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**ADDIS ABABA UNIVERSITY**

**COLLEGE OF DEVELOPMENT STUDIES**

**CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT**

**THE EFFECT OF ANTHROPOGENIC FACTORS ON WETLAND  
ECOSYSTEM: THE CASE OF SULULTA, OROMIYA REGION,  
ETHIOPIA**

**BY**

**NAHOM LEMA SHISHIGU**

JUNE, 2020

ADDIS ABABA, ETHIOPIA

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ECOSYSTEM: THE CASE OF SULULTA OROMIYA REGION,  
ETHIOPIA**

*A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY, SCHOOL OF GRADUATE  
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THE AWARD OF THE DEGREE OF MASTER OF ART IN ENVIRONMENT AND  
SUSTAINABLE DEVELOPMENT*

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This is to certify that the research thesis conducted by Mr. Nahom Lema, entitled: “*The Effect of Anthropogenic factors on Wetland Ecosystem: The Case of Sululta, Oromiya Region, Ethiopia*”. Submitted in partial Fulfiment of the requirements for the degree of MA in Environment and sustainable development complies with the regulation of the university and meets the accepted standard with respects to originally and quality.

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## List of Acronyms

|       |                                                    |
|-------|----------------------------------------------------|
| ADLI  | Agricultural Development Lead by Industrialization |
| CBD   | Conservation of Bio Diversity                      |
| CSA   | Statistical Agency                                 |
| CSE   | Conservation Strategy of Ethiopia                  |
| DAs   | Development Agents                                 |
| ECA   | Economic Commission for Africa                     |
| ETM   | Enhanced Thematic Mapper                           |
| FCC   | False Composite Classification                     |
| FDRE  | Democratic of Ethiopia                             |
| GIS   | Geographic Information System                      |
| GPS   | Geographical positioning system                    |
| IWRM  | Integrated Water Resource Management               |
| LULC  | Land Use Land Cover                                |
| MEA   | Millennium Environment Assessment                  |
| MSS   | Multi-Spectral Sensor                              |
| NDVI  | Normalized Difference Forest Index                 |
| OUPi  | Oromia Urban Planning Institute                    |
| R&D   | Research and Development                           |
| RS    | Remote Sensing                                     |
| SDGs  | Sustainable Development Goals                      |
| SPSS  | Statistical Package for Social Science             |
| SSA   | Sub Saharan Africa                                 |
| TCC   | True Color Classification                          |
| TM    | Thematic Mapper                                    |
| UNCBD | United Nations Convention on Biological Diversity  |
| UNEP  | United Nations Environment Programme               |
| USA   | United States of America                           |
| UTM   | Universal Transverse Mercator                      |

## **Abstract**

*Wetlands provide multiple ecosystem services such as water and water quality storage and regulation, providing unique habitats for flora and fauna, and regulating micro-climate conditions. Wetland conversion to settlement, agricultural use and industrial development are an ongoing practice in periurban area and becomes a threat to wetland. This research examined the effects of anthropogenic factors on a wetland ecosystem in Sululta Oromia region Ethiopia. Mixed approaches such as key informant interviews, focus group discussion and household survey (396 respondents) were employed to collect relevant data. A three year's satellite image (1986, 2000, and 2020) analysis was also made to understand the trend of land use land cover change in the area. The LULC imagery data were checked for accuracy assessment and kappa statistics, which is 85.71 and 0.878 percent, respectively. The LULC rate of change of Sululta from an initial year to final (1986 to 2020) that is, both wetland and vegetated land were decreased by 843 ha (18 percent), and 1704 ha (37 percent) respectively. While Settlement, bare land and cultivated lands increased by 1935 ha 42 percent, 488 ha 11 percent and 124 ha 3 percent respectively. This indicates that the LULC of settlement, bare land and cultivated lands were increased at the cost of wetland and forest class. The past 34 years satellite image analysis reveals that the current situation of Sululta wetland is characterized by highly degraded and depleted because of population dynamics and settlement expansions. The researcher suggests the administrations should consider these anthropogenic activities.*

**Key words:** Anthropogenic activities, GIS, Sululta, LULC, Wetland.

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1. Background of the Study**

Wetlands are among the most productive ecosystems in the world and provide many functions, or products and services owing to their diverse species and habitat (Mironga, 2005; Mwakaje, 2009). Wetlands contain countless products and services of economic value as a result sustain millions of individuals residing in the periphery and those residing outside the wetlands at domestic, regional and international levels (USAID, 2014). Wetlands are also habitat for biota (Ramachandra et al., 2011; Roy et al., 2012; Hagos et al., 2014). Despite the great social-ecological contribution, estimates show that the global wetlands cover 7 to 9 million kilometer square only; which is equal to 4 to 6 percent of the land surface of the earth (Mitsch et al., 2000).

Over the past centuries, however, human activities have severely threatened wetlands and their services with distinctive natural and cultural values (Ramsar, 2018). As Davidson (2014) points out, the global extent of wetlands in the twentieth century is estimated to have declined between 64 and 71 percent, and wetland losses and degradation continue globally. Since the 20th century, the need for food, together with limited understanding of the ecological function of wetland ecosystems, has resulted to public pressure for the disappearance of current wetlands around the globe since they were considered 'wasted lands' or even disease sources such as malaria (Dodouras and Lyratzaki, 2012). In particular, in emerging nations, wetlands heavily deteriorated due to unsustainable human operations motivated by population growth and the heavy reliance on natural resources for livelihoods (Von die Heyden 2007).

Africa's wetlands, estimated at around 1,310,000 kilometers square, provide an important source of water and nutrients needed for the biological productivity and survival of humans. Despite their significance, African wetlands are heavily modified as motivated by economic and monetary motives. Sustainable wetland management is therefore critical to the long-term health, security and welfare of many African populations (Gerubin, 2017).

In Sub-Saharan Africa, except South Africa, there is little information on wetlands (Thondhlana *et al.*, 2012). In the meantime, wetland conditions also present certain challenges, such as diseases and considered wild wasteland (Msipa 2009).

Ethiopia is one of Africa's most populous countries where most people live in rural areas and depend on natural resources such as wetlands for their livelihoods. Wetlands provide different socioeconomic values and services to the rural communities that include food, fodder, water (for domestic use, animals and farming), fuel wood, medicine and construction materials (Amsalu and Addisu 2014). Despite the variable values and services, the country's wetlands have been continually degraded (Amsalu and Addisu 2014; Wondafrash, 2003).

Sululta wetland has many environmental benefits, such as run-off reduction, groundwater recharge, wastewater purification, and home for a variety of bird life. However, the administration and local inhabitants do not regard these advantages, so the present wetland asset situation does not appear to be regarded. Wetlands in the study area are severely modified through the creation of artificial lakes, streams and fountains for recreation, storage of water for fishing and planting and the like.

## **1.2. Statement of the Problem**

The connection between man and his environment has always altered over millennia, depending on his understanding and knowledge of the physical setting. As people have grown their pressure on the environment intensified (Ezeaku *et al.*, 2008; Jimoh *et al.*, 2012). Increasing population density in the wetland area has usually associated with higher amounts of impermeable surfaces, watershed alterations, coupled with decreased capacity of these systems to naturally hold surface runoff (Brody *et al.* (2007).

Due to fast population growth, urban migration and the inability of consecutive authorities to handle urban growth, sululta has extended unplanned, leading to a more land takeover in the wetland area. In the recent history, Sululta has experienced a significant disturbance. A wetland tour shows a number of new operations that mean huge invasion of latest times. The operations include, but are not limited to; housing and commercial buildings and agricultural practices (Elizabeth, 2000).

The forest cover has also been significantly reduced, and the wetland is now experiencing more noticeable flooding events than before during severe storms. All of these operations are putting a bunch of stress on the wetland, affecting its ecological role and degrading it. These activities have led to Sululta expansion as the cost of wetland degradation and loss. Although there are currently insufficient data to link urbanization with wetland invasion, the size and biodiversity of unconverted portions of wetlands have drastically decreased, with some areas being completely lost (Tekalegn, 2009).

Wetland loss continues despite changes in the legislative framework towards sustainable wetland conservation. To the finest of my understanding, no study has so far attempted to show comprehensively the interconnections between Sululta's watershed sustainability, property use and management constructions, although these variables are recognized to behave in conjunction as they determine wetland conservation (Abebe and Gheb, 2003).

Some past wetland surveys concentrated on agronomic operations (Mujaju *et al.*, 2013), development (Masaka *et al.*, 2014), reviewing current policies without evaluating their impact on wetland circumstances and cultural organizations overall knowledge (Mberekko, 2008), but shunning the nested strategy that is critical to wetland management. This leaves it difficult to effectively generalize and apply the outcomes through strategy. If the complicated socio-ecological relationships within wetlands are not understood, the larger image of wetland degradation may be unstoppable (Gardner and Davidson, 2011). These studies missed the effect of human activities on wetlands and their services. Therefore, the aim of this study was to examine the effects of anthropogenic factors on wetland ecosystem in Sululta, Oromia region, Ethiopia.

### **1.3. Research Question**

- ❖ What are the major anthropogenic activities that affect wetland ecosystem in the study area?
- ❖ What are the patterns and nature of LULC Change in the study area (1986, 2000, and 2020)?
- ❖ To what extent and rate of LULC changes affected wetlands in the study area between 1986, 2000 and 2020?
- ❖ What are the drivers of LULC change in the study area?

## **1.4. Objectives of the Study**

### **1.4.1. General Objective**

The general objective of the study was to analyze the effects of anthropogenic activities on wetland ecosystem in Sululta.

### **1.4.2. Specific Objectives**

Specifically, the study attempts to address the following objectives;

- ❖ To assess the effects of anthropogenic activities on wetland ecosystem.
- ❖ To analyze the patterns of LULC change in the study area (1986,2000 and 2020)
- ❖ To understand the magnitude and rate of LULC changes in the study area.
- ❖ To investigate the drivers of LULC change in the study area.

## **1.5. Significance of the Study**

The study will benefit wetland (lake) environmental and development actors as well as policymakers at all levels of government to show wetland management issues. It will lead to add sustainable ecological growth in the area. This study can help to show the pattern of wetland change issues and provide initial views and additional information for researchers who want to see the issue differently in the area. In addition to those listed above, it would be useful for future researchers, students, and academics to digest the effects of urbanization on the wetland ecosystem.

## **1.6. Scope of the Study**

This thesis work was only limited to sululta Oromiya region, Ethiopia. Generally, the scope of the study mainly focused on analyzing the effects of anthropogenic activities on the pattern and rate of LULC change wetland ecosystem and its services using community perception and satellite image analysis of three different periods (1986, 2000 and 2020).

## **1.7. Limitation of the study**

There were many limitations in which researcher faced during the period of research. These were the problem of Internet dysfunction, the absence of intended year's aerial photographs and the high quality of the intended years and month's satellite image. In addition the outbreak of the Coronavirus (Covid-19) pandemic, the researcher faced challenges to collect data through focus

group discussion and time constraint due to Covid-19. Other drawbacks were financial deficiency for the collection of ground control data and so on.

## **1.8. Organizations of the Thesis**

The thesis is organized into five chapters. Chapter 1 includes the context, problem statement, and study importance, including the nature and limitations of the analysis. The second chapter offers a study of the literatures in question. Chapter 3 focuses on methodological issues; research design, sampling procedures, data gathering tools and data analysis methods. Chapter 4 deals with the data analysis and presentation. Lastly, Chapter 5 offers conclusions and recommendations based on data observations and data interpretations.

## **1.9. Ethical Considerations**

Ethics had a great relevance in research work and the researcher considered the ethical issues critically as much as possible. Therefore, the researcher was considered the research values of voluntary participation, confidentiality, anonymity to ensure protection of respondents from any possible harm that could arise from participating in the study. Thus, the researcher clearly introduced the purpose of the study as a partial fulfillment of a Masters Study program in MA in Environment and Sustainable Development and requests the respondents to participate in the study on a voluntary basis such that refusal or abstaining from participating was being permitted. The researcher also assures the respondent confidentiality of the information given and protection from any possible harm that could arise from the study since the findings would be used for the intended purposes only and the researcher give consent to respondents their response does not disclose to anybody without their consent.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1. Concepts and Definitions of Wetland

Man has been associated with wetlands at various locations for a very long time. Therefore, the notion of wetlands has different meanings due to the unique interactions with distinct interest groups in distinct areas of the globe (Maltby & Barker 2009). The different meanings may be linked to a people's culture, background, or socioeconomic uses to which it was put, etc. The term wetland, however, is a recent vocabulary in comparison with the association of man with it (Keddy, 2000).

Wetlands are usually associated with floods, swamps, wastelands, mosquito-infested mud holes, and so on. According to Haslam (2003), 'wetland' is originally a North American term and is commonly referred in non-ecological literature on the other side of the Atlantic as bogs, fens, marsh, swamps, sloughs, morasses, moor, mires, flood meadows, etc.

Wetlands have a mix of aquatic and terrestrial conditions that produce complex ecosystems that do not fully fit into aquatic or terrestrial ecology. They have typical characteristics and species of the communities they divide as transitional zones (Mitsch & Gosselink, 1993). Hence, wetland features are mainly determined by hydrological procedures that may display daily, seasonal or longer-term changes in relation to regional climate and site place (Halls, 1997).

Wetland is a collective term for ecosystems whose formation has been dominated by water and whose processes and characteristics are largely controlled by water (Getachew *et al.*, 2012). Similarly, Sabai (1999 in Mekonnen and Aticho, 2011) refers to wetland as "a general term applied to open water habitats and seasonally or permanently waterlogged land areas, including lakes, rivers and estuarine and fresh water marshes". On the other hand, Coeardian et al. (1979 in Sabai 1999:6) defines wetlands as "lands of transition between terrestrial and aquatic systems where the water table is usually at or near the surface of the land or the land is covered by shallow water".

## **2.2. The Importance of Wetlands**

### **2.2.1. Water Regulation and Purification**

Wetlands maintain natural cycles like recharging water supplies through groundwater sapping (Hansson *et al.*, 2005). Wetlands are also an important part of nitrogen cycling because of the presence of oxygen, which allows chemical changes of nitrogen to take place (Faulkner and Richardson, 1986). Wetlands can also be used in urban areas to treat sewage, and help retain nitrogen and phosphorus (Tekalegn, 2009).

The availability of plants and animals on wetlands allow nutrients to accumulate and reduces the flow of sewage water (Bolund and Hunhammar, 1999). People benefit from these wetlands in direct or indirect ways. In assessing the environmental condition of wetlands and how sustainable the function performed by a wetland is, various models have been used (Hruby, 1999). As natural filters due to a variety of forest and unique soils, wetlands can improve water quality by reducing eutrophication and storing sediments (Kadlec and Knight, 1996; Mitsch *et al.*, 2001). This function will depend on where the wetland is located since this affects the amount and source of water available in the wetland.

Wetlands in low-lying areas such as swamps will receive more runoff as compared to those near mountains such as mountain bogs. Wetlands are also habitats of different animal and plant species and many African wild animals depend on wetlands during dry periods (Keddy, 2010). Unique plant species not found in other parts of the landscape are only available on these wetlands, and these include hydrophytes plants such as Typhaceae (Hugget *et al.*, 2000). Fish, mammals, reptiles, amphibians rely on wetlands for breeding and migratory birds and many endangered species rely on wetlands for their survival (Hugget *et al.*, 2000). These species can enhance the recreational values of wetlands (De Groot *et al.*, 2002).

### **2.2.2. Recreational and Aesthetic Value**

Wetlands are valued for their aesthetic and cultural values and are economically important as tourist attraction places to generate revenue (Turner *et al.*, 2000). Bird watching is one recreational activity attracting tourists at famous Ramsar sites such as Monavale vlei in Harare (Murungweni, 2013).

Wetlands like most natural environments are also therapeutic (Bolund and Hunhammer, 1999). The green wetland plants can enhance the physical and psychological health of urban citizens (Ulrich et al., 1991). A study made on people who were under stress and exposed to different environments showed that the level of stress decreased in those people who were exposed to natural and green environments (Ulrich et al., 1991). Wetlands can therefore enhance the health of human beings through spiritual enhancement and cognitive development and provide different opportunities for reflection (Ulrich et al., 1991). Continued provision of these services and existence of these wetlands can only be guaranteed if people use these valuable ecosystems sustainably. Human activities affect the natural structure of most wetlands such that some are failing to perform their functions effectively (Magadza, 1994).

### **2.2.3. Regulating function**

Wetlands act as carbon sinks, storing carbon dioxide and thereby regulating the concentration of carbon dioxide in the atmosphere (Keddy, 2010). Wetlands help to reduce flooding because of the soils and forest, which encourage infiltration at the expense of runoff, enhancing groundwater recharge and reducing downstream volume of water and peak discharge (Bobbink et al., 2006). The forest structure on wetlands can alter the occurrence of natural hazards such as droughts since they increase water storage capacity (De Groot et al., 2002). Wetlands cannot stop flooding, but they hold water temporarily and reduce the velocity of the water. This can reduce loss of crops by farmers and protect those who live in floodplain areas against the risk of property loss due to flooding (Smith et al., 1995).

Wetland soils hold water and release it in dry seasons for human, animal and plant use (Silvius et al., 2000). However, there has been debate about soil and water processes and the role in the regulation of stream flow (Scoones, 1991). During the dry season, wetlands can reduce stream flow because of the high evapotranspiration from the wetland surface (Scoones, 1991). The water is, therefore, important in maintaining ecological processes within the wetland community. Pollutants can also be filtered by wetlands through the forest cover on wetlands when they are trapped and absorbed as nutrients, reducing them from reaching the adjacent rivers and lakes (De Groot et al., 2002).

However, wetland functions depend on the nature and role of the surrounding landscape like human landscape transformation such as agriculture (Smith et al., 1995). The hydrological structure, water quality, and the nature of sediment accumulation in wetland ecology are all affected by different anthropogenic conversion of the surrounding landscape (Hill and Keddy, 1992; Ehrenfeld and Schneider, 1993). Different land uses, such as waste dumping, infrastructural development and agriculture therefore affect the ecological and hydrological functioning of wetlands. The surrounding landscape also affects biomass concentration, amount of organic material, type of plant species and the ability of the wetland to provide refuge for different animal species (Holt et al., 1995).

#### **2.2.4. Nutrient Recycling and Food Production**

Wetlands produce goods such as fish, rice, berries and timber, and some societies depend on these goods for their wellbeing since they can sell or use them for human consumption (Keddy, 2010). It is important for people to understand the different functions to make strategic decisions on the exploitation and use of wetlands. Planning and management of wetlands are sometimes done without the involvement of all stakeholders. Much research on mapping wetlands and on the effects of wetland degradation does not always consider the roles of local people who use and value wetlands. It is therefore the aim of this study to investigate human use of wetlands and their environmental impacts.

Wetlands are a major asset in sub-Saharan Africa, including Ethiopia, which supports agricultural livelihoods, especially in regions with low or unstable precipitation, land scarce or where uplands have bad soil characteristics and therefore low agricultural potential (Dixon and Wood, 2002; 2003). Wetlands are providing humanity with natural resources and facilities. They are a cause of nutrition, tourism, social assets, monitoring of floods and enhanced performance of water. They are also important for the conservation of biodiversity and wildlife (Desta, 2003).

#### **2.2.5. Environmental, Economic and Social Functions**

Wetlands perform important environmental, economic and social functions because of the interactions between physical, chemical and biological elements of wetland, such as soils, water,

plants and animals (Smith et al., 1995; Finlayson et al., 1999). Functions of wetlands refer to their ability to meet human needs by providing goods and services (De Groot et al., 2002).

According to Hailu (2003), virtually all households in Ethiopia's Western Wellaga and Illubabor zones use wetlands directly or indirectly. The main uses are social / ceremonial reeds, medicinal plants, thatching reed used for housing construction and granary roofing, household water supplies, dry seasonal grazing land, livestock water, temporary reed huts, farming and craft materials. Wetlands perform important environmental, economic and social functions because of the interactions between physical, chemical and biological elements of wetland, such as soils, water, plants and animals (Smith et al., 1995; Finlayson et al., 1999). Functions of wetlands refer to their ability to meet human needs by providing goods and services (De Groot et al., 2002). Generally Wetlands provide multiple ecosystem services such as storing and regulating water flows and water quality, providing unique habitats to flora and fauna, and regulating micro-climatic conditions (Teferi *et al.*, 2010).

