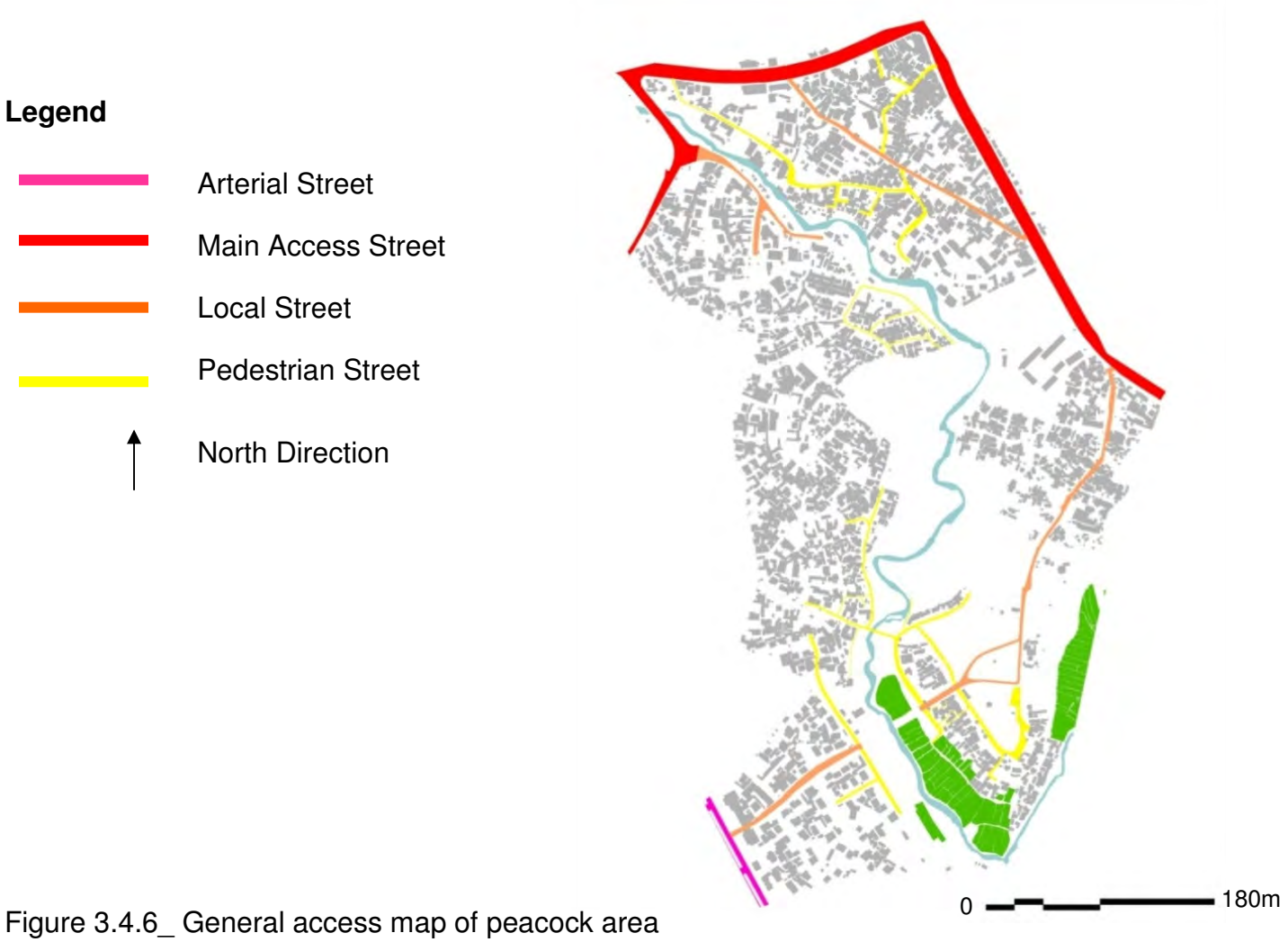


Figure 3.4.6_ General access map of peacock area

However, unique to this area, majority of the buildings faces the green field adjacent to the riverfront. The usability of the river as a source for their agricultural product guides the settlement pattern.

Activities other than residential function are picked and represented in boxes below to investigate the parameters which influence the activity.

