ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT AND DEVELOPMENT STUDIES

DRIVERS AND IMPLICATIONS OF URBAN EXPANSION, THE CASE OF SULULTA TOWN, ETHIOPIA

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A thesis submitted to the Center for Environment and Development Studies, Addis Ababa University, in partial fulfillment of the requirements for the degree of Master of Art in Environment and Sustainable Development

December, 2022

Addis Ababa, Ethiopia

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This is to certify the thesis prepared by ALIMA ABDELLA, entitled: "*DRIVERS AND IMPLICATIONS OF URBAN EXPANSION, THE CASE OF SULULTA TOWN, ETHIOPIA*" is submitted in partial fulfillment of the requirements for the degree of Master of Art in Environment and Sustainable Development fulfills the regulations of the University and meets the accepted standards with regards to the originality and quality.

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Finally, I dedicate this thesis to my dear parents.

Abstract

Urban areas are the most dynamic regions in the world in both demographic and spatial dimensions with serving as the social, economic and political centers of our modern life. In the last three decades, rapid urbanization has been recorded in Ethiopia at large and Sululta town in particular, thus providing an indication of increasing urban issues and environmental problems in such areas. As its proximity to the capital city, the rapid growth of Addis Ababa poses enormous opportunities and challenges for the development of surrounding towns including the Sululta town. The main objective of this study was to assess and analyze the drivers of the built up land use and land cover changes of Sululta towns and its implication on the settlements. In this study, Remote Sensing, Geographic Information System, and intensity analysis with assessment of the driving factors were used together within an integrated framework to analyze the changes and dynamics of Land Use Land Cover in Sululta town. The changes and intensity analysis were evaluated for four classes of land-use (built-up, agriculture, grass land and vegetation) and at three levels: time, category, and transition for the last three decades (1990-2020). The results showed that the land-use land cover changes were significant and found to be accelerated in the last two-time intervals (2000-2010 and 2010-2020) as a result of the land use intensity was higher than the uniform intensity and the recognition of Sululta town as a town administration, while there was a slowdown in the first period (1990-2000). The annual land use change intensity during the first-time interval (1990-2000) was less than from the uniform intensity and greater than for the remaining period. For the category level, the built up class experienced more gain than loss during all time intervals and agricultural land experienced more loss than gain. For the transition level analysis, the agricultural class was more contributed to the built-up area than grass land during all time intervals. Built-up areal coverage increased from 0.56% to 22.64% of the total study area within 30 years interval. The annual land use change intensity also increased from 0.35% to 1.99%. Besides, the increase in population size, rural-urban migration, location of the town and housing preference, resettlement because of political chaos, and informal access to land are the major driving forces for the Sululta town rapid expansion. The land brokers and private investors (speculators) are the key actors who contributed to the dramatic expansion on Sululta town and impacted on proliferation of informal settlements and; imbalance between demand and supply of land for housing. The author recommends having a master plan to be revised in short term periods. If exist, it has to be implemented properly.

Key words: Urbanization, Land Use Land Cover (LULC), Settlements, Land use intensity

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Acronyms and Abbreviations

AOI	Area of Interest
CSA	Central Statistics Agency
GIS	Geographical Information System
DEM	Digital Elevation Model
EC	Ethiopian Calendar
ETM+	Enhanced Thematic Mapper Plus
FGD	Focus Group Discussion
KII	Key Informant Interviews
LULC	Land Use Land Cover
NYU	New York University
OLI	Operational Land Imaging
SADC	Swiss Agency for Development and Cooperation
SRTM	Shuttle Radar Thematic Mapper
TM	Thematic Mapper
UN	United Nations
USGS	United States Geological Survey
WB	World Bank

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Globally, compared to others, urban landscapes are extraordinarily the most dynamic components of our environment. Always, there is a rapid change in both demographic and spatial dimensions with serving as the social, economic and political centers of the human modern life (Galeon, 2008). Globally, more than half of the world's population now lives in urban areas and this number is expected to increase significantly by 2050. It means nearly 7 of 10 people in the world will live in the urban areas (UN, 2018). Predictions reveal that, spatial extent and population density of African cities could be more than triple by 2035 (NYU, 2015). According to the 2007 population census based prediction, Ethiopia is the most populous country in Africa next to Nigeria with a population estimated at 99.39 million (CSA, 2016). Out of which over 19.4% lives in urban and peri-urban areas in terms of percentage of total population residing in cities, Ethiopia has small number of urban dwellers compared to many developing countries' including Sub-Saharan African countries. This labeled the country the least urbanized nation in Africa. However, the recent phenomenon displays a rapid rate of urbanization in the pace at which people are immensely migrating to urban centers.

Given, Ethiopia is the oldest agrarian nation; the majority of the people are still agriculture dependent. Scholars in the field argue that the favorable environment for agricultural practice could contribute for slow rate of urbanization. Nonetheless, it still could not meet the food demand of the nation and provide adequate employment and income for the alarmingly growing population. This entails that diversification of the economy is a critical development strategy for fast economic growth and poverty reduction. In the quest for poverty reduction, urban and peri-urban development can play a significantly role if properly planned and managed. Specifically, diversifying nation's economy, like industrialization and manufacturing oriented development strategies have proved potential to ensure fast economic growth. Moreover, public-led investments in infrastructural and other economic activities concentrating in urban centers have the potential to attract and accommodate landless rural to move to urban areas (SADC, 2017). This in turn allows innovation and new ideas to emerge.

Long-term economic development is generally associated with a movement of workers from low-productive economic sector like agricultural labor (in rural areas) to a high-productive sector like manufacturing labor. This is unlikely to happen in rural Urbanization has a multifaceted impact on the overall growth and development of a nation. A structural transformation that embraces industrialization and manufacture economic sectors not only boosts incomes of individuals earning a higher wage, but it also provides capital to invest in inputs and mechanization for greater agricultural productivity growth in rural areas. Similarly, assuming a greater share of individuals move toward off-farm labor, this frees up agricultural land for more productive farmers (that choose to stay in agriculture), resulting in greater productivity effects among agricultural laborers (Mellor, 1995). In sum, urbanization, if supported by appropriate infrastructure, has the potential to boost total factor productivity and economic output through positive agglomeration effects.

1.2 Problem Statement

Until the millennium, Ethiopia has been led by agrarian economy. Since the inception of the millennium, Ethiopia started to integrate industry and manufacturing with the agriculture. Consequently, urban expansion has boomed since 2000. Among the cities in Ethiopia, Addis Ababa, the capital city, is home to 25% of the urban population in Ethiopia. The city alone currently contributes approximately 50% towards the national GDP, highlighting its strategic role within the overall economic development of the country (Erena et al., 2017). Despite the strong economic growth trends, Addis Ababa faces significant development challenges (World Bank, 2015). These challenges also distributed and faced by its surrounding towns including the Sululta town, the study area of this research.

In the past three decades, rapid urbanization has been recorded in Ethiopia at large and Sululta town in particular, thus providing an indication of increasing urban issues and environmental problems in such areas (SADC, 2017; Berhanu et al., 2019). Its spatial location, proximity to the capital city, makes Sululta area as one of the fastest growing towns in the country. Urbanization happening in Sululta environ is both a blessing and curse. In the former case, massive population movement to the area lessons the complicated challenges that Addis Ababa city is facing. In other words, a population that would have been settled in Addis Ababa, with a lot of demand like space, water, energy, etc. means, a relief as all these burdens are dissipated to another location. Because of huge demand for urban activities with limited financial power to attain basic needs, many peoples prefer to live at surrounding towns of Addis Ababa including Sululta town. Consequently, numerous public and private

workers intend to living in Sululta town for the sake of benefiting low housing cost and simple living style. In the latter case, converting ecologically sensitive landscapes such as wetlands, grasslands and vegetation to settlements has huge environmental cost and will not be sustainable.

What happened in Sululta Environs is that, following the demand for urban land forced people to settle in the most unsuitable areas surrounding rural and peri-urban areas by converting highly productive agricultural lands, wetlands and grasslands. Such unplanned and unwise use of land eventually created ecological imbalance. The urban growth of Sululta in general is not led by a proper plan and good management of land, although brought a considerable economic benefit. Spatial extent change and driving forces for the improper urban built-up growth and its implication on the settlements of Sululta are not well studied and identified. However, some argue that it is due to wrong design and implementation of the planting manufacturing and industrial factories. Others claim that no, these factories are in the right places, undesirable urban expansion is happening due to illegal settlements and wrong implementation of the master plan. Others associate the problem with lack of integrated master plan, if existed; it is very weak and poorly implemented. Indeed, if one looks only the commercial and manufacturing expansions, their location appears appropriate but, when one looks the intricate interaction of drivers-cause-impact of landscape change, it is very difficult to know what brings which change. Indeed, planting of any factory/industry is guided by high level governing body and a pre-prepared master-plan. The expansion of individual houses around these factories is often unplanned as many of the residential houses have been constructed without the knowledge of the governing body. Any urban sprawl from inner cities and informal settlement with people living in the outskirts of the town should be checked and controlled. Indeed, such type of uncontrolled and unplanned expansion is very common to urban Ethiopia and the same is true in Sululta. In fact, a considerable people from the nearby rural villages also, moved to settle in Sululta town.

Besides to industrialization led inappropriate urban expansion, massive migration of people due to conflict and instability contributed to the inappropriate urban expansion of Sululta town. In recent years, the proliferation of conflicts and security problem in the country resulted in massive migration of people from different regional urban centers to the capital city and its surroundings. However, it is very difficult to know the contributing factors for inappropriate settlements happening in Sululta environs and put appropriate solution without scientific evidence. Cognizant to all these problems, the present study was conceptualized to

provide scientific research evidences to planners and policy makers who can solve the problem sustainably by integrating remote sensing and socio-economic analysis methodologically and empirically that makes unique from other studies.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of the study is to understand the drivers and impacts of land use land cover change happening in Sululta environs so that sustainable solutions can be developed based on scientific research evidences.

1.3.2 Specific Objectives

The specific objectives of this thesis were to:

- Map and analyze the changes of Land Use Land Cover (LULC) of Sululta town over the last three decades (1990 to 2020);
- Examine and understand the intensity and direction of urbanization
- Analyze the main drivers of urban expansion and its implication

1.4 Research Question

The main research questions of this study are:

- How much is the extent and rate of urbanization is on Sululta town over the last three decades from 1990s to 2020 year?
- What are the major driving factors and actors contributing to the built-up land use and land cover changes of Sululta towns and its major impact?
- In which time interval the built-up land use intensity is very high and why?

1.5 Significance of the Study

Monitoring and analysis of changes in urban expansion and its driving factors are needed in order to provide information on existing land use patterns and changes for decision makers to support sustainable development of the town. The study will be highly useful to Sululta town urban planning and development office, land administration and management office, environmental protection office, and policy makers, to make decision concerning land resource management, social and environmental development, for monitoring the negative consequences and increases the benefits.

1.6 Scope of the Study

This study spatially covers the current boundary of Sululta town. Therefore, the sample was selected from the population who lives within the study area; who have age differences and based on their occupations; who are working in governmental organizations and non-governmental organizations.

1.7 Limitations of the Study

The limitation of the study was lack of financial constraint.

