THE IMPACT OF UNPLANNED URBAN WATERFRONT DEVELOPMENT ON LAKE HAWASSA

M.Sc THESIS IN ENVIRONMENTAL PLANNING AND LANDSCAPE DESIGN

BY -ANASIMOS TEKALIGN

ADVISOR: -ABREHAM WORKENEH

ETHIOPIAN INSTITUTE OF ARCHITECTURE, BUILDING CONSTRUCTION AND CITY DEVELOPMENT

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This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and to the School of Graduate Studies of Addis Ababa University in partial fulfillment of all requirements for the degree Masters in Environmental Planning and Landscape Design.

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DECLARATION

I hereby declare that this thesis (The Impact of Unplanned Urban Waterfront Development on Lake Hawassa) has been carried out by me under the supervision and continuous advice of Abreham Workeneh, within the Ethiopian Institute of Architecture, Building Construction and City Development / EiABC/, Addis Ababa University, during the year 2013 as part of a Master of Science program in Environmental Planning and Landscape Design. I further declare that this work is my original work and has not been presented and submitted to any other University or Institution for the award of any degree or diploma.

Addis Ababa

June, 2013

_____

Anasimos Tekalign

CONFIRMATION

This thesis has been submitted for examination with my approval as a university advisor.

Signature_____Date of submission_____.

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ABSTRACT

Urban Waterfront development has direct and indirect deteriorating impacts on lake. This problem will be aggravated if there is no sustainable waterfront planning and management. In Hawassa waterfront there has not been any concern given to the water front development even at the master plan level as a local development plan. As the same time the interest and expansion of development towards natural waterfront is increasing tremendously. This unplanned development has negative impacts on the Lake due to land use land cover change and problems emanated from types of land uses. The practice and awareness of important stakeholders within and without the waterfront also plays important role in degrading or conserving the lake. The average yearly percentage of change of development, forest cover, bare land and flooded zone has been increased by 1.47 %, 1.46 %, 4.76 % and 5.72 % respectively while wetland size, grassland and agricultural land has decreased at an average yearly percentage rate of 0.74 %, 13 %, and 1.94 % respectively. Development is increased proportionally with the decrease in wetland, grassland and forest cover. As development increases the demand for land resulted in the encroachment of natural land covers. The natural buffers become fragmented that ecosystem services like waste treatment, flood prevention and supporting the ecology diminished which has significant negative impact on the lake. Because of lack of municipal waste treatment, Organic waste from household's end up into the lake causing eutrophication. There is also uncontrolled utilization of surface and ground water resources which does not consider the water budget of the lake. In addition, different land use types have impacting the fragile littoral zones and the lake through removal and defragmentation of the natural landscape, pollution and unsustainable consumption of resources. Even if there are possible legal and planning aspects and bodies for conserving lakes in Ethiopia the implementation is weak in the waterfront of Lake Hawassa. Therefore sustainable waterfront development plan and management plan are essential alongside with collaborative implementation.

Key words

Water front; waterfront development; land use and land cover

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ACRONYMS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved oxygen
EIA	Environmental Impact Assessment
GI	Green infrastructure
GIS	Geographic information systems
LUC	Land Use Change
MODIS	Moderate Resolution Imaging Spectrometer
SNNPRS	Southern Nation, Nationalities and Peoples Regional State
STPs	Storm water Treatment Practices
TM	Thematic Mapper
TSS	Total Suspended Solids
USGS	United States Geological Survey
UTM	Universal Transverse mercantum
ENVI	Environment for Visualizing Images

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Ethiopian lakes are associated with lacustrine, palustrine and floodplain wetlands. Lake and wetlands are fundamental parts of the structure and welfare of Ethiopian societies. They have long been important resources for the people as a source of water and food. To be more specific they play important roles in fisheries, irrigation and tourism development that may change the lives of millions of people across the country (*Tenalem A*, 2009).

Lake Hawassa has multiple importances to anthropogenic developments through ecosystem services, functions, goods and values. Various recreational, tourism and socioeconomic activities have been and will be the characteristics of Lake Hawassa waterfront. Hence, wise use of natural resources is mandatory. However there are inconsistent and unplanned waterfront developments taking place especially around the fringe zone since human settlement started.

The population of the city is increasing in unprecedented rate at the same time the geopolitical importance of the city attracts infrastructural, industrial and tourism development which can deteriorate the natural system with the urban ecological footprint unless early sustainable intervention actions are taken. Promoting the protection of the interface between water bodies and land (e.g. Lake Shores, river banks and wetlands) are stated in the environmental policy of Ethiopia. *However,* Urbanization, settlements and pollution from industrialization are putting pressure on the ecosystem of the lake by the application of sewerage, agro-chemicals, salinization related to irrigation, overflowing, siltation and soil erosion.

According to Zipperer (1993), human development has direct impact of removing existing natural habitat as well as fragmenting the habitat that remains. Paved roads, residential and commercial development often serve as barrier or hazard to wildlife movement and native plant dispersal. A human development also has an indirect impact

by creating a number of different kinds of intrusions with varying depth of impact into adjacent natural habitats. These intrusions include increased air, water and noise pollution; changes in microclimatic conditions due to higher sunlight and wind levels; increased populations of invasive weed' species; and increased frequency of disturbance due to direct contact with humans, human pets and associated rural/suburban pest' species.

Resorts and hotels in Hawassa town along the shoreline have multiple impacts on the lake and the fringe zone ecosystem. This problem will be aggravated if there are no planning and management framework of the waterfront.

The interconnected wetlands at Hawassa support various vital biological and non-biological resources. These resources provide various essential functions and values for the community that has long lived in the area. They support the lives of the human population, domestic livestock and wildlife. They are, however, being degraded as a result of unmanaged and harmful human activities in the catchment. Land use and modification, industrial discharge and activities associated with urbanization are the major causes of this degradation (Zerihun Desta ,1997).

Riparian zones are crucial transition zones between surface water and their catchments. They contribute substantially to catchment biodiversity and serve to mediate the lateral movements of biota, chemicals and sediments between water bodies and their catchments. Floodplains are riparian zones and with the flooding they are highly productive systems. However, human activities have degraded many floodplains by curtailing or preventing natural floods (David B., Richard J. 2007) Fringe zone vegetation plays important role in the ecology of wetland which supports diversified flora and fauna. Lake Hawassa support high waterfowl species diversity which can be cited as a tourist attraction. But, the intrusions of development are engulfing littoral vegetation belts resulting in the deterioration of overall biodiversity.

According to Tadesse (2007*),* Producers (Phytoplankton, macrophytes and detritus) are not well exploited by the organisms in the system and energy transfers to higher trophic levels are very low. This indicates that the primary production can support much more

than the present herbivorous animals. In contrast the consumers are highly exploited by the system. The analysis also reveals that the lake is in a developmental stage, which means it is very vulnerable for small perturbations which are naturally or antropogenically induced. Extra care should be given to maintain the natural and gradual development of the lake. Due to anthropogenic interference exotic terrestrial and aquatic species are being introduced to the native ecosystems. For example threat caused by expansion of the highly invasive water Hyacinths (*Eichhornia sp.*) along several parts of the Lake Tana shorelines.

1.2 Problem statement

Lake Hawassa is one of the most productive and aesthetically desirable rift valley lakes in Ethiopia with multiple ecosystem value, goods, functions and services. However, besides lots of studies on the hydrology, chemistry and specific issues on the lake the impact of unplanned waterfront urban development on the lake are not researched well.

Assessing the past and present conditions of wetlands provides valuable information about the potential obstacles to sustain these crucial ecosystems. Based on this perspective, efforts are being made to identify the challenges that these wetlands face. Untreated toxic discharges from industries in Hawassa's industrial estate have, since the 1980s, attracted increasing concern. At present, state-owned factories (textile, flour, ceramics, sisal and tobacco) operate within the estate. While the flour and tobacco factories release no waste into these ecosystems, the other three factories do. The nature and amount of waste discharged from the ceramic and sisal factories has not been investigated, but the discharge from the Hawassa Textile Factory has been studied.

There is no doubt that the number of people living in Lake Hawassa's catchment has increased substantially in the last couple of decades. Due to these natural resources are consumed in unsustainable manner which include the vegetation cover. As the vegetation cover of the catchment declines, nutrient and sediment loads increase and, at least theoretically, alter the chemical and physical features of wetlands. This, in turn, modifies species composition, distribution, abundance and the activities of organisms that rely on these aquatic ecosystems. Lake Hawassa's water level has increased,

inundating Marabou nesting sites. The nests in Acacia albida trees, are destroyed when the lake floods. The dead trees are then used by locals for firewood. Consequently, the birds are forced to move to live in Acacia albida trees in Hawassa town, and have to fly further to get food around the lake.

Hawassa is a rapidly growing town. Its population and Business activities are expanding in many sectors, and nearby wetlands may suffer negative consequences. For instance, the amount of solid and liquid wastes generated by different sources (e.g. Hotels, health centers, households and factories) are increasing in size and composition. Practically all of Hawassa's drainage lines end up in the lake. The municipality has no system to collect and manage liquid wastes. The time will come when managing waste by discharging it into the lake will cease primarily due to the lack of assimilative capacity of the lake. Most of the waste from developing countries is organic, although toxic inorganic and pathogenic wastes are not absent (Lardinois and van de Klundert, 1993). Organic waste loading in such systems contributes to BOD rises, affecting different ecosystem elements, including biological resources (Miller, 1995; Cunningham and Saigo, 1995).

Urbanization and ecotourism development of Hawassa are extremely growing in an undetermined manner causing unexpected ecosystem and biodiversity loss. Pollutions are the major problem of this development subsidizing aquatic natural productivity which is the foundation of the terrestrial shoreline ecosystem.

Construction of dikes, roads and buildings to meet the infrastructural demands of the city has altered the natural land-cover. These intrusions are also affecting vegetation buffers surrounding the lakes which can serve as habitat for fauna and insulate urban ecology with aquatic ecology.

The rate of change of land use land cover has an impact on the ecology of the overall watershed spatially the most fragile aquatic ecosystem and fringe zone. The ecological footprint of urban development hinders the ecology of Lake Ecosystem by waste release and unwise use of resources. These have decreased the ecosystem value,

goods, functions and services in the present condition or will totally demolish the natural system in the future.

The above problems threatened the survival of the lake as a functional ecosystem, its recreational importance and economic reliability is caused by the absence of a waterfront development planning and management system. The master plans so far which have prepared for the city either considered the Lake as a back yard or in the case of recent city plan gave no serious attention instead acknowledging the pressure and allocating waterfront site for private investments. Therefore the lake has not only been endangered by uncontrolled private development activities but has also lost its publicness.

Therefore, the consolidated intensity of urban development within the waterfront has multiple impacts on the lake which have been further aggravated by the absence of sustainable waterfront development planning and management.

1.3 Research questions

The main research question of the study is what is the impact of unplanned urban waterfront development on Lake Hawassa? Relaying on this major question the following sub questions where augmented which have contributions in attaining the general objective of the research.

I. What is the land use and land cover changes observed on the waterfront of Lake Hawassa?

II. What has been the approach of master plans prepared for the city towards the lake and its impacts on the lake?

III. What has been the out look of residents and other stakeholders within the waterfront and their impact?

IV. What factors have contributed to lack of concern to sustainable waterfront development?

1.4 Research objective

1.4.1 General objectives

The general objectives of this research are to assess the impact of unplanned urban waterfront development on Lake Hawassa and to analyze it in relation to the concept of sustainable environmental planning for possible management and conservation measures.

1.4.2 Specific objectives

I. To assess the spatial and temporal change in land use and land cover of Lake Hawassa waterfront.

II. To disclose the impacts on the natural ecosystem by analyzing the type, pattern and landscape ecology of the vegetations surrounding the urbanized shore area.

III. To analyze the impacts caused by unplanned urban waterfront development on water quality and fringe zone ecology by assessing master plans.

IV. To assess solid waste and liquid waste management practices in the waterfront of Lake Hawassa and,

V. To evaluate the contributions of stakeholders within the waterfront.

1.5 Limitation of the study

The limitations of the study are lack of high resolution digital images, absence of previous land use map of Hawassa and shortage of budget. The lack of digital satellite images with high resolution impairs the quality of the finding especially the land use change analysis. Even if efforts are made to manage the exiting data by enhancing the images there are some problems concerning the outputs. The other limitation is the absence of land use land cover map of Hawassa city which might be used for analyzing the concerns given by each land use plan of the city and their impacts on the Lake. The last and the most important limitation of the study is shortage of budget that might be used to study the socio economic and environmental aspects in depth.

1.6 Significance of the study

Assessing the impact of unplanned waterfront development on the lake has multiple importances for several sectors of ecological conservation, sustainable urban planning and environmental protection. The study also indirectly reveals the significance of planned and properly managed waterfront development and its contribution to the protection of urban lakes. Anyone who is concerned in conservation of the lake and the immediate waterfront ecology can find essential information from the research where to start and to focus. The multi assessment of various problems and the cause of the problems incite peoples for conserving the urban lakes.

In addition the study can be used to plan the waterfront sustainably in a manner that considering the protection of Lake Hawassa and other lake sides. What aspects to be considered in the lake front urban planning and what aspects to be avoided are clearly shown in the research.

The other relevance of the study is that it shows the problem in provocation of environmental laws and principles within the waterfront such as buffer zone intrusions, waste management problem, expansion of illegal activities at the shoreline and extra, therefore, government environmental protection body's could act accordingly. Also, how to manage the problem and where to give emphasis?

It can also used as to prepare management plan for urban lakefront development such as to manage urban lake side recreational activities, fishery, hotel industries and others.

It also highlights possible research areas that could be studied in depth to find more important and abiding results.

1.7 Organization of the Study

The study is categorized into five chapters

Chapter one deals with introducing the study, the problem statement, the research questions, research objectives, limitation and significance of the study.

Chapter two reviews some of the major theories related to the study particularly the basics of waterfront and waterfront development. Sustainable environmental planning emphasizing waterfront development and its sustainability, land use and water quality, threats and challenges of urban lakes, application of GIS and RS to asses urban waterfront development and the evolution of waterfront development are also included.

Chapter three describes the research methods and methodologies, while chapter four discuss with land use land cover change of Hawassa waterfront and its impact on Lake Hawassa. Waterfront land use planning and management, specific land use and their impacts, major problems within the waterfront and management issues are also discussed in this chapter.

Chapter Five comprises the conclusion and recommendation parts.

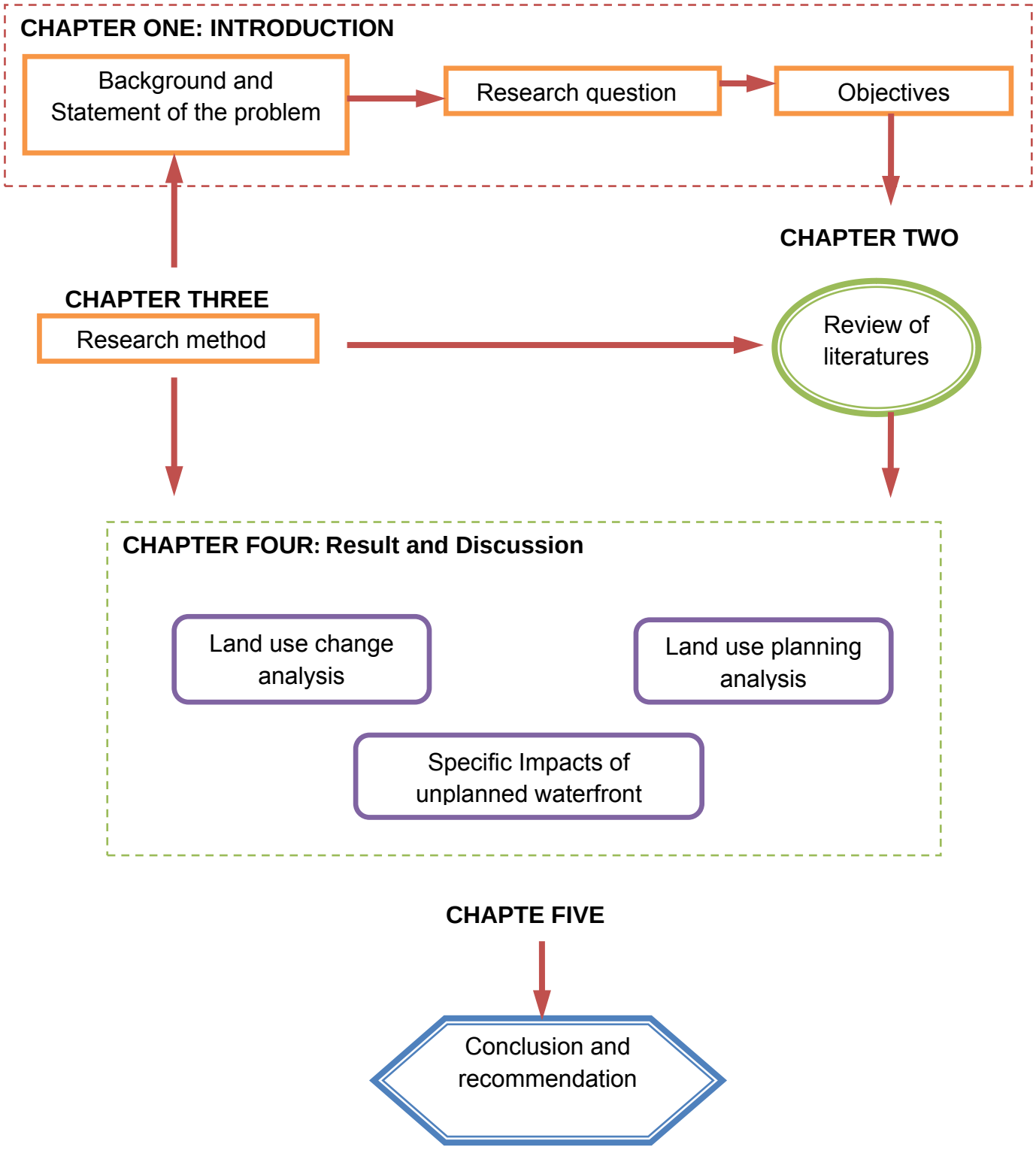

Figure 1 Schematic diagram of research organization

CHAPTER TWO: LITERATURE REVIEW

2.1 Waterfront and Waterfront Development

Waterfront is defined as the zone of interaction between urban development and the water. It is here that the needs of the water, the city, and its inhabitants come together. Breen & Rigby (1994, p. 10) sees waterfront as the water's edge in cities and towns of all sizes and the water body may be a river, lake, ocean, bay, creek, or canal. Zhang (2002) characterized waterfront as a place integrating land with water and having a natural attraction to people. In fact, the seashore and riverfront were the most attractive water features for human settlement. In most countries, the land in front of water was developed earlier than the inland areas. Hussein (2006) defines an urban riverfront as a dynamic area where cities engage their shorelines.

In common use, Dong (2004) refers to waterfront as a land fronting on to water. Even the word waterfront itself is clear; some researchers prefer to use several different words replacing the term waterfront with those such as city port, harbor front, lakeside and lake edge and lakefront (Hoyle, 2002; Hussein, 2006; Roy Mann, 1973; Watson, 1986).

A more detailed definition by Guo (1998) as cited in Dong (2004, p. 7) described the waterfront as the interface point where land and water meet, between approximately 200 to 300 meters from the water line and 1 to 2 km to the land site and also takes in land within 20 minutes walking distance. Wu & Gao, 2002, as cited in Dong (2004, p. 7) added the waterfront area should have multiple features which incorporate each other and surrounded by structural and non structural objects to form a focal point.

In area of development, Breen & Rigby (1996, 1994) considered waterfront development may not necessarily need to be directly fronting water but May only need to look attached to the water. They believe that commanding a view of water can be considered waterfront property. However, Goodwin (1999) argued that waterfront boundaries are difficult to determine because they are contained between relatively

homogeneous land uses (such as housing, large-scale industrial plants or waterfront parks) and in some cases the boundaries may be indistinct, especially when industrial waterfronts have been abandoned with only a small part remaining, which might form the nucleus for revitalization planning efforts.

Dong (2004) agreed that waterfront developments have several expressive and varying interpretations due to characteristics of sites and cities. Ryckbost (2005) see waterfronts as any property that has a strong visual or physical connection to water and water itself have a variety of perspective, whereby it can be lake, ocean, river or stream. As a conclusion, the best definition for waterfront development is development directly fronting water for any purposes and the water components can include river delta, coastal plains, wetlands, beached and dunes, lagoon, and other water features not excluded watershed area. However, for the planning purposes, watershed is impractical to be embraced by this definition because waterfront zone is a special area endowed with special characteristics.

Summarizing the previous discussions and the characteristics of well documented waterfront development cases (Breen & Rigby, 1994), we can find out certain key traits of the waterfront:

- It is an urbanized area, a substantial space;

- Water and land are the two important elements of waterfront;

- It has fuzzy spatial boundaries, which vary from place to place;

- A particular fabric of mixed land uses characterizes this particular area of the city;

- It accommodates the interaction between the city and the water and the human settlement and nature;

- The “water” can be a river, lake or sea.