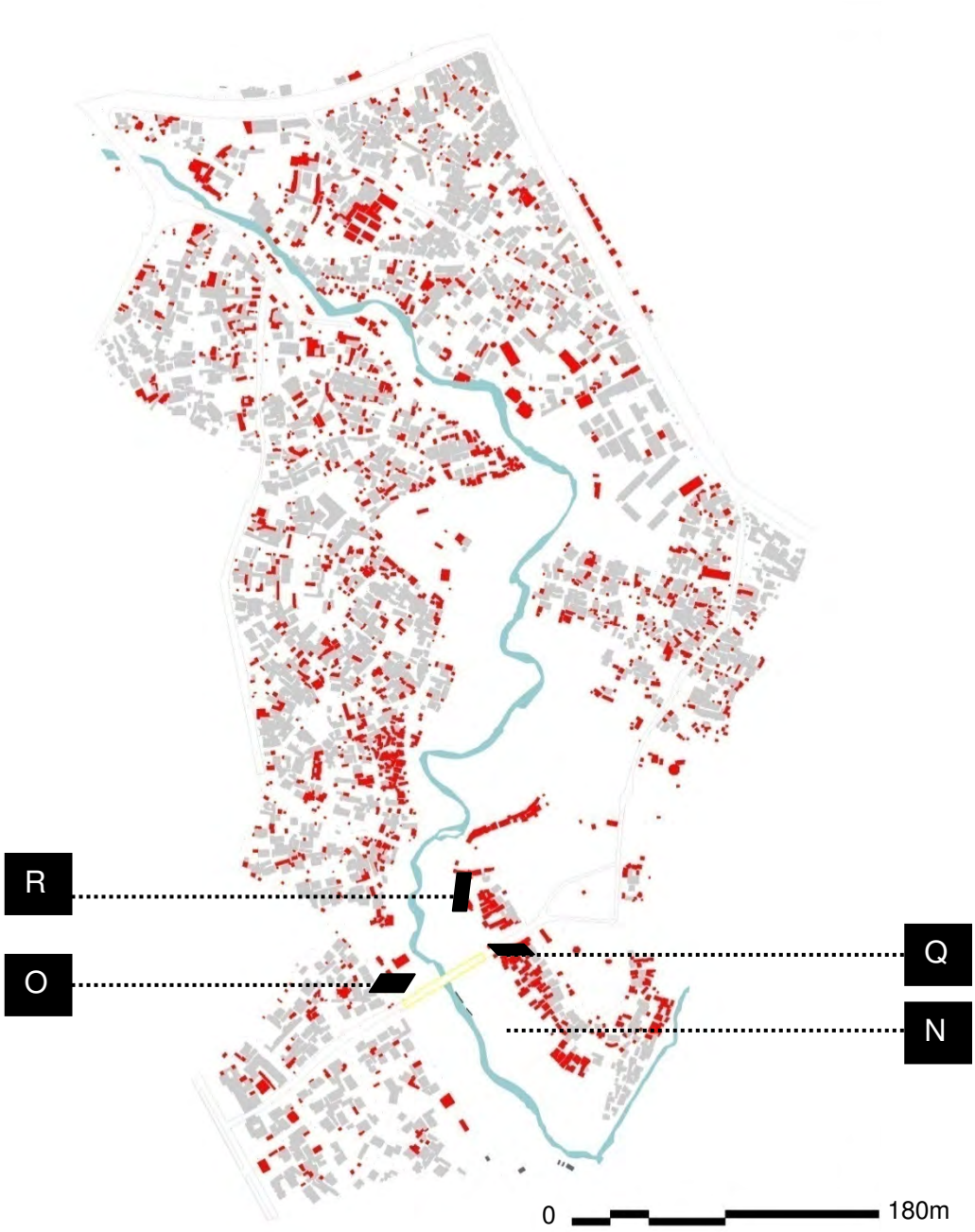


Figure 3.4.7_ Selected activities along case area 4/peacock area/

N_ Activity

Working area: ___meter square

Lease condition: informal

Choice of place/space: flood pain /food production/

Relation with the river: river water source as input

Work in the area since: before 1995 GC

Communal agriculture

Box 35_ Activity along case area 4

O_ Activity

Working area: ___meter square

Lease condition: temporary license from micro and small enterprise

Choice of place/space: availability of vacant land

Relation with the river: none

Work in the area since: 2006 GC

HCB production area

Box 36_ Activity along case area 4

P_ Activity

Working area: ___meter square

Lease condition: Government owned

Choice of place/space: availability of vacant land

Relation with the river: fertile soil

Work in the area since: 2006 GC

Seedling production

Box 37_ Activity along case area 4

Q_ Activity

Working area: 16 meter square

Lease condition: informal

Choice of place/space: availability of low rate rent

Relation with the river: none

Work in the area since: 2006 GC

Cattle barn

Box 38_ Activity along case area 4

R_ Activity

Working area: ___meter square

Lease condition: informal

Choice of place/space: availability of vacant land /flood plain/

Relation with the river: take input from river wateer

Work in the area since: 1997 GC

Private Domestic agriculture

Box 39_ Activity along case area 4

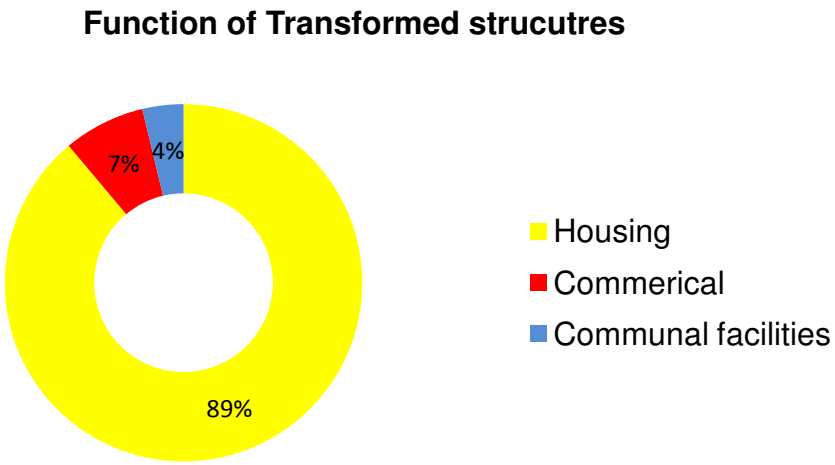
Activities

Food production activity R and N highly depend on the river as an input resource. The food production is used both for domestic and also for commercial purposes. However, the absence of public access towards these activities is observed. Security being the main reason, the area is discourages passer-by by the addition of access barriers. Vacant lands are appropriated by young cooperatives working after acquiring a temporary license from the *kebele* micro and small enterprise. Almost of all of the activities except activity O in this case area are hidden and in-accessible to the urban pubic. Most of the activities happening in this case area are far away from major access street and are less accessible. It can be understood that these activities are production based activities which don't need direct

relation of public. But the product is user-intended. The mineral content of the river water needs further investigation health wise, since the river water is directly applied to produce sensitive vegetables like tomato, carrot and cabbages without any sort of purification mechanism.

The Axial map illustrates the urban access route integration in figure 3.4.8. The axial map is developed using AGRAPH space syntax analyzer software. The output of the map also emphasizes the above assumption since most of the activities presented in box above and the transformed units are located along the less-integrated access routes.

After conducting fieldwork, the function of transformed structures was identified. Structure built for residential functions dominated with 24 units out of 27. Only one unit was constructed for communal purpose and two for commercial purpose. The dominance of residential function is directly related with the proximity of main access street. As the riverside area is farthest apart from the main street and it is less accessible and less visible it discourages commercial activities.



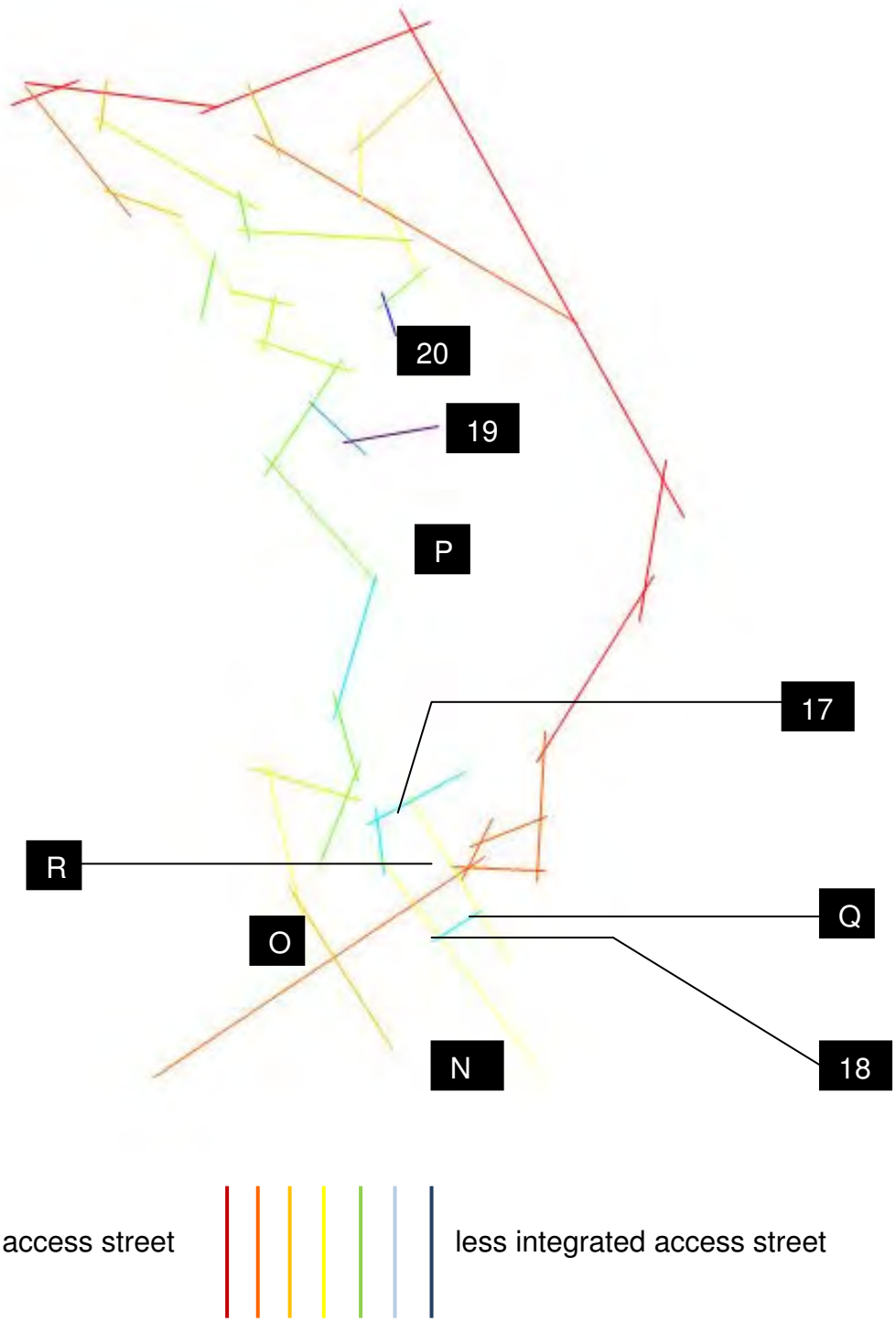


Figure 3.4.8_ Axial map of case area 4 (AGRAPH space syntax software output)

Cross Case Analysis and Findings

4. 1 Cross Case Analysis and Findings

Transformation

In all the case areas, a significant transformation of built-up units is observed between the years 1995- to 2002 as seen in the morphology maps of 2002 (part 3; figure 3.1.2; 3.2.2; 3.3.2; 3.4.2). The maximum and minimum distance between near-by major access route and the river is marked as X and Y respectively. The x distance is longer in case area 2 and case area 4 with 197 meters and 450 meters respectively. Case area 1 has the least X distance (44meters). Substantial number of transformed built up units are exhibited in areas which are furthest away from near-by access routes. It can be understood from the above data that, as the distance between nearby access route and the river is furthest away, the more it hosts transformation of built-up structures.

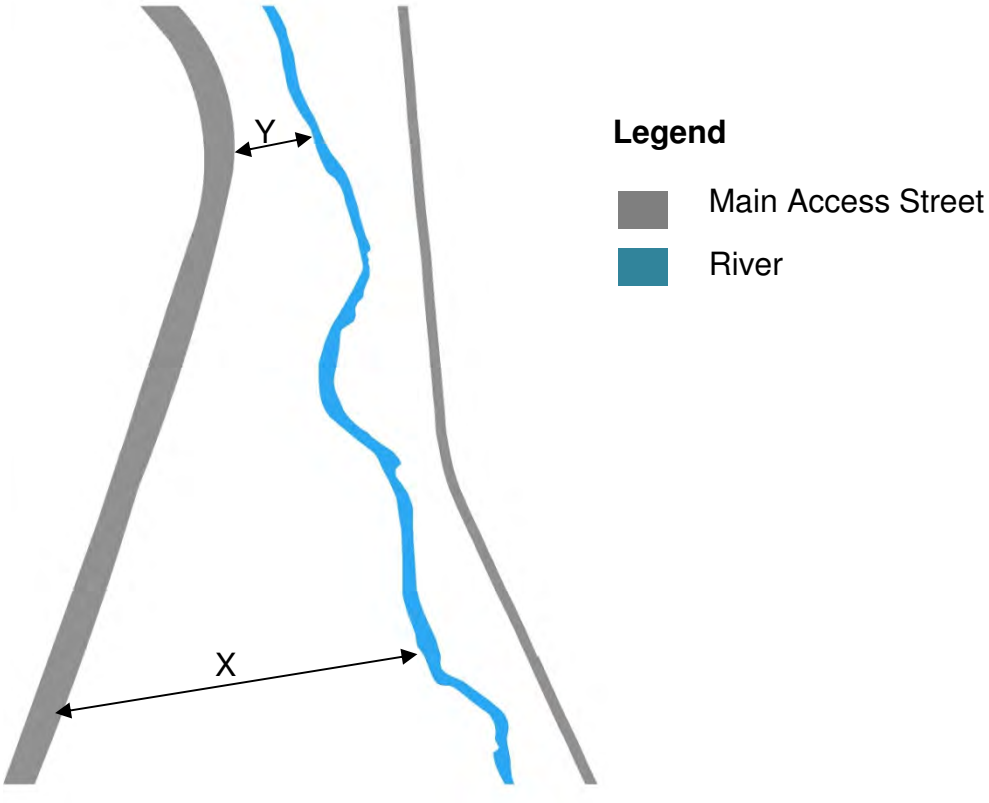


Figure 4.1 _ maximum and minimum proximity between river-edge and access street

Type of built-up transformations:

Basically, three type of transformation were observed in all the case areas. Spatially and physically extended spaces on existing structures, new additions within existing compound and new additions on vacant land/open space and access/.