Table 2.1: Ecosystem goods and services provided by wetlands

| Types of Services                      | Examples                                                                                                                         |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Providing ecosystem services.          | Storage, recycling, processing and acquisition of nutrients. Products obtained from ecosystems.                                  |
| Nutrient Cycling and Food production   | Production of fish, wild game, fruits and grains.                                                                                |
| Fresh water                            | Storage and retention of water for domestic, industrial and agricultural use.                                                    |
| Fiber and fuel                         | Production of logs, fuel wood, peat and fodder                                                                                   |
| Bio chemicals                          | Extraction of medicines and other materials from biota.                                                                          |
| Genetic materials                      | Genes for resistance to plant pathogens, ornamental species, etc.                                                                |
| Climate Regulation                     | Source of and sink for greenhouse gases; influences local and regional temperature, precipitation, and other climatic processes. |
| Water Regulation (Hydrological Flows)  | Ground water re-charges and discharge retention.                                                                                 |
| Water Purification and Water Treatment | Retention, recovery and removal of excess nutrients and other pollutants.                                                        |
| Hazard Regulation                      | Retention of soils and sediments, Flood control and storm protection.                                                            |
| Cultural Ecosystem Services.           | Non-material benefits obtained from ecosystems.                                                                                  |
| Spiritual and Inspirational            | Sources of inspiration; many religions attach spiritual and wetland ecosystems religious values to aspects of                    |
| Recreational                           | Opportunities for recreational activities.                                                                                       |
| Aesthetics                             | Wetland ecosystems and their resources are a source of beauty and attraction to tourists.                                        |
| Educational                            | Opportunities for formal and informal education and training.                                                                    |
| Supporting Ecosystem Services.         | Services necessary for the production of all other ecosystem services.                                                           |
| Soil Formation                         | Sediment retention and accumulation of organic matter.                                                                           |

Source: UNDP/NEMA/UNEP Poverty Environment Initiative, (2009) &WRI (2009)

## **2.3. Wetland Threats**

Wetlands most prevalent hazards are a mixture of social, financial and environmental variables that have enhanced stress on Ethiopian lakes ' natural assets. Another limitation to the judicious use of African forests is the absence of understanding by promoters and natural resource managers about the advantages they provide and the methods they can use in a viable way (Jogo and Hassan, 2010). Loss, destruction and alteration of wetlands have been and continue to be seen as an advanced mode of development even at the level of government (Abebe and Geheb, 2003).

Kumsa (2015) noted that the most serious threats to wetland in the western region are unsustainable use of wetland resources through over grazing, over cultivation, over abstraction of water for domestic use, agriculture and urban expansions. According to EPA (2000) report most of the wetlands, ecosystems in Ethiopia are severely degraded and most of the floristic and fauna species are endangered. This is due to land used does not consider conservation while they are under pressure by the farming population, which is in horrible need of land for pasture and crop farming. Another impediment is the lack of any strategic plan and capacity for wetland conservation systems and agricultural applications (Leykun, 2003).

Currently, some wetlands are at the edge of extinction. The situation of Lake Haramaya in the east wetland exhibits this reality. The resources and the lake disappeared for reason they cannot comprehend. Many lakes of the Great Rift Valley are also similarly exposed to severe degradation. The dangers would refer to Ziway, and Abijata wetlands where current human actions related to resource extraction are being maximized beyond the resources reviving capacity. In Ethiopia, wetlands are often considered as wastelands and are thought to face obstacles to agricultural development, human and animal health associated with troubles and catastrophes such as floods, diseases like malaria and schistosomiasis (Legesse, 2007).

### **2.3.1. Natural Factors**

Wetlands are perhaps the world's most endangered habitats. Such habitats also face increasingly extreme challenges such as flooding, storms, soil degradation and subsidence due to natural mechanisms that have the ability to destroy the wetland climate. Natural causes like climate change can alter the environment, resulting in unwelcome long-term results. Anthropogenic

factors derive from deforestation in the upper watersheds, depletion of Acacia trees, and agriculture of lake shores and degradation of buffer zones. Many important threats include siltation, water diversion, over exploitation and pollutant leakage into the wetland. The key environmental threats to wetlands are discussed below.

#### **2.3.1.1. Flooding**

Wetlands act as natural sponges that absorb, and gradually release salt water, sun, snowmelt, freshwater, and floodwaters. Trees, root mats, and other wetland plants also slow down the pace of floodwaters and more gradually spread them across the flood plain (Costanza, et al, 2008). Nearly all wetlands, although their size and depth differ greatly, are subject to some measure of flooding, especially coastal and estuarine wetlands (Kusher, 2009). Internationally, however, wetlands have been recognized as critical in lowering the surge level and wave height and flood protection, increasing annual floodwaters due to climate change and heavy rain, and because of the loss of wetland habitat in the upper catchments.

Over the last 100 years in particular, vast floodplain regions have been flooded and cut off from their waterways by artificial embankments (termed bunds, dykes or levees in different countries). This means the water is condensed into ever-narrower areas that used to disperse gradually and comparatively shallowly across vast flood plains. Consequently, as and when engineered riverbanks are broken, rivers are higher and more likely to cause harm-even devastating-impacts. For example, flooding has become more regular and more devastating in China's middle reaches of the Yangtze River as a direct result of floodplain erosion, especially when combined with the erosion of forest cover in the drainage basin of the river (Ramsar Convention, 2013).

#### **2.3.1.2. Subsidence**

Subsistence represents another natural threat to wetlands. Land subsidence is an environmental hazard caused by groundwater overdraft or oil extraction, resulting in the earth's surface gradually settling or sudden sinking due to the sub-surface movement of the earth's materials. More than 200 instances of land subsidence have been recorded worldwide in the last few years (Ustun, *et al*, 2010). Land subsidence in combination with the fall of groundwater levels has been recognized as a possible issue of different parts of the world. They are generally referred to as peat, which muck, which contains more than 30 percent organic matter by nature. Subsidence

happens when certain soil is removed or exposed to air that allows organic material to oxidation. Hence, the underlying materials are often compacted by paths, fills, and other materials put in wetland soil, allowing it to settle or fall accordingly. Cracker and water enter the foundation. Roads are built in wetlands and are subject to differential settlement (MEA, 2005).

#### **2.3.1.3. Soil Erosion**

Soil erosion is the removal of wind, water and other natural forces from the soil particles. This naturally occurring process is speeding up in areas where human activities have disturbed soil. Lands used to grow new crops are particularly susceptible to soil erosion. Soil particles from the leaved disturbed sites are transported by run-off to lower elevated areas as long as the water flow is sufficient to transport them. As the water velocity reduces, a part of the transferred sediment is deposited. Sedimentation is the result of soil erosion.

When wetlands are flooded with so much mud, the extreme effect arises is that they no longer retain water; therefore, these wetlands lack their ability to fulfill other normal wetland functions. While wetland loss is intuitive when the basins are completely filled with sediment, the relationship between functional loss and degradation to gradual but chronic filling is less well appreciated and understood (Ehsan and Farhad, 2014).

Soil depletion is a natural threat to habitats in the wetlands. Without wetland protection, soil erosion will result in two physical losses: 1) soil degradation and desertification wasteland; and 2) loss of nutrient content (Zhou, *et al.*, 2011). This can have long-term destructive effects on wetland ecosystems, as sedimentation-affected wetlands can lose their open water areas and become choked with aquatic forest. This altered wetland habitat has less diversity and is of much less value to wildlife, Sedimentation also has smoothest aquatic invertebrates and destroys the habitat they need to survive and Sediment suspended in the water columns turns water red. This cloudy water prevents sunlight from reaching plants and algae, reducing nutritional and photosynthesis levels. Red water also makes it difficult to feed aquatic animals that rely on sight to obtain their food and fish gill coats, preventing oxygen intake (Kusher, 2009).

#### **2.3.1.4. Drought**

Drought as a climatic phenomenon refers to below-normal rainfall occurring and/or lasting. Droughts are a natural part of climate change and may occur at a number of time scales – from

days, months, seasons, or years (Gilbert et al, 2012). Drought is considered one of the most challenging threats facing wetlands due to climate change, global warming, and it happens. In many ways, too, dryness affects wetlands. Plants and animals, like humans, depend on water. When a drought occurs, their food intake may diminish and can destroy their habitat.

Drought is likely to affect wetlands including microorganisms in the soil that drive biogeochemical cycling in the soil. Frequent drought may reduce the potential of wetlands to act as global carbon sinks or may gradually transform them into atmospheric carbon sources in general, and methane in particular (Tian, *et al*, 2012). During the drought, due to the rise in temperature and high rate of evaporation, aquatic plants would need water to escalate. On the other hand, substantial declines in river flow and surface water resources decrease their ability to purify pollutants along the path of water flows, resulting in significant declines in water quality.

### **2.3.2. Anthropogenic Factors**

Natural ecosystems, especially freshwater ecosystems in the inland flood plain, are undergoing profound and extensive disturbances by humans worldwide. Key indicator of these disturbances is that humans extensively reclaim natural wetlands to expand their economic benefits. Therefore, most habitats of natural ecosystems have been changed into farms or urban areas rapidly and continuously (Ehsan and Farhad, 2014).

In Ethiopia, anthropogenic activities that affect the quality and safety of wetlands and surface waters are increasing because of the growing human population number. Similarly, the wetland ecosystems and biological resources are being impacted by population growth due to the increasing pressure of resource uses. Anthropogenic activities such as industry, urban complex, expansion of human settlements, farmland expansion, overgrazing, massive forest removal for food, construction materials and fuel wood, and open burning in an attempt to convert to farmlands are causing severe deterioration to wetlands and their surroundings in Ethiopia (Gebretsadik and Mereke, 2017).

These impacts are widely prevalent in wetlands around the and in the rift system in the country (Dejen, 2003). Increased human activities in the rift valley area of Ethiopia have also resulted in open forest, which is floristically poor and uniform. Conversion of natural forest, overgrazing of natural grasslands and clearing of forests for firewood and construction purpose are the

consequences of population pressure and related impacts in the rift systems in Ethiopia (Abera, 2016).

#### **2.3.2.1. Agricultural Activities**

Agricultural operations in wetlands have influenced the physical characteristics of the area over time; these characteristics are soil and water quality. Wetlands are among the most successful ecosystems because of their characteristics. They are vital to human well-being in the framework of socioeconomic advantages, hence their livelihoods, and perform a critical part of the setting, such as water purification, air retention and water stream regulation, ecosystem equilibrium through conservation and conservation of biodiversity, coal sequestration and air supply (Mwakubo et al. 2008).

Numerous extraordinary civic establishments, including the Maya, Inca and Aztec in Latin America, the Khmer in Asia, the Swamp, Middle Easterners in Mesopotamia, and the Nile and Niger in Africa, used them. A portion of the world's largest wetlands is noteworthy today. Botswana's Okavango Delta and Brazil's Pantanal are known for wildlife tourism; Egypt's Nile Delta, India's and Bangladesh's Ganges Delta, and Vietnam's Mekong Delta, though all highly adapted, support all-inclusive, remarkable farming and other natural activities (Gosselink and Baumann, 1980).

Agricultural practices are considered more critical, according to Allen and Debra (1990), as much as hazards vary between distinct fields and also within wetlands. This is partly due to the extent of wetland farming, which has witnessed an enormous expansion in recent times and has muddled wetlands around the world. However, the nature of most wetlands has undergone extensive and retrievable transformations that have changed as people seek to increase agricultural profitability (Abila, 2005).

The connection between irrigation farming and its effects on wetland environments, structures has frequently been portrayed as one of an instant trade in comparison to ecology between the animal need for nourishment. The reality is much more perplexing, as revealed by this recorded study, as both natural frameworks and nature could be flexible (Alwe, 1980). For instance, where wildlife can change waterfowl adapting to paddy rice as a change to the ordinary wetland setting, individuals will change too intentionally. For example, as individuals have learned about the

important facilities that wetlands provide, the response has been to explore wetland conservation and restore methods (Agwata, 2005).

Another downside to using the expanding pesticide is improving resistance in species of vermin. The individual vermin that survives applications of pesticides continues to breed, progressively delivering a population with more prominent resistance to the connected chemicals. In this way, pesticides need to be used as part of continually expanding quantities or replaced with new chemicals to control sufficient populations of bother. Subsequently, these natural compounds in the earth are deeply relentless and accumulate in creature tissues, resulting in water sully, angle executions, and decreasing populations of some feathered creatures. Since some of these new pesticides can be deeply dissolved in water, they may drain under the agricultural regions to groundwater and cause water pollution (Rebelo et al, 2009).

#### **2.3.2.2. Urbanization and Settlements**

Building housing constructions on wetlands is one of the most important land-use operations that affect the physical elements of the setting such as water and land cover. These exercises are based on agriculture, development, water redirection, and a large group of others (Ajibola et al, 2012). MEA (2005) stated that the degradation and loss of inland wetlands and species were driven by structural improvements (e.g. lodging, reservoirs, dykes and levees), land use changes, water withdrawals, contamination, overharvesting, and the presence of outsiders.

Degeneration of coastal wetlands through land improvement and water management reduces the boundary of wetlands to offer notable administrations of the biological system. Human procedures anticipated to reduce life-threatening damage and extreme atmospheric characteristics have inadvertently extended wetland susceptibility by altering periodic wetland hydrological components (Ramsar, 2009). Urbanization may affect wetlands at the scene level, through the loss of wide regions, at the level of complex wetlands, through the waste or adjustment of a portion of the units in a collection of firmly divided wetlands, and at the level of the individual wetlands, through change or fracture (Weller, 1988).

As a result, during the construction and operational phase, large amounts of solid waste are generated. This includes cuttings of metal, components that have been dismissed, buried components, plastic sacks, and vacant cartons, and crushed glass among other building project

components. During the building implementation stage, huge community-polluting waste production occurs (UNCBD, 2010).

Urban expansion is at the expense of productive and fertile wetland, farmland, and forest in many of the developing countries. The cases of the Madras Metropolitan Region of India were discussed by Thengvel and Sachithanandan (1998); the rural area of 3,318 hectares in 1964 expanded by threefold and became 20,747 hectares in 1991; To extended urban settlement, Egypt lost more than 10 per cent of 16 productive farmland in the country (Hardoy et. al, 2001, quoted by Minwuyelet 2000).

In the other hand, there is no environmental conservation program to support urban development. Urban waste relay on open canals, open road side drains, and ground holes as a daily waste disposal system, particularly in growing areas. This exposes the people to disease and air pollution related to sanitation. Besides the soil, natural services such as clean air and water, peace and calm, access to the landscape and recreational amenities are natural principles that rural agricultural societies lack due to urban peripheral growth (Balchin et al., 1995), as quoted by Feyera Abdissa.

### **2.3.2.3. Infrastructure Development**

The infrastructure development, such as highways and structures, is often built across wetlands, thus influencing the physical atmosphere, the characteristics of which are water quality and air quality. This is because it is inexpensive for wetlands. Construction of roads or scaffolds across wetlands is frequently believed to be more practical than around them (winter, 1988). Carriage networks may capture a wetland irrespective of the use of culverts. Such unintentional impoundment and hydrological adjustment can change the wetland elements and thus increase sedimentation, leading to an influence on the physical environment (Mitsch and Gosselink 1993).

Developers more often than not build business equipment without scheduling how to properly dispose of effluent; thus, wastewater (fresh materials) is either channeled to a river or carelessly disposed of. Lack of sewer route maintenance causes to tubes being blocked (Nijkamp, 1986). Areas not supplied by a sewer route use septic tanks that, if not well maintained, also pose other hazards. Some are poorly built, while others have insufficient

water supply, thus presenting a hazardous safety danger to the human organism, including person; leading in habitat reduction (Zedler, 2005).

Building projects and maintained highways also lead in further run-off by creating impermeable regions and soil compaction (Mwakaje, 2009). Impermeable areas and compacted soils generally have higher run-off coefficients than natural areas, and higher flood peaks are common in developed areas. Increased runoff from paved grounds and expanding roofs result in extreme flooding and drainage system overflows.

## **2.4. Impacts of Wetland Degradation**

The influence of man has many immediate and indirect effects on wetlands. Construction, for instance, supposedly affects wetlands through immediate habitat loss, contributions to suspended solids, shifts in hydrology, and modified soil performance (Darnell 1976). Indirect impacts, including changes in hydrology, eutrophication and sedimentation, may alter wetlands more than direct impacts, such as drainage and filling (Keddy 1983). Urbanization may influence wetlands at landscape stage, by the destruction of comprehensive fields, by the complexity of wetlands, by the drainage or alteration of some of the structures in a cluster of tightly located wetlands, and by alteration or fragmentation at the stage of the respective forests (Weller 1988).

### **2.4.1. Hydrological Impact**

The changes on wetlands by hydrologic impacts had been far more dramatic than other impacts. Hydrologic changes have large and immediate effects on a wetland's physical condition, including the depth, duration, and frequency of inundation of the wetland. The changes in hydrology caused by urbanization can exert complete control over a wetland's existence and characteristics. Hopkinson and Day (1980) predicted that urbanization bordering a swamp forest would increase runoff volumes by 4.2 times. It is also likely that greater surface runoff will increase the rate of inflow to wetlands that disturb wetland biota and wetland substrates (Stockdale, 1991).

### **2.4.2. Ecological Impact**

Impacts on wetland hydrology and water quality can, in turn, affect wetland forest. Horner (1986) stated that emergent zones in Pacific Northwest wetlands receiving urban runoff are

dominated by an opportunistic grass species, *Phalaris arundinaceous*, while non-impacted wetlands contain more diverse groupings of species. There have been numerous reports on the tolerance to flooding of wetland and non-wetland trees and plants (e.g. US EPA 1993).

Just as hydrological changes affect plants in wetlands, they also affect animal communities in wetlands. Increased impermeability in wetland watersheds can reduce water-dependent stream base flows and groundwater supplies, prolong dry periods in wetlands, and impact species (Azous, 1991). For reproduction, development, and larval growth, many amphibians involve standing water. With changing water concentrations, amphibians and reptile populations may encounter alterations in reproduction habits and population structure (Minton 1968 in Azous 1991). Uncontrolled urban expansion also results in landscape fragmentation, wildlife habitat destruction and biodiversity reduction. These effects render it crucial for worldwide environmental change studies to understand the variables influencing metropolitan development.

### **2.4.3. Socioeconomic Impact**

The consequences of loss and degradation of wetlands in Ethiopia are enormous and directly affect the rural livelihood base. Wetland degradation has many challenges, including native flora and fauna decline and degradation, lack of natural soil resources. Various traditional professions, social conditions, and cultural traditions have been influenced (Kumsa 2015). Wetland diversion also leads to water loss, human relocation, disruption of conventional agricultural processes, habitat degradation, salinization, intensified waterborne diseases and other adverse ecological impacts (WCED, 1987).

Losses of communal resources collected from the wetlands, water, dry seasonal pasture, declining food crop production are just a few to mention (Dixon and Wood, 2003). Habitat pollution and overfishing of selected species are among the major concerns in the Ethiopian lakes. Wassie et al (2012) reported that selective fishing in Lake Tana caused the *Labeobarbus* population to decline by 75 percent during the 1990s. Other significant threats include excessive water abstraction from wetlands, erosion, and sedimentation.

Ghermandiet al., (2008) discovered excessive water abstraction from Lake Alemaya, Southeast Ethiopia caused full drying of the lake by the year 2000, 12 years earlier than expected.

Recently, the bottom valley wetlands of South-West Ethiopia have been increasingly treated, resulting primarily from the expansion of drainage and cultivation (Dixon and Wood, 2003).

Loss of wetlands thus exacerbates climate disturbances by increasing carbon build-ups in the atmosphere. Since Ethiopia is vulnerable to desertification and persistent drought, the effects of the lack of wetlands may be more evident in complicating the local situation. It can affect the hydrological cycle or rainfall patterns. Rivers and streams might lose their power, i.e. create water scarcity and narrow opportunities for irrigation-based farming. Wetlands play a crucial role in the carbon cycle, and the loss of wetlands may have impacts that encourage global warming and climate change (Shimeles and Geremew 2008).

## **2.5. Distribution and Extent of Wetlands in Ethiopia**

Climate circumstances creating various wetland ecosystems, including 12 rivers, eight main lakes and countless marshes and catchment meadows (Abunie, 2003). It has been found in all alpine (high mountain) agro-ecological zones to desert ecosystems in low-lying regions and in all traditional climatic zones (Wood, 2001). All other kinds of wetlands are discovered in Ethiopia, except inland wetlands, consisting of flood plains, rivers, swamps / marshes, marshy woodlands and human-made wetlands. However, the commonly known kinds of wetlands are lakes and wetlands, which together make up about 0.16percent of the complete region of the country (EPA, 2000).

The country has a number of important swamp areas. The Lakes are also the widely distributed wetland types in Ethiopia, both in the highlands and lowlands of the country with the highest concentration in the large East African Rift valley system (Hughes and Hughes, 1992; EPA, 2000; Leykun, 2003). Similarly, other common types of wetlands are riverine wetlands across the country. In the Awash, Abay, Baro, Gibe, Wabe Shebelle and Dawa Rivers catchment meadows, such wetlands are particularly widespread (Getachew, 2000). Detailed inventory of Ethiopia's wetland asset foundation has not yet undertaken.

However, depending on fragmented data, Ethiopia's complete wetland coverage is about 2percent (22,600 kilometer square) of the complete ground region of the country (EWNRA, 2008). Tesfaye (1990), however, estimated that Ethiopian wetlands covered an area of 13,699 kilometer square or 1.14 percent of the land surface of the country. There are 58 major lakes

and marshes in Ethiopia, and 77 wetlands. Wonderfrash (2003), however, maintains that Ethiopia is "endowed with too many wetlands to count.

## **2.6. Wetland and Sustainable Development**

Wetlands are vital to human wellbeing, inclusive economic growth, climate mitigation and adaptation. They provide water to human consumption and to agriculture. They defend our coasts and help to keep cities and communities secure and resilient. They are the largest store of natural carbon on Earth. Biological diversity is supported and the abundant and unique nature (Kotze, 2010). They are key to managing and responding to climate change. They provide opportunities for healthy life and are important for human health and well-being. Wetlands offer a myriad of benefits and services. By definition, either wetlands are water-saturated land areas, permanently or seasonally, so they take on a distinct ecosystem's characteristic (Ramser Convention 2020).

Wetlands include lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peat land, floodplains, and the oasis, including other human-made wetlands such as rice paddies, saltpans, and farming ponds. Multiple benefits and services provided by wetlands are essential to attaining the Sustainable Development Goals (SDGs). The 2030 Agenda for Sustainable Development provides a comprehensive roadmap for a sustainable future. The program is translated into action by 17 targets, each with a set of concrete objectives (Ramser Convention 2020).