1.8 Organization of the Thesis

This thesis was divided into five chapters. The first chapter deals with introduction part which includes: the background of the study, statement of the problem, objective of the study, significant of the study, the scope of the study and limitation of the study. The second chapter deals with review of related literatures on urbanization, urban expansion and driving factors for urbanization. The third chapter focuses on research methodology which contains description of the study area, method of data collection and data analysis. Chapter four describes the results and discussion, which presented the detailed results from image classification and collected data. In this chapter, LULC maps generated using maximum likelihood classification; change detection and intensity analysis are presented. Lastly, conclusions and recommendations forwarded in the fifth chapter based on the forgoing discussion and analysis from the previous chapter.

CHAPTER TWO: LITERATURE REVIEW

2.1 Conceptual Definition

Urban area as opposite to rural area can be characterized based on the number of residents, the population density, the percent of people not dependent upon agriculture, or the provision of public utilities and services. The definition of urban area can vary from country to country. Some countries like Ethiopia define an urban area as any locality having a population size of 2,000 or more inhabitants of which at least 50% of its labor force is engaged in nonagricultural activities, while some countries set a minimum population of 20,000 for this criterion. In general, there is no universal standard and each country develops its own set of criteria for distinguishing urban areas (MUDHCo, 2014).

Urbanization is a complicated process of social and economic development, which perceived differently in different disciplines. For instance, demography defines urbanization as the process of transforming rural populations into urban populations. Economics defines urbanization as a process of change in the industrial structure; and industrialization occurs ahead of urbanization and promotes economic growth. Ecology believes that the process of urbanization is the evolution of the ecosystem. Sociologists define urbanization from the perspective of social relations and organizational changes (Gao, Y. et.al. 2021). In most literatures, urbanization defined as the growth of the urban centres both in economy and population. However, in developing countries like Ethiopia, it does not go along with an economic development. Accordingly, it defined as the process of development of urban areas where population growth and population flow typically result in rapid acceleration in the size of the urban areas (Adem K. (2010). This later definition of urbanization is more comprehensive and fits the purpose of this study.

Besides, urban expansion is the horizontal expansion of urban areas towards outskirts and defined as a form of low-density spatial development characterized by scattered and discontinuous leapfrog expansion or segregated urban land uses. Recently, it has been evident that urban areas are encroaching towards outskirts at the expense of farm lands and natural resources, and most of the areas covered by informal settlements (Tamirat, 2016). Likewise, urban sprawl is the rapid expansion of the geographic extent of cities and towns, often characterized by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation (Bhat et al., 2017).

Urban expansion is a dynamic and complex phenomenon often involving adverse changes in land use and land cover (LULC). The definition of land use and land cover has been used interchangeably in the land use research community because of the availability of many existing information systems. However, these two terms explain two different issues and meanings. Land cover refers to the observed biophysical cover on the earth's surface including vegetation, bare soil, grass lands, rock surfaces and water bodies. Whereas land use is the utilization of land cover type by human activities for the purpose of agriculture, forestry, settlement and pasture by altering land surface processes including biogeochemistry, hydrology and biodiversity (Di Gregorio and Jansen, 2000).

2.2 Theory of Urbanization and Land Use Changes

As discussed earlier, urbanization is the population shift from rural to urban areas, the gradual increase in the proportion of people living in urban areas, and the ways in which each society adapts to this change. As predicted from (UN-Habitat, 2016), the proportion of people living in urban area will increase by 66% compared to rural. There are several explanations on what drives urbanization and how cities had emerged. Some of the available literatures on the theories of urbanization have ideas that intersect with others; while some came up as a build up from other theories. Some of these theories (Bodo, 2019; Nikhil, 2020) are highlighted below to understand of why and how urbanization takes place.

A. Self-Generated Urbanisation

This theory requires two conditions for the expansion and formation of urbanization i.e generation of surplus products and allow large communities work successfully alone (Bodo, 2015). It holds that rural-urban migration was the source and industrialisation was also identified as the driving force behind movement of the people from rural to urban areas (Childe, 1950).

B. Dependency Theory

The dependency theory argues that urban regions could establish, expand and develop only if either intentional coercion or through the inherent logic of capitalism in certain areas as mostly seen now on the developing countries. They are sources of input for developed countries create unequal structure and disproportionate development in the society (London, 1987). Hence developing countries receive larger foreign investment in agriculture as well as non-agricultural sectors.

C. Urban Bias Theory

This theory argues that government policies favour the urban settlements and created disparity between the rural and urban areas. Since all the developments and industries concentrate on the urban areas, infrastructures like water, sanitation, quality education, road, electricity and good health are built on these areas. Thus the people from rural areas will be forced to move at the expense of their own (Bates, 1981). The sufferings and abject poverty among the people in the rural areas is attributed to urban bias (Lipton, 1977).

D. Modern Theory of Urbanization

Modern theory of urbanization was developed in the mid-20th century resulted from the introduction of new things and innovations within the society through industrialisation, technological application, information penetration and cultural diffusion (Smith, 1996). Application and emerging of technology is seen as the main driving force of urbanisation in the society by pulling people from rural and pushing to urban (Berliner, 1977).

2.3 Urbanization Processes and Forms in Ethiopia

Ethiopia, as the second-most populous country in Africa has been experiencing a rapid urbanization process since the implementation of economic development and privatization policy to stimulate national economic growth. However, as it is observed in numerous developing countries, the intensified constraints, following the fast urbanization processes in the country, are unplanned and uncontrolled that resulting in scattered urban growth, loss of farmland, and environmental degradation. In addition, the urban physical growth rate has been faster than the rise in infrastructures and service delivery in Ethiopian cities (Berhanu et.al, 2019).

Before the founding of Addis Ababa at the end of nineteenth century, only a small number of towns existed in Ethiopia. Likewise, a substantial number of towns did not exist for long period. However, it has changed significantly in terms of size and distribution over the last three decades. During the 1984-2021 period, the total population increased by 158%, from 39.4 to 103 million. This was accompanied by rapid urbanization with the urban population increasing by 414% from 4.45 to 22.88 million. There was, however, a significant change in 1991 in both administrative and economic systems. The economic system changed from a communist to a market-led economy while the administrative systems transformed from unitary to federal system. As a result, the urban evolution and ecosystem are different before and after 1991 (Mezgebo, 2021).

The economic reforms and the change from a command to a market-led economy in 1991 can be used as a base for assessment of urbanization and urban growth. In the pre-reform period, in 1984, the urban population was 4.45 million. Of the total urban population, 32% were living in Addis Ababa and about 22% in the largest 22 towns with threshold of 20,000 inhabitants. In the post-reform period, the urban population increased to 11.84 million by 2007 with annual growth rate of 4.8% due to natural growth and rural to urban migration. Concurrent to this trend, the number of urban centers with threshold of 20,000 inhabitants increased to 85, with about three small towns being transformed to medium-size towns annually (Tsegaye, 2010).

By the end of 2007, about 40% of the total urban population was dispersed in 912 small towns with a size of less than 20,000 residents. The rest of the population was distributed in 85 cities with an average of 84,100 inhabitants (Addis Ababa included) or 51,900 inhabitants (Addis Ababa excluded). Addis Ababa comprised 38% of the 85 cities‟ total population and was at the top of the urban hierarchy.

In 2021, based on the CSA (2013) projection, the total urban population is expected to reach 22.88 million with 200 cities with the threshold of 20,000 inhabitants. In both pre- and post-reform periods, Addis Ababa was the only urban center with millions of inhabitants and remained firmly at the top of the urban hierarchy. It will continue to do so until 2037 and probably beyond. Addis Ababa is 11 times larger than the second largest city in 2014 (MoUDHC, 2015). The excessive primacy causes an overstretched provision of public services and makes the city deficient to serve the labour market. This is partly exhibited by the fact that residents seeking employment and services are caught up by a weak public transport system, congested traffic, poor sewer systems and waste disposal management.

In general, the urban development strategy of Ethiopia is mainly based on expropriation of peri-urban agricultural land from local peri-urban farmers. The trend in the growth of urban populations is likely to continue given the shift in emphasis from agricultural to industrial-led development. Recognizing urbanization as a major factor in socio-economic development, the government is embarking on a programme to convert rural kebeles into urban centres. Moreover, public investments undertaken in construction of sugar factories, dams, industrial parks, airports, rail ways, dry ports and roads in many places of the country contribute to fast urbanization with higher agglomeration of new people as settlers.

2.4 Urban Land Use and Land Cover Changes

Urban expansion is a dynamic and complex process associated with progressive demographic as well as economic, social, or political processes that often have adverse effects on LULC changes (Wiatkowska et al., 2021). These changes determined by ongoing processes of urbanization, are some of the most important and very often irreversible types of environmental change, which in turn affect the transformation of natural vegetation cover and the functioning of urban ecosystems. Population in urban areas increases at an average rate of 2.3% per year from 2000 - 2030 and by almost 2 billion until 2030 (Nations, 2001; Cohen, 2006).

The spatial expansion of built-up areas in most urban centres around the world is mainly accelerated by urban population growth. It contributes to an increase in impervious surfaces, such as buildings, roads, parking lots, infrastructure, etc., which are the indicators of the degree of urbanization, reflecting the environmental quality of urban areas. In turn, the growth of built-up land affects, among other things, the formation of urban heat islands, increased pollution, water management and the structure and functioning of the city. Thus, land cover types and the spatial configuration of their structures affect the quality of human life (Wiatkowska et al., 2021). In Ethiopia, the urban land use land cover changes commonly happen with the cost of agricultural and grass land in the peri-urban area as a result of rapid population growth, industrialization, other natural and human activities (Moisa and Gemeda, 2021).

2.5 Urban Land Use Intensities: Features and Extent in Ethiopia

Urban land use intensity refers to the extent to which the land in urban areas is developed which widely used in urban planning, landscape analysis and land use management. Urban land use intensity and population density can be regarded as two major indicators of urban, with the former focusing on the physical characteristics of a city. Thus, high density in the study indicates the gathering of a large number of buildings and floor areas over a land parcel. It has been argued that there are strong but complex associations between sustainable development and physical characteristics of cities, such as density, size and amount of open space. It seems high density may boost vitality in an area. Recently, the debates and analysis of high density and its influence on urban vitality have become major interests for city governors and planners in many countries (Yang, J., et.al, 2018).

In Ethiopian, urban areas are growing in a low-density development pattern and the growth was not led by an urban plan. Such types of development have the potential to hamper the growth of rapid and sustainable urbanization. It has an impact on the cost of infrastructure development and service delivery, supplying developed urban land for a different development purpose, the efficiency of mass transports within the city administration and its impacts extends beyond their administrative boundary i.e. on agricultural development and hence in food security (Belete and Gezie, 2017).

To sustain urban development and rapid urbanization, the supply of urban land must be sustainable and should be utilized in an efficient manner. To ensure this, city might implement different land use regulations and planning tools. Thus land use regulations and plans must be supported by appropriate density regulations and standards based on the level of development (capacity), environmental and socioeconomic context within the city administration. To do so a comprehensive density policy guidelines and strategies, regulations and institutions and finance are a critical factor (Koroso, et al., 2020).