Location			
Case area 1	13/31	11/31	7/31
Case area 2	20/79	38/79	21/79
Case area 3	31/56	16/56	9/56
Case area 4	25/84	37/84	22/84
Total	89/250/35.6%/	102/250/40.8%/	59/250/23.6%/

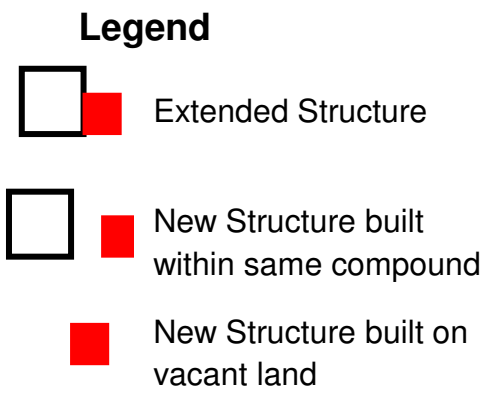


Table 4.1_ Summary of type of transformation of built up structures

The result of the above summary table 4.1 shows that majority of the transformed structures were new structures constructed next to existing structure within the same or existing compound. The transformations of the structures were carried out both by government owned units as well as on owner occupied units. New structures are tend to be constructed on vacant land and within existing compound as the proximity between the river-edge and main access street are furthest apart.

Function of the Transformed structures:

The function of the transformed built-up structures were investigated and categorized in to three major functions- Housing, Commercial and common facilities.

Three types of housing activities were observed while conducting fieldwork. Housing added for day to day activity(new space needed with increasing number of family size like additional bed room, kitchen etc), housing added in order to earn additional income by letting/renting/ the additional rooms and using the additional room to sustain their economic livelihood/cattle barn, mini-shops/. Likewise, schools, communal toilet facilities and community gardens are grouped under common facilities. Structures built mainly

constructed for economic reasons like '*'teletafi'* shops and workshops are summarized under commercial.

From the data obtained during fieldwork, it was found out that most of the transformed units are under housing category in all the cases (see table 4.2). Dominance of housing transformation was observed in case area 4 and case area 2 with 89% and 73.7% respectively.

Function of Transformed units	Color code	Case 1	Case 2	Case 3	Case 4	Total /average/
Housing		14/35	27/37	9/26	24/27	74/125 (59.2%)
Commercial		8/35	3/37	8/26	2/27	21/125 (16.8%)
Common facilities		13/35	7/37	9/26	1/27	30/125 (24%)

Table 4.2_ summary of function of the transformed unit's

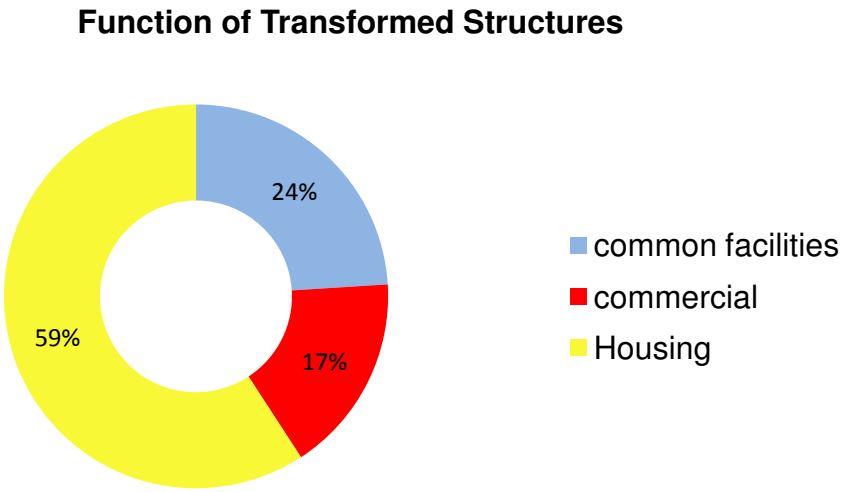


Figure 4.1_ Summary of function of transformed built up structures

The average percentage of transformed structures of all the cases is illustrated in the above pie-chart. Majority of the transformed functions/activity/ is within housing category with average percentage of 59.2%. The communal facilities ranked second with 24% and commercial based structures ranked the least (16.8%).

The function of the transformed units is highly linked with the distance between the locations of the transformed unit with the major access route. The activity tends to be commercial-based as the area is near-by major access route. And when the proximity between the access and the land is farthest apart, the activity tends to be predominantly housing. Thus, the spatial configuration of riverside urban areas (inner city) is highly influenced by the existence of near-by access routes.

Tenure

Although, it was difficult to obtain ownership data for all the case areas, from sample data gathered while field work, majority of the structures in case area 1, case area 2 and case area 3 are under the ownership of *Kebele.* In contrary to the other cases, case area- 4 land coverage is predominantly under private ownership.

The transformed housing units of all the cases are summarized below in table 4.3.

location	Tenure		Acquire title deed& legal permit	Access to solid waste collection	Access to potable water	Toilet facility		
	kebele	private				private	common	outside
Case 1	30/35	5/35	none	29.5/35	27/35	7/35	23/35	30/35
Case 2	26/37	11/37	12/37	12/37	29.5/37	12/37	21/37	30/37
Case 3	17/26	9/26	13/26	15/26	17.5/26	9/26	14/26	6/26
Case 4	8/27	19/27	18/27	19.5/27	21/27	9/27	9/27	10/27
Total	64.8%	35.2%	34.4%	60.8%	76%	29.6%	53.6%	60.8%

Table 4.3 _ summary of housing conditions of all the case areas

Housing units built without obtaining legal/formal document are considered informal in this study. The transformation in case area 1/afencho-ber/ is carried out informally in unauthorized manner both on privately owned units as well as on *kebele* houses. Likewise, in casearea2 less than half of the transformation have acquire legal permit. The tendency of formalizing the transformation is observed in case area 3 and case area 4. This tendency of acquiring legal permission is directly linked with house ownership. Majority of the interviewee's have pointed out the same feedback saying "it is very difficult to obtain even a maintenance permit let- alone for new additions for structures which are under *kebele* ownership". The numeric percentage has also show the same output as the interview, since

most of the built-up structures which acquire legal permit to add or modify in case area 3 and case area4 are under private ownership.

Infrastructure:

Sewage line: Urban growth in developing countries tends to be rapid and unplanned, characterized by minimal or non-existent sanitation services. According to UN-HABITAT (2008), 83% of the population in 43 African cities lacked toilets connected to sewers. Like many African cities, lack of toilet facilities is evident is the case study area /inner city of Addis Ababa/. In all the case areas, absence of proper drainage line is observed. In some part of case area 3, storm water drainage line exists. But most of the housing units lack proper drainage line. As a result they discharge their drainage on access streets and pipes which are directly connected with the river. The other challenge in most of the case areas is the availability of toilet facility. On average, 13% of housing units, on the selected case areas have access to toilet facility neither commonly nor privately. These units use open toilet system mainly along the river course. Moreover, majority of the toilets in all the case areas are located outside the housing unit and dry pit-latrine system is employed in these toilets. Furthermore, access to these toilet facilities is limited only to pedestrian access. Absence of vehicular access route made the removal of the sewer out of the pit latrine difficult. These difficultly have pushed residents to look for alternative ways of disposing their sewers in less difficult way through connecting their sewer lines directly to the river. The tendency of connecting sewers and drainages /both storm water and grey water/ directly to the near-by river and streams as an alternative solution is evident in most of the sites.

Solid wastes; according to AA EPA (2010), daily waste generated per person is estimated 4.5kg and only 70% of the city's solid waste is collected. 20% of waste generated is dumped in unauthorized areas causing environmental degradation. Solid wastes are collected basically in three methods; door –to door, block and container collection systems. All three methods are considered as the same in this study .Looking at the above table 5.2, access to solid waste collection system is available mainly in case area 1 and case area 2 as there are solid waste collecting containers located within the area. As most of the housing units lack solid waste disposal system in case area 3 and some part of case area 1 and case area 2, house hold waste is deposited on river edges and narrow corridors within the case areas.