- The waterfront area can be a historical port area or an urban area for other uses adjacent to water.

The discussion of the concept of the waterfront and the water that crosses between three different phases of waterfront transformation (waterfront establishment, the decline of waterfront and the waterfront redevelopment) has helped to understand the concept in a more holistic manner. There are two main findings unveiled from this discussion. First, each of the phases helped to identify relevant attributes from the context that can be categorized into three main aspects of the concept of response of the waterfront towards the water. These are physical, functional dimensions and the user experience of the area.

This shows that the integration of these three aspects must be taken into consideration to achieve good response of the waterfront towards the water. It is also acknowledged that some of the activities are closely related to the local culture's spiritual activities such as those observed in Ujjain, India.

Although an increasing number of authors had shown concern that many waterfront developments are not responding to the water and also the increasing concern of the importance of urban design to achieve this, there is still a clear gap in the body of knowledge on why this happened.

The discussions on and specific tool for evaluating the responses of the waterfront towards the urban river in Kuala Lumpur show that there is similarity between the concepts of waterfronts' response to the water with the concept of urban design. (Nurul Syala A. 2011). It comprises several attributes (of the physical, functional dimension) from the context and the user experience, which promotes contextual integration as one of its key factors. All the authors that discuss urban design have stressed the importance of contextual integration. This shows that the response of the waterfront to the water can be evaluated through the level of the contextual integration of the relevant attributes from the context.

Adopting this concept and relating it to the urban design, integrates several key principles of urban design. Therefore, the Integrative Theory of Urban Design attempted by Ernest Sternberg is found to be more relevant to explain the concept as a whole compared to other authors who discussed each principle separately. This allows the

relevant attributes to be categorized into the related principles (good form, legibility, vitality, comfort and meaning). Furthermore, through these principles several additional attributes that have been found relevant to achieve the contextual integration have been extracted for the overall framework for the research; this makes thirteen attributes altogether. The attributes identified are chosen based on the condition of Kuala Lumpur waterfront.

Some of the attributes, which have been identified as being important to achieve contextual integration between the waterfront and the water have been minimally discussed and researched in the context of waterfronts. This creates a problem in determining the possible measurement to evaluate the attributes later. Therefore, reference has been made to the context of other public places as waterfronts are also categorized under public places. These include seven attributes – 'enclosure', 'direct access to the water', 'link the waterfront to the city', 'seating areas', 'shade', 'universal design' and continuous activities'. (Nurul Syala A. 2011).

2.2 Sustainable Development

The term "sustainable development" has become very popular in recent years because it implies that the production and consumption of goods and services and the building of houses, offices, factories, and stores can be done without harming the natural environment. The natural environment provides the air, water, and land resources that sustain human life and serves as a "sink" for human wastes. The natural environment, however, does not have a limitless ability to absorb and assimilate waste or to provide "natural capital" for human consumption. Natural environments have a limit or "carrying capacity" for how much waste and human development they can accommodate (Social-Environmental Planning the Design Interface between Every forest and Everycity, 2010).

Understanding sustainable resource use and sustainable development requires paying some attention to cities. Cities are where most of our consumed resources end up. Nearly half the people in the world now live in urban areas. And in a century, 80 to 90 percent of us are expected to live in urban agglomerations. Cities have extraordinary often disastrous impacts on the environment. They can also have beneficial

environmental effects: resource use is more efficient where people can share goods and services; less energy is spent in transportation and production when people don't have to travel too far. Some of the greatest promise for innovative improvements also comes from cities, where people are close enough together to share ideas and resources, to teach each other new methods of doing things, and to recognize the need for cooperative, collaborative environmental problem solving. (Principles of environmental science: inquiry and applications, 2006)

2.2.1 Waterfront development and sustainable environmental planning

Though waterfront rehabilitation is increasingly being employed in developed world cities, the environmental benefits are not always clear. Nonetheless, As developing world cities struggle to break from the traditional model of 'pollute first, clean up later', it is critical that they employ strategies which minimize or remediate environmental impacts while still promoting economic development. Though waterways may not be restored to pristine conditions, the incremental improvements appear to be a necessary catalyst for sustainable urban development. (Environ. Res. Lett, 2009).

In September 2000, the International Centre Cities on Water conference, Venice, under the aegis of the United Nations Urban 21 developed 10 Principles for Sustainable Urban Waterfront Development. These topics have been previously developed by Wasserstadt GmbH, Berlin in collaboration with the Centre Cities on Water, Venice in the course of international seminars attended by local administrators, public and private entrepreneurs, university professors and scholars of the processes to requalify urban waterfronts.

Principle 1 - Secure the quality of water and the environment. The quality of water in the system of streams, rivers, canals, lakes, bays and the sea is a prerequisite for all waterfront developments. The municipalities are responsible for the sustainable recovery of derelict banks and contaminated water.

Principle 2 - Waterfronts are part of the existing urban fabric. New waterfronts should be conceived as an integral part of the existing city and contribute to its vitality. Water is a

part of the urban landscape and should be utilized for specific functions such as waterborne transport, entertainment and culture.

Principle 3 - The historic identity gives character. Collective heritage of water and city, of events, landmarks and nature should be utilized to give the waterfront redevelopment character and meaning. The preservation of the industrial past is an integral element of sustainable redevelopment.

Principle 4 - Mixed use is a priority. Waterfronts should celebrate the water by offering a diversity of cultural, commercial and housing uses. Those that require access to water should have priority. Housing neighborhoods should be mixed both functionally and socially.

Principle 5 - Public access is a prerequisite. Waterfronts should be both physically and visually accessible for locals and tourists of all ages and income. Public spaces should constructed in high quality to allow intensive use Where it does not disturb work in progress.

Principle 6 - Planning in public private partnerships speeds the process. New waterfront developments should be planned in public private partnerships. Public authorities must guarantee the quality of the design, supply infrastructure, and generate both a social equilibrium. Private developers should be involved from the start to insure knowledge of the markets and to speed the development. The coordinators of complex waterfront developments must guarantee their long-term economic, social and ecological success.

Principle 7 - Public participation is an element of sustainability. Cities should benefit from sustainable waterfront development not only in ecological and economical terms but also socially. The community should be informed and involved in discussions continuously from the start.

Principle 8 - Waterfronts are long-term projects. Waterfronts need to be redeveloped step by step so the entire city can benefit from their potentials. They are a challenge for more than one generation and need a variety of characters both in architecture, public space and art. Public administration must give impulses on a political level to ensure

that the objectives are realized independently of economic cycles or short-term interests.

Principle 9 - Re-vitalization is an ongoing process. All master planning must be based on the detailed analysis of the principle functions and meanings the waterfront concerned. Plans should be flexible, adapt to change and incorporate all relevant disciplines. To encourage a system of sustainable growth, the management and operation of waterfronts during the day and at night must have equal priority to building them.

Principle 10 - Waterfronts profit from international networking. The re-development of waterfronts is a highly complex task that involves professionals of many disciplines. The exchange of knowledge in an international network between contacts involved in waterfronts on different levels offers both individual support and information about the most important projects completed or underway

2.2.2 Riparian ecology

Riparian vegetation is an important boundary between the terrestrial and aquatic ecosystems and may ameliorate some of the impacts of catchment land use on river health. An intact riparian community acts as a filter for particulate material coming from the catchment. Considerable work has been done on the design of such filter strips to protect stream values (Herron & Hairsine 1998; Prosser & Karssies 2001). The riparian tree community can add leaf litter and large woody debris to the stream, providing food and habitat. Then canopy provides shade to the aquatic ecosystem, reducing stream temperature and affecting fish behavior (Pusey & Arthington 2003).

Jansen and Robertson (2001) have explored the impacts of domestic livestock grazing of riparian areas, and commonly the first step in stream restoration is to exclude grazing directly from stream banks. Rios and Bailey (2006) examined the influence of riparian vegetation on macro invertebrate community structure in streams and found that taxon richness of the macro invertebrate community increased with increased tree cover in the riparian zone at the reach scale. They found no relationship between the macro invertebrate community and land cover at the whole-basin scale.

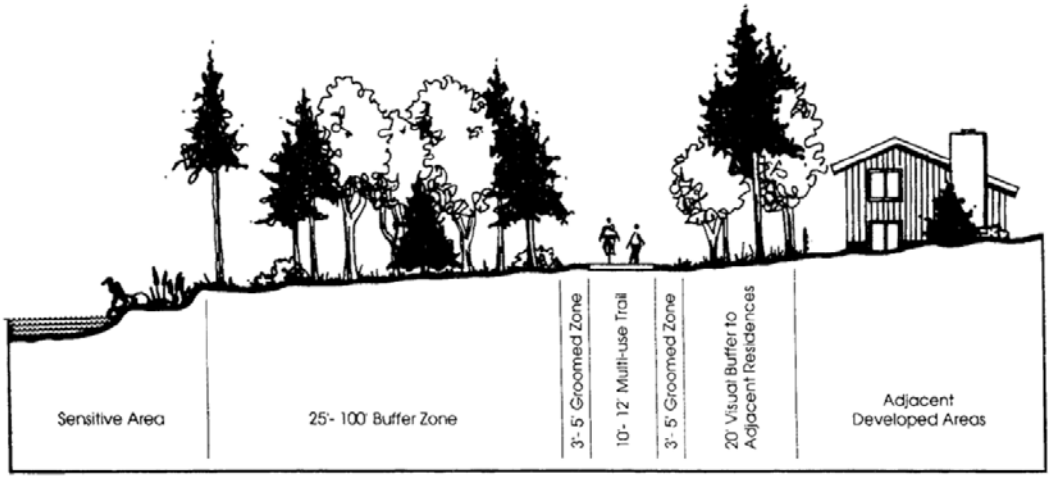

Figure 2 Typical cross section of near shore area adapted from (source: Frank Mitchell, 2002)

The diversity of the estuarine environment includes the marsh and bay grass community of aquatic, riparian, and land species; the microorganism plankton community of both plants (phytoplankton) and animals (zooplankton); the nekton community of free-Swimming larger species; and the benthic community of bottom dwellers. Estuaries play an important role in the life cycle of many species, including shrimp and anadramous fish. Protection of coastal ecology depends on both habitat and water quality protection. Habitat protection requires managing shoreline and marshland uses, including the establishment of buffer zones between water and development and other intensive human use. Water quality protection requires management of development, land uses, and wastewater discharges not only in the coastal zone but also in the larger watershed draining into the estuary (*Randolph.J*, 2003).

Buffer functions and their benefits are ecological and social. They include:

• Hydrologic effects such as promoting groundwater recharge, moderating flooding by intercepting rain and snow melt, reducing sunlight penetration (thereby slowing the rate of spring snow melt), and storing flood waters that overflow stream banks, lakes, and wetlands.

• Water quality maintenance through at least partial removal of sediment, phosphorous, and nitrogen from runoff passing through a naturally vegetated buffer. Forested buffers also contribute to neutralization of acid precipitation, due to ion exchange that occurs as precipitation filters through the forest canopy. The percentage of pollutants removed depends on the pollutant load, the nature of the material, the amount of runoff, and the character of the buffer area. The pollutant removal rate is not generally a linear relationship with buffer width, but decreases with increasing buffer width. More pollutant removal occurs in the first 100 ft than the second hundred.

• Wildlife habitat opportunities, such as providing foraging and nesting habitat as well as cover for a mix of upland, aquatic, and wetland species. Buffer areas can also serve as travel routes for migratory and nomadic, as well as resident, species. They also support plant diversity in the ecotones represented. Buffers protect surface waters and wetlands from temperature increases, which reduces water's capacity to hold oxygen. Leaf litter and woody debris from buffers along smaller streams supply most of the energy processed by the stream. The woody debris also traps the leaf litter, making it available to organisms over a long period of time. These streamside buffers help stabilize banks as well, and naturally undercut areas beneath tree roots offer cover for fish, turtles, and other creatures.

• Recreation and aesthetics benefits from the visual screen buffers provide along surface waters, and they frame wetlands and surface waters in the landscape, particularly in hilly or mountainous terrain.

Buffers can protect both habitat and water quality functions and values, but protecting habitats requires wider, connected buffers. Buffers are protected in ways such as:-

• Voluntary and regulatory methods may be used to protect buffers, preferably in combination. Voluntary measures have the potential to provide optimal protection, but rely on landowner initiative. Regulatory measures apply broadly but typically provide less than ideal, and sometimes less than adequate, protection. Thus, a strategy that encompasses both approaches can result in minimum standards being met widely, with more desirable protection occurring in areas where landowners have chosen to provide

it. S uch voluntary pr otection c an be as sured ov er l ong t ime p eriods t hrough conservation easements and land acquisition by public agencies or private conservation groups.

• Cit izens appear t o s upport t he w ater r esources and ot her f eatures t hat s hore l and buffers can protect. They also appear to support actions needed to conserve ecological and social functions and values of buffers, particularly voluntary ones.

• A l andscape des ign and m anagement appr oach t hat em braces w ater qual ity protection and c onservation of biodiversity will give consideration to shore land buffers as a m eans to s upport both functions. Thou gh buffers alone c annot fully protect w ater quality and bi odiversity, they ar e a k ey pi ece i n a l arger l andscape v iew t hat w ould encompass t hese goal s. A l andscape de sign t hat f ollows t his pat h w ill complement regulatory ef forts by others t o protect t he s ame f eatures, resources, f unctions, an d values. Aesthetics and ot her social values will also be supported by such an appr oach. (Frank Mitchell, 2002)

2.2.3 Land Use and Water Quality

Land us es gener ate physical, bi ological, and c hemical pol lution t hat jeopardize w ater quality. A lthough s ome w ater pollution m ay oc cur nat urally, s uch as er oding s tream banks, m ost w ater pol lution i s the r esult of hum an ac tivities. W ater pol lution oc curs when a c hemical, ph ysical, or biological substance exceeds t he c apacity of a w ater body to assimilate or break down that substance and harms the aquatic ecosystem or water s upply. W hile w ater i tself c an onl y di lute po llutants, bac teria i n t he w ater and adjacent s oils an d v egetation can ac tually br eak down or absorb pol lution. The assimilative c apacity of w ater l argely depe nds on t he am ounts and t ypes of pollution, whether surface or groundwater is involved, the size and flow of the water body, and the time of year. Moving surface water is always more quickly cleansed than standing water or groundwater, because it is regularly replenished by precipitation and base flow.

Assimilative c apacity i s gr eater i n t he s pring (with s nowmelt a nd hi gher precipitation rates and higher stream flows) than in the late summer, when little rain falls and stream flows are lower. Moving surface water receives oxygen through aeration, which enables

bacteria in the water to break down additional waste. A large lake or standing body of water generally dilutes more waste than smaller bodies. The assimilative capacity of groundwater is very limited and mainly depends on the filtering capacities of overlying soil, rock, and vegetation.

Water pollution sources can be divided into point sources, which come from stationary and easily identifiable sites such as a sewage outfall pipe or a factory, and nonpoint sources, which come from dispersed or less identifiable locations. Nonpoint sources of pollution are often difficult to identify and control because they can be hard to see, they may be mobile or temporary, and the pollution generated may vary considerably over time. Yet, studies report that between 70% and 90% of all water pollution comes from nonpoint source pollutants (ibid.). There are more than 40 potential nonpoint sources of water pollution (Social-Environmental Planning the Design Interface between Every forest and every city, 2010).

There is a pressing need to understand the consequences of human activities, such as land transformations, on watershed ecosystem services. This is a challenging task because different indicators of water quality and yield are expected to vary in their responsiveness to large versus local-scale heterogeneity in land use and land cover (LUC). Relying on water quality data collected between 1977 and 2000 from dozens of gauge stations in Puerto Rico together with precipitation data and land cover maps to (1) quantify impacts of spatial heterogeneity in LUC on several water quality indicators; (2) determine the spatial scale at which this heterogeneity influences water quality; and (3) examine how antecedent precipitation modulates these impacts. The models explained 30–58% of observed variance in water quality metrics. Temporal variation in antecedent precipitation and changes in LUC between measurements periods rather than spatial variation in LUC accounted for the majority of variation in water quality. Urbanization and pasture development generally degraded water quality while agriculture and secondary forest regrowth had mixed impacts. The spatial scale over which LUC influences water quality differed across indicators. Turbidity and dissolved oxygen (DO) responded to LUC in large-scale watersheds, in-stream nitrogen concentrations to LUC in riparian buffers of large watersheds, and fecal matter content

and in stream phosphorus concentration to LUC at the sub-watershed scale. Stream discharge modulated impacts of LUC on water quality for most of the metrics (Marı´a U., Charles B., Yili Lim, Javier A. Arce-Nazario. 2011).

2.2.4 Relationships of urban waterfront settlers and lake

Petrillo (1985) mentioned that having human activity can enhance the waterfront area and add to the natural setting. In enhancing it, it is better to consider the existing surrounding activity as in the case of California's coastal program which moved to ensure that the new construction of the urban waterfront would be compatible in the type of use with the existing surrounding to avoid introducing something that is out of place or not acceptable by the locals themselves.

The integration on the diversity of use in both land and water is found significant to allow for more dynamic opening onto the water' and vibrant waterfront area (Mann, 1988). Some cities increase the waterfront attachment through commercial investment by having diversity of use through their public water transportation such as ferry services and water buses. Waterfront transportation is also very much related to recreational appeal through the viewing and visits of the working vessels, educational vessels, Social and Behavioral Sciences (Tunbridge, 1988). West (1989) stated that in North America, many of the renewal efforts are concentrated on waterfront enhancement activities such as up-scale restaurants, cafes, condominiums, hotels, and gift-shops, all of which benefits environmentally and economically compared to waterfront dependent activities. Waterfront dependen tactivities such as boating, marinas and others are considered low-profit operations and operated because it is perceived to be more related to the waterside activity.

2.2.5 Green Prints for Green Infrastructures

Green infrastructure (GI) is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. The network consists of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks, and other conservation lands; and

working farms, ranches, and forests. GI differs from conventional approaches to open space planning because, rather than looking at land conservation in isolation or in opposition to development; it aims to work in concert with land development, growth management, and built infrastructure planning. GI is "smart conservation." It is proactive not reactive, systematic not hap hazard, holistic not piecemeal, multijurisdictional not single jurisdictional, multifunctional not single purpose and multiscale not single scale (Benedict and McMahon, 2002).

Cities are a complex interaction of the natural and built elements. In order to maintain some degree of balance in the natural systems, we have to introduce engineered systems to create and transport energy, to remove and process wastes, to control storm runoff, and so on. This article presents details that reflect a rethinking in our conventional engineering responses, seeking ways to work more closely with natural processes to resolve some of the deficiencies and excesses that come with urban living. This approach is described by the term “green infrastructure.”

According to Donald W., Alen P. Robert t., 2003 , The “green infrastructure” of a city is comprised of natural and designed systems and elements of the city that function in ways analogous to natural processes in managing air, water, microclimatic and energy resources. The most obvious part of this infrastructure are trees, open spaces of vacant lots, lawns and parks, and stream corridors, that is, all places that have water-pervious surfaces and/ or soil to support plant material. Because it imitates natural systems, “green structure” is holistic and includes waterways and microclimatic systems that vegetation, land and water bodies create—essentially those parts of the urban system that are ecologically based. The green infrastructure performs ecological, recreational and aesthetic functions in the city. It improves the quality of the urban environment, provides access to natural habitats, avoids damage to the built form, and, in general, keeps all of us healthy, Moreover, wise use and expansion of green structure is cost-efficient at both the individual home/business level and for the municipality.

Hardscape paving has been implicated in a wide range of ecological problems. Most paving materials create surface stability by excluding water from the soil, and this impermeability causes a number of difficulties. Soil absorbs rainfall and nurtures flora,

fauna, and humans, but impervious surfaces increase runoff, causing erosion and flooding, depleting soil water, and contributing to siltation and water pollution.

Modern construction has created such vast nonporous areas that many communities are being forced to limit the creation of new impervious surfaces. This hardening of the landscape results in a net reduction in the biologically productive surface of the earth as areas of pavement replace cornfields, meadows, forest, or desert. Moreover, paving consumes non-renewable resources both in building the lots and in the fuel required to truck the materials to the site. Asphalt, the material for most parking lots, is a complex mix of hydrocarbons, the mixing and application of which is an air-polluting act in itself. Site planning policies can help to avoid unnecessary paving.

• Density zoning. Local policy that uses overall density (a number of units per acre, or a percentage of acreage devoted to structures) works better than minimum lot sizes, because it allows flexible adaptation to site topography.

• Combined land uses. Zoning that allows residences and work places to coexist makes walking, biking, or public transit much easier for workers. This is often a matter of removing barriers to coexistence from existing zoning laws.

• Impervious surface limits. Set a maximum percentage of the site area that can be impervious, this must include both paved and roofed areas, existing and new. Where this level is set to 10% or lower, streams and other hydrological features of the area can be considered protected. Above 10%, impacts are serious enough to require mitigation; and where 30% of the area is impervious, degradation of the ecosystem is almost inevitable. In urban areas already far over this threshold, incentive programs for reducing impervious cover can be effective.