2.6 Drivers of Urban Land Use Changes

Land use/land cover change (LULC) has become part of the global science agenda. It is driven by human activities and is associated with negative impacts on ecosystems observed at local, regional and global scales. To understand the phenomenon of urban land use change, assessing it with sophisticated methods of geo-informatics and statistics is not sufficient. It is needed to assess its driving factors that used to explain why urban land use change occurs at a given rate and in a given pattern. However, first of all, it is crucial to note that there is no grand theory of urbanization or comprehensive explanatory model of urban land use change that would make it possible to interpret and explain actual observations. Instead, social sciences and economics have offered various theories that hint at important drivers of land consuming human activities.

The major drivers of urban land use changes can be economic, political, and social issues merge with circumstances of modernization to make people want to migrate from rural to urban areas (Gao and O'Neill, 2020). The major causes of urbanization can be categorized in the following clusters (SADC, 2017):

A. Demography

Demography is a cluster of driving forces consisting of different components which affect size and composition of population and households that affects the expansion of the spatial extent of the living place for the demand of people. Population growth is influential, because the behavior of actors is often related to demographic characteristics (Lu et al., 2013; Simwanda et al., 2019).

B. Economy

In this cluster, a wide set of economic developments and determinants were clustered. For example, growth in income and trust funds, rise in double-income households, changes in economic structure, agglomeration forces, global and local market developments (e.g. agricultural products), and organization of production processes. Furthermore, each of these economic components is also influenced by different factors; a description of these relationships can be found in the supporting notes, per sector (Mahtta et al., 2022). Many people may choose to migrate from a rural or urban area, as it is generally not as economically stable or wealthy as a booming urban area gives more employment opportunities (Thapa & Murayama, 2010).

C. Technology

Technological developments and innovations are an important driving force behind developments in many sectors and the organization of society as a whole, which often results in land-use changes (Goi, 2017). Technological developments which increase productivity in agriculture, technological options affecting underground storage or desalination of water, or internet enabling online shopping. Other technologies that give better communication, medical facilities, and various social amenities can attract those from rural areas.

D. Societal values and trends

Societal values have an important impact on almost any type of land use. For example, many urban areas allow for better living standards, including superior educational facilities, better access to healthcare, modern housing, more recreational activities and other social services. Changes in people's lifestyles can directly affect housing types and locational preferences, as well as consumption patterns, and with that the type and location of economic production. More indirectly, societal values regarding nature, landscape or agricultural production, for example, may affect governmental budgets, such as for nature development, and restrictions

and regulations could affect the size and type of agricultural production (Simwanda et al., 2019).

E. Climate change and energy transition

Climate change influences land use in multiple ways; for example, via rising sea levels, periods of intensified rainfall or drought, changing temperatures and humidity affecting conditions for biotopes or agricultural production. Consequences of climate change changes policies, such as mitigation or adaptation strategies. The need for energy transition from fossil fuels towards more sustainable energy production is driven by mitigation policies addressing climate change, as well as by a growing scarcity of accessible fossil energy sources. The impact of such a transition is likely to differ from sector to sector, because of the varying complexities, possibilities and costs of such transitions. In transport, for example, such a change of energy source is complicated, because of on-board storage of energy sources (e.g., in cars and aircraft). If petroleum sources become scarce, and alternative fuels remain rather unsuccessful, large price increases could affect the transport market and, indirectly, the organization of economic production and urban systems (processes such as globalization and urban sprawl).

F. Policies

To realize government ambitions, the various government levels have access to a large and diverse set of policies affecting land-use (Feng and Wang, 2021) . These policies can be categorized by dimension:

- Scale: international, national or local;
- Sectoral level: spatial planning or sector specific;
- Type: juridical and financial, and communication/information instruments.

G. Political Chaos

In many countries, war, civil unrest, and other sources of political disorder often are woes of developing areas. This instability and potential danger can be enough to make anyone want to move. This kind of chaos is recently happening in different regions of Ethiopia.

2.7 Impact of Rapid Urban Growth on the Pattern of Settlement

The dynamic urbanization process of urban centers may stimulate a massive growth of urban settlements in the past few decades. Housing demand in urban areas is largely an outcome of rapid and large-scale urbanization. The migration of rural households to urban areas and urban to urban in search of better urban opportunities has immense pressure on affordable land and housing (UN-Habitat, 2007). The increase in population means an increase in demand for land/house with in high competition and caused to increment of land value. As result the urban poor excluded from such real property market competition.

The shortage of affordable housing units or land requires fast decision from concerned authorities (municipality) due to those people who do not have housing unit and unable to afford rental price are suffering a lot and will search shortcut solutions. Beyond that absence of immediate decision of concerned responsible government bodies resulting proliferation of unauthorized housing unit construction (UN Habitat, 2007). The growth of slums can create many problems, for example inadequate waste disposal, high incidences of disease and conflict. Rapid urbanization also puts pressure on transport systems and job opportunities.

Urban settlement pattern is the predominant visible result of the described on-going process of rapid urbanization. The formation and development of it is considered influenced by natural, socio-economic, cultural, and political attributes jointly, among others. However, on a large research scale, most existing studies only applied landscape/spatial metrics to quantify the appearance of urban settlement patterns, the underlying features shaping these urban settlement patterns were frequently neglected due to data scarcity or the complexity of the relationships. Thus, it is imperative to utilize a more systemic and comprehensive framework for analyzing various factors and shaping urban settlement patterns (Lifeng and Zhong, 2019).

2.8 Conceptual Framework

The following conceptual framework shows how drivers and impacts of built-up land use and land cover (LULC) changes of Sululta towns are interrelated. The drivers of built-up land use and land cover (LULC) changes are multidimensional which emanates mainly from demography, economy, social, political, environmental, technology dimensions. These driving forces lead to affect the settlement trend, pattern and overall situation of the town.

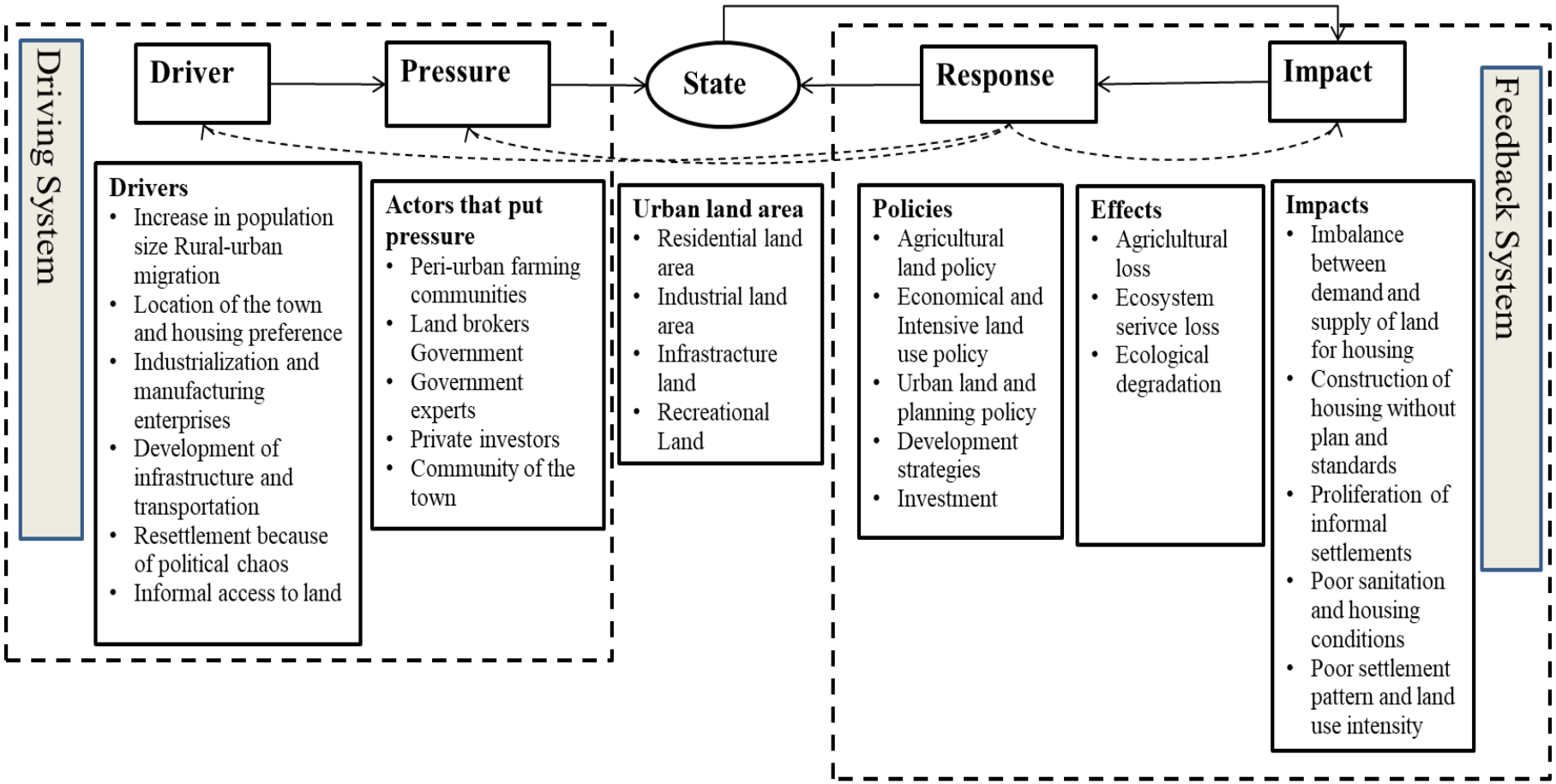


Figure 2.1: Conceptual framework of the study (Authors attribution)

CHAPTER THREE: METHODOLOGY

3.1 Description of the Study Area

Sululta is located in one of the eight towns of Oromia special zone bordering Addis Ababa. It is very close to the district capital town Chancho and the capital city of Ethiopia Addis Ababa, which are far about 15 and 23 km in the north and south direction, respectively. It is situated at about 09° 12′ 21″ N and 38° 44′ 22″ E with an elevation between 2547 - 2891 meters above mean sea level. According to Sululta town socio-economic profile hand book, the town was established in 1929 EC. Currently, the study area has a total spatial extent of 9,068 hectares. Sululta has the same general climatologically characteristics as that of Addis Ababa. The total population of Sululta town in 2007 was 12,452 of which 6,014 are men and 6,438 are women (CSA, 2007). However, currently the number of population living with in the town is around 161,843 as from Sululta town administration office. At this time, Sululta town has four kebeles namely Kebele 01, Nono Mene-Abichu, Qaso-Weserbi and Wele Lube. The major economic activities in the town are trade, farming, industries, hotels service and other social services.