The various benefits and resources that wetlands offer are crucial to achieving the Sustainable Development Goals (SDGs). The SDGs represent an ambitious agenda for poverty eradication and achieving sustainable development by 2030. This 2030 Sustainable Development Agenda provides a comprehensive route map for a sustainable future. This program is translated into action by 17 objectives, each with a number of concrete goals. Wetland smart and sustainable use as driven by the Ramsar Convention on Wetlands would be crucial to helping countries achieve their SDG objectives. The Fourth Strategic Plan (2016-2024) of the Ramsar Convention identifies four central priorities and 19 concrete objectives that explicitly reflect both the SDGs and the Aichi objectives identified by the Convention on Biological Diversity (Ramser Convention 2020).

### SDG 17 – PARTNERSHIPS FOR THE GOALS

The Ramsar Convention works in partnership with other MEAs to support governments in achieving the SDGs.

### SDG 16 – PEACE, JUSTICE & STRONG INSTITUTIONS

Effective management of transboundary wetlands contributes to peace and security.

### SDG 15 – LIFE ON LAND

40% of all the world's species live and breed in wetlands.

### SDG 14 – LIFE BELOW WATER

Healthy and productive oceans rely on well functioning coastal and marine wetlands.

### SDG 13 – CLIMATE ACTION

Peatlands cover only 3% of global land but store twice as much carbon as the entire world's forest biomass.

### SDG 12 – RESPONSIBLE CONSUMPTION & PRODUCTION

Wetland areas properly managed can sustainably support increased demands for water in all sectors.

### SDG 11 – SUSTAINABLE CITIES & COMMUNITIES

Urban wetlands play a vital role in making cities safe, resilient and sustainable.

### SDG 10 – REDUCED INEQUALITY

Healthy wetlands mitigate the risk to an estimated 5 billion people living with poor access to water by 2050.

### SDG 9 – INDUSTRY, INNOVATION & INFRASTRUCTURE

Healthy wetlands form a natural buffer against the increasing number of natural disasters.

### SDG 1 – NO POVERTY

More than a billion people depend on wetlands for a living.

### SDG 2 – ZERO HUNGER

Rice, grown in wetland paddies, is the staple diet of 3.5 billion people.

### SDG 3 – GOOD HEALTH & WELL BEING

Half of international tourists seek relaxation in wetland areas, especially coastal zones.

### SDG 4 – QUALITY EDUCATION

Safe water access enhances educational opportunities, especially for girls.

### SDG 5 – GENDER EQUALITY

Women play a central role in the provision, management and safeguarding of water.

### SDG 6 – CLEAN WATER & SANITATION

Almost all of the world's consumption of freshwater is drawn either directly or indirectly from wetlands.

### SDG 7 – AFFORDABLE & CLEAN ENERGY

Sustainable upstream water management can provide affordable and clean energy.

### SDG 8 – DECENT WORK & ECONOMIC GROWTH

Wetlands sustain 266 million jobs in wetland tourism and travel.



Figure 2.1. How Wetlands Support Achievement of the SDGs

Source: Ramsar Convention 2018

## 2.7. Conceptual Framework

It is conceptualized in the research that the factors of the predictor would affect the variability of the result. The conceptual framework demonstrates the impacts of urbanization operations on wetlands, the physical setting in the region of Oromiya, a situation of sululta wetland. Among the variables that influence the wetland ecosystem the main and most observed during the study are; agricultural operations, building public infrastructure and building housing buildings.

In this research, soil erosion has been caused by agricultural operations on wetlands such as land reclamation and transformation of wetlands to agricultural land, thus affecting the physical part of the setting that is soil cover. Furthermore, according to Abila (2005), the use of Agrochemicals such as fertilizers and pesticides also affects the water resource attribute of the physical environment.

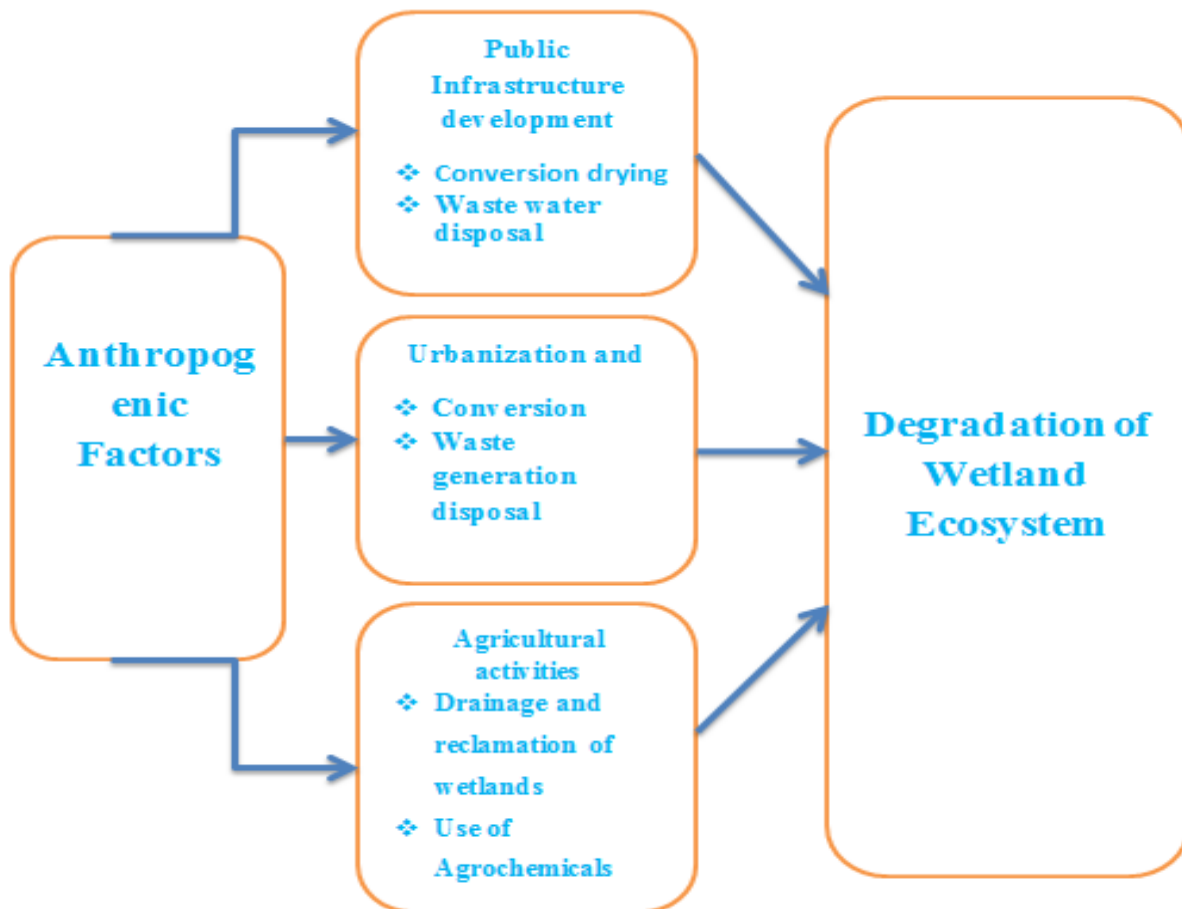


Figure 2.2: Conceptual framework  
Source Developed by Researcher 2020

## CHAPTER THREE

### THE STUDY AREA AND RESEARCH METHODOLOGY

#### 3.1. Description of the Study Area

##### 3.1.1. Location

This study was carried in Sululta area in the Surrounding Addis Ababa, Special Zone of Oromia. The study area is located approximately 23 km from the capital city of Addis Ababa (Ethiopian capital). The study area has 42,459 inhabitants and an area of 4588.3 ha. Located  $09^{\circ} 17' 84''$  N Latitude &  $38^{\circ} 75' 79''$  East Length. As historical and elderly peoples' sources show Sululta inaugurated in 1929 by Italian fishiest. Sululta has been expanding its size since its establishment (became under reform) by adding the surrounding periphery areas (Lamessa, 2017).

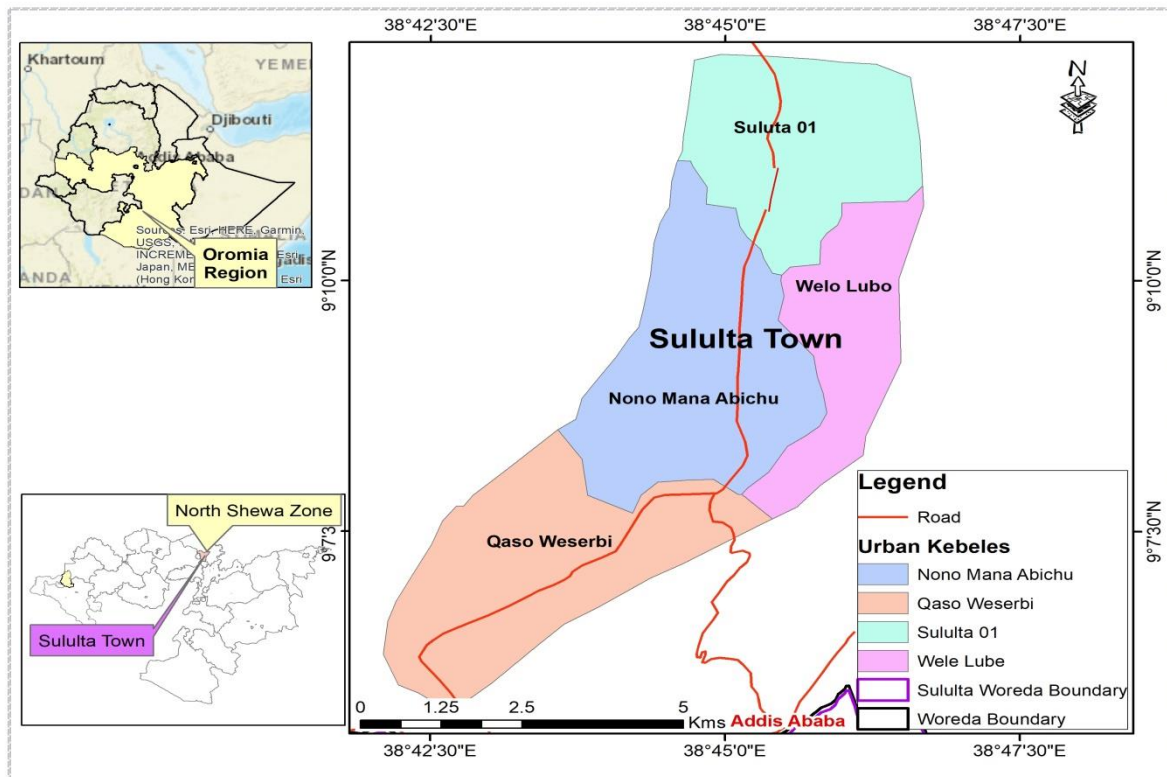


Figure 3.1. Location Map of the study area (from GIS).

**Source:** survey data, 2020

### **3.1.2. Climate**

The monthly and annual temperature data is found from National Meteorology Service Agency obtained from 2004 to 2019. The analysis of mean monthly and mean average annual temperature of the town shows that the town has experienced a cold temperature that can be categorized in the temperate climatic zone. Sululta town area is categorized under the thermal zone range of less than 10-20<sup>0</sup>C, which is cool temperature sensation. Thermal zones are mainly based on the relationship between altitude and temperature and hence are function of altitude. Thus, the mean average annual temperature of the town (14.3<sup>0</sup>C) is closer to the cool temperature sensation category. Therefore, Sululta Town has a cool temperature that to a lesser extent needs room heating intervention whenever the temperature tends to fall below 10<sup>0</sup>C (National Meteorological Agency).

### **3.1.3. Rain fall**

Sululta town gets rainfall almost throughout a year. The pattern of rainfall varies on monthly basis throughout the year. The average monthly rainfall ranges from 3.4 mm in the month of December up to 332.7 mm in the month of July. From 2004 to 2019, the town has got average annual rainfall of 1232.3mm which enables the town to be categorized under big rainfall places of the country. Heavy rain is received in summer (June to August) and light rain is in spring season (National Meteorological Agency).

### **3.1.4. Geology and Soils**

#### **3.1.4.1. Geology**

The geological setting of the study area is generally classified in to two major groups; namely, Tertiary Volcanic (Plateau Basalts) and Quaternary units (Rift Volcanic and Sediments). The classification is based on age of eruptions, spatial distribution, and mode of occurrence. Tertiary Plateau Basalts are part of the Trap-Series volcanic products consisting huge accumulation of basaltic rocks with minor silica intercalations, whereas the Quaternary Rift Volcanic and sediments comprise variety of rock units (both acidic and basic) associated to the formation of the Main Rift System during the Quaternary Period. However, each of them has subdivisions; whereby Tertiary Volcanic (Plateau Basalts) consists of Aiba Basalt, Alaji Basalt and Chancho

Basalt on the other hand Quaternary units (Rift Volcanic and Sediments) comprises Adama Group and Entoto Silicics (Merga, 2012).

#### **3.1.4.2. Soils**

Soils are the world's natural resource and a soil map is a spatial representation of these resources. Therefore, soil map is fundamental and should be the starting point when planning every type of land use. In the study area there are four major types of soil which are stated below. Cambisols are soils with initial stage of soil formation or weakly developed soils relating to their parent material. Beginning transformation of soil material is evident from weak, mostly brownish discoloration and/or structure formation below the surface horizon. The cambisol in the study area is found distributive in limited places. The soil texture is loamy to clay and identified on undulating to rolling plateaus in the study area with stony phase and limited in depth (Negassa.2017).

Leptosols are soils with an incomplete solum and/or without clearly expressed morphological features. They are particularly common in hilly to mountainous area of the southern fringe of the study area and it covers a small proportion of the area. Luvisols are soils whose dominant characteristic is a marked textural differentiation within the soil profile, with the surface horizon being depleted of clay and with accumulation of clay in a subsurface. Normally, it is not present as individual particles but is clustered to aggregates that consist wholly of clay or of a mixture of clay and other mineral and/or organic soil material. Luvisols have typically a brown to dark brown surface horizon over a reddish brown to strong brown. As you can observe from the map the large proportion of the study area is occupied by this type of soil particularly the central part of the Town where the existing built up area is lied. Vertisols are soils having, after the upper 20 cm have been mixed, 30 percent or clay in all horizons to a depth of at least 50 cm. In the study area vertisols are found almost to the southeastern direction associated with Luvisol and Leptosol (Merga; 2012)

#### **3.1.5. Drainage System and Wetland**

The major drainage pattern in the study area is associated with streams and rivers, in which the streams tend to form from two major rivers in the area. These are Dima, and Billo rivers, as most areas is flat and the rivers transient through it are narrow in width and shallow in depth, they are

over flooded. In addition, they also filled with wastes discharged into it by different units. These in turn aggravated the river pollution and unpleasant odor that prohibited the dwellers to get the benefits that the resource gives (Merga, 2012).

### **3.1.6. Socioeconomic Activities**

Agriculture & dairy farming, trade, and commerce are the main economic activity in the study area. Dairy farming is a major household occupation among those engaged in farming. This is because the area is filled with grass, which is the main source of animal feed in the region for crop production due to water logging problems. It is the leading sub-sector in terms of employment, food security, revenue, and overall contribution to people's socioeconomic wellbeing. For their livelihood, the majority of the people in the region rely on the agricultural sector, with 14,249 directly or indirectly working in the sector and contributing 37.5 percent of the area's population revenue (Merga, 2012).

#### **3.1.6.1. Basic Social Services of the Town**

There is strong evidence that provision of early childhood education through pre-school institutions plays a positive role on the future learning potential of children. According to data from Sululta Town education Office, (2018), non-governmental organizations, communities, private institutions and confidence-based organizations are the operators of pre-primary education programs. Hence, there are 37 kindergartens, which were owned by private entity and about 4,262 total students enrolled with these 37KGs (Gizachew, 2019).

Accordingly, in 2018, primary level -education in Sululta town was being provided by 35 schools, of which 18 schools were first cycle (1-4) and the remaining 17 were second cycle (5-8). With regard to ownership out of these schools most of the schools (26) were privately owned, and the remaining 9 were owned by governmental body and totally 12,409 students enrolled with these 35 primary schools. This shows higher participation of private owners in the town.

The First and Second cycle secondary educational service in Sululta in year 2018 was being provided by two institutions situated in one compound. Both were owned by government body and have no separate physical setting. That is to say, there is no separate secondary and preparatory schools in the town. With regard to enrollment at secondary level in year 2015, the

number of students enrolled in the first cycle (9-10) and second cycle (11-12) secondary schools totaled some 1,670 and 233 students, respectively. Totally, there were 1903 students in the secondary and preparatory school (Gizachew, 2019).

### **3.1.6.2. Economic Base of the Town**

Sululta town is one of the town of Oromia regions, which are found in Finfinne surrounding special zone of Oromia. This town is located on the main road that takes from Addis Ababa to Fitcha. Its proximity to Addis-Ababa town gives her best advantage. Sululta town is also found on the road that takes to Darban cement factory and this gave the best advantage for Sululta town to enhance their income for different households in the town. Not only has its proximity to capital town of the zone but also its location found near Entoto Mountain and its forest coverage is best economic advantage for the town. The basic economic activities of the town include: Livestock and Livestock products, Manufacturing, Agro-industry, Water production, Trade and commerce, Construction materials like quarry, Agriculture like crop production. In general, in Sululta town crops, Pulses and at minimum oil seeds are found. Even though the town earns revenue from other economic activities, the major economic base of the town is trade and commerce (Gizachew, 2019).

### **3.1.6.3. Ecosystem Services**

Ecosystem Services is the mechanism by which the ecosystem provides resources that we often take for granted, such as clean water, forest and wildlife habitat and native and agricultural field pollination. If we are in the town or rural areas, the environment in which people live offers products and services that are very familiar to us in this way. Here, the services an ecosystem can provide are designed to moderate extreme weather and its effects, disperse seeds, mitigate drought and floods, and protect people from the harmful ultraviolet rays of the sun. It was also help to cycle and move nutrients, protect streams and rivers against erosion, detoxify and decompose waste and control agricultural pests. It also creates and retains soils and renews fertility, contributes to climate stability, purifies the air and water, and pollinates crops and forest (Gizachew, 2019).

#### 3.1.6.4. Population Size and Distribution

In terms of population, Sululta Town is one of the fastest growing towns in Oromia. While it is a challenge to obtain demographic data in the Oromia Special Zone in general and Sululta area, according to the second and third national censuses carried out in 1994 and 2007, the population size of Sululta was 1,271 and 6,407, respectively. These two censuses are deceptive and cannot reflect the present situation (only concentrated as one kebele on Sululta. Unlike most urban areas in the region, the demographic feature in towns around Finfinne has unique characteristics. The only data integrating all the localities incorporated under /Ganda/ town administration is that of the 2016 town profile.

Taking this data issue into account, the analysis partly relies on the two population censuses and town profile / survey performed by town administration in 2016, and projections based on past patterns. The urban population size of Sululta town was counted as 37,988 in 2014, according to the survey. Based on this figure, an attempt has been made to estimate the population size of Sululta, and thus the town's current (2020) population size is estimated to be close to 42,459 (CSA, 2010).



Figure 3.2: Population Size and Distribution

Source: Based on CSA, 2010

#### 3.1.7. Land Use Plan of the Study Area

Land use plan is an important aspect of modeling and understanding the earth as a system and is a key input for planning and management activities. According to Sululta Socio Economic Profile, 2016, the study area is characterized by livestock grassland with 33.1percent of households engaged in agriculture which is dominantly dairy farm endowed in livestock grass.

Besides the open grassland and cultivated lands, the mainland-cover types are flower farm, plantation forest and woodland forests surrounding “Entoto” mountain. However, the trend is rapidly changing towards legal and illegal urban expansion. The area under settlements is expanding very rapidly on peri urban agricultural land due to residences, industry, social services, green area, urban Agriculture and transport and terminal. Looking all the existing non-agricultural use, residence is a visible major urban land use. The existing green area is unique, all the different types of greens like urban agriculture, grazing land and protective forest available in within the boundary of the study area. Generally, the existing land use and percentage is shown in the map and figure 3.2.