Accessibility: River side areas in case area 2/Piassa-Eribekentu/, case area 3/Eribekentu-Filwoha/ and case area 4/ peacock/ are not integrated with near-by access routes. The river edge is not accessible as there is absence of river-front avenue in all the case areas except in a small portion of case area 1/Afencho-ber/, where, the major access street passes along the river front before crossing the bridge. However, most of the riverside areas in case area 1are not accessible to pedestrian as well as vehicles. Majority of access routes on case area 1, case area 2 and case area 3 are characterize as dead-end streets terminated before reaching the river edge. Access to the river-edge in case area 4 is also restricted to public access through the intervention of barriers. Only those who have agricultural plot have easy access to the river-edge.

Public spaces and communal/semi public/ open spaces:

Absence of public open space is evident on all case areas. However, there are public close-parks administered by the city government in case area 1/Ethio-korea zemachoch park/, case area 3 /ambassador park/and case area 4/central park/. Though, these closed-parks are located along the river-edge, the side which face the river is fenced with solid blind wall hindering river visibility. Moreover, main access to the parks /except ambassador/ is situated on the less integrated access routes (See space syntax generated maps in part 3).

Absence of communal open spaces is also observed on almost all case areas except those communal agricultural areas in case area 4 and case area 2. The communities use near-by access streets and path ways as multi-functional space for their day- to -day activity.

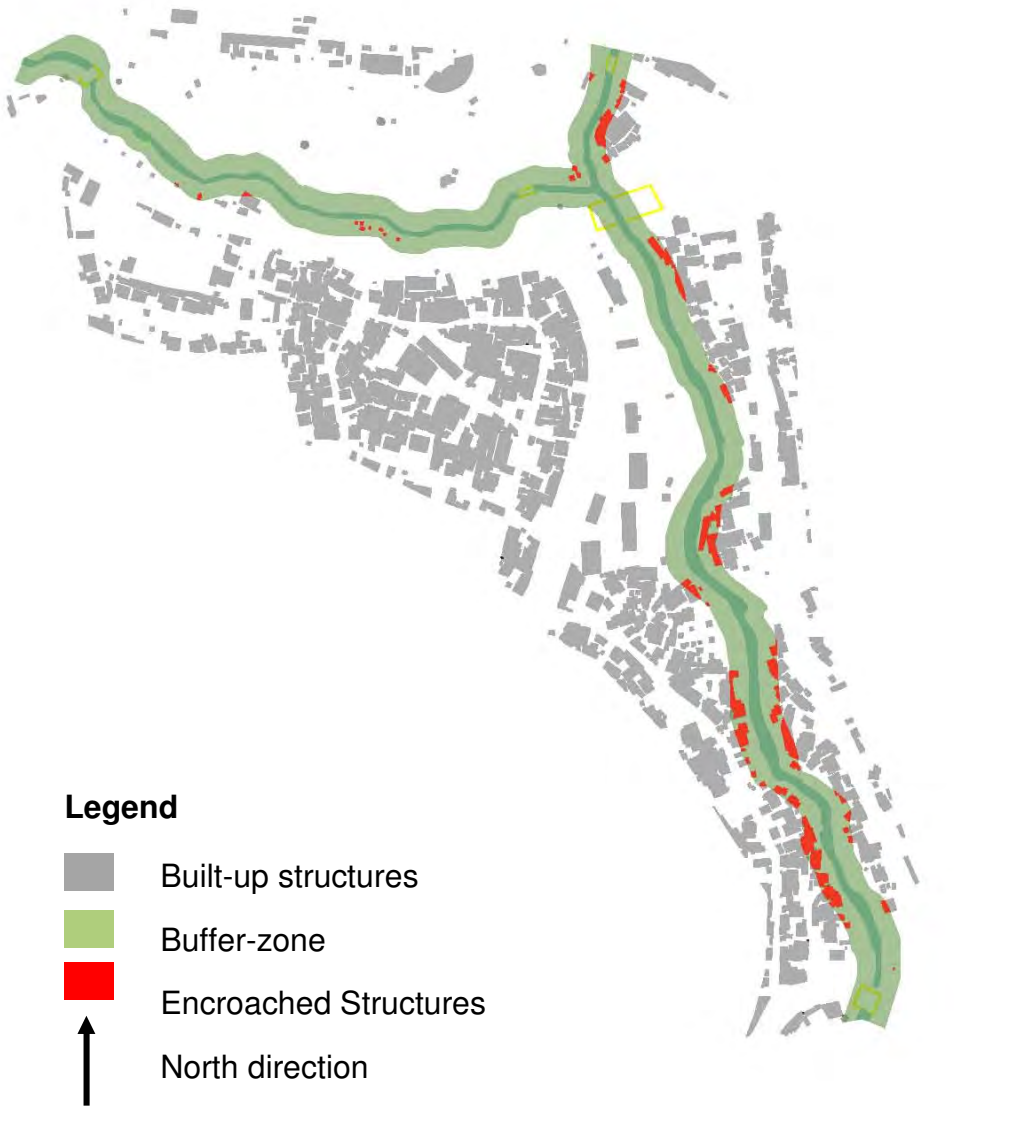
River edge typology/Topography/: inner city river-edge topography can be characterized in to three types- steeply sloped on both sides; and gradually sloped on both sides and combination of steeply sloped and gradually sloped on either sides.

Figure 4.3_ Topographic feature of the river

The river-edge topography of case area 4/peacock/ is characterized as steeply sloped on one side and have a flood plain character on the opposite side where most of agriculture practice is taking place. In contrary to case area4, on the rest case areas, both sides of the river-edge are characterized by steeply sloped topography. Gradual sloped topography promotes direct use of the river while the highly/steeply/ sloped topography of the river-edge discourages the usability of the river water and as a result highly sloped river-edges receive direct drainage and house-hold sewages. Topographic feature of the river-edges is also an important parameter playing crucial role in determining type of activity taking place within the setting.

Legal framework:

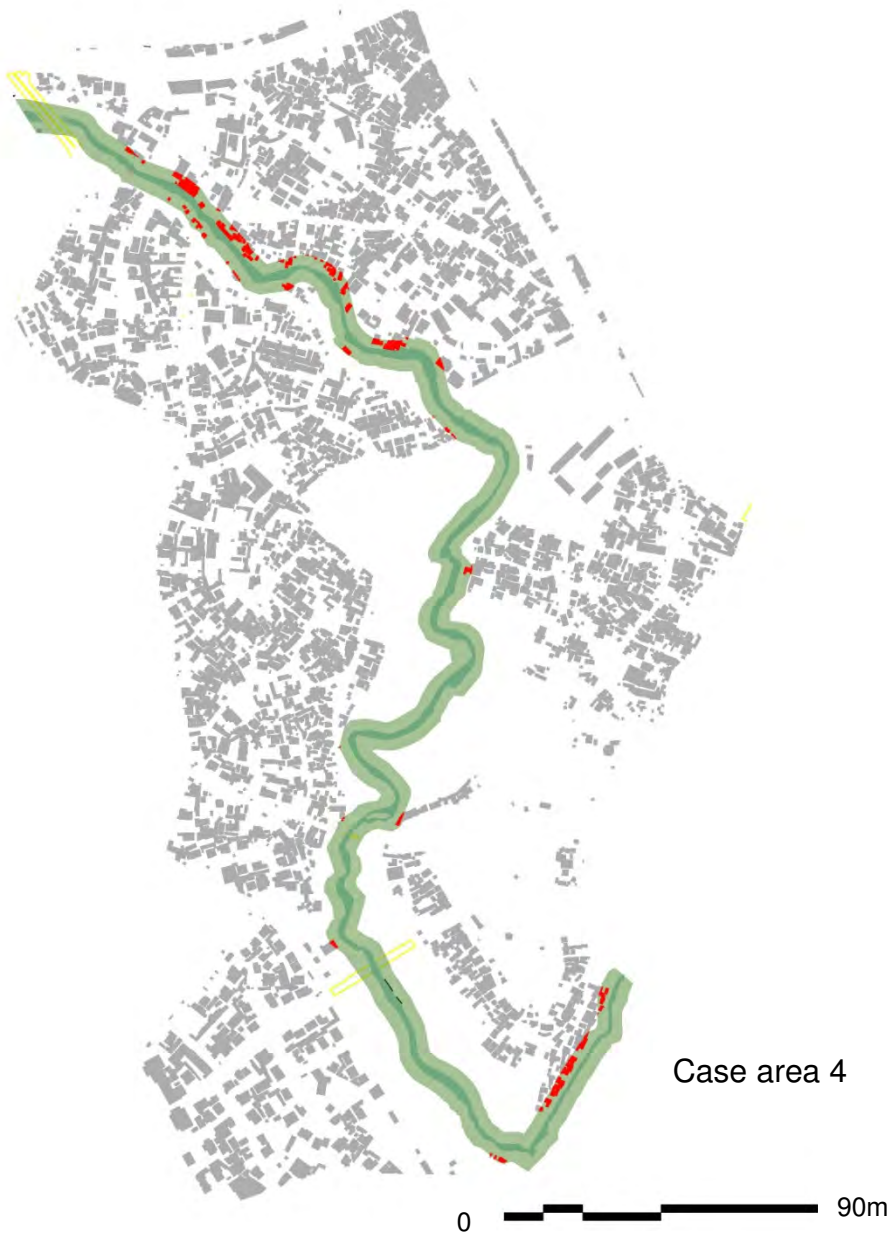
According to the structure plan of the city (2002), any settlement and physical intervention within minimum offset distance of 15 meter from edge of the river is considered illegal. The buffer zone is expected to develop as urban green corridor. However, the buffer zone is hosting settlements in most of the case study areas. Moreover, any addition and extension of space in urban areas without legal permit is illegal. But majority of the settlements exercise horizontal and sometimes vertical extensions until the space is saturated putting huge pressure on the urban services. Furthermore, these transformed structures are constructed in a self built manner without a proper professional conduct (Daniel, 2006). The minimum offset buffer zone distance of all the case study area is illustrated in figure 4.4 where the red color marks are structures located within the buffer zone. There is less tendency of encroachment of the buffer zone area in case area 4 as the land is mainly used for agricultural purposes.