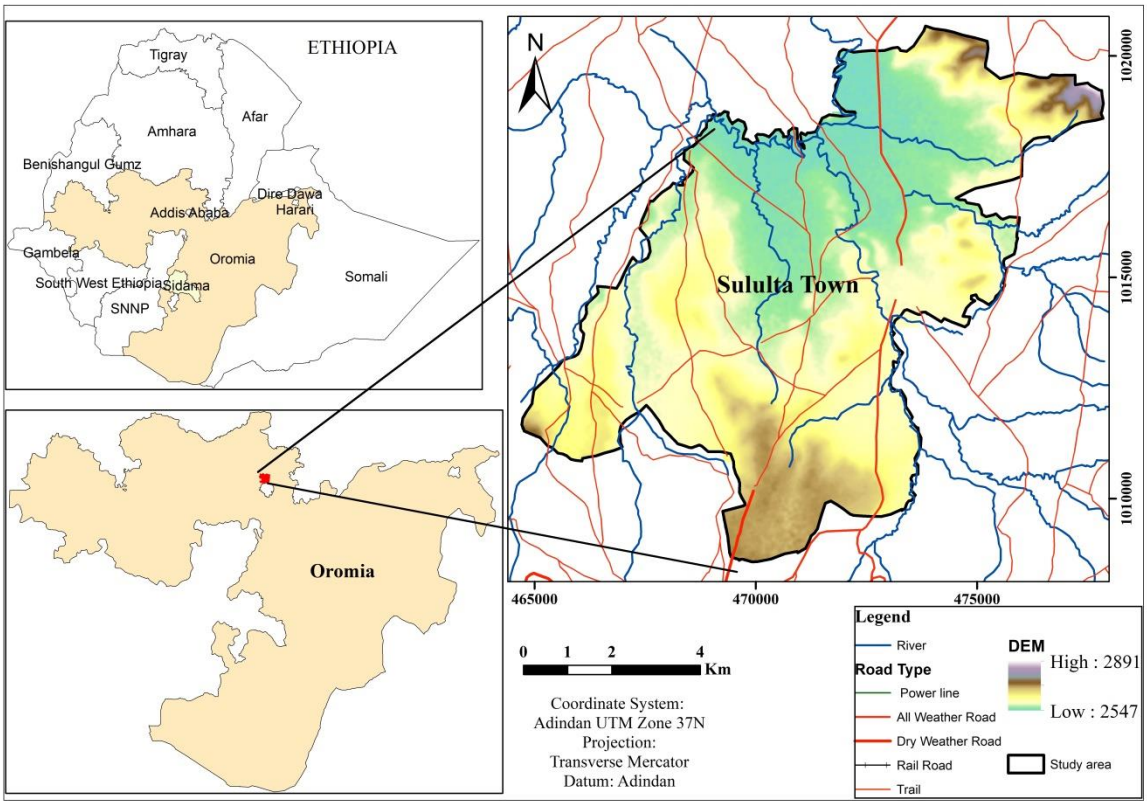


Figure 3.1: Location map of the study area (Source: Central Statistics Agency of Ethiopia; and SRTM DEM from USGS)

3.2 Research Design

In this research, integrated research approach with GIS, remote sensing and socio-economic survey was employed to assess the drivers of the built-up land use and land cover changes of Sululta towns and its implication on the settlements of the town. Hence, the nature of this study involves both quantitative and qualitative design. The quantitative design focuses on the spatial assessment and analysis like rate and extent of the urban expansion of the study area, and the land use intensity. Whereas, the qualitative design employed through focus interview and group discussion to deal with the major drivers of the urban land use land cover changes and its impact on the settlement. Accordingly, this research conducted in three phases: pre-fieldwork, fieldwork and post fieldwork phases. In the first phase, research questionnaire development and field work preparation had undertaken. Then, data collection conducted from field and secondary data sources. Finally, the collected data has been processed, analyzed and the findings presented to achieve the predefined objectives of the research.

3.3 Data Type and Sources

The study is based on both quantitative and qualitative data types required for the study that collected from both primary and secondary sources to achieve the aim of the study. Reliable data was used to effectively achieve the designed objectives of the study.

3.3.1. Primary Data Sources

The primary data was collected using in-depth interviews, focus group discussions and questionnaires for officials and experts of Sululta Town Land Development and Management office, Community and each Kebele administrators. In addition, GPS sample data and direct field observation by the researcher was used to field verification and collect first-hand information respectively.

3.3.2. Secondary Data Sources

The secondary data was collected from different sources like published and unpublished materials, books, articles, reports, previous study documents and population data from Sululta Town Land Development and Management Office. In addition, the satellite images also used to assess the remotely sensed data of the study area for the last three decades study years. In general, the below table (Table 3.1) summarize the detail of satellite images that were used in this study and the figure shows stacked images (Figure 3.2).

Table 3.1: Details of the remotely sensed data used for this study

Satellite	Path/row	Acquisition date	Sensor	Source
Landsat	168/54	Dec, 1990	Thematic Mapper	United States Geological Survey (USGS)
		Dec, 2000	Enhanced Thematic Mapper Plus	
		Dec, 2010	Enhanced Thematic Mapper Plus (Destrip algorithm was used)	
		Dec, 2020	Operational Land Imager	

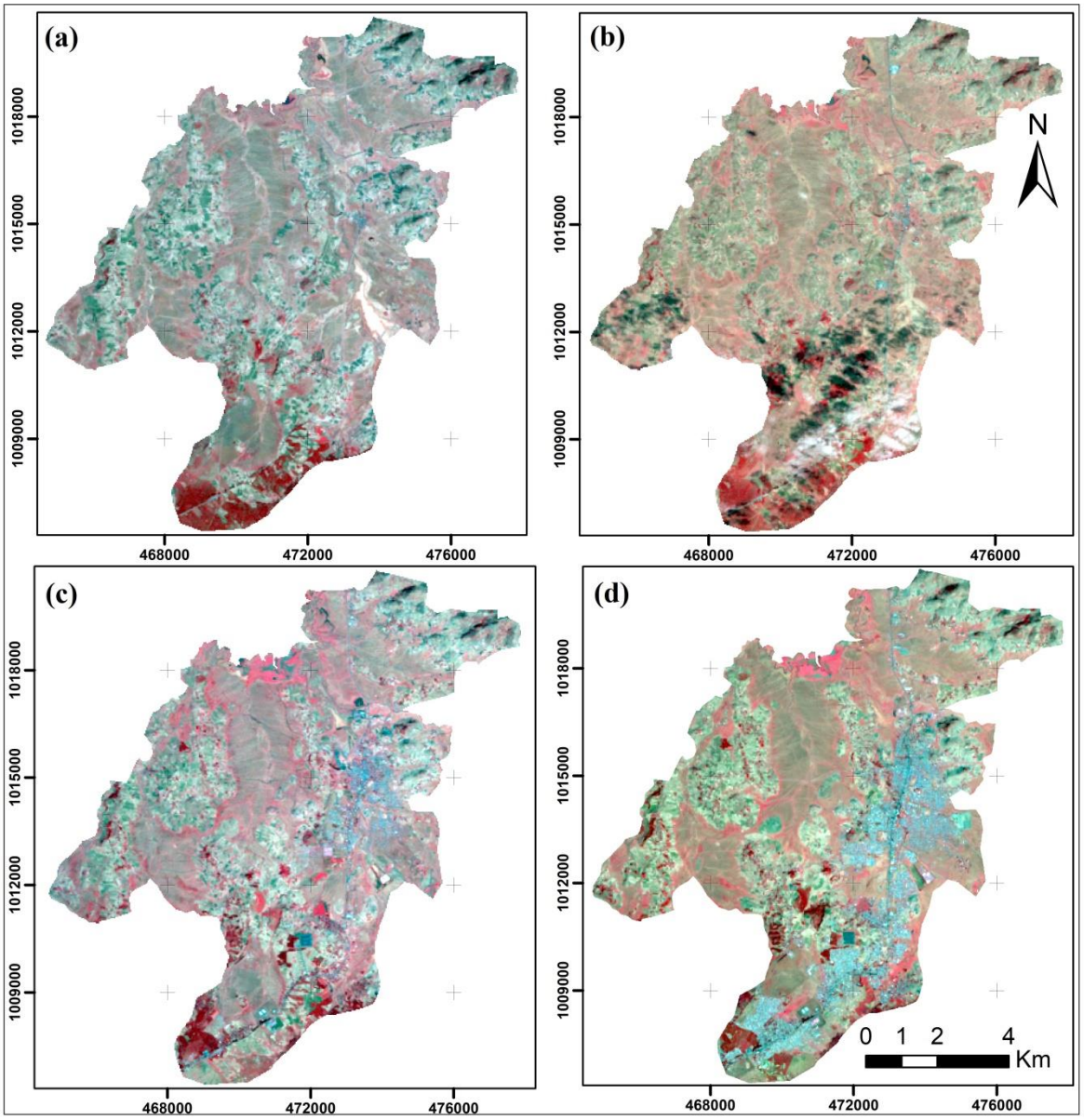


Figure 3.2: Stacked images of the study area, **a)** December 1990 TM; **b)** December 2000 ETM+; **c)** December 2010 ETM+; **d)** December 2020 OLI;

3.4 Data Collection Methods

In this study, remotely sensed data and field survey are the main data source to assess the drivers of the built-up land use and land cover changes of Sululta town and its implication on the settlements. The following sub-sections discuss the two kinds of data and data collection methods for this study.

3.4.1 Remotely Sensed Data

Primary data sources or existing large-scale representative survey data to assess and examine a particular issue gives superior results. However, it is not effective when the scope of implementation becomes at larger geographical scales due to budget and time constraints, and

better to use the remotely sensed data (Rathinam et.al. 2017). Remotely sensed imageries are data that collected without physical contact between the sensor and the earth surface as a target. These data collected from satellites or aircraft and can be used as main data source for land use land cover mapping. It provides synoptic, spatially, and spectrally consistent, frequently updated measurements of land surface characteristics (Kerr and Cihlar, 2005).

In this study, the remotely sensed satellite data specifically the Landsat satellite images from the United States Geological Survey (USGS) was downloaded and used mainly to assess the level of urbanization of Sululta town through producing time series LULC maps for the past 30 years: 1990, 2000, 2010 and 2020. These periods selected because of major political and land use policy history was recorded. All of the images that were used in this study expected were clear and nearly free from cloud cover which was captured during dry season. In addition to this, ground truth data were collected from the field using Handheld GPS that was used for validating the LULC classified image into different classes by observing the real LULC of the town.

3.4.2 Socio-Economic Survey

In addition to spatio-temporal assessment of built-up land use and land cover changes, the major driving factors of urbanization was assessed using socio-economic field and desk surveys. To do this, we used a range of data collection instruments to ensure that all relevant information gathered and triangulated. This includes:

- **Key Informant Interview (KII):** Mixed questionnaire that consists of both close and open-ended type questions for this study prepared and distributed for the selected participants. The participants were selected purposively including heads and experts from Sululta town land development and management and kebele administration offices and community participants.
- **Focus Group Discussions (FGDs):** Two FGDs undertaken. The first one having 5 members from land development and management office; and Kebele administrators. The second one having 5 members from the community. The discussions undertaken using the checklists and discussion guides under the guidance of the researcher to get their views and perspectives on the drivers of the built-up land use and land cover changes of Sululta towns and its implication on the settlements.
- **Field Observation:** The researcher conducted field observation as data collection instrument to observe the extent of recent urban expansion with key informant to observe the trends in physical growth of the town and create mental map of the town.

The researcher captured numerous photos that show the level and patterns of Sululta town expansion.

3.5 Data Analysis Methods

3.5.1 Spatio-temporal Analysis

Spatiotemporal analysis of land use is the process of identifying variations in the state of land utilization through different period of times. The following procedures were implemented to produce the LULC maps and change detection which gives us to assess the level of urbanization. ERDAS Imagine 2014 and Arc GIS 10.8 software's were used for satellite image processing and LULC change analysis respectively.