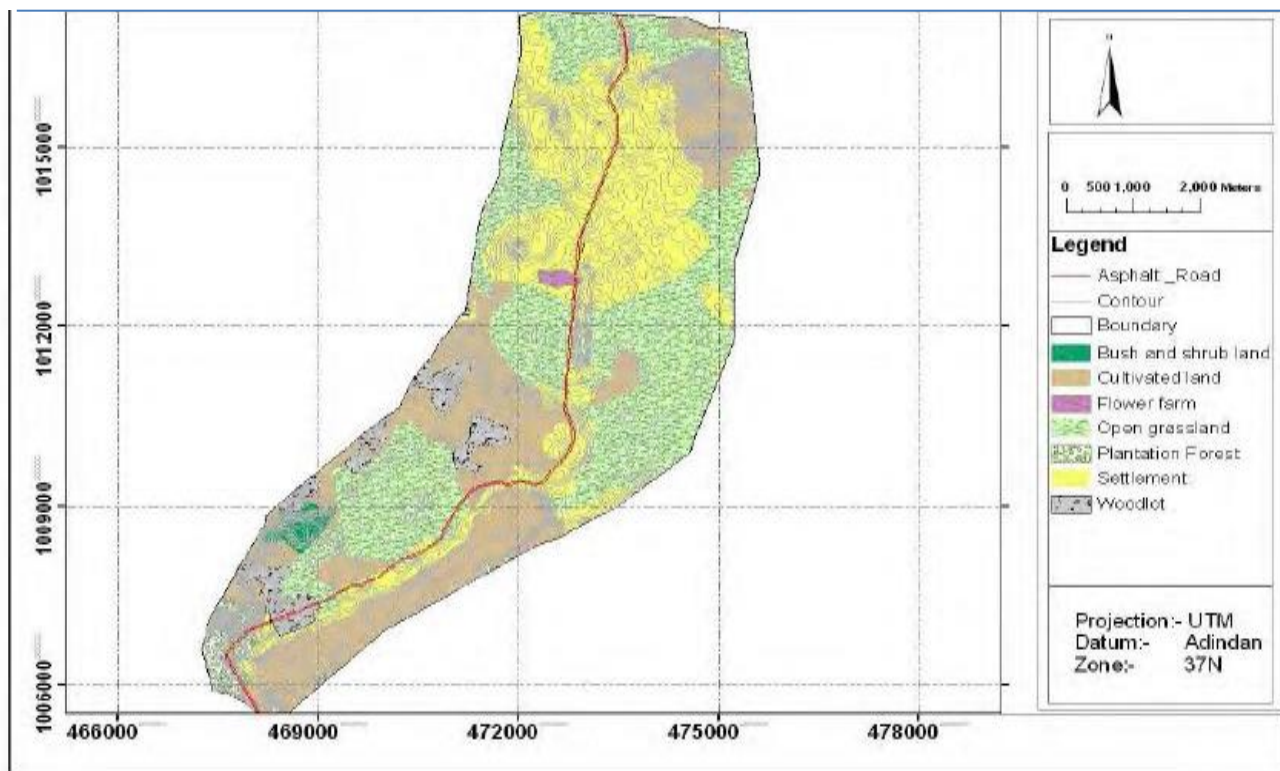


Figure 3.3: Components of The land use plan of the study area

Source: Merga (2012)

Table.3.1. Existing land use classification and its distribution

| Land Use Land Cover Class | 1986   |            | 2000   |            | 2020 |            |
|---------------------------|--------|------------|--------|------------|------|------------|
|                           | Ha     | Percentage | Ha     | Percentage | Ha   | Percentage |
| Wetlands                  | 1506.2 | 32.8       | 1206.6 | 26.3       | 663  | 14.5       |
| Forest                    | 2286.1 | 49.8       | 1020.5 | 22.2       | 582  | 12.7       |
| Urban Settlement          | 24.1   | 0.5        | 52     | 1.1        | 597  | 13         |
| Cultivated land           | 662.9  | 14.4       | 2142.1 | 46.7       | 787  | 17.2       |
| Bare Land                 | 109    | 2.4        | 167.1  | 3.6        | 1959 | 42.7       |
| Total Area                | 4588   | 100        | 4588   | 100        | 4588 | 100        |

**Source:** Survey data, 2020

### 3.2. Research Approaches

This study employed mixed research approach; it embraces both qualitative and quantitative Approaches. That means mixed approach involves collecting and analyzing diverse types of data to comprehensively understand a research problem (Creswell 2003).

### 3.3. Research Design

The study was used research models that are both descriptive and explorative. The study used descriptive research design to describe the state of affairs during the study period, while explorative examine the effects of anthropogenic activities on wetland ecosystem and its services through LULC. (Creswell, 2003). A cross sectional survey design was also used in this study. The study design was chosen because it is well suited to the goal of describing variables and their distribution patterns and it allows data to be collected at a single point in time. Therefore the design is economic in nature; and it is suitable in situations where time is limited (Hulley *et al.*, 2013).

### 3.4. Type and Sources of Data

#### 3.4.1. Primary Data

In the first place, primary source of data important for the investigation of both the land use land cover changes in time series due to anthropogenic factors taking place in Sululta, which includes the four kebeles . For this purpose satellite image of 1986, 2000 and 2020 used. Latest Google Earth imageries are used due to the study area has small area and possible to digitizing and TM Landsat of the study area hadn't high resolution image. The primary data

were gathered through field survey in four kebeles of the study area. The data were also gathered from different target informants who are purposely-selected elders, kebele administrators, sectorial officials and administrators.

### **3.4.2. Secondary Data**

Secondary data sources have abundantly been used for the study. Books, journals and articles, internet resources are widely been utilized. Literature and policy review and archival analysis also conducted in the form of desk research. Secondary data was collected from the official documents of the sululta Town administration and Oromyia housing and urban planning offices on information pertaining to land-use plans, development plans and general profile of the Town proper and the surrounding fringe settlements. Qualitative and quantitative data sources are triangulated in order to confirm information gap of one by the other.

## **3.5. Sampling Design**

### **3.5.1. Population of the study**

According to survey conducted by CSA in 2010, and estimates made based on the past trends, the current total populations of Sululta town are about 42,459. The target populations for this study were 396 respondents drawn from the total populations through stratified simple random sampling techniques from four stratum.

### **3.5.2. Target population**

The target population for this study was drawn from the people who live in the four kebeles of Sululta. Based on CSA, 2010 data the total households of Sululta are about 19,873. The target populations for this study were 392 respondents drawn from the total household through stratified simple random sampling techniques from four kebeles.

### **3.5.3. Sampling Techniques**

It was difficult to include the entire population or households of the selected kebeles in this study area due to time and budget constraints. Therefore, the researcher took representative samples of the four kebeles to get representative households. The researcher used both probability and non-probability sampling techniques. From the probability sampling, stratified simple random sampling was used for sampling households from different kebeles through lottery method. Additionally, from

non-probability sampling, purposive sampling was selected to involve the sample elements directly as they have reliable information that was required for the study.

### 3.5.4. Sample size determination

Based on the information predicted by (CSA, 2010), the total household of sululta as of 2020 is 19,873. Sululta is divided into four kebeles, namely: Sululta 01, Kasowes, Nonomen and Walelube, with a population of 14,256, 12,388, 9,528 and 6,287, respectively. However, those all 42,459 were the population of this study. To select the respondent households in the selected Kebeles the researcher used a stratified simple random sampling technique. The sample size was calculated using the following formula developed by (Yamane, 1967) with 95 percent confidence level.

$$n = \frac{N}{1+N(e)^2}$$

Where;

N= Population size, which equals, 459

n= Sample size

e= Margin of errors/error margin, i.e., 0.05 (95 Percent)

$$n = \frac{19,873}{1+19,873(0.05)^2}$$

$$n = \frac{19,873}{1+19,873(0.05)^2}$$

$$n = \frac{19,873}{1+49.7}$$

$$n=392$$

Therefore, the total sample size was 392

To calculate the sample size for each kebele, first, the researcher calculates percentage value for each Kebeles calculated based on the following formula;

$$X = \frac{ni}{N} * n$$

Table 3.2.Required sample size determination of each kebele

| Name of kebeles  | No. of houses holds populations in each kebele (Ni) | Percentage | Required sample size of each Kebele | Sampling techniques               |
|------------------|-----------------------------------------------------|------------|-------------------------------------|-----------------------------------|
| Sululta 01       | 6,558                                               | 33         | $6558/19,873 \times 392 = 129$      | Stratified simple random sampling |
| Kaso wesrbi      | 5,763                                               | 29         | $5,763/19,873 \times 392 = 114$     |                                   |
| Nono Mene Abichu | 4,571                                               | 23         | $4,571/19,873 \times 392 = 90$      |                                   |
| Wale Lube        | 2,981                                               | 15         | $2,981/19,873 \times 392 = 59$      |                                   |
| Total            | 19,873                                              | 100        | 392                                 |                                   |

**Source:** survey data, 2020

### 3.6. Tools of Data Collection

To investigate the issue in detail, the study was employed both qualitative and quantitative data were collected. The quantitative data were gathered using questionnaires and qualitative data was collected through observation and interview.

#### 3.6.1. Survey Questionnaire

The primary data collected through a survey questionnaire. Before filling the questionnaire, each respondent offers a permission document to read and register, and written instructions provided. The questions designed to be answered with a five-point Likert scale about anthropogenic influence on wetland and its services using a scale ranging from 1= strongly disagree to 5= strongly agree.

#### 3.6.2. Key Informant Interview

The key informant interview was employed for the purpose of qualitative data. Thirteen Key informant interviews were conducted from local peoples, wereda experts and kebele DAs which accounts four DAs, four elder local people and five experts from Woreda agricultural offices.

### **3.6.3. Observation**

Observation was employed to cross check the data found from different sources and the reality. This method is one way of collecting the qualitative data by gathering first- hand data from concerned bodies and farmers“ who lives in the study area and it is also good for collecting and taking photographs in the form of observation checklists.

## **3.7. Methods for LULC change detection Analysis**

### **3.7.1. Acquiring Image**

The Landsat TM (1986) medium resolution (30 m resolution) and Landsat 7 ETM + (2000) medium resolution - blue, green, red and near infrared (30 m resolution) and panchromatic (grey scale 15m) from Earth Explorer server were used for the classification of LULC in 1986 and 2000 respectively. The 2020 Geo eye Imagery (very high- 1m resolution) obtained from Google server was used to classify the 2020 LULC change of the study area. FCC composition of was derived from blue, green, red and near infrared (30 m resolution) and panchromatic (grey scale 15m) were used for classification of LULC image in1986 and 2000. While TCC of the 2020 imagery was derived from BRG bands.

Visual Interpretation and supervised classification were applied to classify the images into LULC classes listed above using Arc GIS ver 17.1). The year 1986 was chosen as a baseline reference year because it represents the pre-revolutionary period (i.e., the Feudal regime). The year 2000 selected to represent a year after land registration and policy was drawn, and 2020 represent simply the latest year of our observation. Based on GPS points in the field and the very resolution imagery (1m) of the area, the level accuracy (the degree of agreement between the GPS data and the same sample points spotted on the high resolution imagery) was determined using Kappa index and confusion matrix (Lillisand and Kiefer, 2000). During the study to analyze the satellite image; image analysis of ERDAS version 13, ArcGIS software, Microsoft word and excel were used for better adjustment.

### **3.7.2. Image processing and classification**

Computer assisted digital image processing was conducted to extract information that involves image classification and accuracy assessment. Before the image actually classified, Image

preprocessing was performed. Image pre-processing is the initial processing of the raw data and normally involves processes like geometric corrections, image enhancement, noise removal and topographic corrections. Geometric and radiometric errors were corrected for each satellite image. After error correction, image enhancement was done to improve the visual interpretation. Band combination and NDVI were the major image enhancement method used in this study. Band combination of 4,3,2 false color combination of band red, green, and blue, respectively was converted to 3,2,1 true color combination with a similar color order as specified above to interpret the image properly. Both supervised and unsupervised digital image classifications were employed to detect the land use, land cover changes in Arc GIS were used with the help of online Google Earth. Five land use types were considered which are wetland, settlement, cultivated land, vegetated land and bare land, to detect wetland change dynamically over time.

Table 3.3. Assigned land use and land use classes' analysis

| s/n | LULC class       | Description                                                                                                                                                                              |
|-----|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Wetland          | Those areas where the water table is at, near, or above the land surface for a significant part of most years. E.g. Marshes, Mudflats, and swamps                                        |
| 2   | Urban Settlement | Urban areas and permanent residential areas of varied pattern, for example, cities, s, villages, strip developments along highways, transportation, power, and communications facilities |
| 3   | Cultivated land  | Areas of land used for growing crops, including homestead                                                                                                                                |
| 4   | Forest           | Refer to all plants and trees collectively, typically those in a specific area                                                                                                           |
| 5   | Bare land        | Sloppy rocks and bare lands either due to overgrazing and erosion                                                                                                                        |

**Source:** survey data, 2020

### 3.7.2.1. Supervised Classification

A person supervises the classifier by first identifying small sample areas of the desired land cover classes. The classifier then compares each sample to the training classes and allocates the sample of the most similar class. Supervised classification can be used to cluster pixels in a data set in to classes corresponding to user defined training classes. This classification type requires that researcher select training area for use as the basis for classification. Various comparison methods are then used to determine if a specific pixel qualifies as a class member. In order to

identify the class features of the images, due to the visibility of the image and the study area is small, manual digitization techniques has been applied.

### **3.7.2.2. Post Classification**

#### **A. Accuracy Assessment**

Usually, the term accuracy is used in thematic analysis of remotely sensed data to describe the degree of validity of a map or classification. A thematic map resulting from a designation can be considered correct because it presents an objective depiction of the land cover of the area it portrays (Foody, 2002). This is thus used to determine and/or quantify how many ground reality Geo-spatial groups have been correctly classified. The accuracy evaluation of post-classification contrast shift identification is performed through different phases. The basic steps include: deciding the total number of samples to be obtained for each category; planning a appropriate sampling scheme (traditional or Geo statistical); collecting field reference information at sample locations; generating an error matrix; and analyzing the error matrix.

#### **B. Confusion Error Matrix/ Classification Error Matrix**

Literatures show that in the assessment of the precision of remote sensing data classification there are several approaches for accuracy measurement. The most commonly marketed and used would come from a matrix of uncertainty or mistake (Foody, 2002). In fact, the uncertainty equation is actually at the core of the literature on accuracy evaluation. It offers an clear framework for an accuracy evaluation as a basic cross-tabulation of the marked class mark to that found in the field or reference data for a collection of cases at different locations (Foody, 2002).

The confusion error matrixes were used to compare the relation between the known reference data (ground truth) and the classification results. The uncertainty index includes different metrics of classification consistency evaluation. According to Foody, the percentage of cases correctly assigned is among the most common. This is an easy to interpret guide on the overall classification accuracy. If emphasis is centered on the consistency of the individual classes, then the percentage of cases correctly allocated can be calculated from the uncertainty equation by comparing the number of cases correctly allocated to the class to the total number of cases in that class. The most commonly used methods of measuring include; average precision, accuracy of the consumer and accuracy of the manufacturer.

**Overall Accuracy:** The overall accuracy is determined by summing the number of pixels correctly identified and dividing by the total pixel count. The picture of ground truth, or field of ground truth, determines the real pixel type. The correctly classified pixels are located along the misunderstanding matrix table diagonal which lists the number of pixels that have been categorized into the correct ground truth class. The total pixel count is the sum of all the pixels in all the classes of ground truth.

**Producer accuracy:** The producer accuracy showing the likelihood that an image pixel has been identified by the classifier in the sample area, given the ground truth of the sample region.

**User accuracy:** User accuracy is a measure that indicates the likelihood of a pixel being a sample class since the classifier has labeled the pixel as a sample.

**Kappa Coefficient/Statistic:** The Kappa coefficient reflects the proportion of agreement achieved after eliminating the proportion of agreement which might be predicted to happen by chance (Foody, 2002). That will be measured in terms of the proportion of good, reasonable and weak agreement, i.e. a value of > 0.80 (80%) good agreement; a value of between 0.40 to 0.80 (40 to 80%) is a reasonable agreement; and a value of < 0.40 (40%) is a weak agreement.

The kappa coefficient is determined by multiplying the total number of pixels in all ground truth groups (N) by the sum of the uncertainty matrix diagonals ( $\sum_k x_{kk}$ ), by subtracting the amount of ground truth pixels in a class time the amount of graded pixels in that class multiplied over all groups and by dividing the total number of pixels squared from the sum of ground truth pixel.

$$K = \frac{N \sum_k x_{kk} - \sum_k x_{k\cdot} x_{\cdot k}}{N^2 - \sum_k x_{k\cdot} x_{\cdot k}}$$

$$K = \left\{ \frac{N \times \text{observed accuracy} - \text{Chance Agreement}}{N^2 - \text{Chance agreement}} \right\}$$

The error matrix (confusion matrix) was generated based on field data and Google Earth map that were not used for classification purposes. This matrix is a comparison of the relationship between known reference data (ground truth) and the classification results.

Table 3.4. Overall Accuracy assessment

| Ground truth      | Land use/Land cover (Field Observed) |            |           |          |            | Total | Users Accuracy percentage |
|-------------------|--------------------------------------|------------|-----------|----------|------------|-------|---------------------------|
| Class Name        | Wetland                              | Vegetation | Bare land | Cropland | Settlement |       |                           |
| Wetland           | 15                                   | 0          | 2         | 1        | 0          | 18    | 83.3                      |
| Vegetation        | 1                                    | 18         | 1         | 0        | 1          | 21    | 85.7                      |
| Bare land         | 0                                    | 1          | 8         | 0        | 0          | 9     | 88.8                      |
| Cropland          | 0                                    | 1          | 3         | 16       | 0          | 20    | 80                        |
| Settlement        | 0                                    | 0          | 1         | 0        | 15         | 16    | 93.75                     |
| Total             | 16                                   | 20         | 15        | 17       | 16         | 84    |                           |
| Producer Accuracy | 93.8                                 | 90         | 53.3      | 94.1     | 93.8       |       |                           |

**Source:** Survey data, 2020

Overall Accuracy (%) = 85.7

**Kappa Statistics** = 0.878

The accuracy assessment in table 3.5, revealed that the average consistency rating is very good, i.e. 85.7 percent, which is higher than the criterion for a reasonably appropriate classification, i.e. 84 percent (Anderson, 1997). Also measured for each land class was the consumers and producer's accuracy assessment, which suggested appropriate agreement. The kappa hat value of 0.878 indicates a better accuracy than the random sample classification resulting from it. Since the value of the kappa has fallen past 80%, it reflects good consensus.

### 3.7.3. Visualization

The most important LULC changes that have occurred in the sululta over the study period from the year 1986 to 2000 were first analyzed by visual interpretation. The visual interpretation can

give a general idea about the LULC changes over the time of 34 years. Using the Landsat satellite image's natural and false color (Figure 4.3) composite images were generated. True and false color composites were chosen as a very simple but very useful technique for visually extracting information from Landsat satellite images and obtaining a general overview of LULC improvements in the field of analysis. Band 3 (red), band 2 (green), and band 1 (blue) were used to create a standard composite color for the Landsat TM and ETM+ info. Landsat MSS data do not have a blue band, and they cannot be used to construct a true natural composite color. However, the normal color composite can be simulated. For the Landsat MSS, the simulated normal color composite can be created using the following formula: Red=MSS2, Green= $(MSS1*3 + MSS2) / 4$  and Blue=MSS1 (Multi-spectral sensor).

The TCC of the 2020 imagery was derived from BRG bands. Visual Interpretation and supervised classification was applied to classify the images into LULC classes listed above using Arc GIS ver 10.1) based on GPS points in the field and the very resolution imagery (1m) of the area, the level accuracy (the degree of agreement between the GPS data and the same sample points spotted on the high resolution imagery) was determined using Kappa index and confusion matrix (Lillisand and Kiefer, 2000). Different color composite images were prepared, in order to select the best band combination, that enhance the raw satellite images for the identification of the different land cover classes in the study area. In this research project the false color composite image made using Land sat TM Land sat 7 ETM bands and Geo eye Google earth were found to be best for the identification of major land cover classes in the study area.

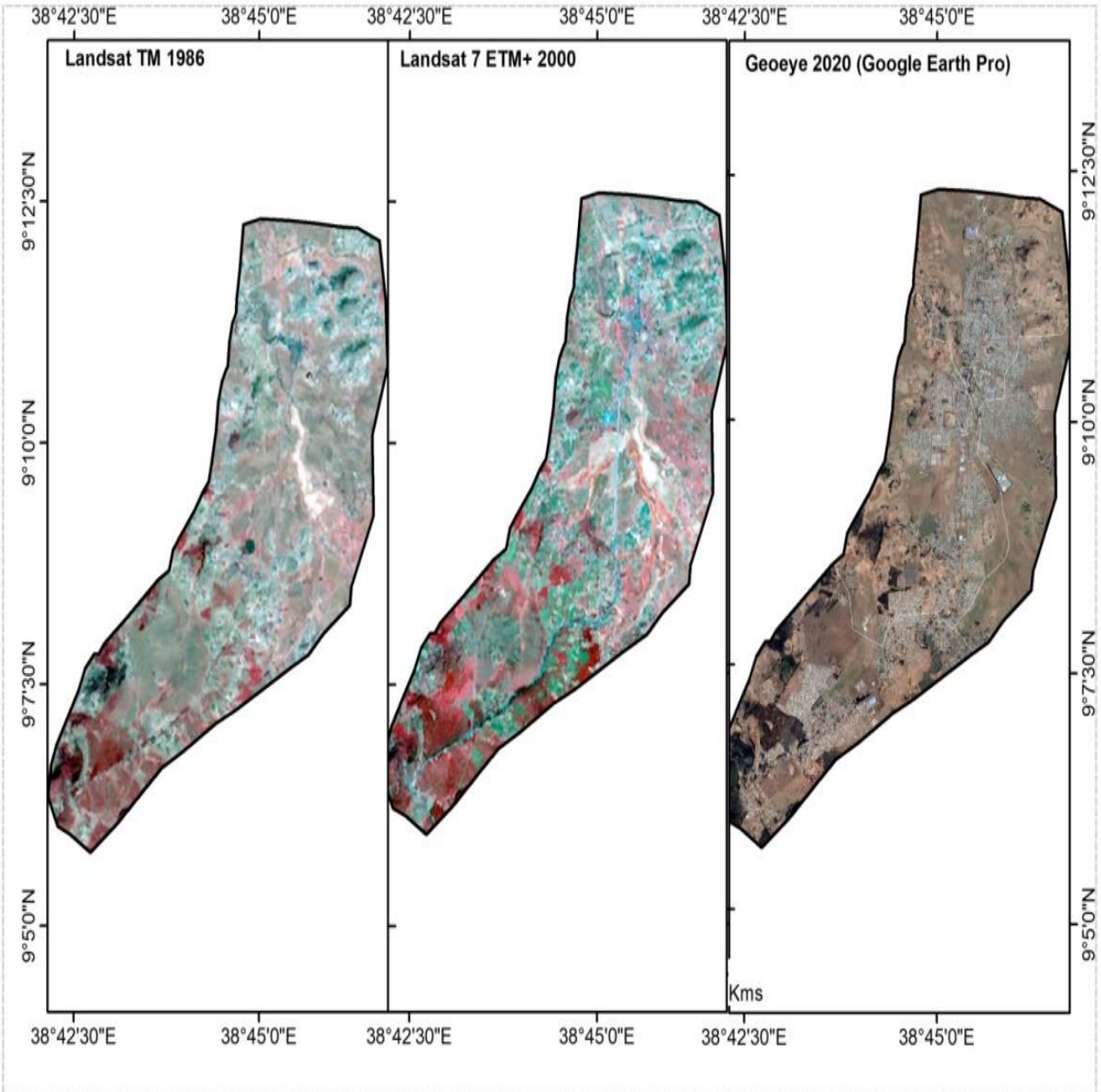


Figure 3.4. False Color Composite satellite image

Source: Survey data, 2020

### **3.8. Methods for Data Analysis and Presentation of survey data**

#### **3.8.1. Data Analysis**

A combination of both quantitative and qualitative data analysis approaches employed. The survey data analyzed and interpreted using descriptive statistics such as mean, standard deviation, frequency distribution and percentage. While, the qualitative data obtained through key informant interview and field observation checklist were analysed using thematic and narrative approaches.