2.2.6 Urban Waterways

All cities are located in specific watersheds and receive some amount of rainfall each year. Many cities are situated at the mouth of rivers or along rivers because of the early dependence upon water transportation and waterpower. All water that passes through a city must somehow be managed so that good quantities and quality of water are available for consumption and to avoid adverse effects such as flooding. Well-protected

and managed waterways are an asset to a community and can bring recreational and ecological benefits to the citizens. All landforms, building and urban pavement, vegetation and surface soil geology serve as "sinks, "catchments" and "filters" of rain- and stormwater runoff. How this water flow is designed and managed has a direct bearing on the priceless resource of the subsurface aquifer, the vital water storage that determines the health and sustainability of any human settlement.

2.3 Threats and challenges of urban lakes

Land planning and design are the primary methods of runoff and pollution control for lake protection. There are four major zones to be considered in lake protection: the actual shoreline, a forested shoreline buffer extending landward, a shore land protection area extending further, and a watershed zone used to control pollutant loadings to the lake.

Cappiella and Schueler (2001) list the following primary considerations in lake protection. They demonstrate that lake areas, especially shorelines, are unique in terms of their ecology, intensity of use, property values, and management.

Riparian buffers are perhaps the most important. These areas of trees and shrubs next to streams, lakes, and wetlands protect water bodies by intercepting surface runoff and the sediment and pollutants it carries. In addition, buffers provide food and cover for wildlife, shade to lower shoreline water temperatures, slow flood flows, stabilize stream banks and shorelines, and provide litter and woody debris for aquatic organisms (*Randolph. J*, 2003).

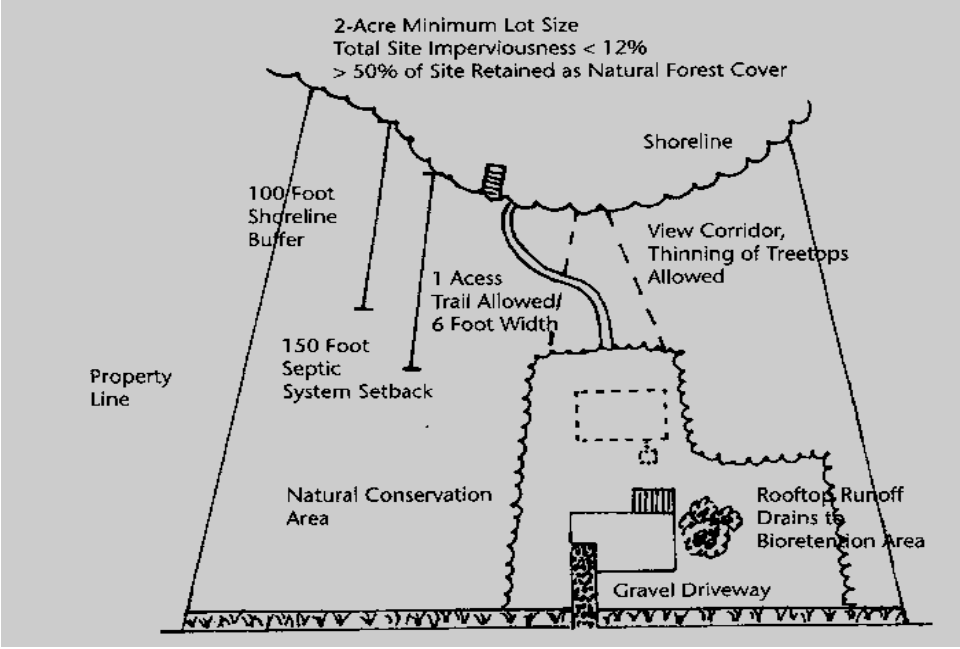

Figure 3 Environmentally Sensitive Design for Residential Shoreline Lot. (Source: Karen Cappiella and Tom Schueler, 2001).

2.4 Empirical literature review: the case of Bahir Dar waterfront planning

In Bahir Dar sustainable waterfront development plan considers public access, green infrastructure, mixed use of waterfront development, diversified job and housing and urban and rural linkage which are based on the out puts from different stakeholders that includes the public, government and NGOs. Problems endangering Lake Tana are major source of pollution from agriculture, solid and liquid waste and industries other problems such as encroachment of the waterfront, environmental hazards like flood, contaminated ponds with urban waste and quaries, threatened wetland with pollution and encroachment, invasive plants like eucalypts grove are mention as major environmental problem. (krystie .B, Krista H. and Josh T., 2011).

Based on the above focus areas and major problems Five principles and strategies were developed through the public consultation process

Principle 1 public access

Principle 2 green infrastructures considers green friendly infrastructures, enhance marine habitats, improve water quality and water management, network green structures, waterfront rehabilitation and public sanitation facilities

Principle 3 mixed use of waterfront aims to balance multiple land uses bay balancing private land uses, cultural gathering places, and economic development and preserve wetlands.

Principle 4 diversified jobs and houses

Principle 5 urban rural linkages

The waterfront plan aims to Move high density development away from waterfront by Incorporating public parks and open green spaces in to high density areas to provide residents access to recreation. Regulating building heights and design within the waterfront having Ban on obstruction of water views, balance build up space ratios and incentives for the use of local architectural styles and materials. Building policies incorporate requirements considering on site waste management, access for the disabled and elderly and free and open public access spaces/routs to the waterfront.

Other sustainable measures are included such as; Recycling and composting, Linking waste management and pov erty reduction, establishing Alternative agricultural processing (aqua farming, dry fish export) and by creation of awareness.

The Waterfront land uses are managed by indentifying areas for development and areas that should be preserved by promoting mixed use, green buffers, park spaces and economic opportunities. Building the green network to frame development by connecting major waterfront corridors, trails and green ways with indigenous forest, wetlands, urban agriculture and public greeneries are another strategy. Regulate and enforce green buffer zone with continuous buffer of indigenous species along waterfront to protect them from the development are highly encouraged.

2.5 Application on GIS and remote sensing for the study waterfront

Geographic information systems (GIS) are used to collect, store, analyze, disseminate and manipulate information that can be referenced to a geographical location. Remote sensing is the technique of obtaining information about an object, area or phenomenon using a device that is not in contact with the object, area or phenomenon under investigation (Lillesand and Kiefer, 1994). The integrated use of GIS and remote sensing can be applied to describe ecosystems, identify a species distribution and habitat use, and to organize conservation strategies for both endemic and introduced species (Scott et al, 1987).

With the wide variety of remote sensing systems available, choosing the proper data source for observing land cover and Coastal waters can be challenging. Characteristics often used to describe and compare these analogue and digital systems are grouped into four different types of resolution: spatial, spectral, radiometric, and temporal. Spatial resolution is a measure of sharpness or fineness of spatial detail. It determines the smallest object that can be resolved by the sensor, or the area on the ground represented by each picture element (pixel). For digital imagery, spatial resolution corresponds to the pixel size.

Spatial resolution is often represented in terms of distance (e.g., 30 m, 1 km, etc.) and describes the side-length of a single pixel. Spectral resolution is a measure of the specific wavelength intervals that a sensor can record. For example, while normal color photographs show differences in the visible region of the electromagnetic spectrum, color infrared photographs and the majority of digital sensors can provide information from both visible and infrared (IR) regions of the spectrum. For digital images, spectral resolution corresponds to the number and location of spectral bands, their width, and the range of sensitivity within each band (Jensen, 2007).

Radiometric resolution is a measure of a sensor's ability to distinguish between two objects of similar reflectance. Radiometric resolution can be thought of as the sensor's ability to make fine or ''subtle'' distinctions between reflectance values.

For example, while the Landsat thematic mapper (TM) has a radiometric resolution of 256 (8 bits), the moderate resolution imaging spectrometer (MODIS) has a radiometric resolution of 4, 096 (12 bi ts). Thi s m eans TM c an i dentify 25 6 di fferent l evels of reflectance in each band, while MODIS can differentiate 4, 096; thus MODIS imagery can potentially show more and finer distinctions between objects of similar reflectance (Camp bell 2007).

Temporal resolution is a measure of how often the same area is visited by the sensor. Temporal resolution does not describe a single image, but rather a series of images that are captured by the same sensor over time. While the temporal resolution of satellite imagery depends on the satellite's orbit characteristics, aerial photography obviously requires special flight planning for each acquisition.

To obtain the required spatial, spectral, and temporal resolutions, coastal ecosystems frequently have to be observed from both satellite and aircraft. Some of the ecosystem health indicators that can be obs erved by remote sensors include natural vegetation cover, w etland l oss and f ragmentation, w etland b iomass c hange, per centage of impervious watershed ar ea, b uffer degr adation, and c hanges i n hy drology, w ater turbidity, c hlorophyll concentration, eut rophication level, s alinity, t emperature, et c. (Lathrop, Cole, and Showalter, 2000; Martin, 2004; Wang, 2010).

Topographic and hydrographic information are basic elements in studies of near shore geomorphology, hydrology, and sedimentary processes. In order to plan sustainable coastal development and implement effective beach erosion control and coastal ecosystem protection strategies, scientists and coastal managers need information on long-term and short term changes taking place along the coast, including beach profiles, changes due to erosion, wetlands changes due to inundation, etc. (Klemas, 2009).

2.6 An evolution of waterfront development

Waterfront began as commerce centers, transportation hubs , manufacturing centers and commercial areas. Therefore, Waterfronts are seen as the focal point in many cities. But, due to various reasons including changing in transportation, containerization shipping and manufacturing this has lead to a significant decline in waterfronts.

The urban waterfront development is widely regarded as a frontier on contemporary urban development, attracting investment and publicity (Malone, 1996). Sydney, London, Amsterdam, Hong Kong, Tokyo, Toronto, Osaka, Kobe and Dublin are examples of cities developed through the waterfront development process. Therefore, understanding the historical milestone of waterfront development is important because this stimulates modern development in the city (Wrenn, 1983). In the book Urban Waterfront Development, Wrenn (1983) divided the historical evolution of waterfront into four periods are as follows:-

(i) Emergence of Waterfront Cities

At this period, the early American settlement was closely tied to the water edge. Waters plays an important role for needs, trade activity and water transportation. Settlements were established after immigrants arrived and the colonial waterfronts were the doors to opportunity. A settlement's waterfront served to link the necessities of people with a familiar and predictable environment.

At that point in its development, the waterfront was nothing more than a few trails converging at a jetty. Rapid growth of waterfront community initiates a building development. However, the waterfront community still relies on waterway transportation due to limited transportation capability at that time.

(ii) Growth of Waterfronts

At these periods, waterfront settlement increased and became a city. The area turned into a busy area to cater for trading activity. Building and warehouse was developed along the waterfront and typically, rows of warehouses blocked the water's edge from the street. By spilling out into the water to expand docking and storage areas, the distance from the city's centre to its shoreline was significantly extended. To make it easy, alternative transportation methods were introduced other than waterways. However, waterfronts become more congested due to more space required to accommodate the need for the railroads. As a result, the central city was further detached from the shoreline. Since 1930s, elevated highways and interstate freeways have appeared near the shoreline. As a consequence, original offices and stores along

the old shoreline were converted to warehouses and resulted in decreased number waterfront workers.

In the meantime, the waterfront environment deteriorated due to the industrial pollution. The water became dirty and the waterfront began to lose its natural attraction to many urban residents.

(iii) Deterioration of Waterfronts

Technologies changed in containerization and shipping, improvements of transportation patterns (highways) and with new ports developed outside the city; the old ports lost the role as the transportation and industry centre. People preferred the highways to railroads because of their freedom of choice and more accessibility. As a result, the waterfront became even more deteriorated.

Besides those factors, increase awareness among public to environmental issue and introduced air and water pollution controls to manufacturers also contributed to ports becoming obsolete and waterfront become neglected. The waterfront virtually becomes a dead, inaccessible and unsafe area, further separating the urban core from the water.

(iv) Re-discovery of Waterfronts

Over time waterfront became a dead due to the commercial failure of many ports, in the 1960s, governments wanted to recover the aesthetic scenery of the waterfront which had become polluted over the years.

There came a chance to reconnect waterfront to the downtown area for public use. Blends of recreational, residential and commercial uses were developed. As a consequence, much more land has been returned to public use. In the meanwhile new container ports were established out side the city where space was plentiful. It is apparent that each city has a different waterfront character, scale and pace, of course experienced variation in the typical waterfront evolution pattern. One fact is common though, urban waterfronts dramatically changed due to the influence of social and technology factors.

CHAPTER THREE: RESEARCH METHODS AND MATERIALS

3.1 Research Area Description

Hawassa is serving as the capital of southern nation's nationalities and peopl e's regional state and Sidama zone. The city lays on the trans-African highway-4 an international road that stretched from Cairo to Cape Town. The city is bounded by the lake in the west, Oromiya region in the north, Wondogenet woreda in the east and Shebedino woreda in the south.

The city administration has an area of 157.2 sq. Kms, divided in to 8 sub-cities and 32 Kebeles, these eight sub cities are Hayek dar e, Meneharia, Tabore, Misrak, Bahil Adarash, Addis ketema, Hawela-tulla and Mehal ketema.

The urban population of Hawassa based on the 2007 census result projection for 2012 is 201,027 which include 103,646 male and 97,381 female population. The Populations of sub cities in the study area are 22,297 in Hayek dar subcity, 22,867 in Addis Ketema subcity and 55,901 in tabor sub city. The number of rural population for male is 59,393 and for females is 56,422 with a total population of 115,576. Therefore the total urban and rural population of Hawassa is 316,842.

The study takes place in Hayek Dar sub city which have Gudumale and Gebeya dar kebeles, Addis Ketema which include Daka and Philadelphia kebeles and part of Hogane wacho and Tilte kebeles from Tabor sub-sity. It is estimated that around 45,000 people live within the waterfront of Lake Hawassa.

Lake Hawassa is the smallest of all major lakes south of Awash basin. The catchment has no surface outlet it is about 15 km long and 5.5 km wide with a maximum depth of 22m (NUPI, 1994). Lake Hawassa is one of the few fresh water lakes that may be used for irrigation. The maximum depth is 18-22m. The shoreline length of the lake is 50-65 km. It is a small closed system but fresh and has high productivity.

Lake Hawassa is a major source of fish for the local community. The fishing shore at Hawassa town, especially when the commercial fish catch is being landed and sold, is dramatic and beautiful place to see. In the western shore areas the lake is being used for drinking by the local community. The littoral zone is extensive and has abundant aquatic vegetation. It is feeding ground for many species of water birds that are extraordinarily abundant (WWSDE, 2001

3.1.1 Location and accessibility

The study area is located within the geographical co-ordinates of 60 45' to 70 15'north and 380 15' to 380 45' east latitude and longitude (UTM: 419485-470099E and 752392-799477N) respectively. The catchment can be accessed in different directions using quite a lot of weathered roads.

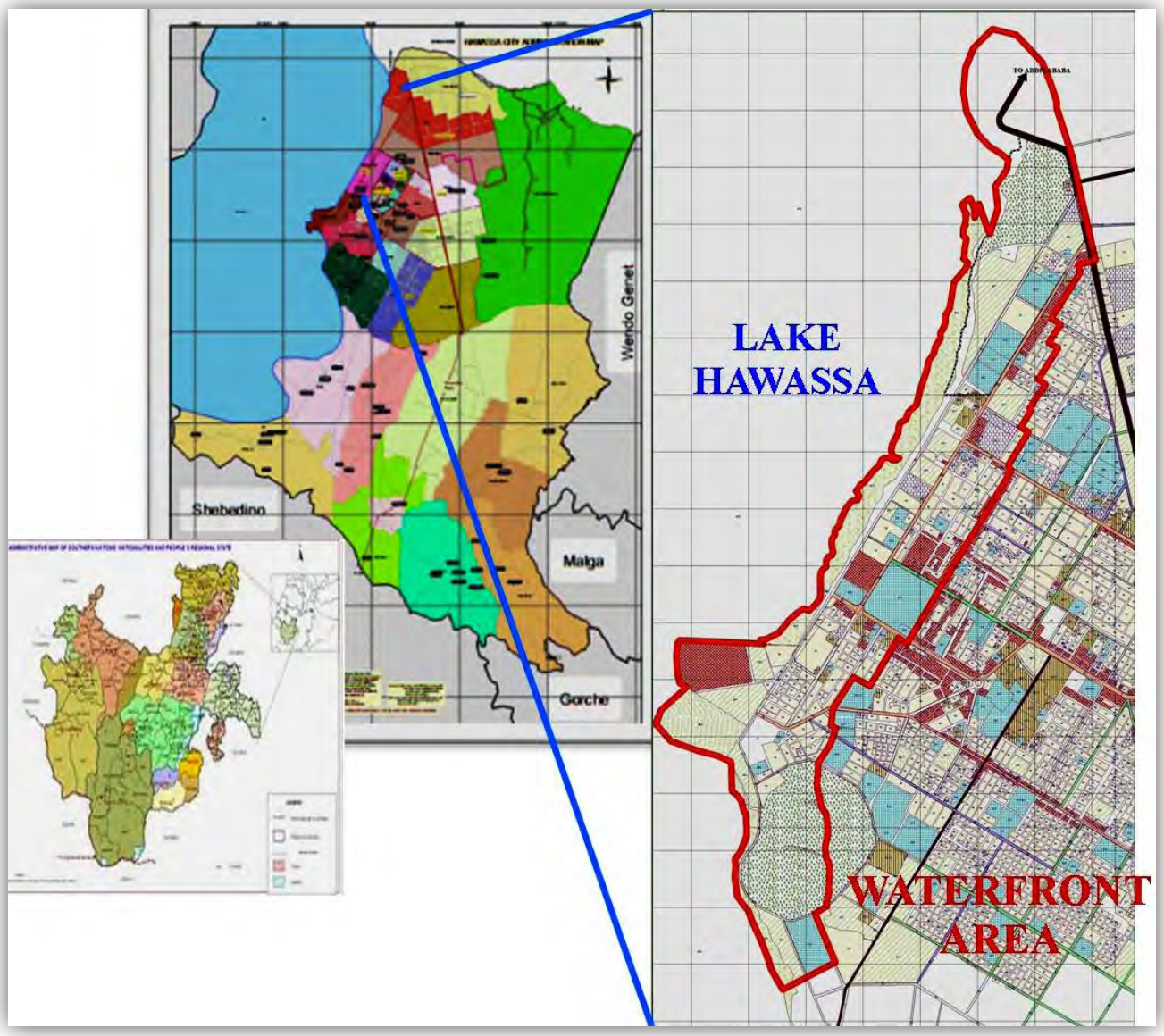

Figure 4 study area of the research. Source: SNNPR plan preparation office

Waterfront delineation is done based on Dong (2004, p. 7) described the waterfront as the interface point where land and water meet, between approximately 200 to 300 meters from the water line and 1 to 2 km to the land site and also takes in land within 20 minutes walking distance. In this study 200 meters from the waterline and 700 meters to the land site are delineated as waterfront based on administrative zone and feasibility of the study. The waterfront also considers only the developed waterfront areas based on the objective of the study. As shown in figure 4.

3.1.2 Climate

Lake Hawassa watershed has extended period of wet season (March-October with mean monthly rainfall varying from 85 to 133mm). June to September rainfall contributes 44% of the mean annual precipitation in the watershed. The climate in the area is dry to sub-humid according to the Thornthwaite's system of defining climate or moisture regions (Dessie, 1995). The mean annual rainfall on bases of 12 to 30 years of record of five rainfall stations that contribute to the watershed is estimated to be 1028 mm. Though there is no other station in the watershed that records temperature to compare with, it can be concluded from Hawassa station that, the lowland part of the catchment annual temperature ranges from 9 ºC to 29 ºC, while mean monthly temperature is 19.7ºC (Yemane, 2004).

3.2 Research Methods

Case study method was used to research the impact of unplanned urban waterfront development on Lake Hawassa. Different types of data collection and data analysis method were consumed to attain the objectives of the research and to answer the research questions. Both qualitative and quantitative data were collected from primary and secondary data sources.

3.2.1 Data collection methods

The study uses a combination of primary and secondary data to assess the impact of unplanned urban waterfront development on Lake Hawassa. Structured interview, focus group discussions, document review, digital land sat and CAD image collection, structured observation and review of similar researches, journals and books were used.

3.2.1.1 Primary data

Interview

Interview with key stakeholders using structured questionnaires to assess the awareness and practice of residents, commercial organizations, hotels and NGOs were conducted. Prior to these by the method of stratified deliberative sampling, samples are selected among residents, commercial organization and hotels. The interview on residents considers key socio economic parameters for analyzing their pressure on the

lake and the fringe zone ecosystem. In addition, discussions with professionals and experts within the area were used as a primary data source for the research.

Focused group discussion

Discussions with fishery associations, shoreline recreational area youth associations and boating associations are conducted to reveal the impact of urbanization on the lake and their role in the protection and the deterioration of the lake and the fringe zone ecosystem. These discussions also analyses socioeconomic activities with nature conservation and management principles.

Site Survey

On-site evaluation by observation of selected sites within waterfront based on principles of landscape ecology and sustainable waterfront development are conducted. The observation takes place using checklist which considers basic parameters of mentioned principles. During the observation the waste management practices are considered. In addition point source pollutions and intrusions are recorded via GPS points and further analysis is done.