Case area 1

Case area 2

Case area 3



Case area 4

Figure 4.4_ Minimum offset buffer-zone area of the case study area

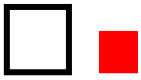
4.2 Synthesis of Findings

The finding of this particular study has proved the existence of built-up transformation in inner city riverside areas and along the river buffer zone area. The reasons, type of built up transformation along with the parameters influencing the transformation is summarized as follows.

Transformation of Structures: the magnitude of transformation of built up structures is highly linked with the location of the area/land/. As the proximity between river-edge and near- by access street is furthest apart the more the area is likely to host ample number of new physical structure additions.

Type of Transformation of built up structures: basically three types of built up transformation is exhibited. The first type of transformation is where structures are extended or added lining the existing structure. This type of transformation is commonly observed in all the case areas. The second type of transformation is new independent structures constructed next to existing structure within the same compound while new structures constructed on vacant lands are categorized as the third type of transformation. The most significant type of transformation in all the case areas is the second type. A very strong link is observed between type of transformation and river-edge proximity to main access route whether the structures are owned by government owned or owner occupied units.

Type 1



Type 2

Type 3

Function of Transformed structures: three types of functions were identified on transformed units, namely, Housing, Commercial and communal facilities. Structures constructed for housing purpose is predominant in all the case areas. The function of the transformed units is also highly linked with the distance and proximity between the location of the transformed unit and access route. The function of the new structure tends to be for commercial purpose as the area is closest to access routes. in the same manner, as the proximity is farthest apart the structure is constructed mainly for housing purpose.

Thus, the spatial configuration of riverside urban areas/inner city riverside areas/ is highly influenced by the existence and absence of integrated access routes. Global report on Human Settlements (2009) has also state that the provision of transport networks and infrastructure is crucial in the development of efficient, healthy and sustainable cities. Shape of the spatial structure of the city is influenced by the role in the provision of infrastructure (Addisalem, 2011).

4.2.1 Factors/parameter/ influencing transformation of built- up structures

The main driving parameters in hosting physical transformation are:

- **Availability of vacant land:** availability of open and vacant land mainly inside the compounds of both government owned structures and privately owned structures which have bigger plot coverage.
- **Absence of ownership claim of the buffer zone area:** even though the Addis Ababa beautification and park development office is assigned to protect the buffer zone area, the office has been highly challenged by the existence of settlements. At this particular study, claim of ownership of the area is only made on legal papers while the practical case shows otherwise.
- **Absence of legal controlling body:** new constructions of structures along the buffer zone area are been built owing to absence of controlling and regulatory body.
- **Accessibility and proximity:** the proximity of the land to main access points is influencing the magnitude of transformation as well as the purpose of the transformation.
- **Topography:**
- **Housing demand:** the housing demand is seen both as social livelihood and economic livelihood.

4.2.2 Positive and negative impacts

In the formation of physical transformation of riverside areas, positive and negative impacts were observed. The following summarized brief points are mentioned in the scope of the findings of the study. Positive aspects of the transformation are observed in this study as most of the transformation:

- Provide access to working space to household members in order to support their livelihood./domestic income generating as well as commercial/
- Are seen as major livelihood strategies and as key shelter delivery strategy, since owner households as well as initial *kebele* house tenants earn income from renting out additional/extended/ rooms. These additional rooms also enable the owner households as well as kebele house tenants to accommodate their adult children and extended families.
- Accommodate social services and facilities. Majority of the communal toilets are constructed on nearby vacant lands for the low income groups.

Negative impacts of the transformation: some of the major negative impacts of the transformation are:

- **Over-crowding:** an attempt of hosting more inhabitants and different activities on limited space might bring an uncontrolled overcrowding which in turn create condition of slums in the area.
- **Health problems:** in the creation of overcrowding conditions, improper suffocation might highly contribute to health problem. Some low income dwellers sustain their livelihood through animal husbandry and selling the animals. The phenomenon will also put the dwellers at risk of health problems associated with animal diseases.
- **Environmental degradation:** lack of sanitation and direct connection of sewers and toilets to storm water drainage pipes and rivers will result in environmental degradation of the riverside area.

4.2.3 Constructive and destructive programs along riverside areas:

The study has observed different activities taking place on riverside areas. Even though, most of these activities are directly connected and are contributing positively to the inhabitants' livelihood, some of the activities are destructive in ecological point of view as they are main source of river pollution. Some of the destructive programs practiced along riverside areas are:

- Illegal slaughter service
- Waste (both solid and liquid) disposals from households
- Waste output from car washing service

Conclusion, Basic Principles and Guidelines

5.1 Conclusion

Transformation of built-up structures in inner city is a common phenomenon in developing countries. There are different explanation to why people transform their house and structures. In these particular findings of the study, it is concluded that most of the built-up physical transformation are mainly for housing purposes. Transformations of built up units for communal facilities and commercial purpose have also been observed in less frequency. These transformations are carried out both by government owned house /keble house/ tenants and owner occupied housing units. Though, in depth study of impact of the transformation in the users socio-economic condition is not investigated, the transformation of housing units has highlighted positive aspect and negative aspect. Positive aspects of the transformation are mainly found as a key livelihood strategy performed by the users and as a main shelter delivery mechanism, as tenants' area able to find accommodation which in turn reduces housing problem of the city (Sheuya, 2004). The limited space available in the dwelling neighborhoods of a developing city is used for a wide range of domestic and income-generating tasks. The continuing increase of urban population has put little option for low income urban dweller other than to generate income from within their own resources and networks (vestbro, 2000, cited in Addisalem 2011). The negative aspects of the built up transformation in the study is generalized as; overcrowding, use of destructive activities along the river-edge, poor sanitation services particularly absence of toilets and high incidence of toilet sharing along with connection of sewage directly to the river causing environmental, ecological as well health problems. The study have summarized the parameters which have influenced the built-up transformation along inner city riverside areas as topographic feature, accessibility, proximity, absence of legal controlling body and availability of vacant land.

The case studies have also revealed that, inner city riverside areas, of Addis Ababa, as what Mello and Holland (2009) stated, do not promote social values and harmonic interaction between people and people, people and built up/manmade/ structures and people and nature. The majority of inner city riverside areas are disregarded and degraded with neighboring buildings giving their back to it while injecting their filthy sewers directly to the river. Moreover, these riverside areas are less accessible, underutilized as well as less visible to the public and majority of the land cover along riverside area is dominated by private uses and private compounds rather than public spaces.

Though, Wubshet (2002) claim that the cause of inaccessibility/absence of foot path and vehicular streets/ of streams and rivers of Addis Ababa and the negligence view of rivers as leftover backyard space is due to cultural backdrop of the inhabitants perception of rivers as source of nuisance and location of evil spirits, the study have found more than half of the case study interviewee's state that they prefer to stay and live along the riverside area. However, the inhabitants do not like the filthy situation of the river.

Water being crucial element of city's life, we have to be conscious in planning and utilizing urban land near watershed areas. Each specific space along riverside areas should be designed using their own unique morphologic character. While setting the norm for the performance of urban waterside spaces and the resultant spatial circumstances, it would also be important to reassert ways of defining and examining attributes of qualitative spaces, filtering contradictory programmatic configurations.

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5.2 Basic Design principles and Guide lines

Based on the findings of this study, the following summarized points are forwarded as recommendation through design guidelines and principles while developing inner city riverside areas of Addis Ababa. The design principles and guide lines are approached and forwarded mainly as land-use strategies along inner city riverside areas. Futuristic assumptions are also made regarding the cleaning of filthy river waters and implementation of green buffer zone as part of the structural plan of the city.