Image Pre-Processing

Raw remote sensed data might contain noise and other deficiencies derived from the sensors onboard or radiative transfer processes. The image preparation and processing operations carried out processing and analysis to correct or minimize image distortions from, (imaging systems, sensors, and observing conditions), are often referred to as pre-processing techniques. After downloading the Landsat data, atmospheric correction (haze removal) and Destriping the 2010 image were performed. In addition, sub-setting was conducted on the basis of Area of Interest (AOI).

Image Classification

Lillesand et al. (2004) defines the image classification as a technique of extracting information from the image based on the reflectance value of an object. The class can be grouped into a thematic layer of having similar urban LULC in the image. In this study, a hybrid classification technique comprising unsupervised and supervised classifications was used to classify the 1990, 2000, 2010 and 2020 images.

We first applied unsupervised classification based on indices (for built-up area, agricultural land, grass land and vegetation) to have a brief picture of the region. Again, depending on the spectral responses of features on the Landsat images, knowledge of the areas, visual analysis of the various remote sensing products, and use of result of unsupervised classification, the same number of indices were identified. The built-up areas consisted of all non-vegetative covers (buildings and roads), including industrial, commercial, transportation, and residential areas within the administrative boundaries.

Supervised image classification with the Maximum Likelihood (ML) classifier algorithm had been employed because of it is one of the most popular and widely used type of image classification techniques in remote sensing, which calculates the possibility of each pixel value to belong to each land cover class and assigns it to the class with the high probability value (Ahmad & Quegan, 2012).

Accuracy Assessment

Accuracy assessment is a critical process in LULC mapping (Odindi et.al. 2019). After conducting image classification, the accuracy of the classification assessed for each class of the land cover using minimum of fifty sample points integrated with Google Earth's high-resolution satellite imagery. These sample points per each LULC class used to develop the confusion/error matrix and calculated to assess the association of reference pixels with classified land use and land cover maps. The arrangement of error/confusion matrix was numbered representing the number of samples allocated to each class comparative to the reference data, in records and fields. The records indicate LULC maps derived from classification while fields indicate reference data collected from the field. The advantage of error/confusion matrix is to determine different statistical values like producer's accuracy (omission error), user's accuracy (commission error), overall accuracy, and kappa coefficient used to assess accuracy assessment (Congalton and Green, 2009).

- **Producer's accuracy** is calculated by dividing the diagonal elements in each category by the sum of pixels of that category which is calculated from the reference data.

$$Producer's\ Accuracy = \frac{Number\ of\ correlated\ pixel\ in\ a\ class}{Total\ sample\ points\ in\ a\ class}\ x\ 100$$

- **User's Accuracy** is calculated by dividing the diagonal elements in a category by the sum of pixels that were classified in that category; the result is a measure of commission error or error of inclusion.

$$User's\ Accuracy = \frac{Number\ of\ correlated\ pixel\ in\ a\ class}{Total\ number\ of\ classifie\ points\ in\ a\ class}\ x\ 100$$

- **Overall accuracy** is calculated by the sum of correctly classified pixels divided by the sum of sample points. It includes only the diagonal elements of the error matrix and it is hard to relate unalike overall accuracy values if an unalike number of accuracy sites were used.

$$Overall\ Accuracy = \frac{the\ sum\ of\ correctly\ classified\ pixels}{Total\ sample\ point}\ x\ 100$$

- **Kappa analysis** is used to show the variation between actual agreements and the agreement anticipated by chance. It includes both diagonal and non-diagonal elements of the error matrix.

$$k = \frac{N\sum_{i=1}^{r} X_{ii} - \sum_{i=1}^{r}(X_i + X_{i+1})}{N^2 - \sum_{i=1}^{r}(X_i + X_{i+1})}\ x\ 100$$

Where: *N* is total number of samples included in the matrix,

X_{ii} is number of observations in row i and column i,

Xi+1-total observations in row i, and X+i- total observations in column i.

This study used khat statistics because it considers non-diagonal elements and compares two classification products statically.The value of K falls between 0 and 1, where the former and later indicates no better than would be expected by chance and perfect agreement respectively. This value is often multiplied by 100 to give a percentage measure of classification accuracy. Once the LULC mapping for the mentioned periods is done, what is changed to what was analyzed.

3.5.2 Land Use Intensity Analysis

Mapping and analyzing the changes of Land Use Land Cover (LULC) may not be adequate for achieving quantitative and systematic LULC feedbacks, and there have been attempts to further clarify substantial causes and processes of land-use change using the transition matrix analysis method. Intensity analysis is a quantitative approach that was developed by Clark University to assess land-use changes based on land-use classes in the following three levels: time interval, category, and transition (Aldwaik and Pontius, 2012). It provides a quantitative framework for calculation of similar class changes during different periods constituting the rows and columns of a square transition matrix. In addition, it gives an opportunity to calculate and compare the observed intensities of LULC with the uniform intensity among different LULC classes (Kourosh Niya et al. 2019; Akodéwou et al., 2020). Accordingly, the first level determines how the annual change percentage (S_t) varies compared to a uniform annual change (*U*).

$$S_t = \frac{(\text{size of change during } [Y_t, Y_{t+1}])100\%}{(\text{size of spatial extent})(\text{duration of } [Y_t, Y_{t+1}])}$$

$$U = \frac{(\text{size of change during all intervals})100\%}{(\text{size of spatial extent})(\text{duration of all intervals})}$$

The second level compares, for each category, a uniform intensity S_t to the intensity of loss (L_{ti}) and the intensity of gain (G_{tj}) during each time interval [Y_t, Y_{t+1}].

$$L_{ti} = \frac{(\text{size of loss of } i \text{ during } [Y_t, Y_{t+1}])100\%}{(\text{size of } i \text{ at time } Y_t)(\text{duration of } [Y_t, Y_{t+1}])}$$

$$G_{tj} = \frac{(\text{size of gain of } j \text{ during } [Y_t, Y_{t+1}])100\%}{(\text{size of } j \text{ at time } Y_{t+1})(\text{duration of } [Y_t, Y_{t+1}])}$$

The last level compares, during an analysed time interval, the transition intensity (R_{tij}) from category *i* to category *j* to a uniform transition intensity (W_{tj}), given the gain of category *j*.

$$R_{tij} = \frac{(\text{size of transition from } i \text{ to } j \text{ during } [Y_t, Y_{t+1}])100\%}{(\text{size of } i \text{ at time } Y_t)(\text{duration of } [Y_t, Y_{t+1}])}$$

$$W_{tj} = \frac{(\text{size of gain of } j \text{ during } [Y_t, Y_{t+1}])100\%}{(\text{size of not } j \text{ at time } Y_t)(\text{duration of } [Y_t, Y_{t+1}])}$$

The land use intensity analysis conducted focusing on from built-up development and density, because of the urbanization is the main attention of this study. However, other land use classes considered in the land use land cover changes and intensity analyses was done.

3.5.3 Drivers and Impact Analysis

The collected data through field survey (Key Informant Interview, Focus Group Discussion and Field Observation) were synthesized into information using SPSS software and presented in graphs and tables to show the drivers of the built-up land use and land cover changes of Sululta town. The following factors were identified and used to assess the driving factors of built-up land use land cover changes or urbanization in Sululta town.

- Increase in population size
- Rural-urban migration
- Location of the town and housing preference
- Explosion of industrialization and manufacturing enterprises
- Development of social infrastructure and transportation

- Resettlement because of political chaos
- Informal access to land

Besides, the impact of rapid urbanization which detected by LULC changes and intensity analysis has been evaluated through systematically selecting relevant impact indicators. These selected impacts includes:

- Imbalance between demand and supply of land for housing
- Construction of housing without plan and standards
- Proliferation of informal settlements
- Poor sanitation and housing conditions
- Poor settlement pattern and land use intensity

The information from these instruments triangulated with the LULC change and intensity analysis results to get more reliable outcomes. The impact assessment outputs had transcribed and discussed by linking the impact with the type of change induced a particular driver. Such narrations will help the town administration and the planners to identify and implement appropriate remedial measures on the unwanted changes. In general, the method of data collection and analysis that were used for this study presented in the following figure.

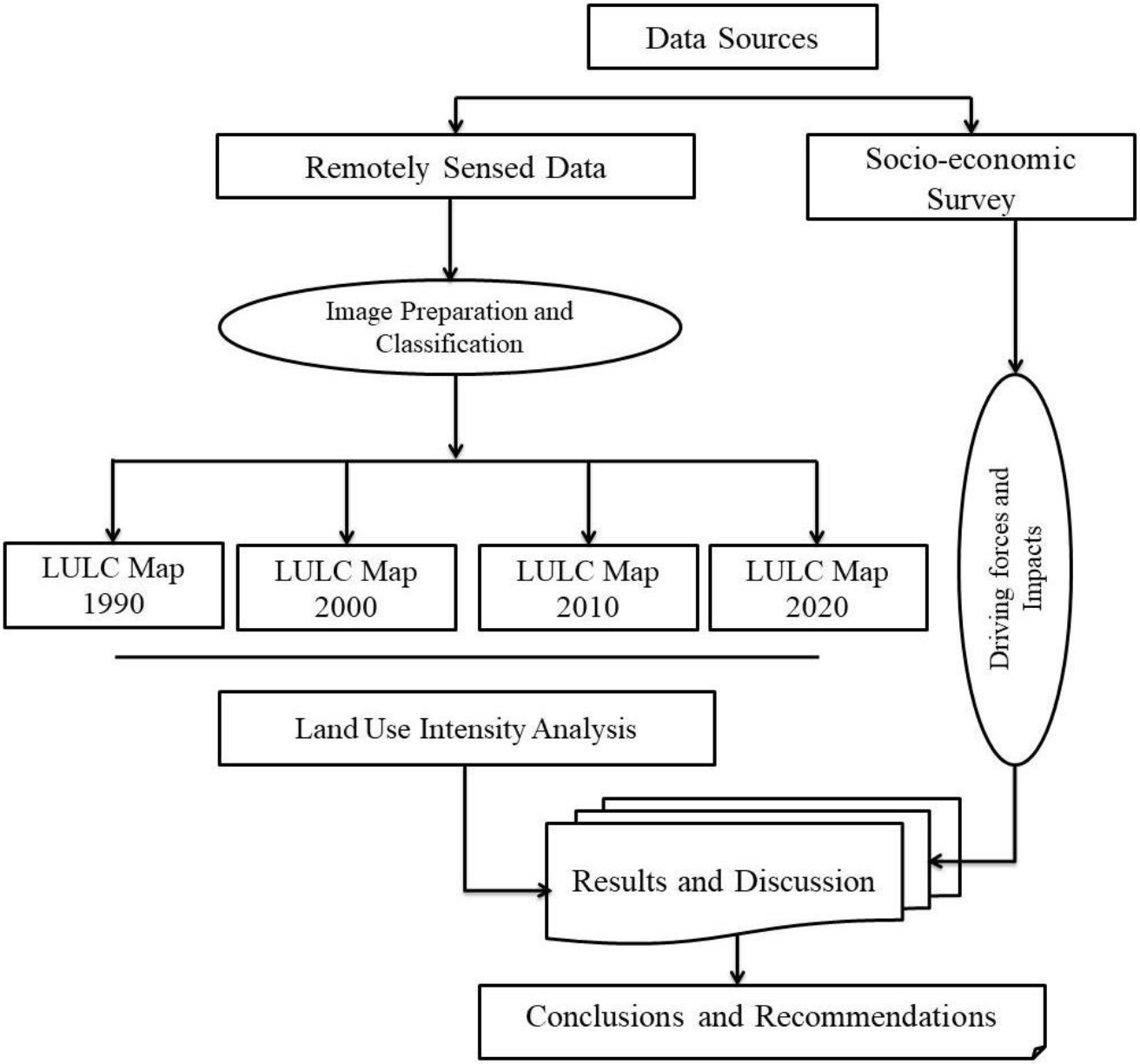


Figure 3.3: Flow chart of methodology

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Landscape mapping and accuracy of the outputs

Although the main objective of the present study was to know about urban expansion, other LULC themes were considered in the assessment for a couple of reasons; 1) to know in which landscape the urbanization process is taking place; 2) which landscape is largely affected and why. For these reasons, the mapping process was performed taking four themes namely vegetated areas, agriculture areas, grasslands/wetlands and settlements/built-ups. Vegetated areas are areas mainly forest and other shrub lands except grass land. Grassland includes both wet grass lands and dry grass lands. Built-ups are land covered by individual settlement homes and large buildings and infrastructures.