#### **3.8.2. Data Validity**

Validity is the degree to which the difference with the measuring instrument reflects the true differences between those tested. To ensure the quality of the content of the research design was checked and the validity of the research constructs. A pilot study was conducted to refine the methodology and test instrument such as a questionnaire before administering the final phase. Questionnaires were tested on potential respondents to make the data collecting instruments objective, relevant, suitable to the problem and reliable as recommended by John Adams et al. (2007:136). Issues raised by respondents were corrected and questionnaires were refined. Besides, proper detection by an advisor was also take to ensure validity of the instruments. Finally, the improved version of the questionnaires was printed, duplicate and dispatches.

#### **3.8.3. Data Reliability**

A reliability analyses was conducted to each variable of the instrument. The reliability of the measures is to examine the effects of anthropogenic activities on wetland ecosystem in sululta. In order to catch important information that might be wasted either during field survey and document analysis and/or in order to validate the information that could be one-sided (biased), triangulation method was used between both the quantitative and qualitative source of information in order to increases confidence in research data , creating innovative ways of understanding a phenomenon, revealing unique findings, challenging or integrating theories and proved a clear understanding of the problem (Thurmond, 2001,p.254).

Triangulation is a powerful technique that facilitates validation of data through cross verification from two or more resources. Particularly in this research, it strives to control for bias so that facts, instances; phenomena can be understood in an objective way for quantitative approach. Whereas, in qualitative approach, it strives to understand the perspective of respondents or a situation by looking at firsthand experience to provide meaningful data.

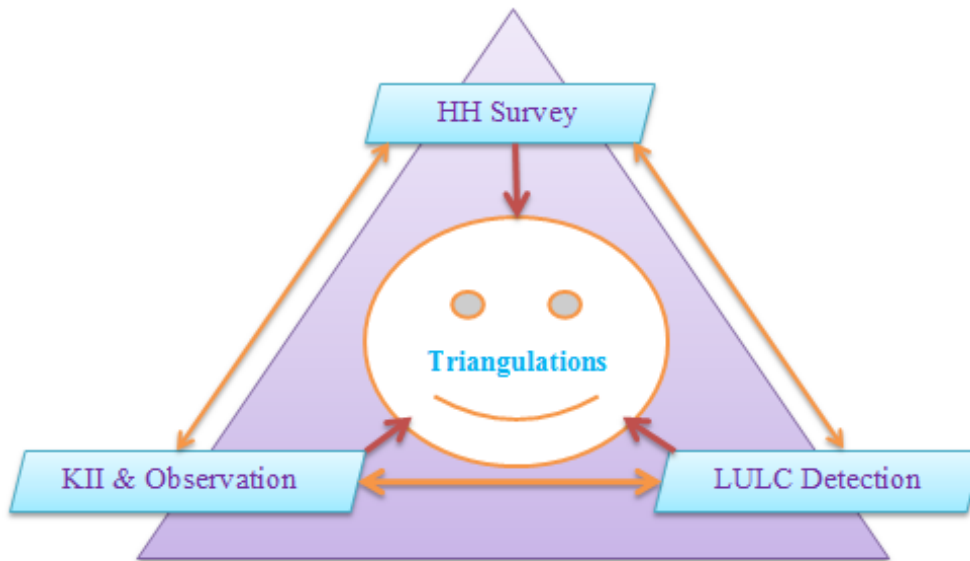


Figure: 3.5. Triangulating data sources

**Source:** Own Formulation (2020)

## CHAPTER FOUR

### DATA PRESENTATION, ANALYSIS AND DISCUSSION

#### 4.1. Socioeconomic Characteristics of the Respondents

Out of 396 questioners dispatched, 373 (94.2 percent) were filled in and returned correctly. Accordingly, demographic and socioeconomic characteristics of respondents such as gender, age, educational level, marital status, family size and occupation are presented below.

**Gender:** The majority of respondents who participated in the study were male and accounted for 291 (78percent), while the female counterparts were 82 (22percent).

**Age:** Table 4.1 below indicates that 84 (22.5percent) respondents were between 18-25 years of age, while 3 (0.8percent) respondents were between 42-49 years of age. This discovery indicates that respondents can comprehend and recognize the issue at hand wetland encroachment and eventual degradation. It can be said that most of the respondents who participated in this research were younger.

**Education:** The participants' level of education is crucial for this study as the respondents' level of education eliminates the bias of uneducated respondents. Table 4.1. The results show that 11(2.9percent) participants were not illiterate, while 10(2.7percent) were university graduates.

**Marital status:** The marriage status of the respondents used to determine whether it positively and adversely influenced their livelihood and view towards wetlands conservation and management. Table 4.1 reveals that 256 (68.6 percent) of the respondents were married, 84 (22.2 percent) of the participants were single. This indicates that many have marriage relationship and they were the individuals who were much more likely to provide information on issues surrounding wetland degradation and management issues.

Table 4.1. Demographic characteristics

| Demographic characteristics                  |                               | Frequency | Percent |
|----------------------------------------------|-------------------------------|-----------|---------|
| <b>Age of respondents</b>                    | 18-25                         | 84        | 22.5    |
|                                              | 26-33                         | 209       | 56      |
|                                              | 34-41                         | 60        | 16.1    |
|                                              | 42-49                         | 17        | 4.6     |
|                                              | Above 50                      | 3         | 0.8     |
|                                              | Total                         | 373       | 100     |
| <b>Educational background of respondents</b> | Non formal educated           | 11        | 2.9     |
|                                              | Grade 1-8 completed           | 294       | 78.8    |
|                                              | Grade 9-12 complete           | 53        | 14.2    |
|                                              | Diploma holder                | 5         | 1.3     |
|                                              | Bachelor degree holder        | 10        | 2.7     |
|                                              | Total                         | 373       | 100     |
| <b>Marital status</b>                        | Married                       | 256       | 68.6    |
|                                              | Single                        | 84        | 22.5    |
|                                              | Separated                     | 3         | 0.8     |
|                                              | Widowed                       | 30        | 8       |
|                                              | Total                         | 373       | 100     |
| <b>Respondents occupation</b>                | Government employee           | 9         | 2.4     |
|                                              | Business man                  | 20        | 5.4     |
|                                              | Firewood and charcoal selling | 35        | 9.4     |
|                                              | Mixed farming                 | 309       | 82.8    |
| <b>Family size of respondents</b>            | Less than 3                   | 126       | 33.8    |
|                                              | 4 to 6                        | 197       | 52.8    |
|                                              | Greater than 7                | 50        | 13.4    |
|                                              | Total                         | 373       | 100     |

**Source:** survey data, 2020

**Occupation:** The study sought information on the respondents' livelihood activities or economic occupation. Table 4.4 indicate that 309(82.8 percent) of the respondents were farmers and 9(2.4percent) of the respondents were government employee or civil servants. This shows that

majority of the respondents understood the study being carried out and would in turn give adequate information on how human activities influence wetlands and physical environment.

**Household size:** Family members, relatives or other people living within the household for an extended period are what represent family size. The survey result shows that the household size ranges from 1 to 7 with an average of 6 persons. Results in Table 4.1 indicate that 52 percent of the surveyed households had a size of 4-6 people. This average household size conforms to the national household size which is 4.8 (CSA, 2010). Large household size has an implication on wetland resource utilization. Having many individuals in the family is more likely to have them engaged in various wetland resource utilization such as farming, fishing and the like, which leads to an increase of the chance of degradation due to an increase in resource utilization pressure. The findings are in line with those in a study by Hatibu (2010) who indicated that large household size has an implication in resource utilization because large household size means high consumption units within the household and which can lead to more resource extraction leading to the degradation of that particular resource.

## **4.2. Community Perceptions about Wetland Values Change and Management**

### **4.2.1. Community perception about the values of wetland**

Community perception of the values of the sululta, when asked about the values of sululta wetland respondents provided a list of the values (fishing, water supply for both domestic use, grazing land & hay production, ground water recharge, recreation and extraction of medicinal plants etc.). Figure 4.1 shows the responses by the community. Pastureland for livestock feed and hay production recorded the highest percentage (49 percent) followed by ground water recharge uses (31 percent) and recreational purposes recorded the least (5 percent).

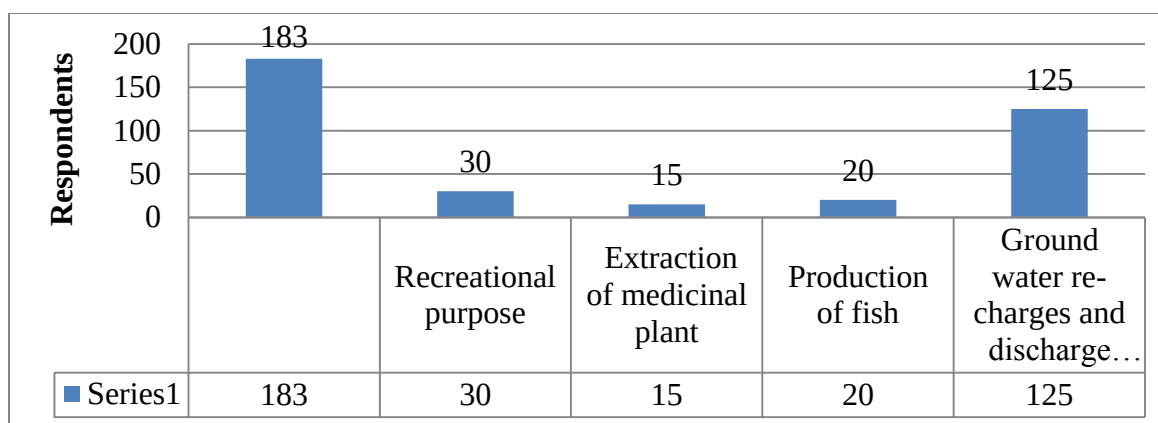


Figure 4.1. Community perceived about values of sululta wetland

**Source:** Survey data, 2020

#### 4.2.2. Community Perception about Wetland Ecosystem Change

Regarding to the wetland ecosystem change when questioned on whether there were any changes in the wetland resulting from activities taking place, about 79.4% of all respondents confirmed that there were changes, while 16.9% said there were none and 3.8% had not responded to the question. Some of the changes mentioned by the respondents include increased number of households and urbanization (53 percent) followed by public infrastructural development which accounts (21%), Agricultural practices (11 percent), poor management (8 percent) and industry development (7 percent) respectively (Table 4.2).

Table 4.2. Community Perception on Major activities affecting the wetland

| Response                                | Frequency | Percentage |
|-----------------------------------------|-----------|------------|
| Urbanization and high population growth | 198       | 53         |
| Agricultural activities                 | 40        | 11         |
| Industry development                    | 25        | 7          |
| public infrastructural expansion        | 80        | 21         |
| Poor management system                  | 30        | 8          |
| Total                                   | 373       | 100        |

**Source:** Survey data, 2020

In the course of the study the researcher came across an elderly man, one Mr. Tadesse, who is believed to be about 65 years of age. He said that the sululta wetland had really changed

from when he first settled there. According to him, industries and settlements have now replaced the wetland area and the water is no longer safe (Box one).

**Box One:**

*One of the respondents states as:*

*“The wetland was a deep and you should not be sitting here in those days. I don't know whether it dried on its own or not when people began settling in the area, but now the marsh is no longer there as you can see. It was replaced by houses since. If the river used to have clean water, you might even use it to wash or cook, but it's not very safe now. Industries are close to the stream; the water smells, and the color is not natural and clean at times. Things have really changed these days; settlements have also greatly replaced even the area used for cultivation. In fact, industries and settlements are now within the wetland and forest ’’.*

#### **4.2.3. Community Perception about the Major Cause of Urbanization**

According to the results of respondents, the major causes of urban expansion in the study area were existence of settlement or high housing demand 150 (40.2 percent), Agriculture 118 (31.6 percent) and the rest 105(28.2 percent) of respondents were said expansion of industry. The reason behind is, increasing size of population, rural urban migration, commercialization, social factors, increasing informal land market and industrialization in the peri-urban areas that result in movement of the people into the town.

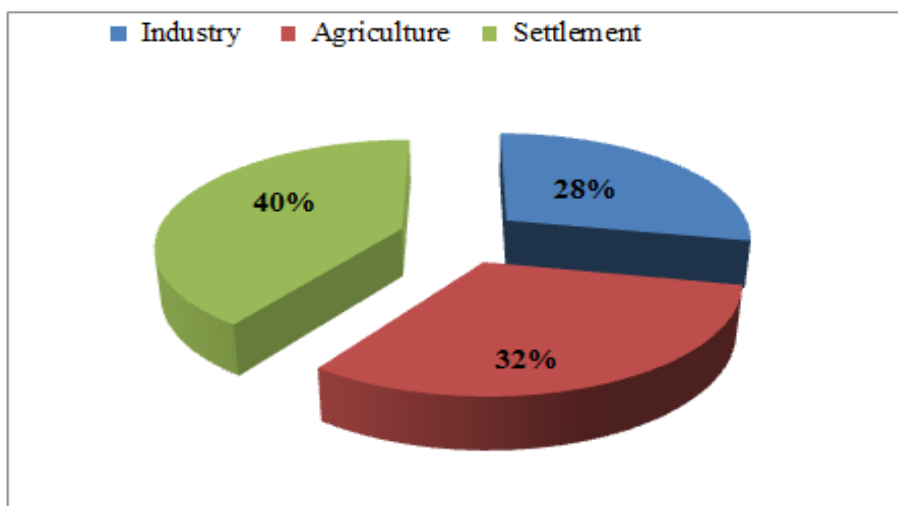


Figure 4.2: Major causes of urbanization

**Source:** Survey data, 2020

As the key informant from municipality clearly stated, the highest cause of urban expansion to the existence of high housing demand is, increasing size of population due to rural urban migration to the town for the seek of commercialization and social factors such as attraction of cities, better standard of living, better educational facilities and job opportunity and increases of informal land market in the study area. Based on these major causes, land grabbing is highly exercised due to lack of appropriate land use management in the town. Therefore, it is possible to conclude the government land use system and controlling mechanisms were not strong. In addition, this condition pushes land use changes of wetland to settlement.

#### **4.2.4. Community perception about Environmental Problems Due to Urbanization**

According to Satterth, W. (1999), the process of urbanization, which is mainly accompanied by high population growth and industrialization, resulted in the occurrence of complex interaction between people and their environment. Urbanization, which is also associated by the conversion of wetland to urban uses, the extraction and depletion of natural resources and the disposal of urban wastes, resulted in the occurrence of wetland environmental problems, which have global effect. In addition, with the absence of efficient social organization and lack of adequate infrastructures the growth of cities/town contributes to intensify environmental problems. Enhance, the recent environmental challenges arise both from the lack of development and unintended consequences of some forms of economic growth.

In the study area, the researcher observed that the fast growing urban expansion in the town lacks other basic urban services that would have gone parallel with the expansion, this in turn has resulted environmental problems in which the respondents have ranked them in terms of their challenges. The biggest problem was mentioned to be poor urban sanitation 265 (71%), 78 (20.9 percent), while the rest 30 (8.1 percent) of respondents were answered that lack of road feeder problem. This is due to inappropriate solid waste disposal; the second most difficult environmental problem was bad odor and aesthetic value disturbance.

Table 4.3. Major Environmental problems due to urbanization

| Major Environmental problems due to unplanned urban expansion | Frequency | Percentage |
|---------------------------------------------------------------|-----------|------------|
| lack of efficient drainage system                             | 78        | 20.9       |
| lack of road feeder                                           | 30        | 8.1        |
| poor urban sanitation and water pollution                     | 265       | 71         |
| Total                                                         | 373       | 100        |

**Source:** Survey data, 2020

#### 4.2.5. Community perceptions to Urban Expansion

As discussed repeatedly, the majority of the respondents were subjected to wetland degradation in the way that violates their rights and interests. Thus, it is important to analyze their feeling and reaction towards the land expropriation. According to the data gathered through survey and group diction, these feelings and reactions vary from a simple oral complaint expression to forceful physical intervention with government body and other concerned security forces. In order to fully access respondent's " feeling towards wetland degradation, I have classified the type of reactions in to three: those who strongly support those who support with conditions and those who strongly oppose. The responses of respondents are presented as 82(22 percent) of respondents Strongly Support, 203 (54.4percent) of respondents Support with conditions while the rest 88 (23.6 percent) of respondents Strongly Oppose about the issues as shown figure 4.3.

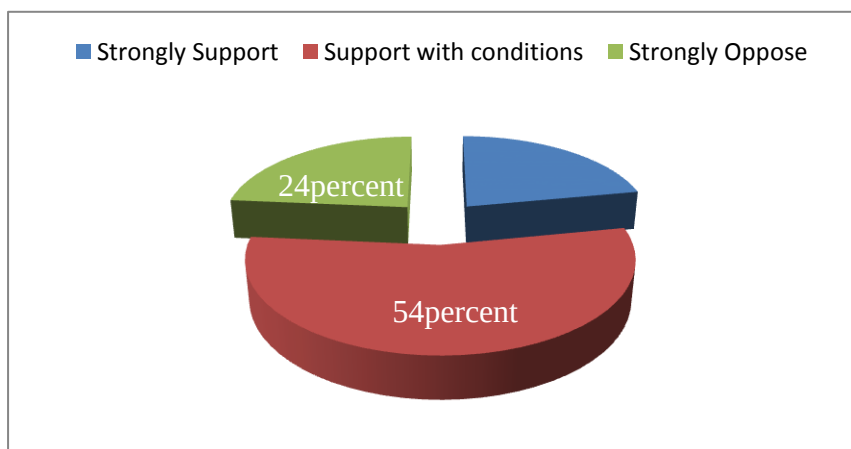


Figure 4.3: Urban expansion as a threats of wetland

**Source:** Survey data, 2020

#### 4.2.6. Community perception about Rate of Wetland Encroachments

Regarding to the wetland encroachments in the study area, respondents were asked How would you describe the rate of encroachment of wetland since you first established here and they respond that 216 (58 percent) highly encroached, 127 (34 percent) of respondents said moderately encroached while the rest 30 (8 percent) of respondents views that the wetland encroachment rate is low. This in turn implies that the rate of wetland encroachments significantly increased from time to time because of urbanization as shown figure 4.4 below.

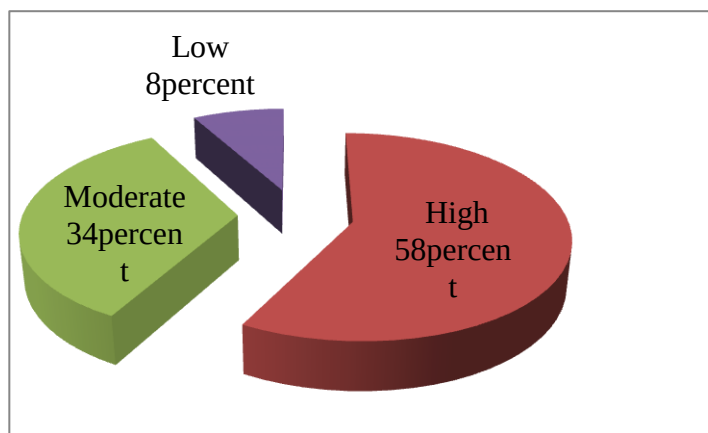


Figure 4.4 Rate of wetland encroachment

**Source:** Survey data, 2020

Regarding to the problem related to urbanization and settlement, the researcher came across a 49 years old guy and he said that currently sululta wetland had dramatically changed to settlement and as results of this so many problems rose. (Box two).

##### **Box Two:**

*“I am 49-year-old farmer living in this area. Some 15 years ago, vegetation and grasslands as well as seasonal wetlands covered much part of sululta area. However due to urban expansion and related human activities much of these natural ecosystems have changed to settlement and urban environment. As a result, wetland ecosystems, grasslands, and vegetation have severely degraded and what you see today is human-dominated landscape in the area.*”

#### **4.2.7. Community Perception towards Wetland Management**

When asked about the amounts of wetland changes, the majority of households (65 %) argued that the wetlands are converted to settlement. Approximately 15 percent, 4 percent and 10 percent of the households argued that the wetlands are changed to farmland, forestland and bare land, respectively. Additionally, 6 percent of the households were give evidence that the wetlands are converted to infrastructural development industry and the like.