Land use strategy in riverside areas should be different from other parts of inner city due to the existence of ample natural resources and characters. Existence of the river along with its sensitive topography, rich soil moisture and natural habitats contribute for the healthy environment and unpolluted air circulation within the setting.

The major challenges of inner city riverside areas on the findings where:

- lack of proper delineation of the green buffer zone area along river-edge
- absence of access leading towards the river
- absence of security of tenure
- lack of sense of land belongingness along the river-edges
- connection of untreated sewers directly to the river along with unauthorized solid waste disposals which are main cause of river water pollution
- absence of communal spaces used as recreational and related activities
- informal and authorized settlements

In general, the main causes of the challenges are pertaining to accessibility, provision of infrastructure, green open spaces, land tenure and programs. Basic principles and guideline strategies are forwarded below for the summarized urban elements.

Road network: access roads within riverside areas should be highly integrated in order to foster and maximize river-front movements, which will in turn also maximize social and economic activities within the movement corridors. The visibility of the river as well as public accessibility will also increase with the introduction of integrated access routes. Topographic character and slope should be considered while introducing access routes within riverside areas in order to minimize the cut-and fill. Restriction of settlements edging the river is important in preventing future river pollution and natural disasters.

Thus, the access route interventions have to be the last bounding permanent physical structure along river-edge which will in turn increase the accessibility of the river.

- Longitudinal access route should be introduced along river-edges right after the buffer zone
- Access routes/streets/ running along the river-edge should be designed for vehicles as well as pedestrian
- The width of river-edge access route should be a minimum of 9 meters, where 4 meters is designated for pedestrian and the rest 5 meters for vehicular circulations.
- Proximity between access route and river should be set minimum

Waste disposal systems: one of major challenges of inner city of Addis Ababa in particular riverside areas is the connection of sewers and untreated storm waters directly to the river. Preventing measures and mechanisms of direct sewer line connection should be implemented. Using the topographic potential of river-side areas will be advantageous to install sewerage lines

- The sewages within the settlements should be collected using the guidance of slope
- The sewage lines should be incorporated with the access route which runs along the river-edge.

Green Open Spaces: Unlike in western countries, the concept of public space is defined differently in Addis Ababa. The Baroque notion of a park landscape, publicly used for relaxation and leisure, does not exist for the broader population. The public space and park areas are scattered and mainly located in the periphery of churches, fenced gardens and along riverside areas in a confined manner (Wubshet, 2002). On top of being confined, these spaces are accessed from a less integrated access routes. In recent years receding of public spaces in the city is observed. This booming city has only 0.6% public green space. In comparison the worldwide metropolitan average however, is 6% per capita (Angelil, 2008), emphasizing the future pressure on Addis Ababa's sustainable development. The arrangements of public spaces in the city are not only dispersed throughout, but also function as disperse. To sustain productive and healthy environment, the city of Addis Ababa has to consider reviving the natural setting without hindering ecologically friendly development strategies.

Land use utilization of riverside areas should incorporate ecological and environmental aspects aside from housing, social service and commercial activities. The buffer zone will act as major urban green infrastructure along river-edge areas which will enhance the ecosystem and ecology of the area.

Communal open spaces: Constructive green programs like community recreational open space, children play ground, etc. could be incorporated along the buffer zone area to activate and increase the usability of the space**.** The inserted green activities and programs along the buffer zone will in turn reduce mistreatment of the area and will also bring accountability regarding its protection and will bring sense of belongingness among the settlers.

Urban agriculture: one of positive green programs both as food security and urban green coverage is the existence of agricultural fields within the city. Existing trends of communal based gardens and agricultures should be promoted along the river-edge.

- The green buffer zone along river-edge areas should be implemented as part of the regulation of the master plan with a minimum offset distance of 15 meter from the edge of the river on both sides.
- The buffer zone should not act as a preservation area or closed park, but rather the buffer zone area should structure communal and public spaces of the city
- A network of public green space should be connected along the river corridors of the city
- Urban agriculture should be promoted especially along flood plains and should be allocated along river-edge by integrating it with the green buffer zone.

Land Tenure and Land allocation: According to EPA (2010) and City Government of Addis Ababa Cleaning Management Agency (CGAACMA, cited in master plan evaluation document, 2011), waste generated by individual residential households attain the lion share waste production with 76%, while institutions generate18% of the total waste generated within the city of Addis Ababa. Thus, ratio of waste generated by institutions is ¼ of the waste generated by individual households. With the above argument, in order to minimize solid waste generated along river-edge, the land cover of inner city urban land edging the river should be either owned or leased by cooperatives. Thus, most of the land cover facing the river-front should be set for institutions inform of cooperatives. Furthermore, using

cooperatives as a strategy to develop riverside areas would also facilitate public participation and make land allocation easier.

Since structures giving their back to the river were found to be the main cause for the lack of sense of belongingness to the river, desire to protect river pollution, river-edge plots should face the river and the buffer zone area as their front ground.

- Cooperative functions/activities/ should be used as a strategy along riverside areas
- No built up structure should give back to the river
- Structure located along river-edge should face the riverfront
- Individual ownership should be minimized on areas edging the river
- Maximum plot frontage should be given for plots facing the river-edge
- Riverside settlers should be empowered to protect the river biodiversity
- Mixed land use should be promoted along riverside areas.
- Accountability and responsibility of protecting the river and river buffer-zone should be assigned for residential settlements whether cooperatives or individual private dwellers.

Programs/ **activities**: Land or space without proper program would lead to lack of belongingness and might bring degrading of the area. So river-edge areas should be assigned for a specific or multi functional activities which are suitable and constructive.

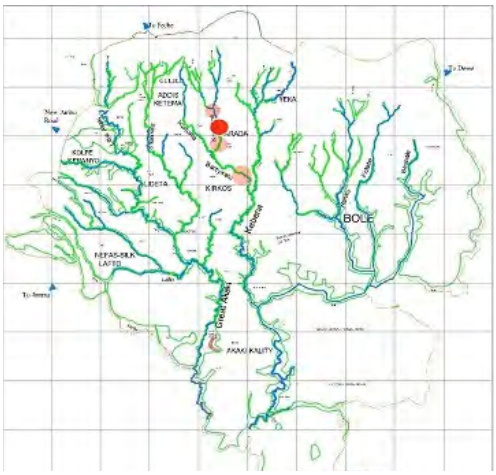
- Distractive programs pertaining to the natural ecology and river water should be avoided
- Income generating activities should be incorporated along buffer zones, open communal spaces.
- Housing design schemes should also incorporate income generating means for the low income groups
- Series of activities which promote public should be incorporated along the river corridor.
- Mixed activities of social, commercial and residential should be integrated along riverside areas.
- Green areas should be allocated apart from the buffer-zone.

5.3 Schematic Design Proposal

Land use design is proposed for one of the case study area using the recommended design principles and guide lines. The following points are the main selection criteria

- Case study area which have variety of topographic character
- Case area which contain variety of programs
- shape and nature of the river
- Study area which have both the farthest distance and closest distance between main access and the river-edge

Based on the above parameters, case area 2/Piassa/ is selected.



Action area

Figure 5.1_ Selected site

Design

Phase 1: buffer zone delineation and providing access adjacent to the buffer zone area

- The introduced access will hold all infrastructure services and it will be the last physical structure.
- Existing green and constructive activities like communal gardens as well as communal open spaces will be accommodated inside the buffer-zone area.

Phase 2: connecting and integrating access streets

At this stage, the gap between the river-edge and main access street will be minimized by the introduction of local streets which are highly integrated with the main street.

Figure 5.2.a_ Phase 1

Figure 5.2.b_ Phase 2

Phase 3: Developing the land-use

- Allocating more communal spaces which stretches from the buffer-zone towards the riverside.
- Develop the land-use according to the design principles and guidelines