Specifically the vegetation pattern, wetland condition, liquid and solid waste management practices and degree of recreational pursuits in relation to natural ecosystem were analyzed.

3.2.1.2 Secondary data

Document review

Documents from government offices, researches, journals, books and other supporting documents were used.

Digital images and maps Review

To analyze the spatial and temporal changes in the waterfront digital land-sat images from USGS were used and vector and raster data of Hawassa area collected from SNNPR planning and design office.

Table 1 list of landsat-5 TM images

Year	Month	Cloud cover
1984	April	0%
1994	December	0%
2003	January	0%
2011	January	0%

(source: USGS land sat look viewer)

3.2.2 Data analysis methods

Primary data collected from interviews and focused group discussions have processed using spreadsheets. Data from interviews and documents correlated with other findings to come up with generalized findings. Analyses of the primary data have made for measuring the socio economical practice and community awareness which is important to determine the impact on the lake and the natural waterfront.

Landscape ecological principles and aquatic ecosystem conservation principles have used to analyze the information gathered while observation and cartography assessments. The pattern, arrangement and characteristics of built structures were analyzed using land use maps, master plan of the city and observation by comparing it with fringe zone ecological principles. Proximity analysis of urban development was used to assess the liquid and solid waste threats which were verified by tacking point source pollution and analyzing utilities from the city and the waterfront.

Ecological landscape analysis was done through observation using GIS software's. The anthropogenic impact on the lake littoral zone was assessed by Vegetation analysis and landscape ecological analysis after delineating the waterfront. Vegetation analysis was done using photographic images to identify the intrusion of exotic species and disturbance of natural landscapes.

Waterfront delineation was done based on Dong's method (2004, p. 7) described the waterfront as the interface point where land and water meet, between approximately 200 to 300 meters from the water line and 1 to 2 km to the land site and lad use also taken within 20 minutes walking distance. In this study 200 meters from the waterline and 700 meters to the land site was delineated as waterfront based on administrative zone and feasibility of the study. The waterfront also considered only the urbanized waterfront areas based on the objective of the study.

Spatial and temporal land use and land cover analysis were made using remote sensing and digital image processing by utilizing ENVI 4.3 and Arc GIS 10 software's. The remote sensing data were corrected for radiometric and geometric errors. GIS Software was used in classifying the land use map and imagery of the study area. As an output based on the findings Land use and land cover maps were generated.

Supervised classification by ENVI 4.3 using ground data points as signatures for each satellite image are used to determine land use change observed in the ten year period of intervals for 27 years. While doing these training points are equally distributed to each cover type with at least 10 points per land use type. At the end of land use classification maps were checked for accuracy using ground data points.

In addition to analyzing the changes in the amount of land use types, the temporal transitions among the land use types were documented and evaluated to see the temporal dynamics of Landscape. The transitions were evaluated using both periodic satellite images. The land use polygon themes were overlaid and the areas, converted from each of the classes to any of the other classes, were computed. The rate of change for each class was calculated using the following formula (Puyravaud, 2003).

$$P = \frac{100}{t_2 - t_1} \ln \frac{A_2}{A_1}$$

Where, P is percentage of land use change per year and A_1 and A_2 are the amount of land use type at time t_1 and t_2, respectively. The spatial dynamics of land use types refer to the temporal change in the size, number, shape, adjacency and the proximity of patches in a landscape.

The overall procedures of digital analysis of the waterfront are presented as follows:-

1. Data procurement

2. Geo-referencing of map

3. Digitization of city and sub-city boundary maps

4. Overlay of vector layer on to the satellite imagery

5. Extraction of the area of interest from the entire satellite data

6. Formulation of land use and land cover maps with different time frame

3.2.3 Research Materials

The following materials were used in this research process

Interview schedules and check lists were used to collect primary data about the status of the waterfront and the socio economic practice of stakeholders within the waterfront.

Base map:-used to assess the extent and type of land use surrounding Lake Hawassa shoreline. It was also used to differentiate the developed and undeveloped areas which were important to assess the impact of urban development.

Satellite data obtained through remote sensing, spatial data in the form of digitized map of the city:-were used to assess the spatial and temporal changes occurred on the waterfront and to analyze its impact on the natural ecosystem of the lake. In addition landscape ecology patterns were assessed based on the latest land sat images of Lake Hawassa waterfront.

Basic image characteristics such as shape, size, tone, texture, pattern and various associated features were considered at the time of interpretation. The images were interpreted and the classification of urban land use categories was selected taking the scale, brightness, contrast and resolution of the data into consideration.

Documents from government officials about the ordinances, conservation and management practices are collected. In addition researches, journals, books and other supporting documents were used.

CHAPTER FOUR: FINDINGS, ANALYSIS AND DISCUSSIONS

4.1 Land use and land cover change of Hawassa Waterfront and its impact on the lake

Hawassa is a very fast growing city among cities in Ethiopian. Within 60 years of rapid development there are radical change observed in the land use and land cover. Especially the waterfront areas changed at large from natural forest to agricultural land and then to urban development. The study assessed the change observed in 27 years starting from 1984 to 2011. The main land use and land cover which were emphasized in the study are development, forest cover, wetland, grassland, bare land, water and agricultural land.

Figure 5 illustrates changes in land use land cover of the waterfront in spatial and temporal aspects. Settlement is the matrix of the landscape expanding into other land use or land cover types. As depicted in figure 5 the continuity and extent of settlement increased in direct proportion with the decrease and defragmentation of other land use land cover types. The patch size and continuity of wetlands and grasslands decreased and disturbed from 1984 to 2011. The flooded area moved towards settlement and settlement also expanded into the lake pressurizing the waterfront especially at the shore area. The development of the city promotes the interest in developing the waterfront for hotel industries and other types of land use towards the littoral zone. Positive changes within the waterfront have been observed in the case of forest cover concentrating in two areas but there is a gradual decrease from 2003 to 2011 as a result of expansion of settlement.

Land cover changes may have immediate and long-lasting impacts on terrestrial hydrology (Calder, 1993) and alter the long term balance between rainfall and evapotranspiration and resultant runoff. In the short-term, destructive land use change may affect the hydrological cycle either through increasing the water yield or through diminishing, or even eliminating, the low flow in some circumstances (Croke et al., 2004). Long-term the reduction in evapotranspiration and water recycling arising from

land cover changes may initiate a feedback mechanism that results in a reduction of rainfall.

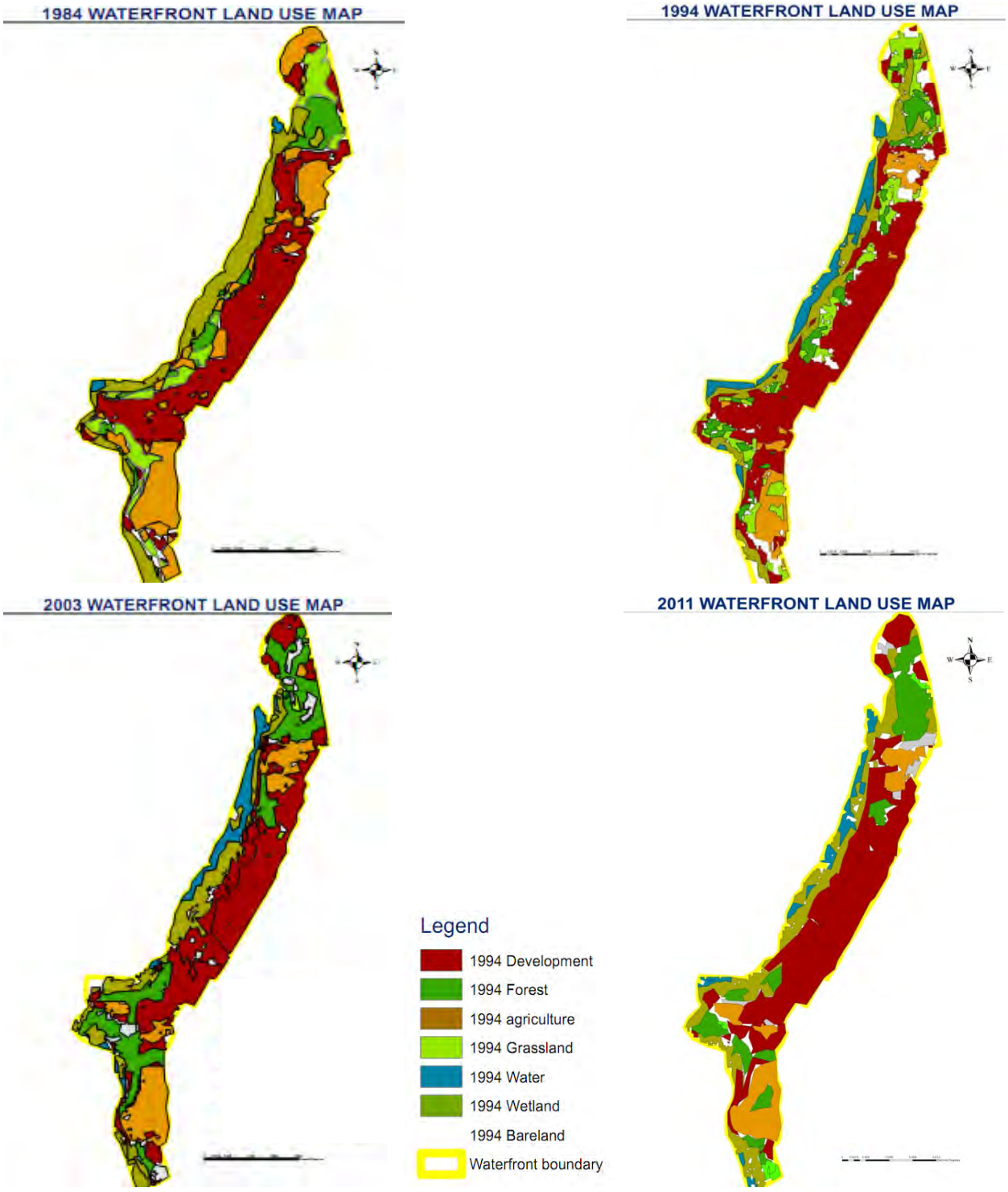

Figure 5 land use change hawassa waterfront from 1984 to 2011 (source: processed digital images procured from USGS)

Table 2 shows the seven land use land cover spatial dynamics in the study area and its yearly percentage of land use change within the given period of time. The spatial dynamics of land use types refer to the temporal change in the size, number, shape, adjacency and the proximity of patches in a landscape. There has been a positive change in development within the waterfront since 1984. Development was highly dramatic from 1984 to 1994 with a yearly rate change of 2.44 %. It slows down to 0.47 % from 1994 to 2003 and accelerated at a rate of 1.42% from 2003 to 2011. The coverage of the forest increased very slightly from 1984 to 1994 and increased at a great rate by 9.32% percent from 1994 to 2003 but it has decreased from 2003 to 2011 by 6.4%. While grasslands or grazing lands decreased by 0.56% from 1984 to 1994 then decreased at a rate of 39.72% until 2003 and increased by 1% from 2003 to 2011.

Table 2 land uses and land cover change within the waterfront in area and its yearly percentage of change from 1984 to 2011.

No	Land use	Area in m² 1984	Area in m² 1994	Percentage of change (1984-1994)	Area in m² 2003	Percentage of change (1994-2003)	Area in m² 2011	Percentage of change (2003-2011)	Area of change in m² (1984-2011)
1	Development	2,799,312	3,571,878	2.44	3,725,077	0.47	4,175,420	1.42	1,376,108
2	Forest	613584	614382	0.009	1421105	9.32	851517	-6.4	237933
3	Wetland	1332397	1101649	-1.86	1036599	-0.69	1007389	-0.35	-325008
4	Bare land	63681	127361	6.93	221743	6.15	244186	1.2	180505
5	Grassland	907,009	858134	-0.56	23840	-39.72	25011	1.02	-881998
6	Agriculture	1694162	631985	-9.86	604590	-0.46	851517	4.38	-842645
7	Water	48611	555351	24.36	427786	-2.9	305700	-4.28	257089

(Source spacial analysis of images procured from USGS)

The implication of these is that the area of wetland and water are decreasing since 1984 except for a huge flooding occurred from 1984 to 1994 which increased the area of water yearly by 24.36%. The loss of wetland within the waterfront from 1984 to 1994 was 1.86% and an average of 0.5 % loss occurred from 1994 to 2011. The loss of water body was higher from 2003 to 2011 which was 4.28 % when it compared with 1994 to 2003 which was 2.9%.

The area of agricultural land decreased from 1984 to 1994 by 9.86 % and slightly decreased by 0.46% by 2003 and increased by 4.38 % from 2003 to 2011 typically at the location around Mount Tabor. The rate of change and spatial arrangement of bare lands has been altered from 1982 to 2011 and the parentage of increase had dropped down to 1.2%.

Generally land use change development, forest cover, bare land and flooded area has increased while wetland, grassland and agricultural land decreased. The spatial scale over which LUC influences water quality differed across indicators. Turbidity and dissolved oxygen (DO) responded to LUC in large-scale watersheds, in-stream nitrogen concentrations to LUC in riparian buffers of large watersheds, and fecal matter content and in stream phosphorus concentration to LUC at the sub-watershed scale. Stream discharge modulated impacts of LUC on water quality for most of the metrics.

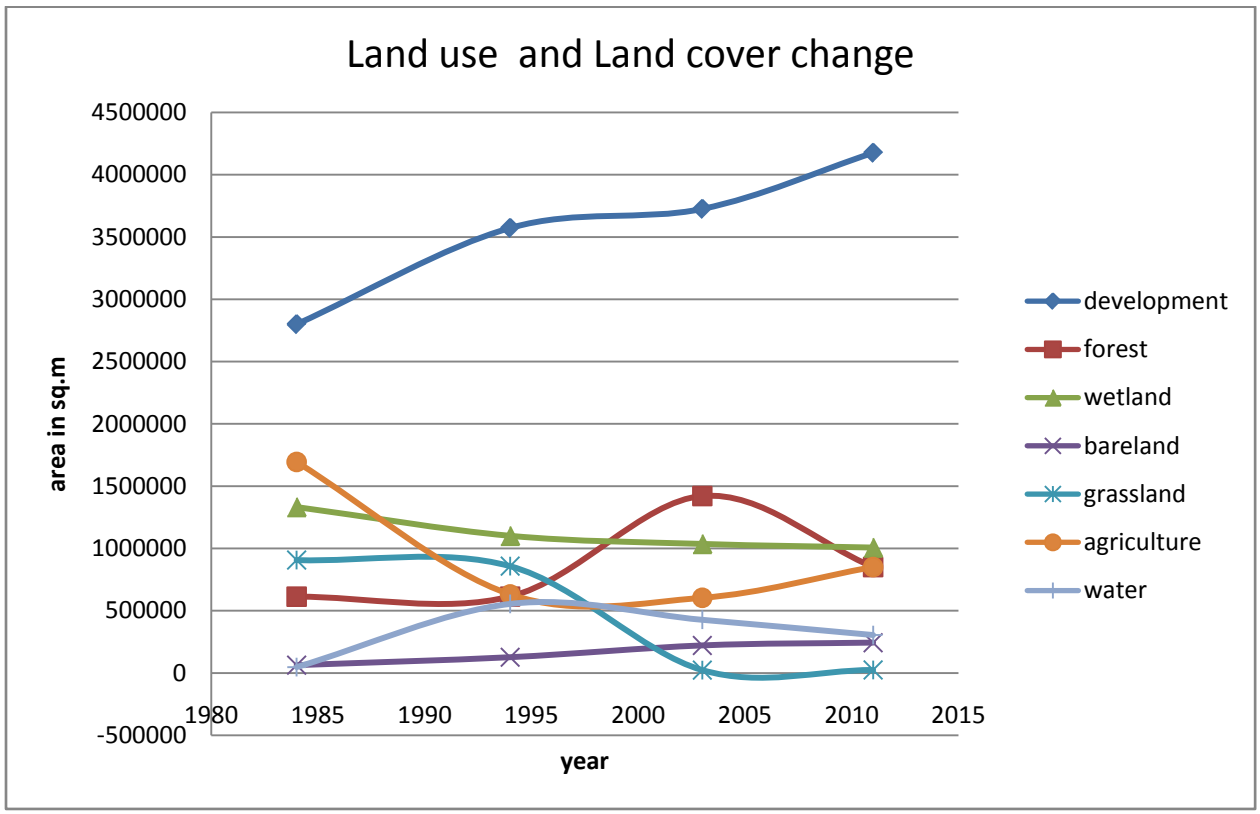

Figure 6 correlation of waterfront land uses land cover change from 1984 to 2011 (source: Own Gis analysis)

Figure 6 summarizes and correlates all the results that have discussed and clearly shows each land use land cover changes and their relation. Development increases in higher amounts than other land use or land cover types especially its proportional to the decrease in wetland, grassland and forest cover from 2003 to 2011. As development increases the demand for land resulted in the encroachment of natural land covers. The natural buffers become fragmented where ecosystem services like waste treatment, flood prevention and supporting the ecology diminished which has significant negative impact on the lake.

Agricultural land and development from 2003 to 2011 increased steeply while forest cover radically decreased which shows the conversion of forest cover to either agricultural or developmental purposes. These two land uses have huge negative impacts on the lake such as waste release and sedimentation. Urban waterfront areas should be developed to enhance the natural ecosystem and to protect the lake.

The highest increment in forest covers from 1998 to 2003 around Tikur Wuhan and Mount Tabor are positive changes to sustain the waterfront and protect the urban lake. Vegetation cover in private and government owned land also have a huge significance in sustaining the area. But it could be meaningless if the density of development increases in this rate that peoples began to cut down those privately owned natural and planted trees for the pursuit of land. The cause of impacts related to land use land cover change of Hawassa waterfront is resulted from lack of proper waterfront development and management planning. There was no special consideration given to the waterfront because of lack of awareness considering the importance of the lake towards maintaining the ecology and ecosystem services.

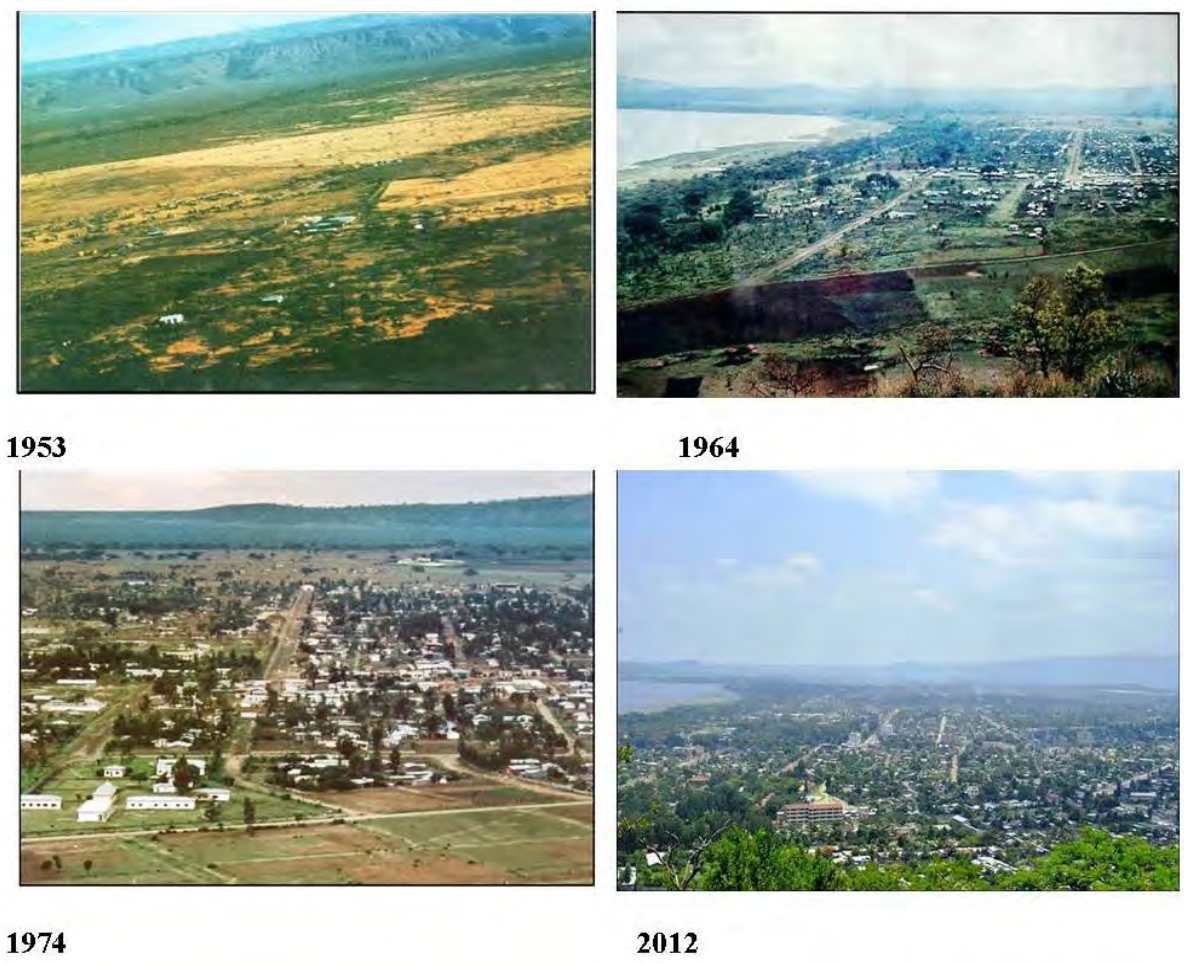

Figure 7 photograph representation of land use changes in Hawassa from 1953 to 2012 (source: *Www.hawassaturism.html*)

Figure-7 represents the land use changes within 58 years from 1953 to 2011. In 1953 the illustration reveals agriculture dominated landscape while in 1964 and 1974 the city was concentrated in the middle and expands and engulfs the whole landscape by 2012.The demand to capture the waterfront area for the hotel industry and other recreational purposes increased along the sprawl of the city. The untapped land within the waterfront around the shore line because of flooding risk is now in high rate of development parallel to the decrease in wetlands and flooded land as shown in figure.