4.1.1 Accuracy Assessment

Before the interpretation of the urbanization process and link the process with the drivers, the appropriateness and quality of the produced maps was assessed applying standard accuracy assessment measures. Producers, users and overall accuracy measurement indices were applied. The accuracy assessment results of image classification shows that the overall classification accuracy is different for all themes produced at different periods. The accuracy assessment result is presented in Table. 4.1 The overall classification accuracy for the year 1990, 2000, 2010 and 2020 was 82, 87, 88 and 92, respectively. The classification Kappa statistics for 1990, 2000, 2010 and 2020 are 82, 82.64, 84 and 89.33 respectively.

Table 4.1: Accuracy assessment result of the classified images by study periods (in percent)

Class	1990		2000		2010		2020	
	Producer accuracy	User accuracy	Producer accuracy	User accuracy	Producer accuracy	User accuracy	Producer accuracy	User accuracy
VEG	80	93.02	84	93.33	86	95.55	88	91.67
AGR	88	78.57	86	76.78	92	75.41	90	90
GL	86	82.69	90	83.33	82	93.18	96	92.31
BU	92	93.88	88	95.65	92	92	94	94
OA	82		87		88		92	
Kappa	82		82.64		84		89.33	

GL-Grassland, BU-Built-up, AG-Agriculture, VE-Vegetation and OA-Overall accuracy

Among the four themes, agriculture landscape was mapped with low accuracy. Contrarily, built-up area is mapped with a higher accuracy followed by Vegetation. However, the accuracy level attained to map the landscape allows to make any assessment using the outputs produced by the study.

4.1.2 Land Use Land Cover Changes from 1990 – 2020

The outputs of the study indicated that, during the base year of the present study (1990), agriculture was the dominant LULC class. It covers 74 km^2 (81.61) of study area. The remaining classes cover 10.12 km^2 (11.16%), 6.05 km^2 (6.67%) and 0.51 km^2 (0.56%) by grass land, vegetation and built-up, respectively. This confirms that, Sululta as a town was not there in the year 1990, rather small scattered villages represent Sululta town. In the year 2000, a small increment on the built-up is detected and expanded at the expense of the decreasing of agricultural land, grass land and vegetation. As depicted in Table 4.2 and Figure 4.1, again agriculture covered the larger portion of Sululta environs with a value of 73.67 km^2 (81.24%), followed by grass land and vegetation accounted 9.04 km^2 (9.97%) and 6.02 km^2 (6.64%), respectively. The built-up area, although yet too small, had showed an increment in area, which is 1.95 km^2 (2.15%).

In 2010, new phenomenon that induces massive expansion of settlements had happened. The LULC classification results of the study area made for the period 2010 revealed that the agriculture was still a dominant LULC type (covering about 74%) of the study area, but the coverage of the built-up increased from 2 to 13 km^2 (2-15%) in ten years interval. A substantial increment of built-up had happened at the expense of the loss of an equivalent agricultural land. Lastly, the LULC result of 2020 shows that agricultural land is the dominant LULC class, which accounted 65.22 km^2 (71.93%). However, the built-up areas again increased and become 20.53 km^2 (22.64%) in line with urbanization percentage of Ethiopia (Belete and Gezie, 2017). The remaining classes, vegetation and grass lands accounted 4.93 km^2 (5.44%). In general, agricultural land is the dominant LULC of the study area in all the study periods (1990, 2000, 2010 and 2020). However, the coverage of built-up areas significantly increased and become the second dominant class in 2010 and 2020, which is after Sululta was recognized as a town. This result is in line with the study conducted by Berhanu et al., (2019) in Oromia Special Zone including Sululta town whatever their magnitude is not the same. The following table (Table 4.2) and figure (figure 4.1) shows the LULC changes of Sululta town in the past three decades.

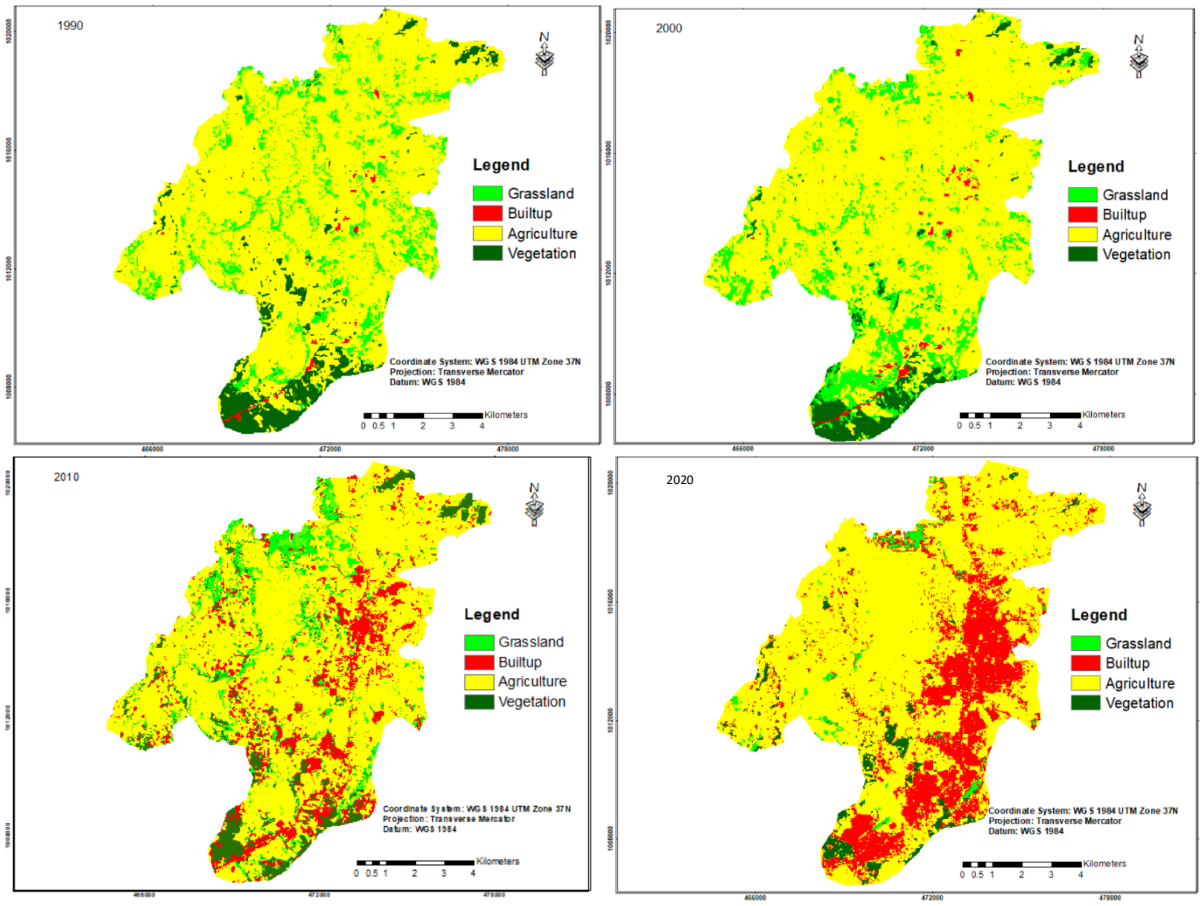


Figure 4.1: LULC maps of Sululta town in 1990, 2000, 2010 and 2020 (Source: by own)

Table 4.2: LULC changes in three different periods

LULC Classes	1990		2000		2010		2020	
	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Agricultural land	74	81.61	73.7	81.24	67.11	74.01	65.2	71.92
Built-up area	0.51	0.56	1.95	2.15	13.15	14.50	20.5	22.64
Grass land	10.12	11.16	9.04	9.97	6.22	6.86	1.74	1.92
Vegetation	6.05	6.67	6.02	6.64	4.2	4.63	3.19	3.52

4.2 Trends of Urban Expansion and Built-Up Analysis

Figure 4.1 shows the overall changes in the land use land cover pattern of Sululta town over the 30 years study period. In 1990 and 2000, the built-up area was very small and in scattered forms in the eastern and south-eastern direction parts of the town. However, the 2010 and 2020 maps show there has been noticeable urban area expansion within a span of 30 years. Currently, the town's spatial extent is increasing and expanding almost in all directions

horizontally along the left and right side of the main road from time to time as shown on figure 4.1 and field observation. However, especially in Qaso kebelle, Athlete sefer and walle, the settlements are expanded abruptly and affected by urban fringe.

Besides, the following table (Table 4.3) reveals that detail changes with statistical results. Between 1990 and 2000, the built up area increased with by 1.44 km^2 (1.59%). The remaining classes which are the agricultural, grass land and vegetation decreased by -0.36%, -1.19% and-0.03% respectively. For 2000-2010 and 2010-2020 the built-up areas significantly increased by 12.35% and 8.14%. On the contrary, the other land use classes decreased in these time intervals. This shows that, the built-up areas expanded gradually and significantly increased while replacing these agricultural, grass land and vegetation during the three time intervals. Such alterations caused by different driving factors that discussed in detail in section 4.4.

Table 4.3: LULC changes in Sululta town from 1990-2020 with three time intervals

LULC	Change (1990-2000)		Change (2000-2010)		Change (2010-2020)		Change (2000-2020)
	Area (in km^2)	%	Area (in km^2)	%	Area (in km^2)	%	% of Increment/decrement
Agricultural land	-0.33	-0.36	-6.56	-7.23	-1.89	-2.08	Decreased to 88
Built-up	1.44	1.59	11.20	12.35	7.38	8.14	Increased by 4,019
Grass land	-1.08	-1.19	-2.82	-3.11	-4.48	-4.94	Decreased to 17
Vegetation	-0.03	-0.03	-1.82	-2.01	-1.01	-1.11	Decreased to 52

4.3 Land Use Intensity Analysis

Based on the transformation matrix of land-use land cover change in three time intervals, total amount of land-use change in each period, annual change intensity, and change intensity in all periods are presented in Figure 4.2. Each of the bars extending from the center axis to the left shows percentage of change level in time intervals of the study. Also, the bars developed from the center axis to the right express the intensity of the changes in the study periods.