When asked about the value of conserving wetlands, the majority of households (60 percent) of the respondents preferred the wetlands to be converted to farmlands. Approximately 9 and 11 percent of the households argued that the wetlands to be the forested and communal grazing lands, respectively. Additionally, 5 percent of the respondents of the households were interested in the wetlands to be investment areas like bottling companies. Yet, 15 percent of the respondents of the households replied the wetlands no to be changed into any other land use. This implies that only 15 percent of respondents were in a position to restoring and protecting wetlands rather converting them mainly to agricultural lands, and urbanization.

Additionally, the KIs, participants in local peoples and experts were asked about the management aspects (conservational activities being performed in/around and/or in their catchments) of the wetlands. The majority of the KIs replied no particularly those respondents from urban and forested wetlands. Meaning, there was no any kind of activities done so far for restoring and protecting wetlands. However, the minors mainly from agricultural wetlands responded as some physical and biological conservation measures (bunds, check dams, and plantations) were done around wetlands/in their catchments. Similarly, the experts reported that there was no any conservation measure done in all wetland types except in some catchments of agricultural wetlands.

#### **4.3. The Effects of Anthropogenic Activities on Wetland Ecosystem**

The interaction between human beings and the environment is the driving force behind ecosystem changes over time. Thus, an increase in an area's population would mean an increase in the interactions and therefore ecosystem changes (Roberts, 1988; Mutyavaviri, 2006). In sululta wetland, the population has increased significantly over the years. Fig 4.1 shows that the

total population of sululta has increased by more than 100% between 1986 and 2020 at the expenses of the wetland ecosystem.

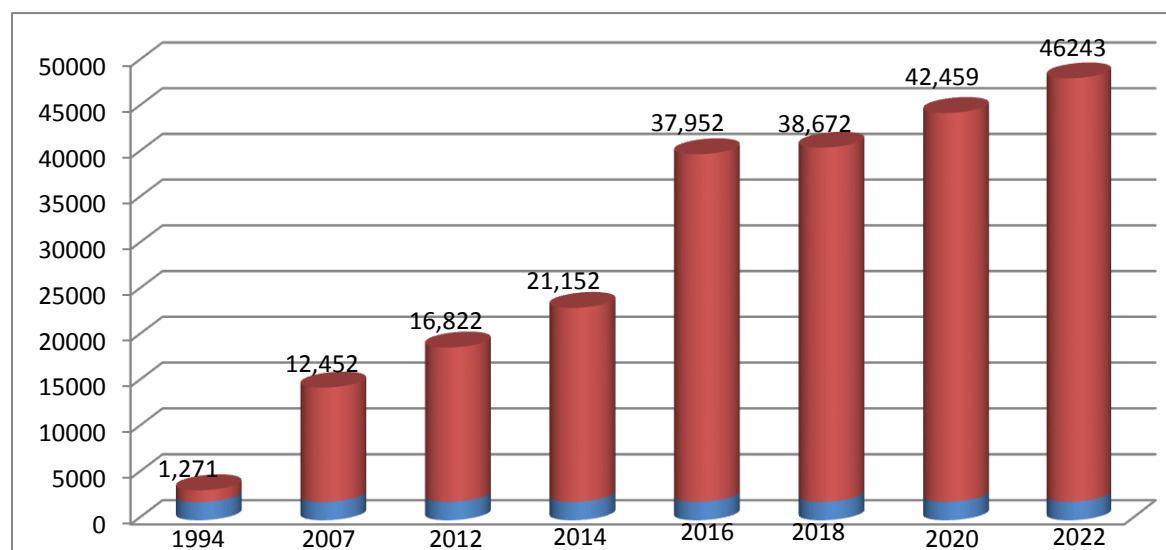


Figure 4.5: Populations of the study area computed from CSA, 1994 and 2007

**Source:** Survey data, 2020

#### 4.3.1. The effects of Agricultural practices

Area under cultivation has increased between 1980 and 2020. This was due to the increase in population which led to an increased demand for food. Fragile wetland area has been converted to crop farming. Cultivation has been reported to be contributing to the impacts on wetland ecosystems. About 29% of the households indicated that land cover is the most affected of the ecosystem aspects discussed. This was a result of agricultural expansion to increase the yields and a response to population growth creating an increased demand for agricultural land.

Cultivation also impacted negatively on the wetland hydrology according to the views of 24 percent of the respondents in the area. By clearing land for cultivation, there was a direct reduction in evapotranspiration. This reduces water vapor and hence precipitation. The respondents indicated that bare grounds promote surface runoff, reduce infiltration and groundwater recharge as well. Coupled with excessive drawing of groundwater for gardening purposes, the resource is never replenished.

The clearance of land had direct impacts on both species richness and evenness. Various tree, grass and animal species were affected by farming. It was reported that some small animal species have significantly reduced in number. Farming also introduced some alien species in the area resulting in the alteration of ecosystem functions.

#### **4.3.2. The Effects of water abstraction by Bottling Company**

The abstraction of water if done excessively can lead to the depletion of wetland ecosystems (Kling et al, 2003, Hugget et al, 2004). This is because it lowers the water table, dries the surface disturbing the microbial habitat and activity. Figure 4.5 illustrates the views of the people concerning impacts of water abstraction on the wetland.

Respondents view land cover as the most affected aspect of the ecosystem. This also affects other ecosystem functions that depend on land cover such as vegetation. It was reported that abstraction depletes the water tables and cause plants and vegetation that relied on that water to wilt. It was observed that due to depleting water levels, some vegetation species could no longer survive leading to their extinction.

Moreover, water abstraction from this wetland to many bottling industries. This poses great strain on groundwater. The rate of extraction by far surpasses the rate of recharge and thus the water table is greatly lowered and this consequently affects wetland ecosystems. Information from respondents suggests that wetlands are declined due to water abstraction for bottling company. As the rate of groundwater extraction exceeds the recharge, the area dries and water loving plants die. This strongly reduces the number of aquatic species - both fauna and flora.

#### **4.3.3. The Effects of urbanization and settlement**

According to Satterth (1999), the process of urbanization, which is mainly accompanied by high population growth and industrialization, resulted in the occurrence of complex interaction between people and their environment. Urbanization, which is also associated with the conversion of wetland to urban uses, the extraction and depletion of natural resources and the disposal of urban wastes, resulted in the occurrence of wetland environmental problems, which have a global effect. In addition, with the absence of efficient social organization and lack of adequate infrastructures the growth of city/ contributes to intensify environmental problems.

Enhance, the recent environmental challenges arise both from the lack of development and unintended consequences of some forms of economic growth.

In the study area, the researcher observed that the fast growing urban expansion in the lacks other basic urban services that would have gone parallel with the expansion, this in turn has resulted environmental problems in which the respondents have ranked them in terms of their challenges. The biggest problem was mentioned to be poor urban sanitation 265 (71 percent), 78 (20.9 percent), while the rest 30 (8.1 percent) of respondents was answered that lack of road feeder problem. This is due to inappropriate solid waste disposal; the second most difficult environmental problem was bad odor and aesthetic value disturbance the finding of this study corresponds with the previous research conducted by (Khan, 2011).

#### **4.4. LULC Change Analysis**

In light of the recent severe environmental degradation in developing countries, monitoring and analysis of land use/cover changes has become critical. Because land use/cover changes have significant effects on basic processes such as biogeochemical cycling, soil erosion and biodiversity (Chapin *et al.* ,2000). Therefore, a comprehensive understanding of land use/cover changes at both local and regional scales is important since it plays a pivotal role in socioeconomic development and global environmental changes (Dixon, 2005). In Africa, it is estimated that five million square kilometers of land is moderately to severely degrade due to rapid land use/cover changes, which have been caused by population increase, agricultural expansion, deforestation, mining, poor land management and recurrent droughts (ECA, 2001).

Wetlands resource utilization issues, are becoming increasingly challenging, especially in urban and semi urban regions with a rapidly growing population .Ethiopian people with a low level of education and low income tend to settle quickly around wetlands. So, remote sensing data such as that of satellite images are a powerful tool for monitoring because they give a visual observation of land cover changes over a period of time and provide information on the trade-offs between different land cover categories. Therefore, wetland information is part of wetland conservation plan. This study planed in assessing and predicting the changes of the wetlands of sululta. Satellite image analysis of the study area revealed the prevalence of five land use/land cover types that include: wetlands, forest, settlement, cultivated land and bare land.

#### 4.4.1. LULC Analysis of 1986

Sululta covered about 4588.3 ha when it was established in the form of urban reform in 1999 E.C as municipality administration. This area covers surrounding rural kebeles delineated as part of the Suluta. As presented in Table 4.12 and Figure 4.4, in the year 1986 the study area wetlands (1506.2 ha) (32.8 percent), forest land (2286.1 ha) and other types as indicated table 4.14.

Table 4.4. Land Use Land Cover Change of 1986 image analysis

| Land Use Land Cover Class | 1986   |            |
|---------------------------|--------|------------|
|                           | Ha     | Percentage |
| Wetlands                  | 1506.2 | 32.8       |
| Forest/vegetation         | 2286.1 | 49.8       |
| Urban Settlement          | 24.1   | 0.5        |
| Cultivated land           | 662.9  | 14.4       |
| Bare Land                 | 109.0  | 2.4        |
| Total Area                | 4588.3 | 100.0      |

**Source:** Survey data, 2020

As the satellite image shows, dense vegetation existed, and wetland covered large amounts of an area during 1986. Population dynamics (rapid population growth and migration) and investment expansion factors were not practical in the area. But now a days as researcher's analyzed secondary and primary data sources, the main factors for the rapid expansion of the study area are these two mentioned problems.

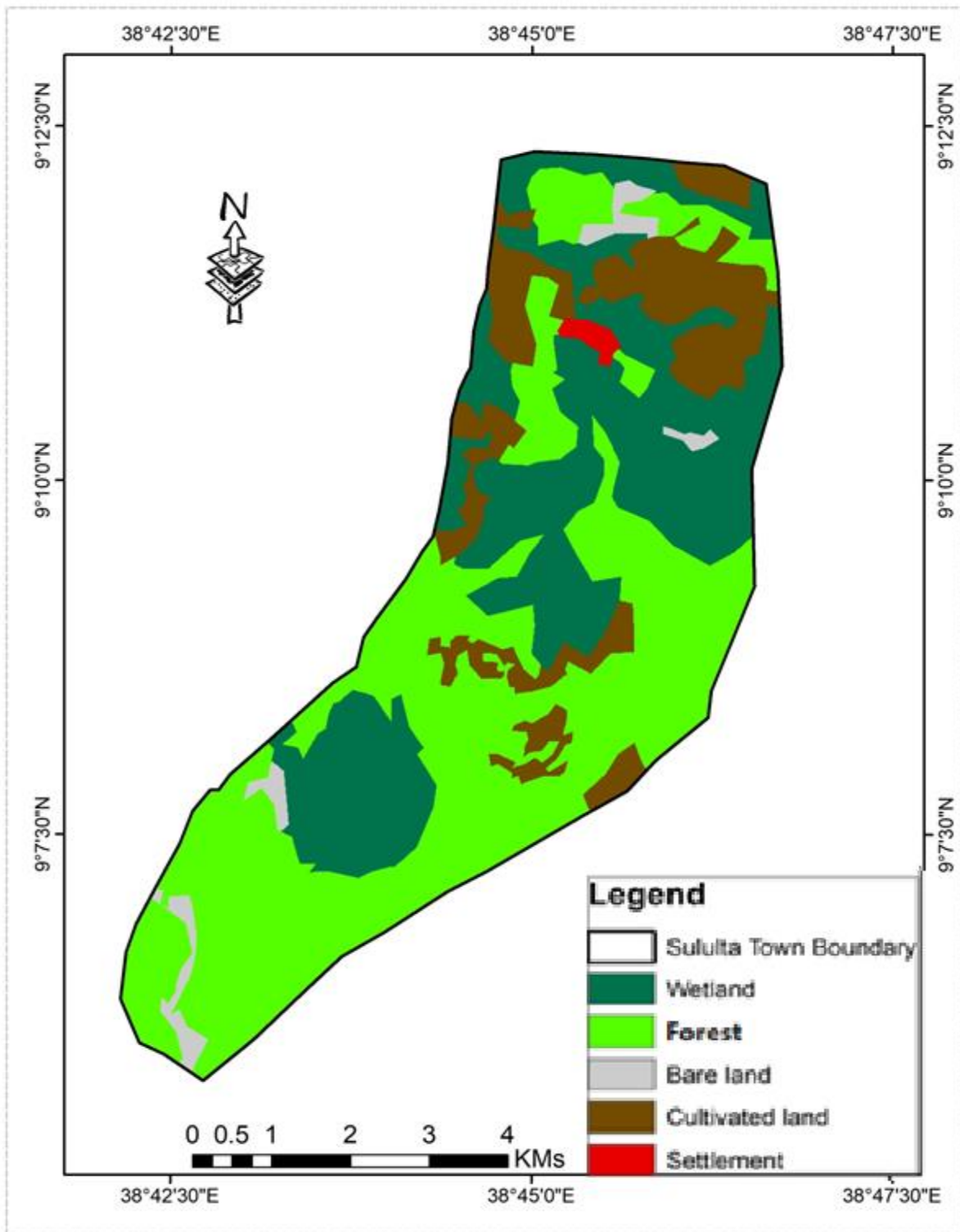


Figure 4.6. LULC Image Analysis of 1986

**Source:** survey data, 2020

#### 4.4.2. LULC Change Analysis of Image 2000

In the year, 2000 the large area covered were cultivated land, which accounts 2142.1 (46.7 percent), followed by wetland and forest land, which is 1206.6 ha (26.3 percent), and 1020.5 ha (22.2 percent) respectively. Whiles settlement and bare land covered 52 ha (1.1 percent) and 167.1 ha (3.6 percent) respectively table4.14.

Table 4.5. Land Use Land Cover Change of analysis 2000

| Land Use Land Cover<br>Class | 2000    |         |
|------------------------------|---------|---------|
|                              | Hectare | Percent |
| Wet Land                     | 1206.6  | 26.3    |
| Forest                       | 1020.5  | 22.2    |
| Urban Settlement             | 52.0    | 1.1     |
| Cultivated Land              | 2142.1  | 46.7    |
| Bare Land                    | 167.1   | 3.6     |
| Total Area                   | 4588.3  | 100.0   |

**Source:** survey data, 2020

The change detection map (fig.4.6) above depicted that cultivated land was the dominated land cover class followed by wetland and forest land respectively in all kebeles. At the same time, forest and wetland become deteriorated, since they were replaced by settlement, bare land and cultivated land classes. This is due the expansion of urbanization and other anthropogenic activities in the study area.

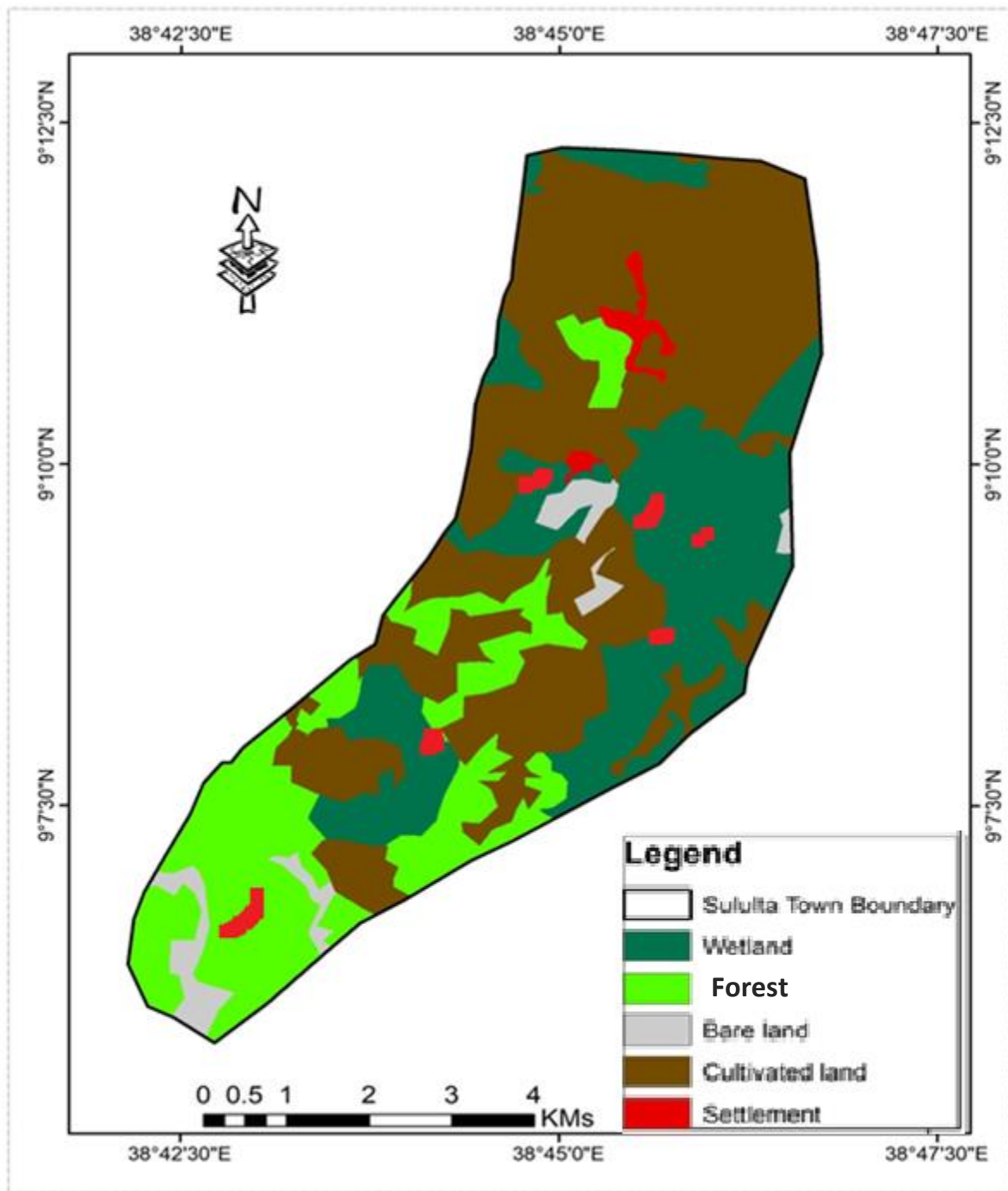


Figure 4.7: LULC 2000

**Source:** Survey data, 2020

#### **4.4.3. LULC Change Matrix from 1986 To 2000**

When we see the amounts of each type of LULC class change detected in from 1986 to 2000, out of 1506 ha of wetland class in 1986, 662 ha (44 percent) of wetland does not change to any class, 85(5.7 percent) of wetland changes to vegetated land, 55 ha (3.7 percent) of wetland were changed to bare land, 679(45.1 percent) of wetland was changed to cultivated land while the rest 24 ha (1.6 percent) of wetland were changed to settlement. This implies that 843 ha of wetland loss to other types of class and 536 ha gain from other classes. Generally in the year 2000 the amounts of net wetland class are 1207 ha that means 299 ha of wetlands were changed to other classes.

Regarding to forest from 2286 Ha of vegetated land in 1986, 904 ha (39.5 percent) of forest persistent as forest class, 513 (22.2 percent) of vegetated land changes to wetland, 75 ha (3.3 percent) of vegetated land was changed to bare land, 792(34.6 percent) of forest was changed to cultivated land while the rest 3 ha (0.1 percent) of vegetated land were changed to settlement. This implies that 117 ha of forest were changed to other types of class and 116 ha gain from other classes. Generally, in the year 2000 the amounts of net forest class were 1021 ha that means 1265 ha of forest were changed to other class.

The LULC of Settlement class change was that, 24 Ha of settlement land in 1986, 18 ha (74.3 percent) of settlement lands were persistent as settlement class, 3 (12.852 percent) of settlement land changes to forest land, while the rest 3 ha (12.85 percent) of settlement land were changed to cultivated land and nothing changed wetland and bare land from settlement. This implies that 6 ha of settlement land were changed to other types of class and 34 ha gain from other classes. Generally, in the year 2000 the amounts of net settlement class were 52 ha that means 28 ha of settlement were gains from other class.

Table 4.15 also reveals that the LULC Land covers change matrix in sululta during the year 1986 to 2000, the Cultivated land class change was that, 663 Ha of cultivated land in 1986, 615ha (92.8 percent) of cultivated lands were persistent as cultivated land class, 27 ha (4.1 percent) of cultivated land changes to wetland, 14 ha (2.1 percent) of cultivated land changed to forest land while the rest 7 ha (1.1 percent) of cultivated land were changed to settlement land and nothing changed bare land from settlement class. This implies that 48 ha of cultivated land

were changed to other types of class and 1479 ha gain from other classes. Generally, in the year 2000 the amounts of net cultivated land class were 2142 ha that means 1479 ha of cultivated land were gains from other class.

Regarding to bare land among 109 Ha of bare and in 1986, 37 ha (33.8 percent) of bare land persistent as bare land class, 5 (4.6 percent) of bare land changes to wetland, 14 ha (12.7 percent) of bare land was changed to forest land, 53 ha (48.9 percent) of bare land was changed to cultivated land while the rest nothing changed to settlement from bare land class. This implies that 72 ha of bare lands were changed to other types of class as discussed above and 52 ha gain from other classes. Generally, in the year 2000 the amounts of net bare land class are 167 ha that means 52 ha of bare lands were gained from other classes table 4.15.