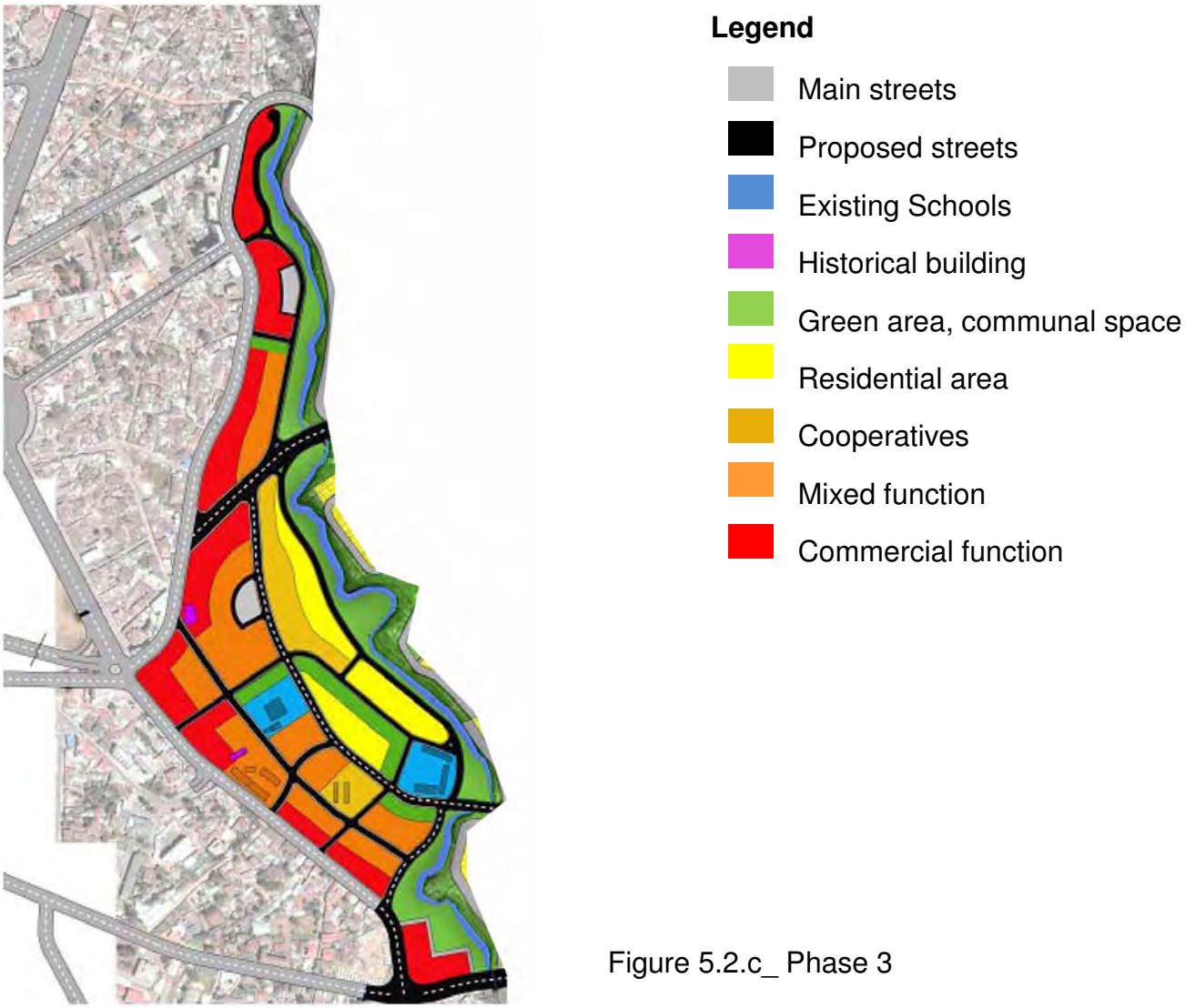


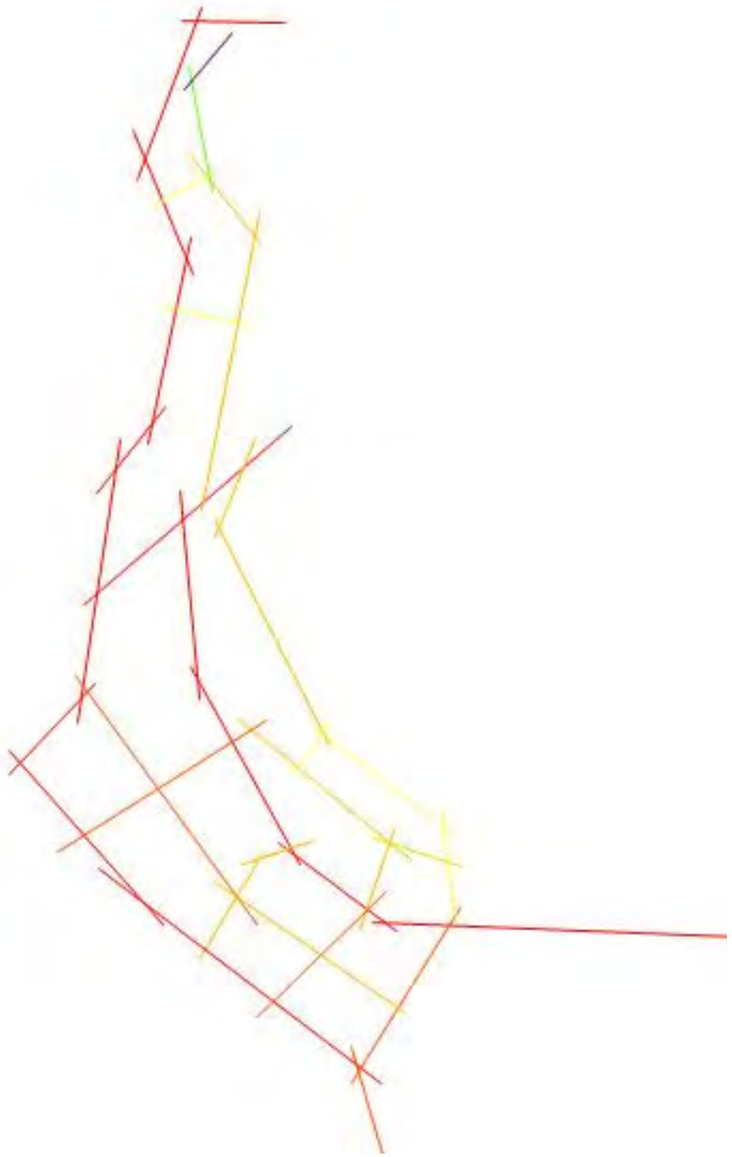
Figure 5.2.c_ Phase 3

- The integration levels of the proposed access streets are tested in AGRAPH space syntax software (see figure 5.3.b) to compare the previous condition and the proposed.

Section A-A

Section B-B

Figure 5.3.a_ the proposed Land-Use



Fi

Highly integrated access

less integrated access

Figure 5.3.b_ Axial map of the designed area

/Source: AGRAPH space syntax software output/

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Internet resources:
http:// chitchat.blogspot.com/

ANNEX

Annex A_ Interview sheet

Questionnaire

Date:27/06/2011

Family head: male/female Age:____ Marital status: married/single/divorced/

Location: S/city____, K.____, W.____, H.no.____ Picture number:_____

Profession/ training/ income generating activity/:_____

Place of birth:_____

1.1 how long have you been living in Addis?

1.2 When did you settle in this area?

1.3 For how long did you live in this neighborhood?

1.4 What was the neighboring situation at the time: vegetation coverage/housing/ the river condition/etc

1.5 Why did you choose this location/area: affordable/ proximity to city center/ availability/ and for what activity?

1.6 Factors influencing your choice of settlement: land availability/ land value/……

1.1 How did you acquire this house: purchase/ rental/kebele house/ family house/built it: when_____

1.2 Ownership; private /government/rental/others:_____

1.3 Does the house have title deed: yes/no

1.4 Do you pay annual land tax regularly: yes/no

1.5 Area of the house/plot:____

1.6 How many units/ rooms do you have:0/1/2/3/4/5/6/7/8/9/_____

1.7 Number of rooms/units belong to the family; all/0/1/2/3/4/5/6/7/8/9/____

1.8 Is any of them shared with other family: yes/no

1.9 If yes which one and to what extent:_____

1.10 House type: detached house/semi-detached/terraced/shack/_____

1.11 Type of rooms: kitchen/living rm/ bed rm/ shower/ toilet/ room for commercial use/_____

1.12 Do you have outside space: yes/no Private/communal

3.1 For what purpose do you use the house: residential/ working/ both/_____

3.2 Has it been changed(functionally): yes/no to what function:_____

3.3 For how long has it been like this (residential/working/others)_____

3.4 where do you cook: inside/outside private/communal/pathway

3.5 Source of energy: kerosene/wood/electricity/coal

- Each unit and its distinct purpose (scaled/dimensioned plans, sections) picture no___
- Movement patterns(neighborhood scale and unit scale)
- Activity pattern and intensity (in different color)
- Activities happening along the river edge
- Accesses [easy, difficulty, width, safety]
- Spatial accessibility and visibility
- Slope and topography
- Services [water pipe, sewage line, drainage, electricity line, phone line,etc]