The dashed line in the below figure indicates the uniform annual change percentage during the temporal extent. Accordingly, the total land-use changes were fast during the two periods: from 2000 to 2010, and from 2010 to 2020, while changes were slow in the time interval from 1990 to 2000. From 1990 to 2000, the annual land use change intensity of 0.35% was less than the uniform intensity (1.38%), which indicated that land use change was slow during this period. However, from 2000 to 2010 and from 2010 to 2020, annual land use change intensity were 1.79% and 1.99%, all of which were greater than the average value; this indicated land use change was fast during these periods. Hence, these changes are certainly associated with the establishment of the Sululta town as town administration and significant development of Addis Ababa. However, the land use intensity of well-developing cities in Ethiopia (capital cities of regional government and federal government) compared to that of Sululta town for Adama, Hawassa, Bahirdar and Addis Ababa is 5.04, 4.82, 3.56 and 3.31 respectively almost concurred to Addis Ababa (Degefu et al., 2021).

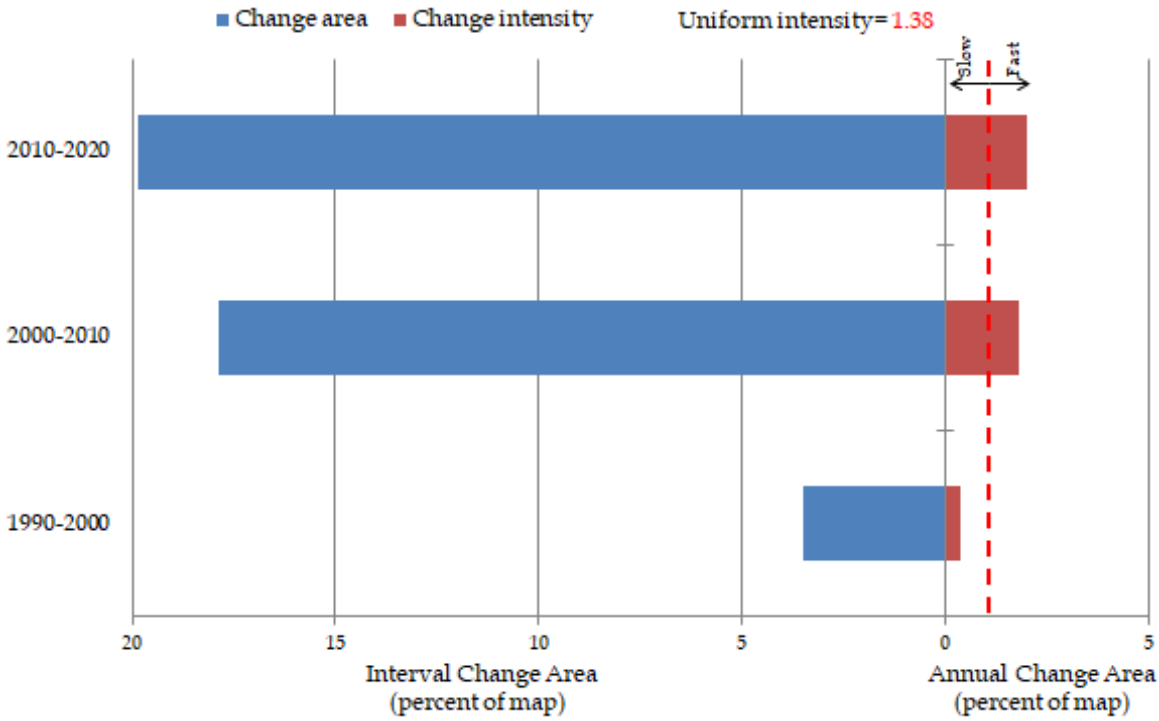


Figure 4.2: Land use intensity change of Sululta town at interval level (Annual Decadal rate of change)

The Land use intensity analysis at category level of Sululta town in all three time intervals of the study (Fig. 4.3), intensity of changes in gain and loss was evaluated. The annual change (bars on the left) shows that built up class experienced more gain than loss during all time intervals, while agricultural land experienced more loss than gain. Particularly, built-up

gained more during the last two-time interval (2000-2010 and 2010-2020); as a result of the study area becomes as town administration and attracts many residents. The grass land is the next class experiencing major changes and more loss within these time intervals.

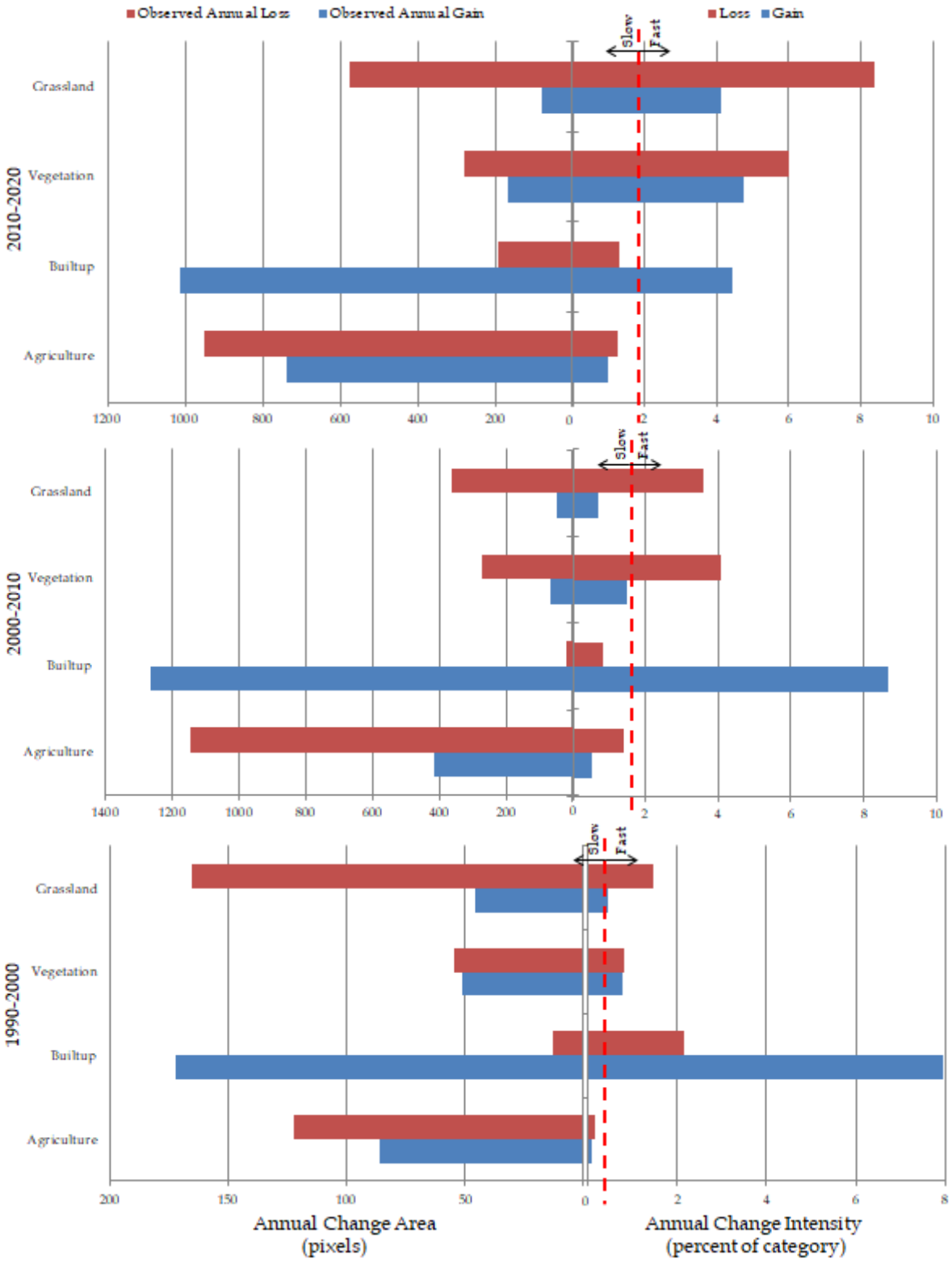
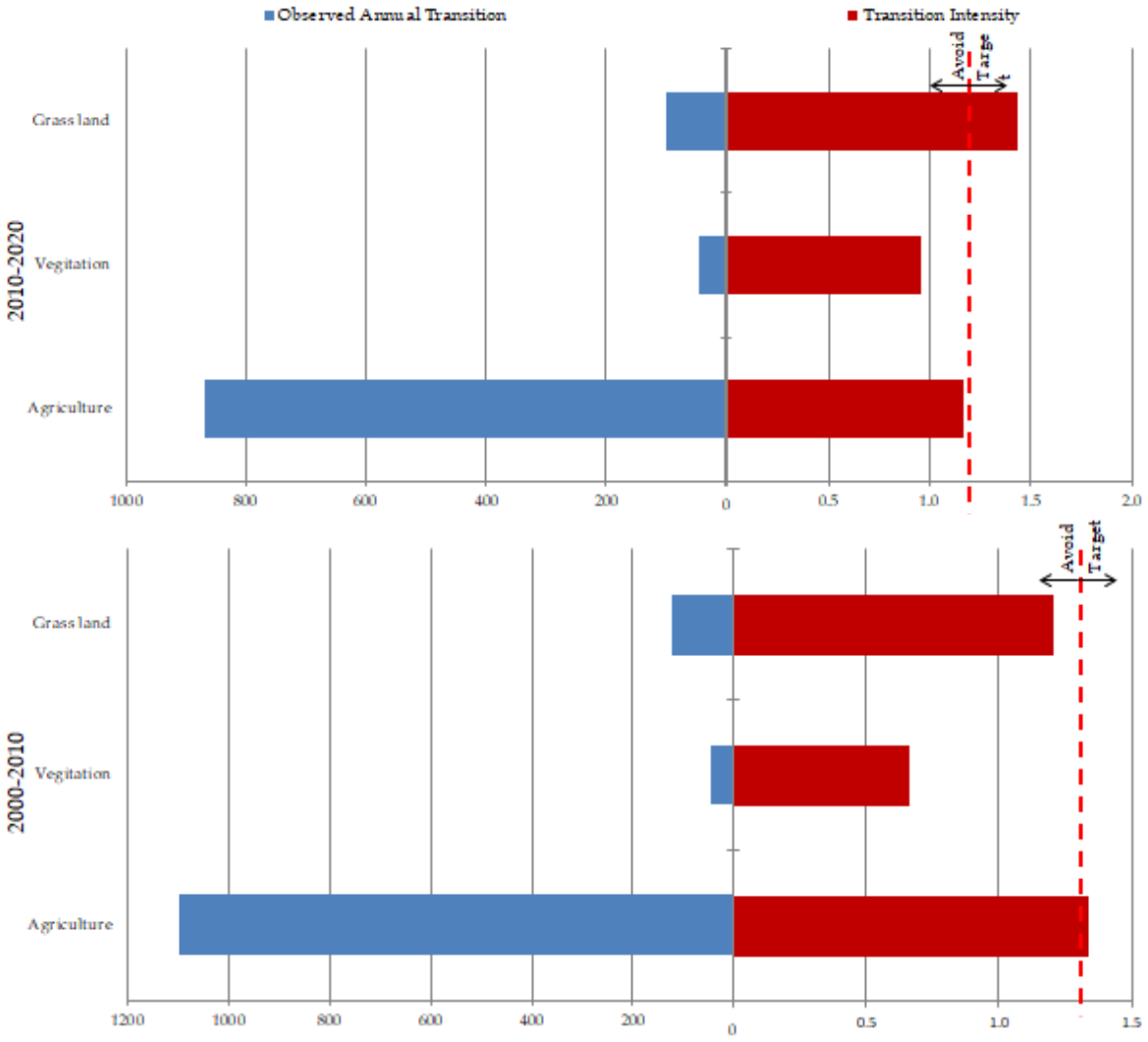


Figure 4.3: Land use intensity change at category level of Sululta town

In the transition level intensity analysis, this study focused on the transitions from agriculture, vegetation and grass land to built-up, as urbanization is the main focus of this study. According to intensity change of urban land at transition level in Sululta town during 1990-2020 (Fig. 4.4), the transitions of urban land were mainly from agricultural land concurred with results studied in Bahirdar (Atalel et al., 2014). However, the grass land was more contributor than agricultural class during the first time interval (1990-2000). Regarding transition intensities, the annual transition intensity of agricultural land were above the uniform intensity (1.28%) during the second time interval (2000-2010) and below the uniform intensity for the remaining period. Conversely, grass land tends to be targeted more intensively during the first- and last-time interval concurred with the study conducted in Addis Ababa by (Nesru et al., 2020).