Waterfront development stage of Lake Hawassa is characterized by three major classes. The first one is pre-development of the waterfront which includes periods

before the 1990, at this time the waterfront was designated as a backyard of the city apart from uses such as fishery. Then the developmental stage follows from 1990 up to 2003 which includes two main anthropogenic and natural changes. The anthropogenic change was resulted from expansion of residential and agricultural land towards the waterfront and the natural change is due to flooding. The occurrence of the flooding repelled further development because of risk. But from 2003 till the present there has been a high rate of redevelopment within the waterfront in hotel industry and ecotourism businesses. However, the redevelopment has not considered proper and sustainable waterfront planning and management. Therefore, there is a greater probability for deterioration of the aquatic and the surrounding ecology.

4.2 Waterfront land use planning

Hawassa has four master plans since its establishment, which are in 1954, 1974, 1994, and 2006. According to the existing master plan 30% of the land is allocated for special functions within the waterfront, 19% for residential, 19% for urban forest, 12 % for services, 9% for commerce and trade, and the remaining for other purposes such as recreation, manufacturing, agriculture and administrative functions. There have been seven local developmental plans but none of them considered the waterfront area. The eighth local developmental plan is under study which focuses on the waterfront.

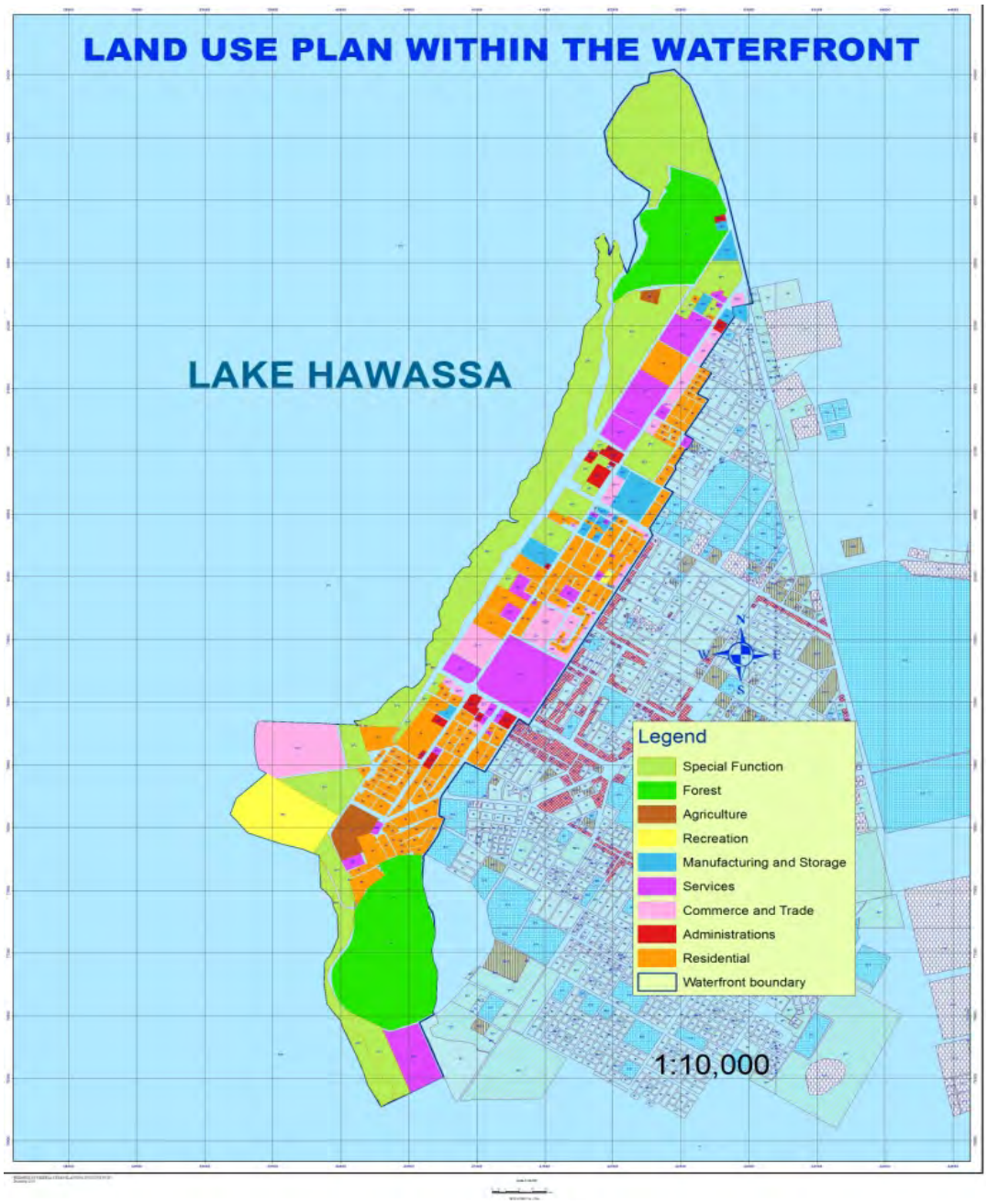

Figure 8 existing Land use plan of Hawassa within the waterfront (source: SNNPR plan preparation office)

The international center city's water conference principle nine indicates revitalization is an ongoing process. All master planning must be based on the detailed analysis of the principle and meanings the waterfront. Plans should be flexible, adapt to change and incorporate all relevant disciplines. To encourage a system of sustainable growth, the

management and operation of waterfronts during the day and at night must have equal priority to building them. When we see the case of Hawassa there has not been detailed plan for waterfront development since today as a result of this the negative impacts on the lake due to the urban development has been aggravated.

Land use planning and design are the primary methods of runoff and pollution control for lake protection. There are four major zones to be considered in lake protection: the actual shoreline, a forested shoreline buffer extending landward, a shore land protection area extending further or the waterfront, and a watershed zone used to control pollutant loadings to the lake. As Lake Hawassa is in a closed hydrogeological system exceptional land use planning at watershed level and detail planning of the waterfront is mandatory. As the result indicated 30 per cent of the land is designated for special functions that lead the waterfront be misused. Lately these fragile ecological areas were used for unplanned recreational expansions and hotel industries. Because of these waste from this development and the removal of fringe zone vegetation has deteriorating the lake.

According to Haik Dar sub city administration office, most of the waterfront developed area has occupied by private owners. For example in Hyike Dar sub-city which shares half of the waterfront area; there are a total of 2,338 unit of land parcels with ownership of 525(22%) governmental, 1424(61%) private, 258(11%) non registered and 131(6%) illegal settlers. From private owned land 180 (13%) are industrial and commercial while the rest is residential.

Betwen the year 1984 -1994 flooding occurred in the city which inundated a huge amount of land that had been used for settlement and urban agriculture. This area was changed into wetlands which are perennial and annual. But when gradually as the demand of land increases and the amount of water degraded; peoples illegally settled in to the vacant places by filling the wetland for residential and recreational purpose. 17 % of the land parcels in Hyike Dar sub-city were unregistered and settled illegally intruding the buffer zone. Figure 9 represents illegal settlements which encroached the wetland that could have multiple direct and indirect impacts on the natural ecology.

Figure 9 illegal settlement at Lake Hawassa buffer zone at Hyik Dar Sub-City (Source: procured from field survey)

Zip-perer (1993), wrote human development has the direct impact of removing existing natural habitat as well as fragmenting the habitat that remains. Paved roads, residential and commercial development often serve as barrier or hazard to wildlife movement and native plant dispersal. Human development also has `indirect' impact by creating a number of different kinds of intrusions with varying depth of impact into adjacent natural habitats. These intrusions include increased air, water and noise pollution; changes in microclimatic conditions due to higher sunlight and wind levels; increased populations of invasive `weed' species; and increased frequency of disturbance due to direct contact with humans, human pets and associated `rural/suburban pest' species.

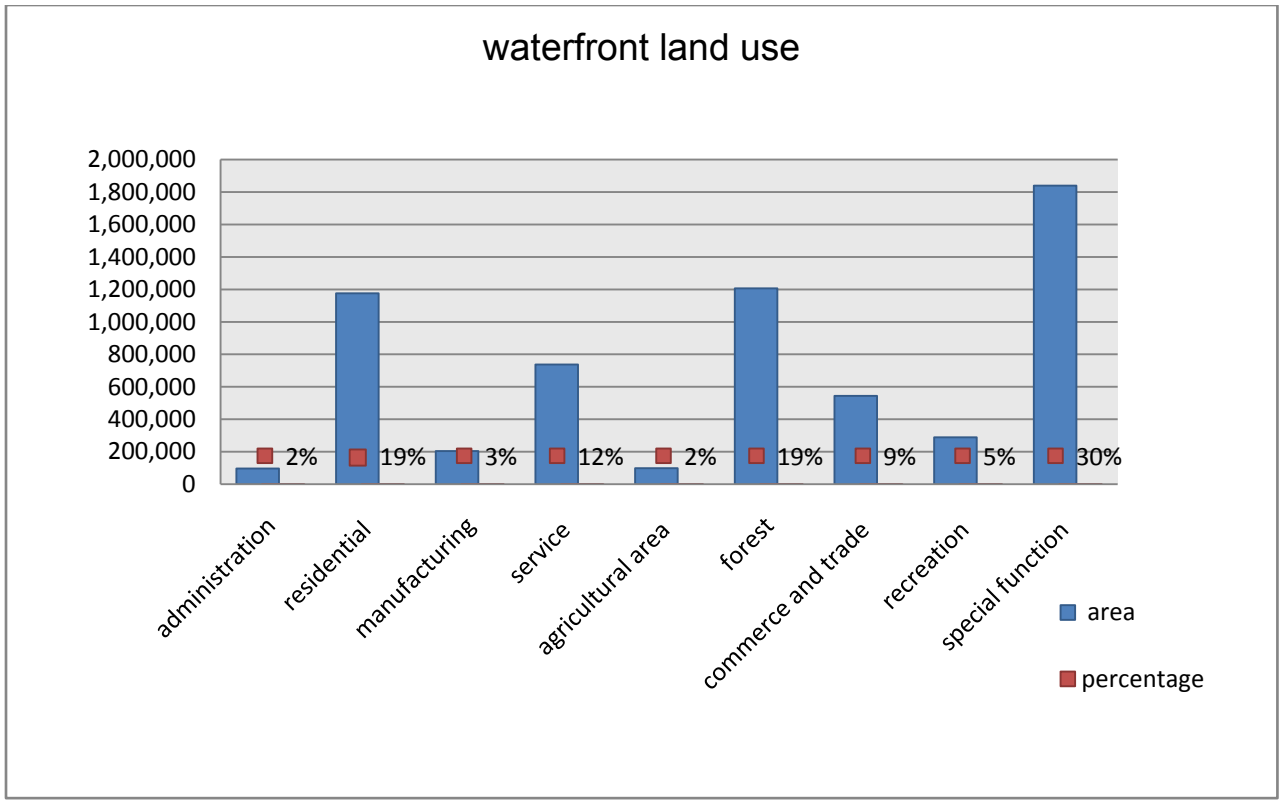

Figure 10 waterfront land use land cover share in percentage (Source: analysis done from the data procured from SNNPR plan preparation office)

According to Yemane (2004), the water balance of lake Hawassa as compared from 1965 to 1998 scenario yields an increment of catchment runoff by as high 22 % therefore the high generation in recent years even for small rain fall inputs as compared to 20 years age could be the result of land use change . Net ground cover component has negatively increases over the simulation period from 1981-1998. Land use development affect phosphorous load , as impervious cover increases runoff from primary phosphorus sources such as Residential land, Commercial land, Roadways, Industrial land, Rural land, Forest land and Agricultural land. Therefore land use development within the waterfront can be used as a sink of runoff from the whole city in to the lake.

The road networks in Hawassa drains all the liquid waste to the lowest gradient which is the lake that can cause the addition of all the urban road pollutions in to the lake without any treatment mechanism. The general road network plan of Hawassa also connects its

drainage line into previously constructed drainage which increases the amount and type of pollutant time to time unless appropriate seepage or waste water and storm water treatment mechanism is installed. Addition of pollutants from road is higher at minor arterial road that runs to the lake such as at the Gudumale recreational site and piazza area as shown in the figure-11 below.

Pollutants from cars and asphalts collected from the entire city disrupt the wetland assimilative capacity to treat wastes which impacts the aquatic ecology.

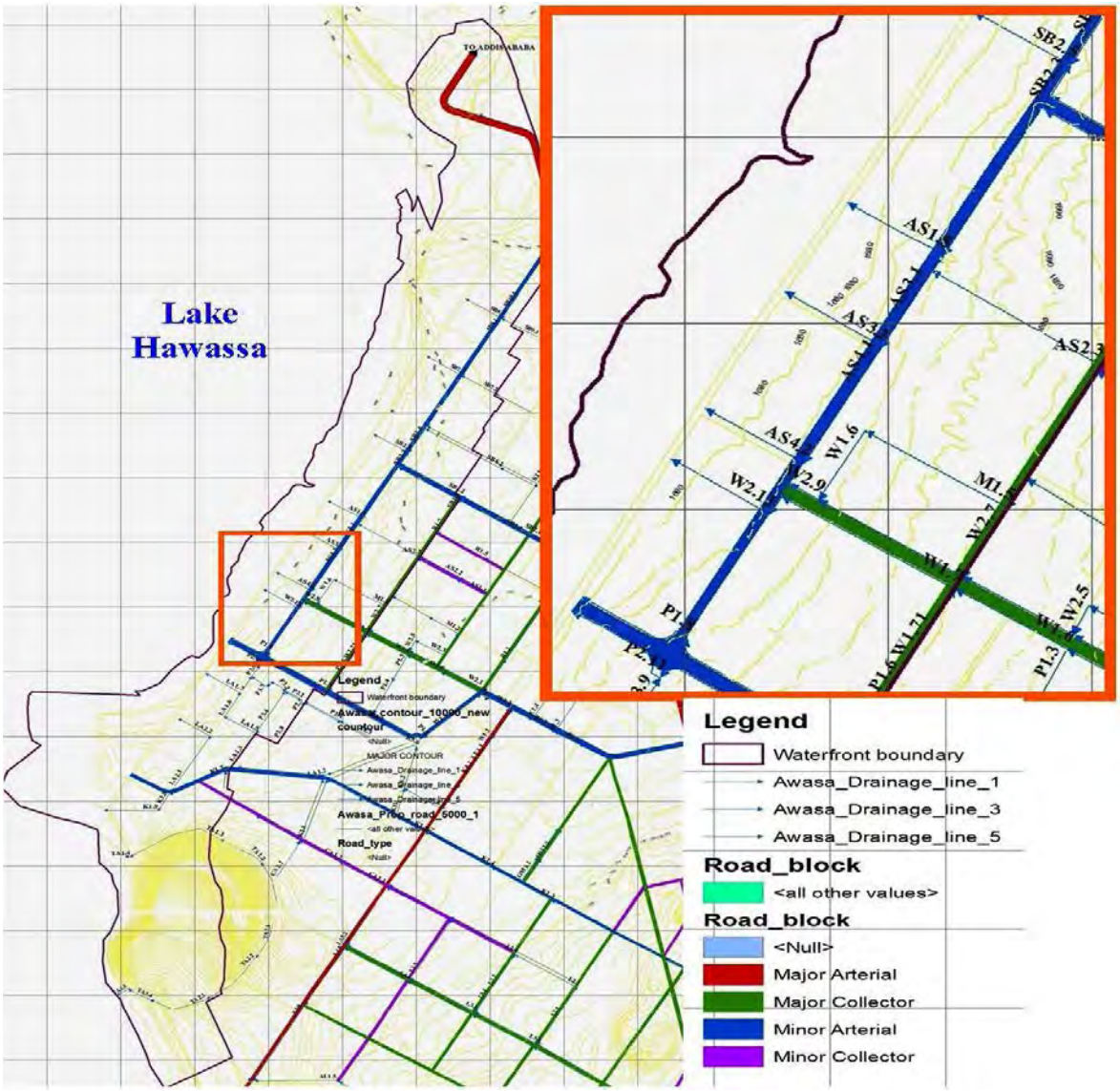

Figure 11 Addition of pollutants through drainages in to the lake (Source: Hawassa plan preparation office)

The above problems in relation to land use planning specially planning the waterfro nt in unsustainable m anner emanated from l ow aw areness about t he nat ural l acustrine ecology an d t he surrounding env ironment among t he professionals and gov ernment officials. Bu t sometimes even t he planning det ermines s ustainable dev elopment t here are huge gap of implementation and enf orcement by t he gov ernment. The planning is only one directional w hich i s gui ded by i nvestments oppor tunities r ather than sustainability.

4.3 Types of land use and their specific impacts on the lake

The study includes 60 samples which represent residential, industrial, commercial and service l and us e t ype within th e w aterfront. Among t he s amples d eliberately t hirty households were assessed based on t he questionnaire which considers the impact of management and practice of residential areas on the lake. The study also includes the socio economic parameters to correlate it with the findings. Focus group discussion is another s tudy input f or t he f inding and analysis of recreational, f ishing and ot her activities within the shore area.

4.3.1 Residential area

Residential developments which are both pure and mixed occupy 19% of the waterfront concentrating at the middle. This type of development could be di fficult for community participation i n c onservation and env ironmental pr otection ac tivities. The r esidential areas at south eas t i ntruded the f ragile l ittoral area di srupting t he buf fer z one vegetation.

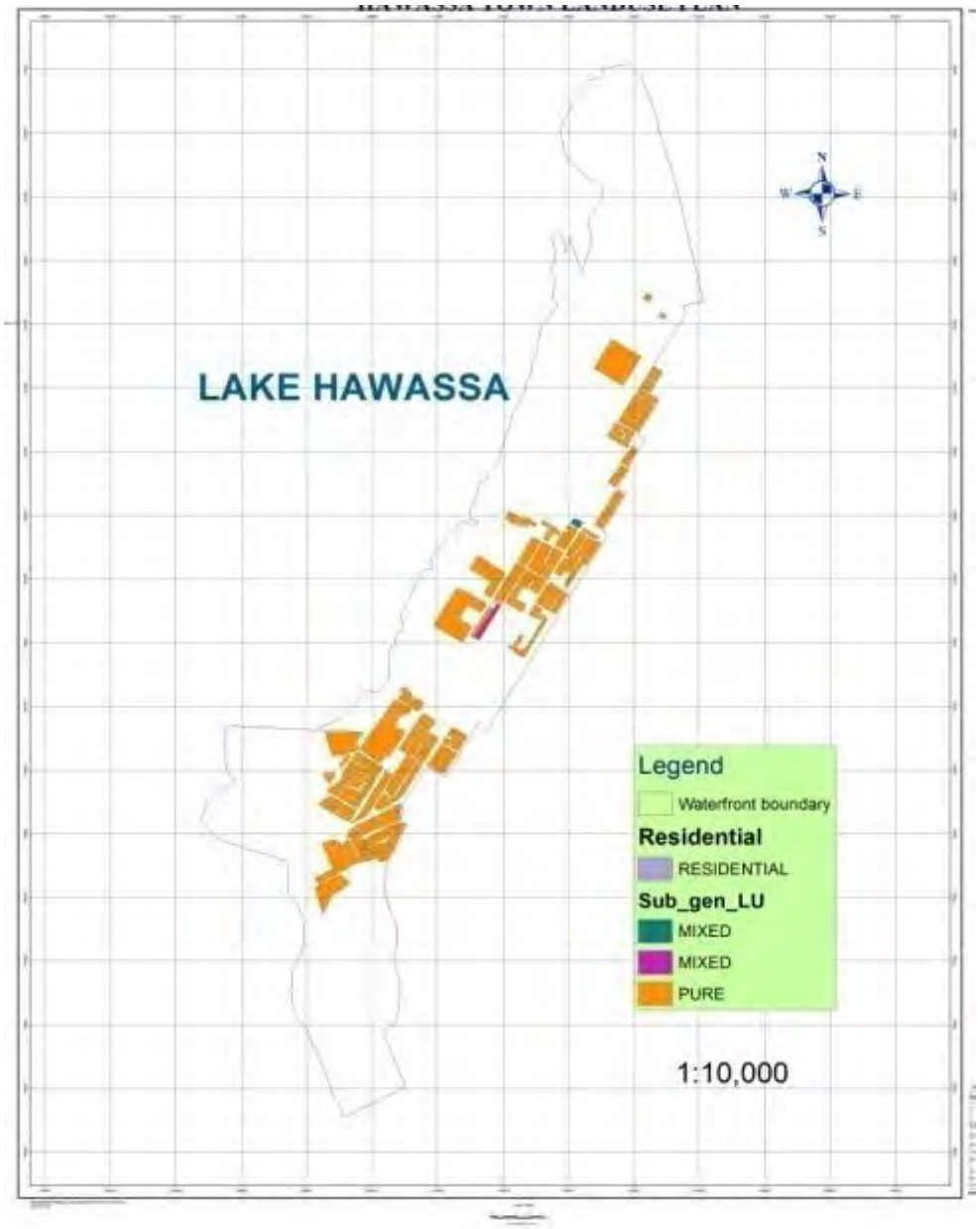

Figure 12 Residential land use plan within the waterfront (source: SNNP R plan preparation office)

The study on the residential development indicates average household size of the settlers within the waterfront is 6. According to projected 2007 census conducted by Central Statistical Agency of Ethiopia, the city has an average of 4.22 persons per household. This shows the household size within the waterfront is higher than that of the city. The source of income for 46.6 % is commerce, 26.6 % is employment, 13.3 %

urban agriculture and other. Peoples living adjacent to the lake engaged into urban agriculture therefore when the population increases the consumption of water and the demand for land increases too. This can cause the unoccupied land to be used for agricultural purpose which is the traits for the lake.