4. Material used to build the house /housing condition: [picture no___]

4.1 Walls: stone/concrete/chicka/plastic/wood/_____

4.2 Inside flooring: stone/concrete/earth/_____

4.3 Roofing: corrugated iron/ plastic/_____

4.4 Choice of material: cheaper/available/ affordable/_____

4.5 Who participated in the construction: friends/neighbors/craftsman/

5.1 How many people live in your house:1/2/3/4/5/6/7/8/9/____

5.2 Who lives in you house: husband/wife/children/parents/brothers/ sisters/other relatives/____

5.3 Who works/earn income in your house: husband/wife/children/____

5.4 What do you do:_____

5.5 Where do you or family work:_____

5.6 How do you travel to work: walk/bus/taxi/car/_____

6.1 Is there any improvement after initial erection /construction:____

6.2 Did you add extensions/ transform the house/ from the original unit? If yes show it on the plan

6.3 Have you maintained the house: yes/no how many times:1/2/3/4/____

6.4 Do you have access to clean water: yes/no Private/communal/buying

6.5 Do you have access to washing facilities: yes/no Private/communal/rental/___

6.6 Do you have access to toilet facility: yes/no Private/communal inside/outside

6.7 Do you have access to solid waste disposal area: yes/no if yes where?[mark it in plan]

7.1 Do you feel safe/unsafe/happy/unhappy/_____ in your neighborhood/house

7.2 Are you happy with the location of your house: yes/no

7.3 What do you like about the neighborhood: the people/proximity to social service/proximity to work/__

7.4 What do you miss in the neighborhood/what do you like to improve:_____

7.5 Which place do you avoid:_____

7.6 Where do the children play:_____

8.1 If you could choose, where or how do you want to live: in a bigger house/in a house with access to outdoor space/in condominium/in the city center/outside the city/with family/_____

8.2 Are you involved in any social activities: idir/iquib/___

8.3 What do you think about the river? A curse/a potential/_____

8.4 For what purpose do you use the river: none/sewage/source of water/planting/washing/___

8.5 Why do you face away from the river?

8.6 Why do you think people throw garbage and dispose on the river

8.7 Have you been to the river edge?

ANNEX-B_INFORMATION ON SYNTAX

Source:

2. www.informedesign.umn.edu ,A Newsletter By Informedeign: A Website For Design And Human Behavior Research, Volume 04, Issue 12 , accessed on April 20, 2010
3. The 7Th Space Syntax Symposium, KTH, Stockholm, Bendik Manum, M.Arch, M.Sc., Ph.D; Faculty of Architecture and Fine Art; Norwegian University of Science and Technology;bendik.manum@ntnu.no; Software Programming: Espen Rusten, June 2009

Space Syntax

Space syntax is about identifying, representing, and measuring the spatial relationships that help us get on with our lives. Space syntax studies the principles we use when designing space. It can be introduced as an attempt to make explicit the spatial relationships that underlie our everyday experience of the designed environment and the way it functions culturally and socially. The aim of space syntax is to arrive at an understanding of principles of spatial design and a critical evaluation of precedents and prospects.

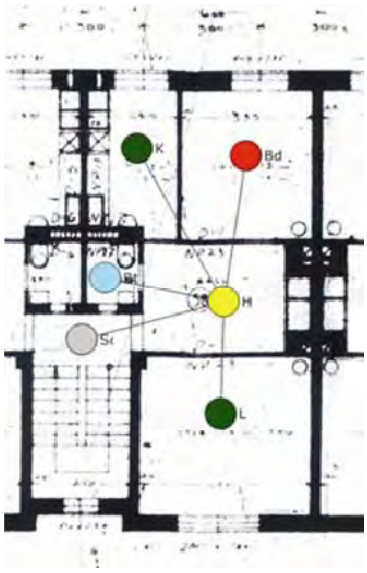
How does space syntax help to deal with design questions, such as those about street design and neighborhood productivity? Space syntax is an expanding set of analytical techniques and measures that are used to test a growing number of specialized hypotheses about the functions and effects of designs.

The techniques all assume there is an intelligible structure to built space as it is perceived and explored by users moving through space. Therefore, the techniques add up to a common framework for describing how spatial environments enable or impede users' behaviors. Before we apply graph theoretic measures, however, we have to read the geometry of a space and translate it into a pattern that supports the type of analysis to be performed (e.g., intersecting lines of movement, connected 2-D convex spaces, intersecting visual polygons). Thus space syntax can be understood as a two-faced tool that can be used to read geometry and to interpret geometry in a graphic, analytical way. This task can be complicated, because our intuitive understanding of space sometimes exceeds the power of available computational algorithms.

Space syntax Analyses of building interiors often look at lines of movement, similar to the analysis of streets. In addition, we analyze visual fields. We consider the visibility polygons (or "isovists," to use the term coined by Michael Benedikt, University of Texas at Austin) from each tile on a grid superimposed over usable space, and we measure their properties and patterns of intersection. The study of visual fields in conjunction with the study of how users occupy and move through space allows us to assess the patterns of what users are likely to be aware of and encounter in a setting. This is particularly relevant when we deal with work environments.

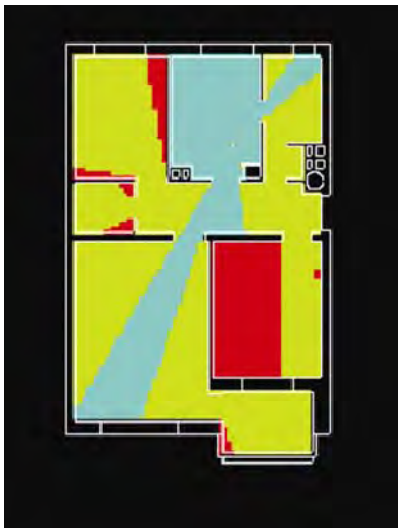
Kinds of space syntax analyses

From the beginning of space syntax research, the development of space syntax theory has been closely followed by evolution of software. The combination of theory, software and numerous analyses of real-life situations has been the fundament for the scientific success of space syntax. Space syntax software are of several kinds that can be distinguished in accordance with the spatial units applied in the modelling; there are “node analyses”, “axial-line analyses” and “visual-field analyses”, the latter also termed “visual graph analyses” (VGA). Figure 1 shows some images typical for these three kinds of modelling.



Node analysis
(drawing a connectivity-graph)

Axial-line analysis



Visual-fields analysis
(here: “isovists” from a particular point)

In node analyses, the space syntax model consists in a “connectivity graph” of nodes and lines (vertexes and edges in mathematical terms) where the nodes usually represent a room or a “subspace” within a room (often a “convex space”), while the lines (or edges) represent connections between the spaces. Node analysis is particularly useful for studying dwellings since they usually consist of enclosed spaces (rooms) connected by doors or door-like openings. In axial-line analyses, the space is represented by straight lines, so-called axial-lines. In brief, the space to be examined is modelled by “fewest and longest straight lines covering all convex spaces”. (Hillier and Hansson, 1984, p. 91-92) Each line is considered as a node in a connectivity graph and for crossing lines the respective nodes are defined as connected. Axial-line modelling captures basic features of continuous spaces such as the outdoor space between buildings in a city, a space that is a “net” of long and intersecting “street-spaces”. Therefore, axial-line modelling is often applied in urban analyses.
In visual-field analyses, the spatial elements on which the calculation is based are “visual-fields” or “isovists”. For spaces not known in advance by the persons being present (spaces

where “what you know is what you see”) or spaces where people’s movements have the character of “free-float”, visual-fields as well as axial-lines are likely to be relevant kinds of modelling. Visual-field analyses are often applied for studying spaces that are complex and overlapping but not “street-alike”, for instance public squares3 in cities and indoor space of buildings like museums or shopping malls.

Most real spaces can be analyzed by any of these three kinds of modelling. However, as the different kinds of modelling capture somewhat different aspects of space, some modelling is likely to be more relevant than other. Which kind of modelling that might be best in a particular study, depends on the kind of space that is examined as well as on the subject of interest. In urban analysis, the field of research and consultancy where space syntax has been most important, axial-lines is the kind of analyses most frequently applied. This is particularly the case when studying large systems as entire cities, which usually consist of thousands of streets.

Why and When to Use Space Syntax

With these caveats in mind, why and when would a practitioner or researcher use space syntax? Practitioners should consider using space syntax to evaluate how alternative design options meet explicit design objectives or to help generate design alternatives that address a specific problem. Space syntax is also applicable in fields of design practice that require collaboration, for example designing pedestrian friendly environments in cities, or improving the intelligibility of complex way finding systems in hospitals. Space syntax researchers have made extensive inquiries into urban design, museum and exhibition design, work environments, and hospital design. Researchers should consider using space syntax when their research requires that they describe with precision how spatial environments enable or impede users’ behaviors.

AGRAPH

AGRAPH, as presented at the Space Syntax Symposium in 2005, is a tool for analyzing “node-and-connection models”, particularly aiming at “easy-to-use-interface” and the possibility of doing modelling and analyses as well as making printable images within one program. This version of AGRAPH is free download from http://www.ntnu.no/ab/forskning. The intention behind the new version of AGRAPH, the version described in the symposium, is to offer a similar tool for axial-line analyses; a software that has an intuitive interface, that does not require any external CAD- or GIS-software and that offers some very useful modelling options. AGRAPH is developed in C# using VisualStudio.NET and runs on PCs operated by WINDOWS. The axial-line version of AGRAPH is made as a “line-mode” in the existing AGRAPH software. The menu is simple and should be manageable without detailed

instructions. Since space syntax modeling consists in numerous abstract interpretation which require knowledge about possibilities and limitations of the particular software to be applied, about the subject of interest (kind of traffic or movement to be examined) and also about the particular city or site. Thus AGRAPH is developed particularly for “site and subject-specific” axial-line modeling.