Table 4.6. Land use/Land cover change matrix during the period 1986 to 2000

| LULC types 1986 | LULC class       | LULC types 2000 |         |            |         |           |         |            |         |            |         |       |         |
|-----------------|------------------|-----------------|---------|------------|---------|-----------|---------|------------|---------|------------|---------|-------|---------|
|                 |                  | Wetland         |         | Vegetation |         | Bare land |         | Cultivated |         | Settlement |         | Total |         |
|                 |                  | Ha.             | Percent | Ha.        | Percent | Ha.       | Percent | Ha.        | Percent | Ha.        | Percent | Ha.   | Percent |
|                 | Wetland          | 662             | 44.0    | 85         | 5.7     | 55        | 3.7     | 679        | 45.1    | 24         | 1.6     | 1506  | 32.8    |
|                 | Vegetation       | 513             | 22.4    | 904        | 39.5    | 75        | 3.3     | 792        | 34.6    | 3          | 0.1     | 2286  | 49.8    |
|                 | Bare land        | 5               | 4.6     | 14         | 12.7    | 37        | 33.8    | 53         | 48.9    | 0          | 0.0     | 109   | 2.4     |
|                 | Cultivated land  | 27              | 4.1     | 14         | 2.0     | 0         | 0.0     | 615        | 92.8    | 7          | 1.1     | 663   | 14.4    |
|                 | Urban Settlement | 0               | 0.0     | 3          | 12.85   | 0         | 0.0     | 3          | 12.85   | 18         | 74.3    | 24    | 0.5     |
|                 | Total            | 1207            | 26.3    | 1021       | 22.2    | 167       | 3.6     | 2142       | 46.7    | 52         | 1.1     | 4588  | 100.0   |

**Source:** survey data, 2020

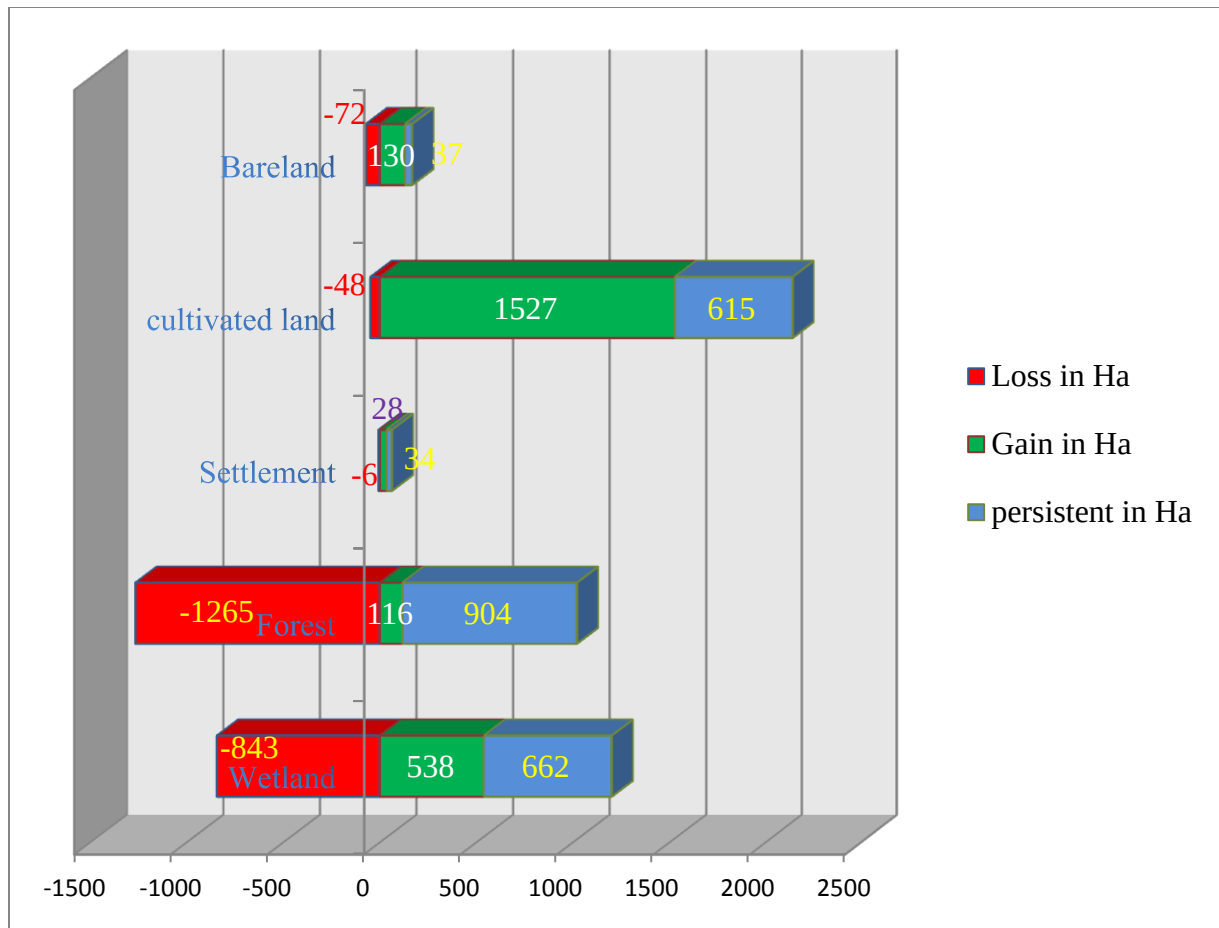


Figure 4.8. LULC Loss and Gain in between 1986 to 2000

**Source:** Survey data, 2020

Generally, the LULC 1986 to 2000 image analysis reveals that Settlement and bare land increased by 28 ha at growth rate of 1 percent and, 58 ha at growth rate of 1 percent respectively. While forest and wetland reduced by 1266 ha at negative growth rate 28 percent, 299.6 ha at negative growth rate of 7 percent respectively. On the other hand, cultivated land was significantly increased from 1986 to 2000 by 1479 at largest growth rate of 32 percent. This due to that time Ethiopia started to exercise the ADLI policy and strategy.

#### 4.4.4. Change Analysis of Image 2020

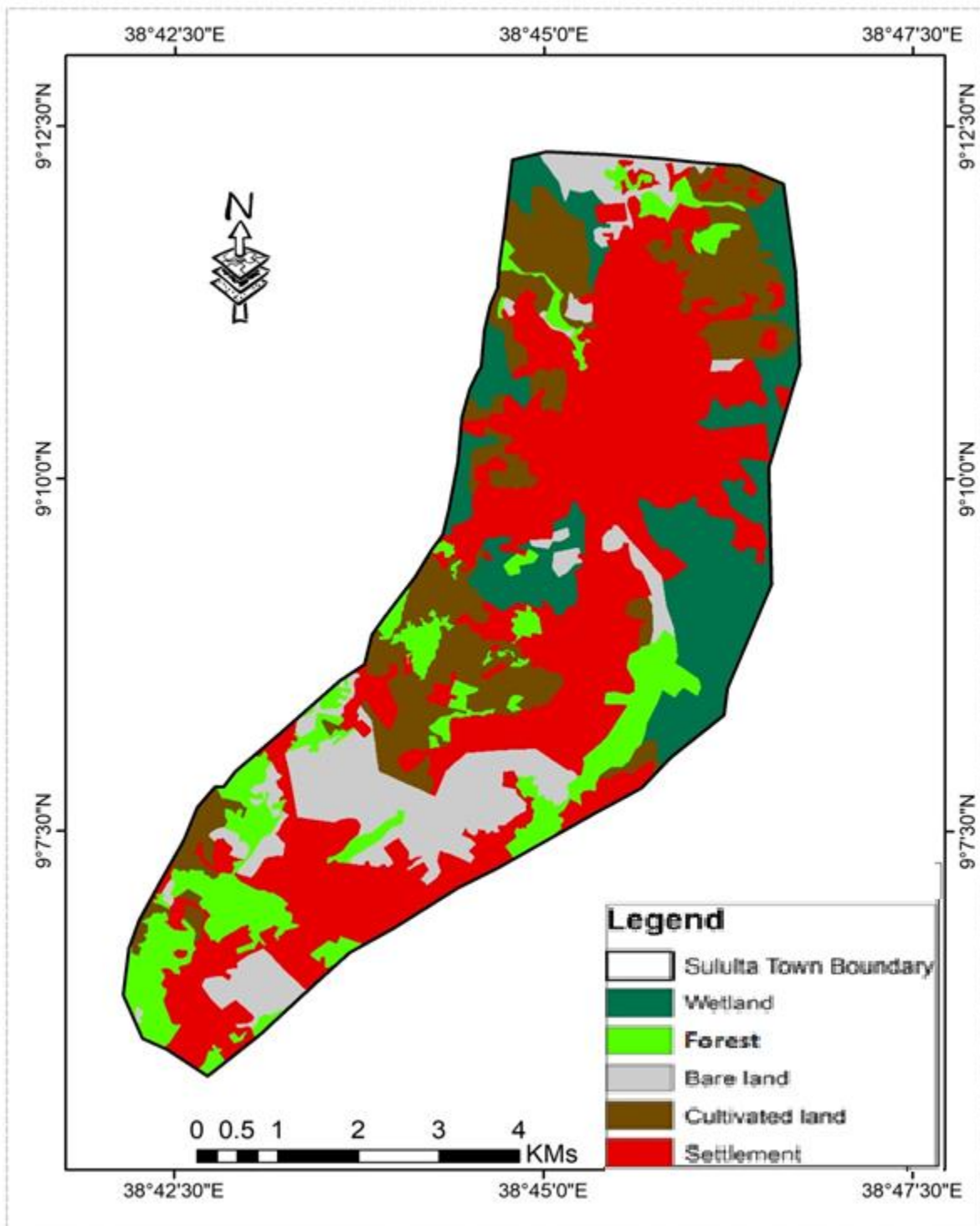


Figure 4.9. Change Analysis of Image 2020

Sources: Developed by researcher

Regarding to forest out of 1021 Ha of wetland in 2000, 355 ha (34.7 percent) of forest persistent as forest class, 5 ha (0.5 percent) of vegetated land was changed to wetland, 182 ha (17.9 percent) of vegetated land were changed to bare land, 112 ha (10.9 percent) of forest was changed to cultivated land while the rest 367 ha (36 percent) of forest land was changed to settlement. This implies that 666 ha of forest lands were changed to other types of class and 228 ha gain from other classes. Generally, in the year 2020 the amounts of net forest class remains are 582 ha that means 439 ha of forest were changed to other types of class from 2000 to 2020.

The LULC change matrix of table 4.17 reveals that out of 52 ha of the settlement class recorded in the year 2000, 50 ha (96.2 percent) of settlement lands were not changed that means persistent as settlement class, 1 ha (1.9 percent) of settlement land changes to bare land, 1 ha (1.9 percent) of settlement land also changes to cultivated land and nothing changed wetland and forest land from settlement class. This implies that only 2 ha of settlement land were changed to bare land and cultivated land class and 1905 ha gain from other classes. Generally, in the year 2020 the amounts of net settlement class were 1959 ha.

#### **4.4.5. LULC Change Matrix from 2000 To 2020**

Table 4.15 also reveals that the LULC Land covers change matrix in sululta during the year 2000 to 2020, out of 2142 Ha of recorded in the year 2000, only 598 ha (27.9) of cultivated lands were persistent as cultivated land class, 270 ha (12.6 percent) of cultivated land changes to wetland, 74 ha (3.5 percent) of cultivated land changed to forest land, 241 ha (11.2 percent) of cultivated land changed to bare land while the rest 959 ha (44.8 percent) of cultivated land were changed to settlement land. This implies that 1544ha of cultivated land were changed to other types of class and 189 ha gain from other classes. Generally, in the year 2020 the amounts of net cultivated land class were 1959 ha that means 1907 ha of cultivated land were gains from another class.

Regarding to bare land among 167 Ha of bare recorded in 2000, 3 ha (2.1 percent) of bare land persistent as bare land class, 17 (10.3 percent) of bare land changes to wetland, 5 ha (2.9 percent) of bare land were changed to forest land, 10 ha (6.1 percent) of bare land was changed to cultivated land while the rest 132 (78 percent) of bare land were changed to settlement from

2000 to 2020. This implies that 154 ha of bare lands was changed to other types of class as discussed above and 594 ha gain from other classes. Generally, in the year 2020 the amounts of net bare land class recorded are 597 ha that means 430 ha of bare lands were gained from other classes.

Table 4.7. Land use/Land cover change matrix during the period 2000 - 2020

| LULC types 2000 | LULC type       | LULC types 2020 |         |        |         |           |         |                 |         |            |         |       |         |
|-----------------|-----------------|-----------------|---------|--------|---------|-----------|---------|-----------------|---------|------------|---------|-------|---------|
|                 |                 | Wetland         |         | Forest |         | Bare land |         | Cultivated land |         | Settlement |         | Total |         |
|                 |                 | Ha.             | percent | Ha.    | percent | Ha.       | Percent | Ha.             | percent | Ha.        | percent | Ha.   | Percent |
|                 | Wetland         | 372             | 30.8    | 149    | 12.3    | 170       | 14.1    | 66              | 5.5     | 451        | 37.4    | 1207  | 26.3    |
|                 | Forest          | 5               | 0.5     | 355    | 34.7    | 182       | 17.9    | 112             | 10.9    | 367        | 36.0    | 1021  | 22.2    |
|                 | Bare land       | 17              | 10.3    | 5      | 2.9     | 3         | 2.1     | 10              | 6.1     | 132        | 78.7    | 167   | 3.6     |
|                 | Cultivated land | 270             | 12.6    | 74     | 3.5     | 241       | 11.2    | 598             | 27.9    | 959        | 44.8    | 2142  | 46.7    |
|                 | Settlement      | 0               | 0.0     | 0      | 0.0     | 1         | 1.7     | 1               | 2.1     | 50         | 96.2    | 52    | 1.1     |
|                 | Total           | 663             | 14.5    | 582    | 12.7    | 597       | 13.0    | 787             | 17.2    | 1959       | 42.7    | 4588  | 100.0   |

Source developed by researcher 2020

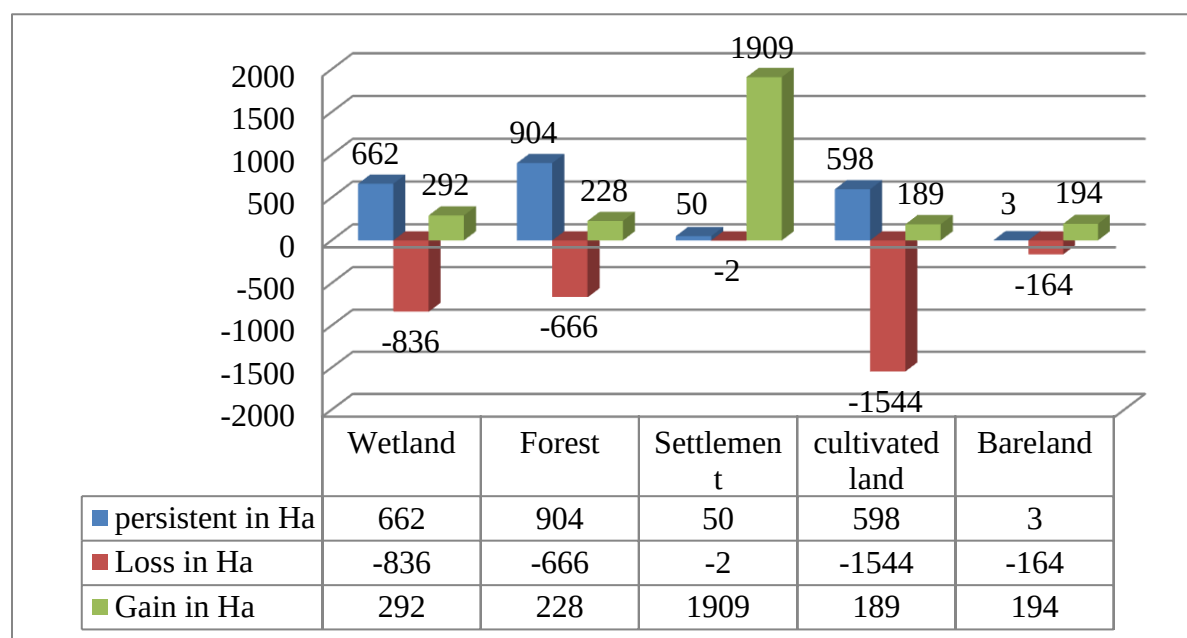


Figure 4.10. LULC Loss and Gain in between 2000 to 2020

Source: Developed by researcher 2020

The LULC change detection from 2000 to 2020 image analysis reveals that Settlement, and bare land were increased by 1907 ha at a growth rate of 42 percent and 430 ha at a growth rate of 9 percent respectively. While 439 reduced forest, wetland and cultivated lands ha at a negative growth rate 10 percent, 543 ha at a negative growth rate of 12 and 1355 ha at a negative growth rate of 30 percent respectively. This is due to that the rate of unplanned urban expansion and other anthropogenic factors are the main triggering factors in the study area.

#### 4.4.6. Combined Analysis of Image 1989, 2000 and 2020

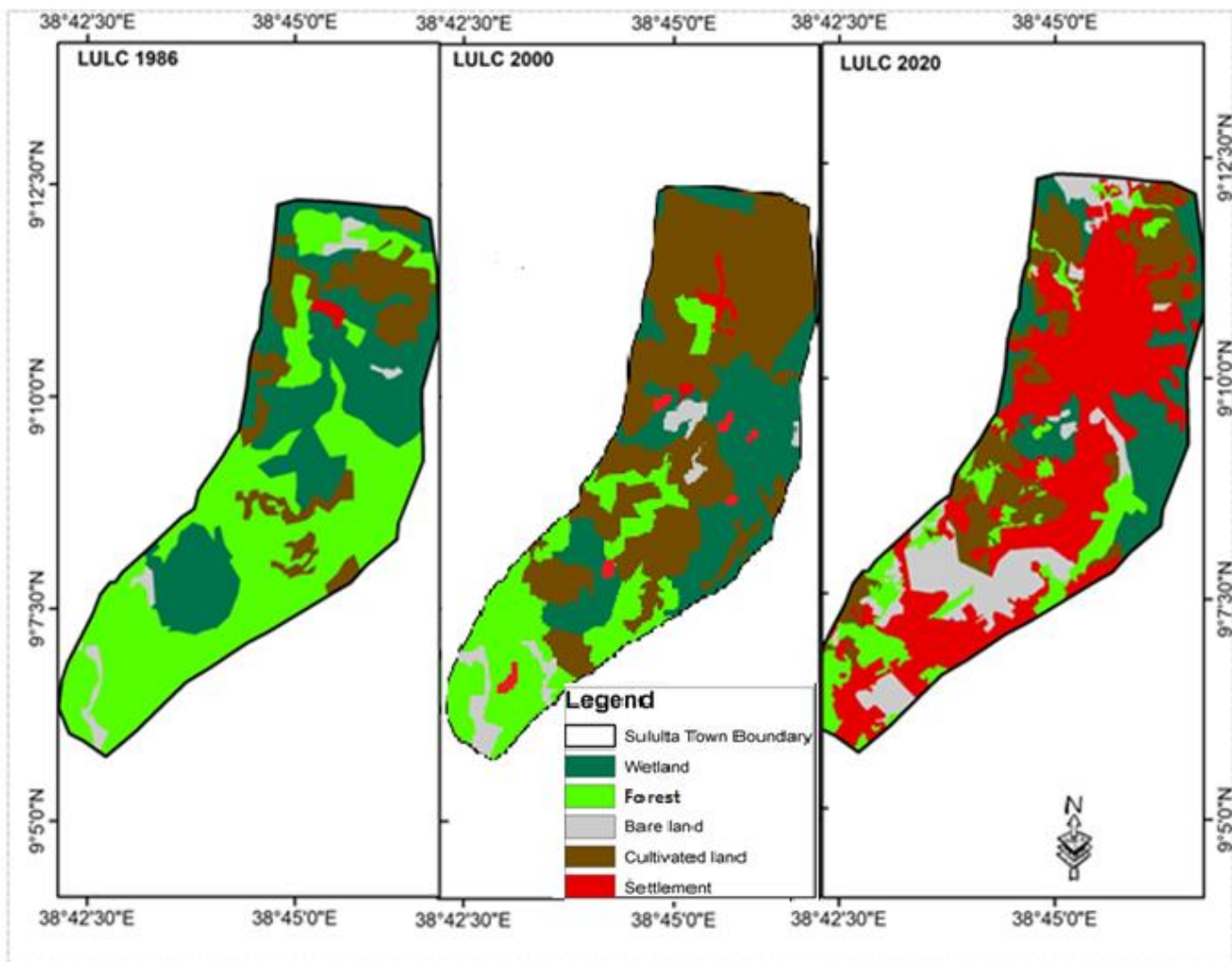


**Figure 4.11. Change Analysis of Image 2020**

**Source:** Survey data, 2020

Table 4.8. Overall LULC change detection rate (1986 - 2020)

| LULC type       | 1986 |         | 2000 |         | 2020   |         | Change 1986 – 2000 |         | Change 2000 - 2020 |         | Change 1986 – 2020 |         |
|-----------------|------|---------|------|---------|--------|---------|--------------------|---------|--------------------|---------|--------------------|---------|
|                 | Ha.  | Percent | Ha.  | Percent | Ha.    | Percent | Ha.                | Percent | Ha.                | Percent | Ha.                | Percent |
| Wetland         | 1506 | 32.8    | 1207 | 26.3    | 663.5  | 14.5    | -300               | -7      | -543               | -12     | -843               | -18     |
| Forest land     | 2286 | 49.8    | 1021 | 22.2    | 581.9  | 12.7    | -1266              | -28     | -439               | -10     | -1704              | -37     |
| Bare land       | 109  | 2.4     | 167  | 3.6     | 597.1  | 13.0    | 58                 | 1       | 430                | 9       | 488                | 11      |
| Cultivated land | 663  | 14.4    | 2142 | 46.7    | 787.3  | 17.2    | 1479               | 32      | -1355              | -30     | 124                | 3       |
| Settlement      | 24   | 0.5     | 52   | 1.1     | 1958.6 | 42.7    | 28                 | 1       | 1907               | 42      | 1935               | 42      |
| Total           | 4588 | 100     | 4588 | 100     | 4588   | 100     | 0                  | 0       | 0                  | 0       | 0                  | 0       |

**Source:** Survey data, 2020

In general, the area coverage of settlement indicates the first highest coverage of urban expansion in the study area. For example, between 1986 and 2020, the overall increased LULC of settlement was 1935 ha and 42 percent growth rate. Similarly, bare land indicates the second highest coverage of expansion next to settlement in the study area. For example, between 1986-2020 the overall increased land LULC of cultivation bare land was 488 ha at a growth rate of 11 percent. Also the area coverage of cultivated land is shown oscillates increment through time in the study area and finally exhibits 124 ha and 3 percent growth rate as compared from the year 1986. On the other hand, the aggregate of vegetated land indicates the first highest reduction of area coverage in the study area over the study period followed by wetland class. For example, in the year between 1986 to 2020, the overall reduced vegetated land LULC was 1704 ha at a negative growth rate of 37percent. Similarly, the coverage of wetland indicates the second highest reduction of area coverage next to forest in the study area. For example, 843 ha of wetlands was deteriorated at a negative growth rate of 18 percent as compared to the year 1986. For example, between 1986-2020, the overall reduced wetland LULC was 597 ha and 13.4 ha negative growth rate.