Table 3 Source of income of peoples living in the study area

Source of income	Commercial activity	Employment	Agriculture	Other
Number of house hold	14	8	4	4
Percentage	46.6 %	26.6 %	13.3 %	13.3 %

(Source: own data collection result)

The settlers manage their solid and liquid waste in different ways. 46. 6 % of the households' solid waste is collected by solid waste collector crew while 26.6 % of the households manage the solid waste by open dumping and the rest 16.6 % and 10 % of the households manage by using open pits and other methods. Wastes from households which dumped onsite are transported by natural mechanisms into the lake. House hold liquid waste management problem is the major problem that only 20% of the households use septic tank for managing liquid waste and the rest 80 % uses the drainage line to release their liquid waste other than excreta. Because of luck of municipal waste treatment Organic waste from household's end up in to the lake causing eutropication; the process by which a body of water becomes rich on dissolved nutrients from sewage, thereby encouraging the growth and decomposition of oxygen-depleting plant life and resulting in harm to other organisms. In Ethiopian Solid and liquid waste proclamation No. 513/2007 it is prohibited to dispose of litter on water bodies, parks, and water ways in urban areas or in other public places while litter bins are available.

Table 4 Residential solid and liquid waste management

Solid waste management	Collected by crew	Open dumping	Pit dumping	Other
	46.6 %	26.6 %	16.6 %	10 %
Liquid waste management	Using septic tank	Releasing through drainage	other	
	2o%	80 %		

(Source: own data collection result)

The energy use of the settlers for cooking and other domestic purpose is fuel wood and charcoal which comprises 73 % and the rest half uses kerosene and the remaining use electricity. The households which use bio fuel are 91 % and the remaining collect from the surrounding. The use of fuel wood could result in the consumption of shore line vegetation and the bi-products of fuel wood are released in to the lake. The energy uses of residential development are not sustainable hence it is better to transform the community to use electricity and other sustainable type of energy.

Considering water use and management; ground water and tap water are used as a source and managing storm water is by means of diversion and permeation. The source of water for 93.3 % is both ground and tap water where the rest 6.7 % is from the lake and other sources. 66.6 % of the residents manage the storm water by diverging it to low gradients but the other 33.3 % let it to infiltrate naturally.

Based on this research finding the amount of ground water consumption among the users is from 25 liters per day up to 500 liters per day. 37.5 % of the residents said that they face ground water degradation with time while the rest 62.5 % explain there is no problem considering the ground water. Accessibility of recreational area, high quality of life, regulation of the micro environment is pointed out by the settlers as the benefits of living with the waterfront.

Considering the positive and negative environmental impacts because of waterfront development 67 % agreed that both impacts are observed but the rest disagree that there is negative impact because of the development. From the positive impacts or contributions preserving the existing trees, planting trees and managing solid waste are mentioned. On the other hand pollution from the land use, the impact of agricultural practice and the recent decrease in volume of the lake are mentioned as negative impacts.

Only a small number of the households have participated infrequently on conserving the lake and the surrounding ecology of the waterfront by retaining the shoreline, planting of trees and cleaning the surrounding shore areas. The community prefers the development of the waterfront as a conserved green area in eco-friendly manner.

Figure 13 waterfront residential developments (Source: procured from field survey)

Water front residential development is intensively expanding vertically and horizontally within the waterfront. Parallel to the population growth condominium buildings begins to expand as the above picture represents. The place where the condominium houses are being constructed is used to be a forest and habitat for different species of animals and birds. I had been there several times for enjoying the marvelous natural forest but now it's all gone. These problems related to residential development is caused by lack of sustainable waterfront planning and little participation of the community for conserving the waterfront. There is also no strategic planning preparation by the government which considers the lake besides immediate residential solutions like building condominiums.

Urban waterfront development must grow with the awareness of responsible stakeholders which take the obligation for conservation and protection.

4.3.2 Commerce and manufacturing

4.3.2.1 Commerce and trade

Among commercial land use type's hotel industries are developing in alarming rate in Hawassa which have huge impacts on the lake more than other land use types within the waterfront. The Hotels are highly dependent on the ecotourism activities which relay on the Lake. The rate of development is very high adjacent to the lake that almost all shore area lands are captured by investors for construction of resorts and luxury hotels. The land use lack detail local developmental plan which considers sustainable waterfront development therefore allocation of lands or grand constructions may have complicated problems in the future. For example neither waterfront development principles or lake side development regulations are considered in the construction of several hotels in Hawassa waterfront.

Table 5 Commercial land use allocation

Commerce and Trade	Area in Meter square	Percentage
Commercial Activities	445,841	82%
Financial Institutions	16,140	3%
Market Place	1,515	0.3%
Others	80,822	14.7%
Total	544,318	

(Source: analysis done from the data procured from SNNPR plan preparation office)

From a total of 54 hectares of commercial and trade activities 82% of land is commercial mainly comprised hotels and urban markets. These land uses are hotspots for managing urban waterfront sustainably.

According to data obtained from interview, there is an average of 50 to 230 employees working at each grand hotel in Hawassa. These hotels are established with high

proximity and abund ance at the s hore ar ea. The s olid and l iquid w aste as sessments reveal t hat ar ound 80% of the hot els m anage t heir s olid w aste b y c ollection t hrough crews but the rest use other methods such as pit dumping and burning.

The liquid waste management practice of 87 % of the hotels is by using septic tanks and the rest use the drainage lines to release liquid wastes. The s eptic t ank t hat ar e used by t he hot els ar e not r egularly c hecked f or maintenances ot her t han ar e being emptied w ithin t hree to f ive m onths. In S olid and l iquid w aste pr oclamation N o. 513/2007 restaurants shall des ign and i mplement s olid and l iquid w aste m anagement system in accordance with direction issued by the concerned environmental agency. In this c ase there is no s trong di rection gi ven by c oncerned environmental agency an d there is some problem in managing wastes among hotels.

The hotels that manage the storm water by diversion are 79% and the remaining use the nat ural l andscape and l et t he s torm w ater t o i nfiltrate. A ll t he hot els bus iness i s directly or indirectly, partially or fully dependent on the lake or the surrounding ecology. Storm w ater m anagement i s on e i mportant as pect i n s ustaining t he w aterfront, l etting the storm water to infiltrate is the right principle in managing runoff and for reduction of urban lake pollution.

The sources of water for 95 % of the hotels within the waterfront is from ground and tap the rest use only ground water for every use by treating ground water. The hotels use a volume of 6000 l iters t o 20, 000 l iters gr ound w ater per day f or any pur pose and a n average of 100 meter cube or 100,000 liters of water for swimming pools per week. The impacts caused by the hotel tourism are both positive and negative. Conservation of the waterfronts by ec otourism ac tivities, par ticipation of the hot els on m anaging t he waterfront and pr eserving t he n atural ex isting t rees ar e t he pos itive i mpacts. W hile releasing of pol lutions by di fferent m eans, degradation of l ands f or c onstruction an d hindrance of the natural shore area are the negative impacts.

The hot els ar e al so c ontributing in s ustainability of t he w aterfront by di fferent m eans such as preserving indigenous trees, maintaining the natural landscape, participating in environmental pr otection ac tivities, c ontrolling illegal f ishermen's and gr ass c utters,

maintaining the fringe zone vegetation to prevent siltation from the landward side and collecting solid wastes in public places and shoreline.

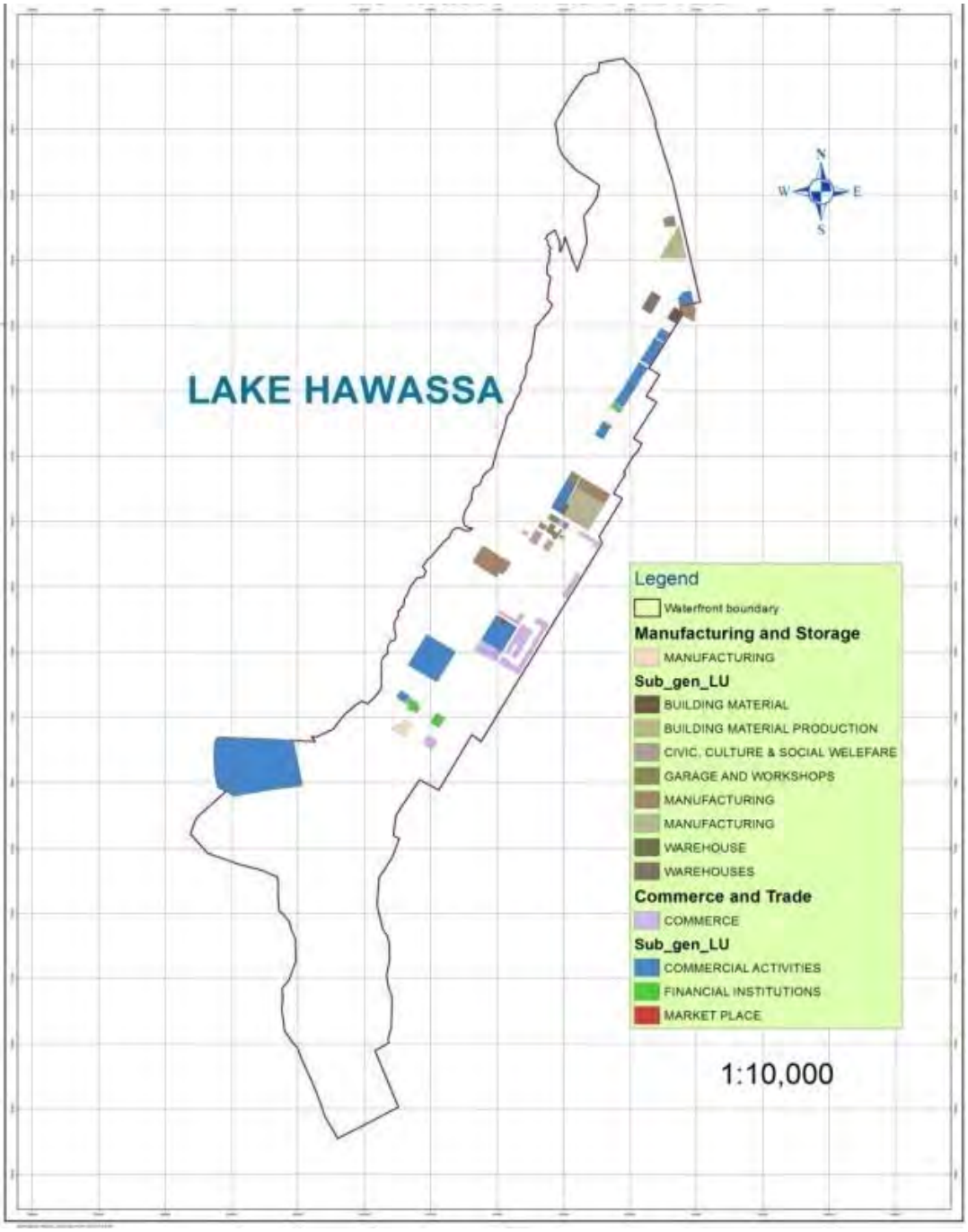

Figure 14 manufacturing and commercial land uses (source: SNNPR plan preparation office)

Environmental impact assessment was done only on one hotel from the sample size and there are no continuous monitoring of environmental management and waste management practice. Based on Ethiopian Environmental Impact Assessment Proclamation No. 299/2002 Without authorization from the Authority or from the relevant regional environmental agency, no person shall commence implementation of any project likely to have negative impacts and thus require environmental impact assessment.

4.3.2.2 Manufacturing

Industries are among the first land use type to be developed within the waterfront. Most of the industrial activities are related to construction materials production, auto mechanics, wood works and metal works. 5 to 45 employees are employed in the industries with full time jobs. Concerning waste management, 83 % of the industries mange their solid waste by dumping onsite and using by recycling; while the rest uses landfill method. All the industries have no liquid waste treatment system and they just release the liquid wastes using the drainage line as a means. Hazardous wastes from industries such as garages have cumulative effect on the aquatic ecology. The source of water for 9 % of the industries are tap water and the rest 91 % use ground water source or directly from the lake. A number of Industries which produces construction materials uses huge amount of water from the lake.

Table 6 Manufacturing land use allocation

Manufacturing	Area in Meter square	Percentage
building material	30,848	16 %
garage and workshops	9,842	5 %
warehouses	14,708	7.5 %
manufacturing	130,950	67.5 %
others	8,002	4 %
Total	194,349	

(Source: analysis done from the data procured from SNNPR plan preparation office)

Manufacturing and commerce are very sensitive land use developments within the waterfront as we see from Hawassa waterfront development there is no due concern given and no control mechanism which caused the above problems to be aggravated.

3.3.3 Services

Health institutes, government higher institutions, schools and government institutes are the major service providers within the waterfront. The solid waste management practice among services is that 12 % is collection by craw, 75 % is by onsite dumping and the rest 13 % is by incineration. When managing the liquid waste 86 % uses septic system while 9 % use liquid waste treatment method and the reset simply release the waste using drainage. The services use ground and tap water as the major source of water but the consumption of ground water is huge. Wastes from hospitals are chemically and biologically hazardous to aquatic ecology however substandard effluents are released from hospitals and strong controlling mechanism on the effluents from health institutes is not issued. Wastes from the Hawassa regional hospital are treated using waste treatment pond and directly released in to the lake. Unless the effluent chemical and biological parameters are measured and managed, the negative impact of the pond will be significant.

Table 7 Services land use allocation

Service	Area in Meter square	Percentage
Civic,Cultural And Social Walefare	42,329	5.7%
Education	446,968	61%
Health	183,553	25%
Public Worship	41,065	5.6%
Utility Service	5,091	0.7
Others	18,072	2%
Total	737,078	

(Source: analysis done from the data procured from SNNPR plan preparation office)

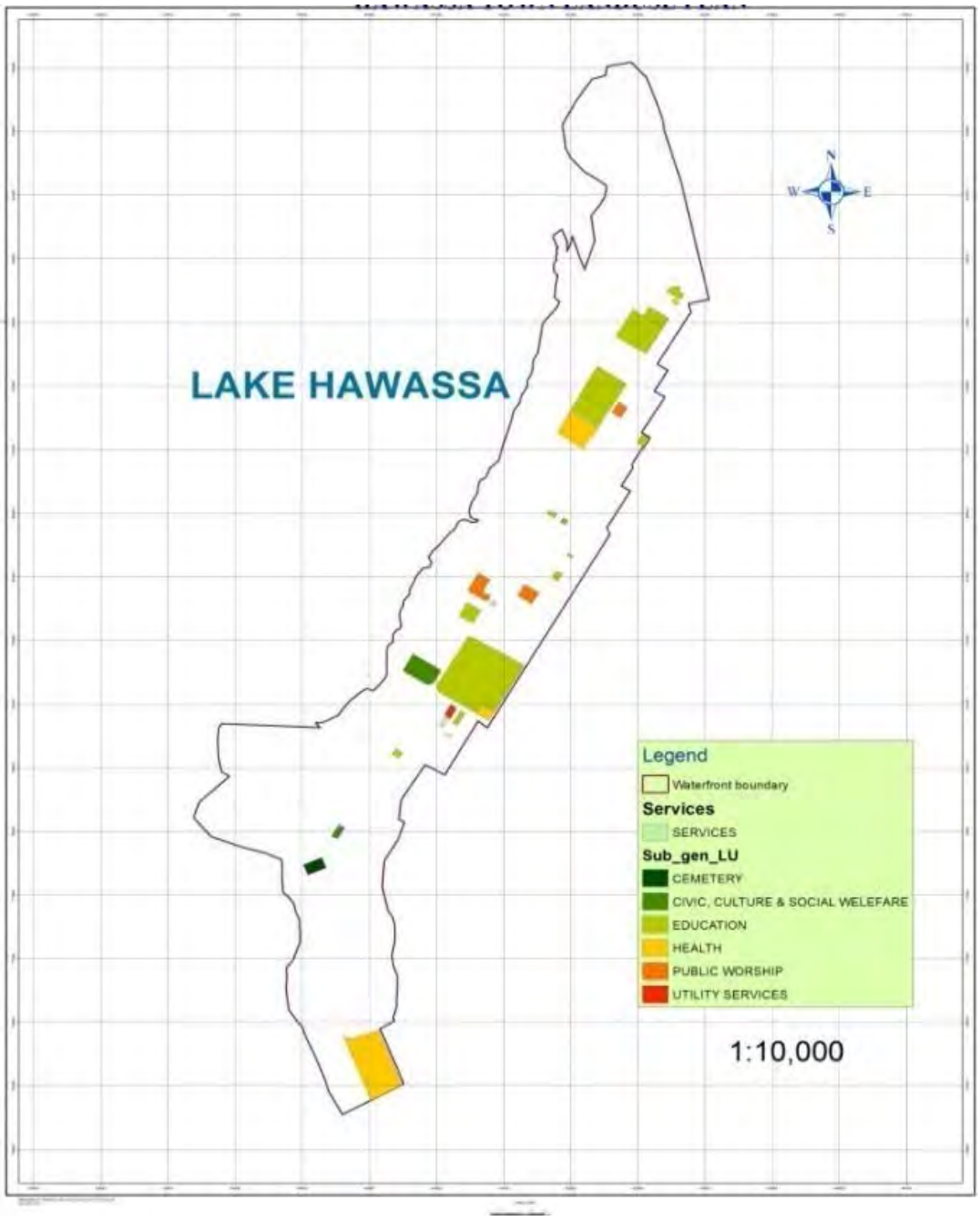

Figure 15 land use of services within the waterfront (source: SNNPR plan preparation office)

3.3.4 Recreation and other shore area activities

Based on the focus group discussion including recreational youth group, boating and fishery associations the socio economic importances of the waterfront were assessed. Problems related to the urban unplanned waterfront development and their impacts on the lake and shoreline ecosystem were also discussed by the participants and remedies were raised. The focus group discussions include leaders from six youth recreational association and two from fishery associations.

These livelihood activities took place within the areas which are allocated as special functions such as vacant space, wet lands and military camp as shown in the table-8 and figure-16 below.

Table 8 Land use allocated for special function

Special function	Area in Meter square	Percentage
Marshy Area	877,568	47.8%
Military Camp	174,417	9.5%
Vacant Land	786,888	42.7%
Total	1,838,873	

(Source: analysis done from the data procured from SNNPR plan preparation office)

In the waterfront there are around 15 recreational associations working within the shore area and gaining economic benefit thorough recreational services such as cultural restaurants, games, boating and other businesses. The shore area recreational business started before 10 years and currently a number of associations are engaging in the business following the current employment policy of the country. The number of fishery association's are around six but there are so many illegal fishery groups whose livelihood depend on the lake. One of the big fishery associations which are working around Amora Gedel has members of 270 peoples and more than 1 000 peoples engaged on several related business at the fish market. This association is producing an average of 3000 fishes per day.

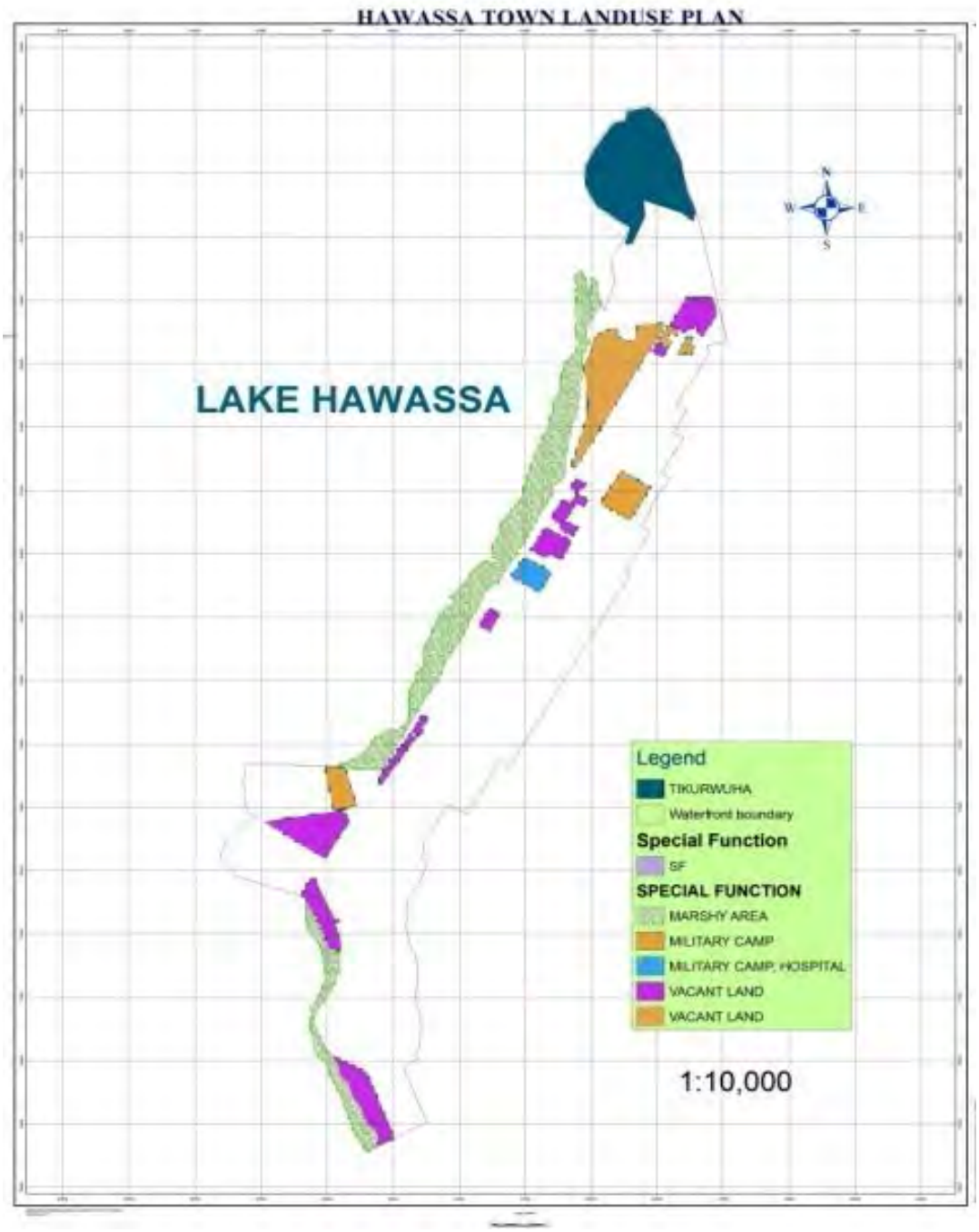

Figure 16 Land allocated for special functions within the waterfront (source: SNNPR plan preparation office)

The profitability of the association was compared with temporal aspects the result of the discussion was different among the recreational association and the fishery association. The recreational association said that their profits boosted since they started the

business because of the increment in recreational pursuit of the people and the shore area are becoming the center of tourist attraction. While the fishery associations complained that their business decreased through time because of the increase in illegal fishers and the deterioration on the lake ecosystem. The only profit they get is from the price of fishes in the markets that are increasing dramatically.

The participants have been working in their business for three months to thirteen years and they discussed that they have seen a lot of positive and negative changes at the lake and within the waterfront. Conservation of the shore area natural resources, the plantation of trees, the recreational activities keep the shoreline public space free from pollutions and illegal grazing and clothe washing are among the positive impacts. While decrease in fish provision, pollutions from development, siltation's, decrease the amount and quality of the lake, increase in population, increase of tourism and ecotourism activities, the revival of uncontrolled hotel industry at the shoreline are among the negative impacts.

Disturbances in the flora and fauna of the fringe zone has been seen such as the decrease in wetland plants like papyrus and terrestrial vegetations where removed. Due to this the amount and kinds of fishes and birds have decreased. Even some of the participants recognized extinct species of birds and habitats within the shoreline. The causes of the mentioned changes are increase in the interest of the shoreline recreational values among the communities and tourists. Specifically the public recreational pursuit increment is caused by the accessibility of restaurants, game zone and dock services.

There have been changes observed due to development and have impacted on the social, economic and environmental aspects. In socio economical aspects around 135 peoples are enrolled directly in the business and more than 450 peoples relay their livelihood on related businesses like restaurant, boating and tourist guiding. There have been both positive and negative environmental impacts on the lake and the surrounding environment caused by waterfront development. These are the increase in siltation from upper catchment and from the city, liquid waste are directly drained in to the wetland, infrastructural and service developments mainly that of hotels and hospitals are

releasing w astes and unt reated effluents i n t o the lake w hich det eriorate t he w ater quality a nd ov erall ec osystems and t he hi gh ut ilization of w ater f rom t he lake by t he municipality and di fferent dev elopmental an d service a ctivities de crease t he am ount of water.

The impacts caused by illegal fishing have impacting the balance between the aquatic ecology w hich results in hi gh al gal gr owth. The hi gh popul ation gr owth r esult i n t he increase in demand of food, water and land so these result the encroachment of lands with ur ban agr iculture, f ishing activity an d t ourism dev elopment. O bviously has be en analyzed that this activity has direct impacts on the lake and the natural waterfront.

Figure 17 Recrational area at t he s horeline of l ake H awassa (Source: pr ocured f rom field survey)

Associations w orking w ithin t he s hore area ar e engaging i n c onservation and Environmental pr otection ac tivities i n c ollaboration with Ha wassa Un iversity, non - governmental or ganizations and gov ernmental or ganizations. Thes e ac tivities ar e cleaning t he s horeline, pl anting t rees, pr omoting t he us e of t raditional d ocking and preventing illegal gr ass cutting and clothe washing. Currently r ecreational a ssociations are participating in conservation of the whole water shade and in awareness creation of the public through different strategies.

In pr eventing t he di sruptions c aused by w astes t hat em anate f rom waterfront developments the r ecreational bus iness a ssociations ar e educ ating t he people and

influencing s takeholders t o w ork w ith them. H owever w astes from fi shery and recreational associations are managed by onsite dumping and burning. The plot of land used by recreational business associations and their number are not controlled by the government. And there is no directly accountable governmental body which works on these issues. The problems related to shoreline activities are resulted from lack of sustainable waterfront development plan, lack management guidelines, absence of responsible bodies and lack of enforcement.

4.4 Major Impacts of Unplanned waterfront development on the lake

The waterfront, especially the shore area is center for a number of business associations which are dependent on the lake. As represented below in table, 29.7% the areas within the waterfront are designated to special functions which currently used as a place for fishing, urban agriculture and recreation. 4.7% and 1.6% of the land are used as recreation and agricultural practice respectively.

Table 9 Share of land use within the waterfront

No	Land Use Type	Area in hectare	Percentage
1	Administration	9.6	1.6%
2	Residential	117.6	19.0%
3	Manufacturing	20.4	3.3%
4	Service	73.7	11.9%
5	Agricultural Area	9.9	1.6%
6	Forest	120.6	19.5%
7	Commerce And Trade	54.4	8.8%
8	Recreation	28.9	4.7%
9	Special Function	183.9	29.7%
	Total	619	

(Source: analysis done from the data procured from SNNPR plan preparation office)

There are only two legal fishery associations which are located at two extremes of the waterfront. Illegal fishing is not allowed but the lake used as livelihood for thousands of illegal fisher men's. There are 15 legal recreational business youth associations and

many more unpatented business groups working at the shoreline of the lake by planting trees and c onstruct m ainly c onsidering t he recreational pur suit. H awassa C ity Environmental P rotection and N atural Resource and B iodiversity P rotection O ffice d id not approve or under gone E IA c oncerning t he bus iness. S uch p roblems r esulted because lack of integration among governmental and non-governmental bodies.

Figure 18 problems related to urban waterfront development on Lake Hawassa

There are 47 boats used by the associations and hotels which are manipulated manually or by using fuel. The boating areas and their voyage roots are not restricted to specific part of the lake because of this the aquatic ecology are being disturbed. The effluent of hydrocarbon from the boats also impairs the water quality and endangers the aquatic life. The city municipality has made no action to overturn the situation besides allocating the shore line to different business associations. Due to the increase in shore area recreational industries it's obvious to profess that expansion of shore area boating will be the major problem facing sustainability of Lake Hawassa. A second symposium on the topic, "Impacts of Small Motorized Watercraft on Shallow Aquatic Systems" Was held in 2000 at Rutgers. The results of this symposium were published in Kennish (2002). Both workshops identified several issues of concern regarding boating activity including: Impacts to submerged aquatic vegetation, Contamination from fuel discharges, Erosion on shorelines, and Re-suspension of bottom sediments and turbidity.

4.4.1 Solid and liquid waste management

According to the City Sanitation, Beautification and Park Management Office 70-80 percent of the solid waste which is generated by urban population is collected by the municipality. The amount of solid waste collected from the city is 6,383 cubic meters per month which is a total of 73,618 cubic meters per year. Around 245 gram of waste collected from each household per day. The rest 20-30 percent of the solid waste is managed onsite and open dumping so this indicates that there is a high probability that these wastes are being washed out and drained in to the lake. Especially, communities in the waterfront area have no access for such services hence the waste management practice are traditional and have a great impact on the lake. There are solid waste problems within the shore area and the buffer zone of the waterfront at several points. Places that are vacant and tagged as special functions are used as solid waste dumping sites.

Figure 19 Mismamanement of solid waste within the waterfront (Source: field survey March, 2013)

Even though the Solid and liquid waste proclamation No. 513/2007 delegate responsibility to the urban administration for ensuring the installation of waste management services, Hawassa city has been a city without liquid waste management since its establishment. All the drainage line from several land use types and roads are drained to the lake with no treatment mechanism. There are multiple point source pollution problems as a result of poor utility line construction such as roads and drainage lines. The major point source pollutions are from municipal drainage lines, drainage line from different infrastructures like hotels, restaurants and hospitals. Because of increase in urban population the waste that are released from the city to the lake also increases; as a result the waste as similative capacity of the lake will be distorted then polluted at irreversible condition.

The root cause of solid waste management problem within the city and the waterfront is low awareness, inadequacy of solid waste management and deficiency of budget to collect urban solid waste and to purchase solid waste collection equipments.

Figure 20 Main drainage lines which end up in to Lake Hawassa (Source: field survey March, 2013)

4.4.2 Water resource consumption problems

The lake used as a direct source of water for different functions in the city. Water are pumped directly from the lake using different pumps which are installed by government and private owners used for urban gardening , construction works, fire extinguishing, for recreational activities like swimming pools , ponds and other several purposes. Around twenty water tanks which are about 40,000 liters are used per day from only one pump. Unless water use from the lake considers the water balance of Lake Hawassa it could be a threat.

Figure 21 Lake Hawassa used as source of water for the city (Source: field survey March, 2013)

Ground water is a major source of water for almost all land use types and it is not known how much water is used from ground water by the city. As a result the water budget of the lake from ground water is decreasing which affects the hydrology of the lake. The unsustainable consumption of water resources is caused by low awareness among s takeholders and the l ake w ater front bal ance has not yet studied f or consumption purpose.

4.4.3 Vegetation and buffer zone management

Plants always play as a platform in sustaining the aquatic and terrestrial ecosystem through production, regulation and waste prevention. Buffers provide food and cover for wildlife, shade to lower shoreline water temperatures, slow flood flows, stabilize stream banks and shorelines, and provide litter and woody debris for aquatic organisms.

Figure 22 Buffer zone of the study area (source: SNNPR plan preparation office)

Removal o r al teration of r iparian v egetation has be en f ound t o al ter s tream w ater temperature pr imarily t hrough c hanges i n i nsulation w hich s hades w aterways and controls air circulation near the water surface (Poole and B erman 2001). Adjacent land use 250–300m from the wetland affects plant diversity.

Differences in the land-use-diversity relationship among different plant functional groups suggest t hat adj acent l and us e af fects w etland pl ant c ommunities i n t wo i mportant ways. First, it alters the abundance and distribution of propagules in adjoining habitats. Second, it alters the number of dispersal routes. The abundance and s pecies diversity of exotic terrestrial vegetations are increasing within the waterfront which could cause ecosystem di sruption. A s listed bel ow i n t able-10 ar ound 17 major ex otic t errestrial species were identified through site analysis.

Table 10 major exotic terrestrial species within the waterfront and there general impacts

No.	Terrestrial exotic species	Impacts on the lake
1	*Acacia Decurrens*	**HYDROLOGICAL IMPACTS** Canopy interception Effects on runoff, Effects on ground water, Effects on water yield and soil moisture and Water use efficiency **EFFECTS ON SOIL QUALITY** Nutrients cycle Soil nutrient depletion , Nutri-ent use efficiency , Effects on soil erosion and land degradation , and Allelopathy **EFFECTS ON BIODIVERSITY** Pests and diseases FAO (2011).
2	*Araucaria Biramulata*	
3	*Azadirachata indica (neem tree)*	
4	*Bauhinia purpurea*	
6	*Bombax malabaricum*	
5	*Callistemon citrinus (bottle brush)*	
7	*Casuarinas equisetifolia*	
8	*Cupressus lusitanica*	
9	*Delonix regia (yedredawa zaf)*	
10	*Eriobotrya japonica (woshmella)*	
11	*Eucalyptus camaldulensis*	
12	*Eucalyptus globulus*	
13	*Ficus elastica*	
14	*Grevillea robusta*	
15	*Jacaranda mimosifolia*	
16	*Schinus molle (qondo berberie)*	
17	*Spathodea campanulata*	

(Source: filed survey March, 2013)

The impacts caused by exotic species include replacement of diverse systems with single (or mixed) species stands of aliens, alteration of soil chemistry, alteration of geomorphological processes, alteration of hydrology, invasions leading to extinction of compositional diversity and the direct threat to indigenous fauna (Cronk & Fuller, 1995). Hydraulics and hydrology can also be influenced, for example by Melaleuca quinquenervia, which raises soil elevations and thereby has influenced the hydraulics of Florida wetlands and the invasion of Pinus spp. in South African fynbos has dramatically reduced the water yield of catchments. Other aspects that have been noted are displacement by direct competition, reduced structural diversity, increased biomass production and disruption of the prevailing vegetation dynamics (van Wilgen & van Wyk, 1999)

In addition aquatic weeds can affect the plants beneath them by forming thick mats which eliminate submerged plants and algae, prevent photosynthesis and block oxygen diffusion from the air, causing the system to become anaerobic (Gopal, 1987).

Plantation of trees is a very important aspect to sustain the waterfront but it should be harmonious with the existing environment. The role of Indigenous trees in conserving urban lakes and surrounding ecology is by far greater than that of exotic species. However, exotic species could be a threat for the ecology even some exotic species act as weeds in some cases. In the case of Hawassa waterfront the distribution of exotic species is very high Proportional to population growth and encroachment. Natural indigenous trees have been gradually replaced by exotic species to create a landscape suitable for recreation. Especially the business associations that work around the shoreline had no awareness around these issues that the majority of the trees planted are exotic.

Riparian buffers are perhaps the most important. These areas of trees and shrubs next to streams, lakes, and wetlands protect water bodies by intercepting surface runoff and the sediment and pollutants it carries. In addition, buffers provide food and cover for wildlife, shade to lower shoreline water temperatures, slow flood flows, stabilize stream

banks and shorelines, and provide litter and woody debris for aquatic organisms (Environmental land use planning and management, 2003).

4.4.4 Urban Agricultural practice

Many agricultural activities within the basin are subsistence-based, although a few large-scale farms exist close to the lake. The notable one is the Centre for Preparation and Expansion of Selected Seeds, which uses various agro-chemicals (pesticides, herbicides, fungicides and fertilizers). The amount and types of chemicals used is not easily determined, but certainly leached chemicals from this and other small-scale farming reach the lake via the drainage system. Although their impact can be imagined, scientific studies are needed to objectively assess and quantify their impacts.

Around 38 hectares of the land within the city administration are utilized by urban agriculture. Vegetation cultivation is the main type of urban agriculture within the waterfront which has a higher impact on the lake than other type urban agriculture such as agro forestry. Extensive urban agriculture is practiced within the waterfront especially the most fragile ecosystem of the fringe zone. The agricultural practice is based on irrational activity or using the fertile wetlands. Vegetable production, cereal production, sugar Cane and agro forestry and livestock rearing are practiced mostly within the waterfront. Extensive farming is practiced around Hawassa referral hospital on the other side of Tabor Mountain. Vegetables and sugarcane also practiced within the flooded area of the lake where place does not considered as wetlands by the community. Vegetables are produced following the shore line when the land is not captured by other land use. The shore area urban agriculture is totally depending on the wetland as a water source. Urban agricultural practice can affect the lake through encroachment of the buffer zone and aggravating erosion which causes sedimentation. As population increases demand for food production increases too which caused the expansion of peripheral urban agriculture. In Hawassa waterfront especially at the back of mount Tabor as represented in the Figure 23, below extensive agriculture is practiced and the immediate buffer zone is removed by the extent of grazing. These cause the addition of sediments and fertilizers into Lake Hawassa.

Figure 23 Urban agriculture at the waterfront of Lake Hawassa (Source: field survey March, 2013)

Livestock rearing is another type of agricultural system which has great impact on the lake specially when practiced around shore are. Grazing is common practice in several parts of the shoreline mainly at the back of Hawassa referral hospital, at the Gudumalle Park, around Haile resort and at Tikur Wuhan fish market. Removing essential fringe zone vegetation and dung from the animals washed into the lake and increase nutrient level that result in eutrophication. Therefore a control mechanism of urban grazing especially that of the highly fragile littoral zone is mandatory.

Figure 24 livestock grazing at the buffer zone of Lake Hawassa (Source: field survey March, 2013)

4.5 Waterfront management

Though waterfront rehabilitation is increasingly being employed in developing world cities, the environmental benefits are not always clear. Nonetheless, As developing world cities struggle to break from the traditional model of 'pollute first, clean up later', it is critical that they employ strategies which minimize or remediate environmental impacts while still promoting economic development. Though waterways may not be restored to pristine conditions, the incremental improvements appear to be a necessary catalyst for sustainable urban development. (Environ. Res. Lett, 2009).

Center for Watershed Protection (2002), discuss Shore land or waterfront Protection Area Extends 250 to 1000 feet from high water mark should have a Special overlay zone for residential development, Regulates development within at least two lot lengths from the lake and Includes shoreline buffer. Nonconforming uses within the waterfront are Livestock operations, Landfills, Industrial or commercial zones, above and below ground storage tanks, Storm water hotspots and golf courses and nonresidential roads. The Storm water and Septic Systems should be designed and implemented in a manner that considers the ecology of urban lakes.

However, since the establishment of Hawassa city there have been little sustainable measures taken to conserve and protect Lake Hawassa. Multi governmental body from federal EPA to sub city administrations has responsibility for the protection and conservation of the lake. There has been no specific governmental body responsible for the lake until the establishment of Lake Hawassa protection and conservation committee by the year 2012 delegated from different stakeholders, although the committee is not strong enough to influence the government for changing the trend in managing the waterfront.

Lately the city municipality has been undergoing study considering the waterfront especially preventing the waste by constructing three constructed wetlands around Fikir Hyik, Gudumale and Tikurwuha. This construction is part of waterfront local developmental plan. Before this initiation the waterfront and the buffer zone have not been delineated and managed well. The municipality delineated a 200m buffer zone protection are but it is not yet implemented. At the sub city level waterfront are managed

via case teams of industry and trade office and sanitation and beautification offices. Solid Waste is collected regularly from homes by 104 workers which are under sanitation case team. The trade and industry case teams establish income generating associations which work and depend on the shore area. This office also controls the waterfront ecosystem from miss management mainly in preserving the existing trees within private and public spaces. Education is also given for recreational associations in order to avoid risks come from human settlements and tourism development mainly from solid and liquid waste mismanagement. The environmental protection and nature conservation of fice al so t ries t o s top bi rd k illers and gi ve a wareness to f ishery associations and engaged in any protection and conservation tasks. Federal EPA is the responsible body for the approval of projects around the lake. Investments which are very huge like five star hotels it is allowed based on preconditions like investment plan, project proposal and environmental impact assessment.

Regardless of the above efforts, there are problems facing sustainability of the waterfront which can have a direct impact on the lake. These are; the lack of proper ecological landscape design for the buffer zone and shore area recreational development, financial problems to do conservation works, illegal tree cutting around Millennium Park and lack of awareness among the tourists and settlers. Other problems such as investment pressure, high demands for recreational pursuit, shore area urban agriculture and pollutions have complicated the case. The wastes from the city are not managed rather discharged into the wetlands and there are no regular control mechanisms of point source pollutions from shore area development.