Table 4.9.LULC change matrix during the period 1986 - 2020

| LULC types 1986 | LULC type       | LULC types 2020 |         |        |         |           |         |          |         |            |         |       |         |
|-----------------|-----------------|-----------------|---------|--------|---------|-----------|---------|----------|---------|------------|---------|-------|---------|
|                 |                 | Wetland         |         | Forest |         | Bare land |         | Cropland |         | Settlement |         | Total |         |
|                 |                 | Ha.             | Percent | Ha.    | Percent | Ha.       | Percent | Ha.      | Percent | Ha.        | Percent | Ha.   | Percent |
|                 | Wetland         | 342             | 22.7    | 42     | 2.8     | 236       | 15.7    | 150      | 9.9     | 736        | 48.9    | 1506  | 32.8    |
|                 | Forest land     | 306             | 13.4    | 516    | 22.6    | 311       | 13.6    | 326      | 14.2    | 827        | 36.2    | 2286  | 49.8    |
|                 | Bare land       | 1               | 1.3     | 8      | 7.7     | 20        | 18.0    | 8        | 7.2     | 72         | 65.8    | 109   | 2.4     |
|                 | Cultivated land | 13              | 2.0     | 14     | 2.2     | 30        | 4.5     | 302      | 45.5    | 303        | 45.8    | 663   | 14.4    |
|                 | Settlement      | 0               | 0.0     | 1      | 5.0     | 1         | 4.5     | 2        | 9.6     | 19         | 80.9    | 24    | 0.5     |
|                 | Total           | 663             | 14.5    | 582    | 12.7    | 597       | 13.0    | 787      | 17.2    | 1959       | 42.7    | 4588  | 100.0   |

**Source:** Survey data, 2020

#### 4.5. Wet Land Depletion

This satellite image analysis has captured a marked depletion of wetlands in sululta. Wetlands are an essential part of the regional ecosystems. In the global carbon cycle, wetlands play a dominant role, containing about 12% of the global carbon pool (Sahagian & Melack, 1998). Thus, despite the present state of global warming and climate change as well as the ongoing high demand for water use (groundwater-surface water interaction), this widespread degradation of the wetlands has become a critical concern.

Figure 4.9 shows gained, lost and persistent wetland area within the watershed from 1986 to 2020. It is clear that very minor parts of wetland changed during the year 1986 to 2000 while major parts of wetlands changed during period of 2000 to 2020. The major change has occurred in the study area which is dominated by settlement. The depletion in wetland extent may cause multi-dimensional impacts, such as: change in carbon storage, loss of biodiversity, increase in flooding, decrease in water quality etc. Therefore, further rigorous research should be designed and performed to investigate the reason and effects of this extensive depletion of wetlands.

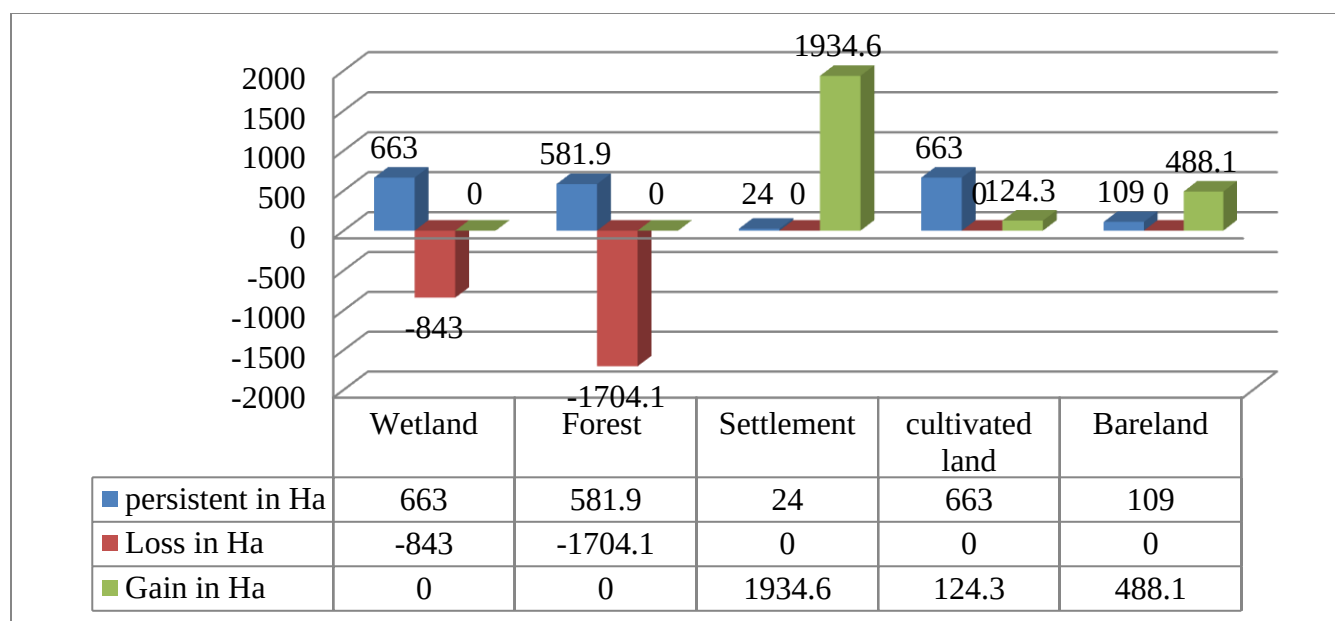


Figure 4.12. LULC Loss and Gain in between 1986 to 2020

**Source:** Survey data, 2020

A reflection on the responses of both key informant interview revealed that there seems to exist a considerable level understanding of the causes of LULC change. This is desirable because it can be thought to imply the greater likelihood of emerging behavioral intentions aimed at mitigating the problems of LULC change. Moreover, a sixty years old household head from weserbe kebele when asked about the causes of LULCC said the following;

**Box Three:**

*"I have born and living here in this kebele and saw many LULCC for many years. This may be because of the growth of population and urban expansion which was causing wet land to be degraded over many years up to now."*

The above response from an interviewee demonstrates the impacts of anthropogenic activities on wetland degradation. The respondent assumes that the population growth results in the wetland degradation and then concludes that the degradation of wetland is caused by population growth and unplanned urbanization. Moreover the finding also in line with studies by Elizabeth (2000).

#### **4.6. The Relationship between LULC Change and Community Perception**

The communities in the study area perceived the effects of anthropogenic activities on wetland and illustrated wetlands degradation and urban expansion to wetlands. This has led to a tremendous increments of environmental pollution, losses of biodiversity, loss of livestock and decrease in water concentrations in the wetland. The quantity and quality of natural water body have fallen. In reality, this has resulted due to anthropogenic factors taking place at the expenses of wetland ecosystems. Wetland encroachment was performed by different anthropogenic activities such as unplanned urban expansion or settlement, bottling industries, as well as agricultural practices. Moreover, the survey result shows that even though communities are perceived well about the provisions and values of wetlands goods and services, due to unplanned urbanization and lack of policies and laws to conserve the wetland the area is becoming at risk in ecological as well as socioeconomic system. For example, there are different consequences of the environmental problems due to wetland degradation such as loss of grassland as a result loss of livestock productivity, increases solid waste disposal on the wetland and loss of forest or permanent plants, extinctions of some endemic wetland biodiversity as well as there is also cultural disturbance and because of this some indigenous knowledge was missed and neglected.

Similarly, the image analysis obtained from satellite data was revealed that large area of wetland and forest lands were transformed to other class types mainly of settlement, bare land and cultivated land from 1986 to 2020. For example, the satellite imagery of 1986 indicates that forest and wetlands were dominated LULC class in the study area in 1986 but now in 2020 those valuable ecosystem LULC classes are deteriorated and changed to other LULC classes mainly to settlement.

Specifically the area coverage of settlement indicates the first highest coverage of urban expansion in the study area. For example, between 1986 to 2020, the overall increased LULC of settlement was 1935 ha and 42 percent growth rate. Bare land indicates the second highest coverage of expansion next to settlement in the study area. The LULC of bare land was 488 ha at a growth rate of 11 percent. Also the area coverage of cultivated land is showing slight increment through time in the study area and finally exhibits 124 ha and 3 percent growth rate as compared from the year 1986. On the other hand, the aggregate of vegetated land indicates the

first highest reduction of area coverage in the study area over the study period followed by wetland class. For example, in the year between 1986 to 2020, the overall reduced vegetated land LULC was 1704 ha at a negative growth rate of 37percent. Similarly, the coverage of wetland indicates the second highest reduction of area coverage next to forest in the study area. For example 843 ha of wetlands were deteriorated at a negative growth rate of 18 percent as compared to the year 1986. For examplebetween1986 to 2020, the overall reduced wetland LULC was 597 ha and 13.4 ha negative growth rate.

The survey results obtained from community perception and the 34 years satellite image analysis of suluta area is support each other and make the study internally consistent and valid. From this, it can be concluded that suluta area is adversely affected by anthropogenic activities mainly of settlement expansion from time to time at increasing rate at the expense of wetland and forest land.

Generally the both the survey results and LULC image analysis results of this study is support the results of previous research conducted different authors such as Teferi et al (2010). The Use of Remote Sensing to Quantify Wetland Loss in the Choke Mountain range, Upper Blue Nile basin, Ethiopia, Gemechu (2010). The Challenges and Opportunities of Wetlands Management in Ethiopia: The case of Abijiata Lake Wetlands, Wali, E. (2015). Urbanization and Loss of Wetland in Port-Harcourt Metropolis, Nigeria and Negasa (2017). Monitoring Urban Expansion and Suitability Analysis for Residential Housing by Using Geographic Information System and Remote Sensing; the Case of Sululta. While it is contradict with some precious research conducted by some authors such Ayele (2017) Land use and land cover change detection analysis using remote sensing techniques: the case of Hawassa, southern Ethiopia. The contradiction may emanate from due to different reasons. For example, the research conducted by Abebe 2017 in Hawassa resulted that urban expansion has positive effect on water bodies and wetlands on the other hand; my study shows that wetland is affect adversely due to different anthropogenic factors. This is due to expansion of suluta is unplanned while Hawassa has a guided master plan for settlement expansion.

## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1. Conclusion**

The survey results from community perception revealed the effects of anthropogenic activities on wetlands and the resultant urban expansion and wetland degradation in the study area. This has followed by a tremendous increments of environmental pollution, losses of biodiversity, loss of livestock and grazing land and decrease in water concentrations in the wetland. Generally, the wetland in the study area is adversely affected by anthropogenic activities mainly of settlement expansion from time to time at increasing rate at the expense of wetland and forest land.

Land use and land cover change of sululta resulted that considerable change has occurred within thirty four (34) years from 1986 to 2020. Though the period of 1986 from 2020 there dramatic change in several LULC categories. For example, wetland exhibited degradation and changed to other LULC class by 843 ha at a negative growth rate of 18 percent, similarly vegetated land also exhibited lost and changed to other LULC class by 1704 ha at a negative growth rate of 37 percent. While settlement has exhibited, gain and obtained from other LULC class and increased by 1935 ha at a growth rate of 42 percent, cultivated land gain and increased by 124 ha at a growth rate of 3 percent and bare land also increased by 488 ha at a growth rate of 11 percent as compared to the beginning of the 1986 imagery result. Accordingly, more land brought under settlement, bare land and cultivated land owing to population growth and their demand for land and land resources.

#### **5.2. Recommendations**

- ❖ Based on the study findings, the following points were recommended for future natural resources management like wetlands in the study area and beyond: Conserve environmental sensitive areas like wetlands, forests, catchments of water bodies and areas with slope greater than twenty percent as well as restrict pollutant activities with buffer zones and public awareness.

- ❖ Wetland resources development, protection and use strategies need to be devised to counteract the deteriorating shrub/bushes and avoid further extinction of important shrub/tree species and migration of associated wild animals.
- ❖ Promote environmentally friendly waste management system by employing involvement of private sectors and 3R (reduce, reuse and recycle) as well as ‘polluters pay principle to minimize wetland pollution.
- ❖ The wetlands resource of the study area is facing various anthropogenic and natural factors, which drive the wetlands to death. Therefore, to manage wetlands under the study in a proactive and sustainable way; there is a need for the government to involve the local residents, knowledgeable individuals (indigenous knowledge), NGOs and other stakeholders.
- ❖ Institutional perception of the values, functions and utilization of wetlands should be harmonized. This could then be followed by formulation official policy on wetlands, promulgation of regulations to govern wetland use and capacity building for monitoring and control of wetland utilization.

### **5.3. Suggestions for Further Research**

The use of high-resolution imageries such as IKONOS and QuickBird is important in generating good quality of land cover maps. Because urban areas have complex and heterogynous features, high-resolution imagery provides better information by mapping these areas. Moreover, the use of ancillary data as ground truth helps for better accuracy of an image classification.

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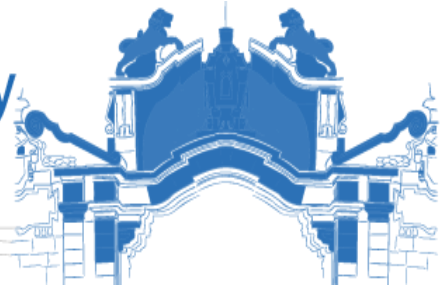
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## ADDIS ABABA UNIVERSITY

### COLLEGE OF DEVELOPMENT STUDIES

#### CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

### Annex I. Survey Questionnaire

#### Part I. Specimen Letter of Consent

#### RE: REQUEST TO CONDUCT A RESEARCH STUDY

My name is Nahom Lema I am a student Addis Ababa University college college of developmet saudies I am undertaking a research entitled: **The Effect of Anthropogenic factors on Wetland Ecosystem:** The Case of Sululta Oromia Region Ethiopia. Please, answer the questions that follow by ticking the appropriate option (if provided) or writing unrestrictedly for open-ended questions. Please answer all questions freely, but objectively.

So, your genuine, honest and timely response is vital for the accomplishment of this study on time. Therefore, I kindly ask you to give your response to items/questions carefully. Finally, I confirm you that the information that you share with me was be kept confidential and only used for the academic purpose. Thank you for your assistance and for sparing your precious time.

Sincerely,

Nahom Lema

#### Address

☎ 251-912150273

Email- [nahomlema2009@gmail.com](mailto:nahomlema2009@gmail.com)

## **PART I. Demographic characteristics information**

1. Gender of respondents
  - A. Female ☐
  - B. Male ☐
2. Age of respondent:
3. What was/ is your major occupation
  - A. Government employee ☐
  - B. Business man ☐
  - C. Crop producer ☐
  - D. fuel wood selling ☐
  - E. Animal husbandry ☐
  - F. Charcoal production ☐
  - G. Mixed farming ☐
  - H. If others, specify.....
4. marital status of respondents
  - A. Married ☐
  - B. Single ☐
  - C. Separated ☐
  - D. Widowed ☐
5. Educational background of respondents
  - A. None educated ☐
  - B. Grade 1-8 completed ☐
  - C. Grade 9-12 complete ☐
  - D. Diploma holder ☐
  - E. Bachelor degree holder ☐
  - F. Master's degree and above ☐
6. Family size 1.Males\_\_\_\_\_ 2.Female \_\_\_\_\_ total\_\_\_\_\_
7. How long did you live here? (Years) \_\_\_\_\_

## Part II. Questions Related To Wetland

### A/ Wetland ecological knowledge

1. What is wetland? .....
2. How peoples reserving wetland? Moreover, how do they use it?  
.....
3. How do you see the Current Status of sululta Wetland System Protection and Conservation?  
.....

### B/ Wetland Ecological benefits

4. Can you tell me the ecological, social and economic importance of wetland for social community?
5. What are the major provisioning ecosystem services you obtain from the wetland?
  - A. Pasture land for livestock feed
  - B. fuel wood
  - C. Extraction of medicines and other materials from biota.
  - D. timber products
  - E. Production of fish, wild game, fruits and grains.
  - F. Ground water recharges and discharge retention for agricultural use.

### C/ Wetland Ecological Threats

#### 6. Which Major activities affecting the sululta wetland

- A. Industry ☐
  - B. Agriculture ☐
  - C. Industry ☐
  - D. Settlement ☐
  - E. Others (specify).....
7. Are you involved in or are you aware of any public infrastructural activities carried out within this wetland area? Please tick the correct response.
  - F. Yes ☐
  - G. No ☐

8. How would you describe the rate of encroachment of wetland since you first established here?

- A. High ☐
- B. Moderate ☐
- C. Low ☐
- D. Others (specify).....

9. How do you perceive this area of aquatic nature?

- A. It needs to be transformed ☐
- B. It is a waste land ☐
- C. It is useful ☐
- D. Other (specify).....

10. Would you say an anthropogenic activity has contributed to the utilization of urban wet lands?

- A. Yes ☐
- B. No ☐

11. If yes How? .....

12. Have you ever received any directives from the government on how to utilize this area?

- A. Yes ☐
- B. No ☐

13. If yes what type of directives .....

#### **D/ Wetland Ecological Management**

1. Who are responsible for the management of the wetlands in sululta?

2. How can be managing the wetland effectively?

Kindly use the space below for any additional information.

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**THANKYOUFOR YOUR TIME ANDPARTICIPATION**

## **Part II Interviews Questions**

1. What is the root cause of Sululta expansion?
2. When was the rapid change of expansion started?
3. In past time before thirty years types of land cover existed in their kebeles?
4. Why other land cover classes change to other classes?
5. What is a consequence of Sululta expansion?
6. What do you suggest for those problems on wetland?

#### Part IV. Check list questions for office representations

1. For how long you have known the sululta wetland and its surrounding?
2. What is the current wetland community looks like?
3. What contribution does this wetland has.
  - a. For the local community
  - b. In enhancing the economic development of local, regional and country
  - c. In conserving biological diversity
  - d. In conserving national heritages having scientific and historic values
  - e. In enhancing the eco-tourism industry in the area?
4. How do you see the present status of the sululta Wetlands) in comparison to the past?
5. What are the factors that contributed for these Wetland degradation/ threat?
  - a. Agricultural activities; how?
  - b. Urbanization or Settlement expansion: how?
  - c. Constructions of Public infrastructure: how?
  - d. Environmental policy constraints: how?
  - e. The establishment of bottling companies in vicinity area? How?
6. What efforts you made to obtain any necessary cooperation from high level officials /organizations and local community in this wetland management?
7. Have you ever consulted the local community if they can cooperate In the lake wetlands managements?
8. Do you think the local community is beneficiary from the wetlands? If yes, in what aspects? Please explain.....

Kindly use the space below for any additional information.

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**THANK YOU FOR YOUR TIME AND PARTICIPATION**

***Annex. II. Photo of the study area taken by the researcher***

**A. Wetland encroached by urbanization**



**Source:** photo taken by the researcher 2020

B. Seasonal Wetland photos



**Source:** photo taken by the researcher 2020

C. Photos of seasonal wetland encroached by urbanization



**Source:** photo taken by the researcher 2020

## Annex III. URKUND Anti Plagiarism Report



### Document Information

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|-------------------|--------------------------------------------|
| Analyzed document | Nahom Lema For Plagiarism.docx (D74614451) |
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| Submitted by      |                                            |
| Submitter email   | nahomlema2009@gmail.com                    |
| Similarity        | 2%                                         |
| Analysis address  | fevera.senbeta.aauni@analysis.arkund.com   |

### Sources included in the report

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