The city administration is on the way to build a new waterfront city on the other side of the waterfront which is around 2000 hectares with a distance of 11 km by land and 6-7 km by water. The new waterfront development will have a 500m buffer zone with luxurious landscape design. The main purpose of the development is making Hawassa the center for recreation and tourism among Ethiopian cities. But without sustainable waterfront planning and management it is not possible to benefit from ecosystem service of the lake.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Environmentally sustainable waterfront development is essential in developing countries like Ethiopia to conserve and manage urban lakes for optimum benefits from ecosystem services. Lake Hawassa waterfront is one of the most important and developed area among Ethiopian waterfront cities with an increasing attraction to our bant ourism development. There are radical changes observed in the land use and land cover from 1984 to 2011. The yearly percentage of change of developed land, forest cover, bare land and flooded zone has been increased by 1.47 %, 1.46 %, 4.76 % and 5. 72 % respectively while wetland size, grassland and agricultural land has decreased at an average yearly percentage rate of 0.74 %, 13 %, and 1.94 % respectively. In general land use change of development, forest cover, bare land and flooded area have been increased while wetland, grassland and agricultural land decreased. Development is increasing proportionally with the decrease in wetland, grassland and forest cover. As development increases the demand for land resulted in the encroachment of natural land covers. The natural buffers become fragmented that ecosystem services like waste treatment, flood prevention and supporting the ecology diminished which has significant negative impact on the lake.

Hawassa has four master plans since its establishment which are in 1954, 1974, 1994, and 2006. According to the existing master plan 30% of the land is allocated for special functions within the waterfront, 19% for residential, 19% for urban forest, 12 % for services, 9% for commerce and trade, and the remaining for other purposes such as recreation, manufacturing, agriculture and administrative functions. There have been seven local developmental plans but none of them considered the waterfront area. Because of lack of detailed plans for waterfront development so far, negative impacts due to the urban development have been aggravated.

The existing master plan which is prepared in 2006 allocate the waterfront to special function, residential, forest, services, commercial activities, recreation, manufacturing and as administrative consequentially based on land use size. In managing and implementing this master plan there are different problems such as expansion of illegal settlement, encroachment of the buffer zone and the road network pollution. Pollution from the land uses, unmanaged runoffs, removal of natural habitats, the intrusion of invasive species, unmanaged water use and den se dev elopment al so ar e m ajor problems impacting the lake that are emanated from different types of land uses.

The high increment in forest covers from 1998 to 2003 around Tikur Wuha and Mount Tabor are positive changes that observed to sustain the waterfront and protect the urban lake. Vegetation cover increment in private and government owned land also have a huge significance in sustaining the area and it should be promoted. But it could be meaningless if the density of development increases in this rate that peoples began to cut down those privately owned natural and planted trees for the pursuit of land.

Land use development affects phosphorous load , as impervious cover increases runoff from primary phosphorus sources such as Residential land, Commercial land, Roadways, Industrial land, Rural land, Forest land and Agricultural land are introduced into the lake. The road networks in Hawassa drains all the runoff to the lowest gradient which is the lake that can cause the addition of all the urban road pollutions into the lake without any treatment mechanism.

Because of lack of municipal waste treatment Organic waste from household's end up into the lake causing eutropication. Excess use of ground water decreases the ground water table which directly affects the lake so ground water use must be based on a water budget study of the lake.

Waterfront residential development is intensively expanding vertically and horizontally within the waterfront. Parallel to the population growth condominium buildings expanded. The impacts caused by the hotel tourism are both positive and negative. Releasing of pollutions by different means, degradation of lands for the construction and the hindrance of the natural shore area are the negative impacts of Hotels. In the

contrary hotels have positive impacts such as sustaining the waterfront by different means such as preserving indigenous trees, maintaining the natural landscape, participating in environmental protection activities, controlling illegal fishermen's and grass cutters, maintaining the fringe zone vegetation to prevent siltation from the landward side and collecting solid wastes in public places and shoreline.

Thousands of peoples' livelihoods depend on the activities around the shoreline of Lake Hawassa in recreational business and fishery. The plot of land used by recreational business associations and their number are not controlled by the government. And there is no directly accountable governmental body which works on these issues. The recreational associations have a positive impact in managing the shore line eco-friendly and prevent the shoreline from pollution and degradation. But there are also negative impacts such as waste disposal problems, distribution of exotic species of plants, destruction of natural habitats for recreational purposes.

Since the establishment of the city little sustainable measures have been taken to conserve and protect Lake Hawassa. Multi governmental body from federal EPA to sub-city administrations has responsibility for the protection and conservation of the lake. However there has been no specific governmental body responsible for managing the waterfront and the lake until the establishment of Lake Hawassa protection and conservation committee by the year 2012 delegated from different stakeholders. The concern for sustaining the waterfront and protecting the lake has been raised lately as a result the city municipality is on the way for studding the waterfront so as to have a sustainable waterfront plan.

5.2 Recommendations

Developing Lake Hawassa waterfront in a sustainable approach considering the inimitable value of Lake Hawassa has multiple significances of supporting the ecology, benefiting the society, enhancing the economy and conserving the culture. However, the study revealed that there are and have been several problems of waterfront development deteriorating the natural aquatic and the most important and fragile littoral zone ecology. There must not be any pause in taking action for the protection and conservation of Lake Hawassa especially in sustaining of the waterfront. Therefore the following important recommendations are made from the finding of the study.

- The precedence of Sustainable waterfront development is sustainable waterfront development and management plan so unlike the past trend of planning the lakefront with the master plans; there should be a specific and detail waterfront development and management plan.
- Municipal Liquid waste from the city should be collected and treated rather than draining into the lake. For implementing these there should be sustainable liquid waste management practices such as recycling and treating the waste with constructed wetlands.
- Revitalizing the waterfront by reallocating Land uses such as manufacturing and commercial which have multiple impacts on the lake and replacing it with eco-friendly land use types.
- Contextualizing land use policies, laws, proclamations and regulations for Lake Hawassa waterfront and implement it by delegation of the responsible body.
- Controlling the expansion of illegal settlement around the Hyik Dar sub city and other places should be considered by the municipality.
- The buffer zone of Lake Hawassa should be managed and protected from the disruption that comes from urban agriculture, intensive grazing, and commercial development and even from unsustainable recreational development.

- There should be a high concern in managing and controlling of the Solid waste within the waterfront. To do so building the awareness and participation of important stakeholders especially the community should be the main strategy.
- Storm water Runoff from the urban roads, residential areas, industrial areas and other land uses should be managed sustainably by increasing permeable surfaces for infiltration.
- Onsite treatment of liquid waste from industrial, manufacturing and service land uses prior to discharging the liquid waste to the city drainage system.
- The water resource consumption of the urban development should be studied and balanced with the water budget of the lake. To do so there must be sustainable water resource management plan in the city.
- The wetland should be delineated as soon as possible in addition of conservation and rehabilitation. Habitats within the shore areas also must be delineated and conserved.
- Considering the ecology of the shore line which is important for conserving the lake there must be continuous vegetation buffer by limiting and regulating access points and other human intrusions. Replacing of exotic species is also very important for conservation of the lake.
- Manage urban green areas, public spaces and recreational areas with sustainable urban waterfront green area planning principles.
- Engage the community and other important stakeholders in protecting and revitalizing the waterfront.

GLOSSARY (Jill bailey, 2004)

Afforestation the establishment of a forest on land not previously forested. this may be by natural colonization by trees or by deliberate planting.

Agroforestry an integrated system of farming in which herbaceous crops and tree crops are cultivated simultaneously on the same patch of land.

Algae a diverse group of photosynthetic eukaryotes, most of which are not highly differentiated into tissues and organs when compared with lower plants. They lack distinguishable roots, stems, or leaves and there is no true vascular system

Allelopathy the release by a plant of a chemical (allelochemical) that poisons or inhibits the growth of nearby plants, so reducing competition

Anthropogenic resulting from the actions of humans. the term is usually applied to environmental changes such as habitat change or pollution.

Aquatic 1. Living or taking place in water. 2. A plant or animal that lives in water aquatic biome

Biodiversity the variety of organisms present in the living world. more specifically, species biodiversity is the number of species present in a particular area or ecosystem. in general, biodiversity tends to be highest in complex and highly productive ecosystems, such as tropical rainforests. biodiversity is often used as an indicator of the health of such ecosystems.

Biological oxygen demand (biochemical oxygen demand; bod) The standard measurement for determining the level of organic pollution in a sample of water. It is the amount of oxygen used by microorganisms feeding on the organic material over a given period of time, usually 5 days, typically expressed as milligrams of oxygen per liter of water. Sewage effluent must be diluted to comply with the statutory bod before it can be disposed of into clean rivers.

Buffer a solution that resists any change in acidity or alkalinity (i.e. a change in h+ concentration). buffers are important in living organisms because they guard against

sudden changes in ph. they involve a chemical equilibrium between a weak acid and its salt or a w eak bas e and i ts s alt. i n bi ochemistry, t he m ain b uffer s ystems ar e t he phosphate (h_2po_4– /hpo_4) and t he carbonate h_2co_3/hco_3) systems. they ar e al so us eful for controlling ph in vitro experiments and cultures.

Chemical oxygen demand (cod) the amount of oxygen consumed in the oxidation of organic an d ox idizable i norganic m atter i n a s ample of w ater, t ypically ex pressed as milligrams of oxygen per liter of water. cod is usually determined by incubating known volumes of w ater w ith k nown q uantities of c hemical r eagents at about 150° c unt il oxidation is complete, then determining the amount of the reagent changed by means of colorimetry or s pectrophotometry. c od i s us ed i n i ndustrial and municipal l aboratories dealing with industrial waste and chemically polluted water. Compare biological oxygen demand.

Carrying capacity (k) the maximum population size that can be supported indefinitely by the available resources of a given environment.

Conservation the management of wild plants and animals or other natural resources to ensure their survival for use by future generations. this may involve the maintenance of particular natural habitats and the control of environmental quality. modern conservation has to consider people as part of natural ecosystems, and to balance the needs of the wild fauna and flora against the social and economic needs of local people to promote the sustainable use of resources. conservation usually aims to preserve biodiversity, but may on oc casion f ocus on t he s urvival of a par ticular endanger ed s pecies, i ncluding such m easures as c aptive b reeding or s eed and gen e banks. w here t he habi tat being conserved is a sub climax (see climax community), it may be necessary to intervene to prevent the natural succession running its course. For example, reed beds may be c ut back to maintain areas of open water.

Corridors connections between fragments of similar habitat in a patchy land scape. for example, a t hin s trip of w oodland m ay l ink t wo m uch gr eater ar eas of w oodland, allowing mixing of species and individuals between the two communities.

Detritus finely divided fragments of dead material, such as dead or partially decayed plants and animals, leaf litter, feces, and products of the breakdown of organic material by decomposers. in forest ecosystems most of the plant production ends up as detritus, because wood is difficult for herbivores to digest.

Dissolved oxygen (do) the quantity of oxygen that is dissolved in an aqueous solution. it is usually expressed as mgl–1 or as percentage saturation. it represents the oxygen available to fish and other aerobic organisms, and indicates the water's ability to support aquatic life. dissolved oxygen can be measured by means of a dissolved oxygen electrode or a fiber optic oxygen sensor.

Divergence A horizontal flow of water in a different direction away from a particular area, e.g. the spreading of ocean surface water in areas of upwelling.

Drainage the movement of water from land, either naturally or artificially, as it flows over the surface and through rocks and soil under the influence of gravity, eventually reaching the sea, an inland lake, or underground reservoir.

Ecology The study of the relationships of organisms to one another and to their living (biotic) and nonliving (abiotic) environment.

Ecopath An ecosystem model that calculates energy flow and biomass production in various conditions for a steadystate ecosystem containing many species. it is used particularly for aquatic ecosystems, especially for estimating sustainable levelsof cropping.

Ecosystem A unit made up of all the living and nonliving components of a particular area that interact and exchange materials with each other. the concept of the ecosystem differs from that of the community in that more emphasis is placed on abiotic factors. the term can be applied on various scales, from small ponds to the whole planet.

Ecotourism Tourism that promotes travel to natural, 'unspoiled' habitats to observe wildlife or indigenous peoples. ecotourism can be an important source of income to local

people as part of a sustainable development program, but all too often it generates disturbance and pollution, destroying the very qualities it set out to promote.

Edge effect The sampling errors that occur at the edges of sampling plots/areas. this may be due to items at the edge of the plots experiencing significantly different conditions from those in the center, or because items overlap the periphery. this effect is especially pronounced in small sampling areas.

Effluent Waste material that is discharged into the environment, for example, from sewage outfalls and factory chimneys.

Environmental management Procedures and controls aimed at conserving the status of an environment. it may involve active intervention to maintain a particular habitat, for example, a particular stage in plant succession. alternatively it may aim to balance the conservation of a particular natural resource with the needs of local human communities to promote sustainable development.

Eutrophication The process that results when an excess of nutrients enters a lake, for example, as sewage or from water draining off land treated with fertilizers. the nutrients stimulate the growth of the algal population, giving a great concentration or bloom of such plants. when these die they are decomposed by bacteria, which use up the oxygen dissolved in the water, so that aquatic animals such as fish are deprived of oxygen and die from suffocation.

Habitat fragmentation The breaking up of a habitat into discrete patches separated by other types of habitat that may not be suited to the species from the original habitat. for example, the clearing of forest for urban development.

Impermeable Describing a substance that does not allow another substance, especially water, to penetrate or pass through it.

Landscape Ecology The study of landscapes taking into account the distribution patterns of communities and ecosystems and the ecological processes that affect them over time.

Littoral 1. The zone of the seashore between the high and low tide mark the term is also applied to organisms living in this zone. since tidal ranges vary continually, the zone is often defined in terms of the upper and lower limits of certain species of organism. compare benthic zone; sublittoral.

2. the zone between the water's edge and a depth of about 6 m in a pond or lake, where light reaches the bottom sediments. rooted hydrophytes, both emergent and submergent, are found in this zone. compare profundal; sublittoral.

Patchiness The degree to which a habitat shows spatial variation in its suitability for a particular species, or the degree to which the distribution of a population shows spatial variation within the habitat.

Septic tank an underground storage tank for domestic waste in an area not connected to sewers. The waste is partially or wholly broken down by anaerobic microorganisms, and the final effluent may be allowed to soak away, or the tank may be emptied at regular intervals.

Sewage liquid-borne waste that contains organic matter in solution or suspension, especially that produced by domestic and commercial premises.

Species diversity The number of species in an area or community and their relative abundance. There are various scales of diversity. Alpha (local) diversity is the number of species in a small area of fairly uniform habitat. Wastewater water that as been used for a process and released because it is no longer required (e.g. industrial effluent, sewage).

Wetland an area that is waterlogged for most of the year with surface or ground water and supports vegetation adapted for such conditions. Such as; fen; estuary; marsh; salt marsh; swamp

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ANNEX

FGD questionnaires

Introduction

Welcome and thank you for coming to this focus group discussion. My name is Anasimos Tekalign and I am from the School EIABC.

The aim of this exercise is to inform my MSc research, entitled: the impact of urban waterfront development on Lake Hawassa: contribution to sustainable planning.

For the next one hour, the group will talk about topics including the significance of lake Hawassa at natural state, ecology and different impacts on it.

Ground Rules:

- Your participation is voluntary and there is no penalty for refusing to participate
- All information shared here is confidential
- Please feel free to speak openly.
- With your permission, we would like to take down notes during our session because we don't want to miss any of your comments. We assure you that all notes taken will only be used for research purposes.

Group introduction: Let us get to know each other. Could each person please state their name, organization and briefly their field of expertise?

1. What economic benefits do you get from the lake? How do you compare the profitability of your business with time frame? Is there any new associations join the business recently?
2. Did you see any changes in the lake and surrounding environment if so what are they?
3. What do you think about the cause of the changes?

4. What are the key social, economic and environmental impacts of developmental change in the area? Provide examples where possible. (NB: impacts are not necessarily negative)

5. Is there any impact because of fishery, boating and recreational business on the lake? If so what are they please discuss it?

6. What are the current tools/ strategies to manage development in the area? Are they effective? Are you satisfied with current approaches? If not, explain and provide alternatives, if possible?

7. What do you think about future pressure of development on the lake (tourism, utilities, higher density development)?

8. What are the current trends in tourism in the study area?

9. What do you think about the impact of tourism development on the lake?

10. Do you think that there is a change in the flora and fauna of the lake and fringe zone? If yes. Please explain the changes specifically?

11. What can be your role in managing and protecting the lake from anthropogenic influence?

Thank you for participating.

Interview

Introduction

My name is Anasimos Tekalign and I am from the School EIABC.The aim of these questions is to inform my M Sc research, entitled: the impact of urban waterfront development on Lake Hawassa: contribution to sustainable planning. All respondents and responses will remain anonymous and the information will be used strictly for research purposes.

S.n	Questions		Response	remark
1.	Type of land use			
	a.	Residential (which type)?		
	b.	Commercial (which type)?		
	c.	Industrial (which type)?		
	d.	Other (please specify)		
2.	Number of residents or employee			
3.	Source of income for HH			
	a.	Trade		
	b.	employment		
	c.	Craft and tourism sector		
	d.	Agriculture (any type)		
	e.	Other specify		
4.	Solid waste management system			
	a.	Collected by municipal		

	b.	Open dumping		
	c.	Open pit		
	d.	other		
5.	Liquid waste management system			
	a.	Septic system or seepage		
	b.	Connecting with sewer		
	c.	Treat the waste		
	d.	other		
6.	What is the source of energy?(for cooking or other use)			
	a.	Bio-fuel		
	b.	Fuel		
	c.	electricity		
	d.	other		
7.	If bio-fuel Where did you get it?			
8.	How do you manage storm water?			
	a.	seepage		
	b.	Diversion of drainage		
	c.	other		
9.	Is y our dev elopment dependant on t he lake?			

	a.	yes		
	b.	no		
10.	If y es, w hat f actors pr ompted y ou t o undertake development within this area?			
	a.	tourism		
	b.	agriculture		
	c.	industry		
	d.	If Other specify		
11.	What is the source of water for any use?			
	a.	Tap water		
	b.	ground water		
	c.	from the lake		
	d.	If Other specify		
12.	If y ou hav e gr ound water s ource i s t here any pr oblem of d rying? O r dec reased i n level?			
	a.	Yes		
	b.	no		
13.	Is t here an y under ground s torage t ank? I f yes. What kind of liquid is stored?			
	a.	Oil		

	b.	gashes fuel		
	c.	Other specify		
14.	What ar e t he par ticular benef its of developing in this area?			
15.	Are t here any em erging po sitive an d negative e nvironmental i mpacts t hat y ou have w itnessed as a r esult of gener al development in the area?		positive	
			negative	
	a.	yes		
	b.	no		

16. H ow c an y our dev elopment ac tivity c ontribute t o p reserving t he ec ology of the area?

17. D id y ou par ticipate i n any kind of l ake or ec ology conservation ac tivities within the waterfront? If yes what are they?

18. W ould y ou l ike t o s ee any c hanges i n l and us e gener ally? I f s o, pl ease elaborate?

19. W hat are t he c urrent t ools/ s trategies t o m anage dev elopment i n t he ar ea? Are they effective? Are you satisfied with current approaches? If not, explain and provide alternatives, if possible?

What is the particular policies/legislation that is required before your development is approved? Are you satisfied with these? If not, please elaborate.

Observation /survey check list

1. Identify areas which urban irrigation agriculture is practiced

2. What are point source pollutions?

No.	Type of point source pollution	GPS points		Photo number	remark
		x	y		

3. Observe for solid waste management system

4. Identify water draining sites and its specific use

No.	Draining pump	GPS points		Photo number	use	remark
		x				

5. Identifying exotic species

5.1 Terrestrial

No.	Terrestrial exotic species	Abundance	remark

6. Delineate wetland using GPS points

No.	Wetland vegetation line o r water m ark or ot her indicator code	GPS points		remark
		x	y	

7. Buffer zone intrusion and management

7.1

No.	Type of Land us e intrusions within t he buffer	GPS points		Land use type	remark
		x	y		

7.2 how is general buffer zone management?

Identify waterfront access points their use

No.	Type of access t o the lake	GPS points		remark
		x	y	

8. What kind of disturbance caused by tourism industry?

Government document review and interview (to Hawassa city municipality)

1. How many associations are there currently registered and get in to business?
   a. Fisheries ----------
   b. Urban agriculture----------
   c. Youth association working along the shore line ----------
   d. Boating associations---------
   e. other-------
2. What are the property types and measure of the waterfront land? Is it private or public?
3. Fetch master plans and LDPs that the city has since its establishment?
4. Evaluate the concern given to waterfront development and environmental sustainability by each master plan especially the existing?
5. Evaluate land use policy and investment policy?
6. Is there any ordinance or legislation for conservation and management of the waterfront? If there what kind?
7. Is there any legislation concerning tourism and tourism infrastructure development?
8. Is there any measure for the treatment of municipal solid and liquid waste?
9. How is the land use land cover of Lake Hawassa waterfront made and managed?
10. How do the municipality and other government body protect and conserve Lake Hawassa and the surrounding ecosystem including bio-diversity?
11. Is there any system of protecting wildlife within the waterfront?