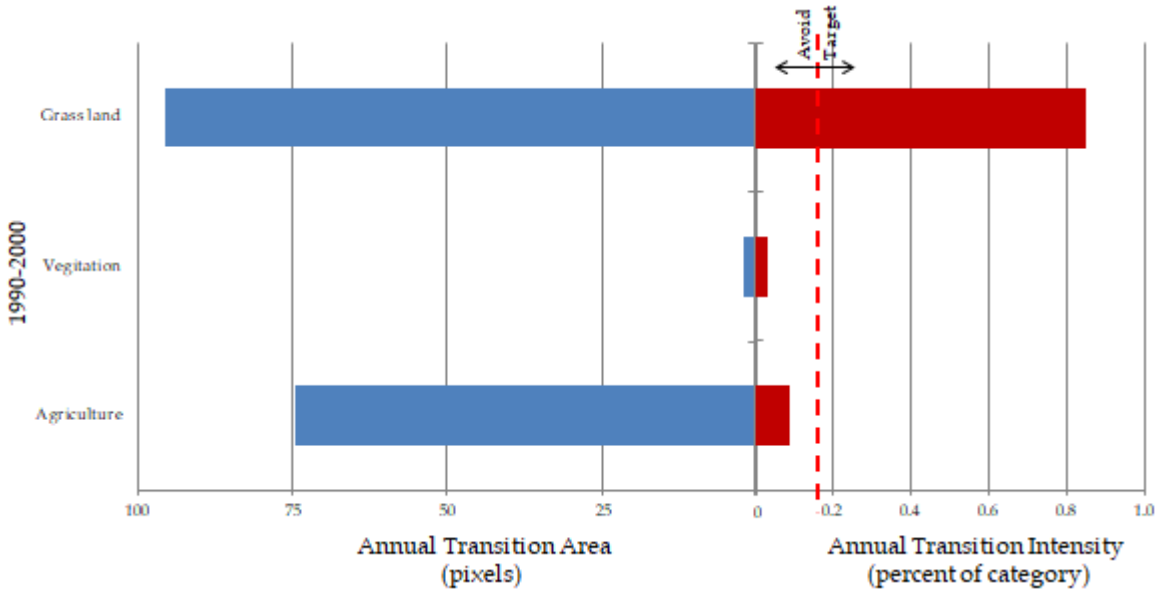


Figure 4.4: Transition intensity to built-up during three-time intervals

4.4 Drivers and Impacts of Land Use Land Cover Changes

As discussed earlier, both the land use land cover change and intensity analysis gives us there is an intensive change in land use/land cover since 1990s. These changes have been undoubtedly linked with the socio-economic and political dynamics happened within and outside of the Sululta town. According to the landscape mapping results, among the considered periods, 2000 is a year where considerable changes had happened. Secondary documents and findings of the study also support that, early 2000s the social and economic mobility of the area has been steered by industrialization, when the country launched industrial park development strategy. To better understand in detail the landscape change with its drivers and implications, the present study conducted detailed socio-economic survey applying KII and FGD tools. The socio-economic survey included all stakeholders with different sex, age category, education status, position and year of experience. Table 4.4 summarizes respondents of the socio-economic survey considered in the present study.

Table 4.4: Characteristics of the respondents

General Characteristics	**Particular feature**	**No of respondent**	**Percent (%)**
Sex	Male	21	55.3
	Female	17	44.7
	Total	**38**	**100**
Age	18-30	7	18.4

	31-40	17	44.7
	41-50	11	28.9
	>51	3	7.9
	Total	**38**	**100**
Place of Birth	Sululta	15	39.5
	Out of Sululta	23	60.5
	Total	**38**	**100**
Current Address	Kebele 01	10	26.3
	Nono Mene-Abichu	10	26.3
	Qaso-Weserbi	10	26.3
	Wele Lube	8	21.1
	Total	**38**	**100**
Education Status	University	11	28.9
	College	7	18.4
	Secondary & preparatory	2	5.2
	Elementary	3	7.9
	Read and write	9	23.7
	Illiterate	6	15.8
	Total	**38**	**100**
Profession	Land Administration	2	5.3
	Urban Planning	2	5.3
	Surveying	5	13.2
	Others	29	76.2
	Total	**38**	**100**
Position	Head	1	2.6
	Deputy Head	2	5.2
	Experts	13	34.2
	Kebele Administrators, Community Residents & Representatives	22	57.8
	Total	**38**	**100**
Year of Experience	1-5	4	10.5

	6-10	9	23.7
	11-15	3	7.9
	16-20	2	5.3
	Above 20	18	50
	Total	**38**	**100**

As depicted in Table 4.4., the majorities of the respondents are matured, literate and currently working in government organization and community representatives. Likewise, 86.9% of the respondents have more than 5 years of experience in Sululta town. All these characteristics of the selected respondents confirm that the generated information's are reliable as it avoids wrong information that could be collected from unfamiliar and irrelevant respondents.

Following proper selection of the respondents, drivers of the induced changes were identified and ranked based on the information collected from the interview. Table 4.5 summarizes the main drivers identified and their level of influence in changing the urban landscape in particular and the overall Sululta environs in general.

Table 4.5: Rate of responses for the driving factors of urbanization in the study area

Main Drivers	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Increase in population size	32(84.2%)	6 (15.8%	-	-	-
Rural-urban migration	9(23.7%)	24(63.2%)	3(7.9%	2(5.3%)	-
Location of the town and housing preference	19(50%)	19(50%)	-	-	-
Explosion of industrialization and manufacturing enterprises	-	14(36.8%)	19 (50%)	5(13.2%)	-
Development of social infrastructure and transportation	-	17(44.7)	13(34.2%)	8(21.1%)	-
Resettlement because of political chaos	16(42.1%)	16(42.1%)	5(13.2%)	1(2.6%)	-
Informal access to land	5(13.2%)	28(73.2%)	5(13.2%)	-	-

According to the survey findings (Table 4.5), most of the respondents (more than 80%) agreed with the increase in population size, rural-urban migration, location of the town and housing preference, resettlement because of political chaos, and informal access to land are the major driving force for the Sululta town rapid expansion. On the other hand, explosion of

industrialization and manufacturing enterprises, and development of social infrastructure and transportation are not considered as driving factors by 13.2% and 21.1% respondents respectively. However, 50% and 34.2% of the respondents are neutral for the same factors. Similar perception was reflected during focus group discussion (FGD) with selected individuals that supported by majority participants.

On the other hand, this study attempted to identify these actors who are contributing to the rapid expansion of Sululta town. Based on the below table (Table 4.6), the respondents agreed with the land brokers (86.9%) and private investors (94.8%) as the key actors who contributed to the dramatic expansion on Sululta town. Next to these actors, the government officials (73.7%), government action (60.6%), and peri-urban farming communities (47.3%) are also contributed significantly.

Table 4.6: Rate of responses for the key actors contributing to the expansion of Sululta town

Key Actors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Peri-urban farming communities	4(10.5%)	14(36.8%)	16(42.1)	4(10.5%)	-
Land brokers	12(31.6)	21(55.3%)	3(7.9%)	2(5.3%)	-
Government	5(13.2%)	18(47.4%)	13(34.2%)	2(5.3%)	-
Government experts	1(2.6%)	27(71.1%)	10(26.3%)	-	-
Private investors	21(55.3)	15(39.5)	2(2.5%)	-	-
Community of the town	1(2.6)	6(15.8%)	28(73.7)	3(7.9)	-

Combination of these drivers and actors leads to be happened a numerous impacts on the study area. Likewise, these identified impacts from literature review assessed by these respondents whether the impacts happened in Sululta town or not. Based on table 4.7, almost all respondents (more than 90%) agreed that the imbalance between demand and supply of land for housing, construction of housing without plan and standards, proliferation of informal settlements, poor sanitation and housing conditions, and poor settlement pattern and land use intensity are the major impacts in Sululta town. In the FGD discussion, similar issues also raised from the participants especially, the informal settlements account more share from the dramatic expansion of Sululta town. In addition to this, the proximity to the capital city also contributed for many people to migrate from rural and other part of the country to Sululta town, which also leads to increase the number of residents in Sululta town, and imbalance between demand and supply of land for housing.

Table 4.7: Rate of responses for the major impacts of urban expansion in Sululta town

Major Impacts	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Imbalance between demand and supply of land for housing	26(68.4%)	11(28.9%)	1(2.6%)	-	-
Construction of housing without plan and standards	16(42.1%)	22(57.9%)		-	-
Proliferation of informal settlements	13(34.2%)	24(63.2%)	1(2.6%)	-	-
Poor sanitation and housing conditions	12(31.6%)	24(63.2%)	2(5.3)	-	-
Poor settlement pattern and land use intensity	8(21.1%)	27(71.1%)	2(5.3%)	1(2.6%)	-

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In this study, remote sensing, GIS, and socio-economic assessment techniques were integrated to understand urban expansion in Sululta town. Landscape changes and intensity analysis were evaluated for four classes of land-use (built-up, agriculture, grass land and vegetation) and at three levels: time, category, and transition for the four periods (1990-2020).

The mapping and change assessment results revealed that the land-use land cover changes were significant and found to be accelerated in the last two time intervals (2000-2010 and 2010-2020). The study identified that multifaceted factors played role for these changes. Specifically, changes measured between 1990 and 2000 were very minimal. But changes measured between 2000 and 2010 were immense. For a tremendous urban expansion measured between 2000 and 2010 is linked with several phenomena. According to the socio-economic survey findings, one of the important phenomenon that could be linked with these changes is a political administration role attached to the Sululta town. The period 2000 is a period when the Sululta town was transformed from a rural village to a town administration. In deed this political designation was driven by another factor like booming of industry and manufacturing economic sector. The immediate response of the new economic movement in the country was due to a shift from agriculture to industrial led economy policy. Several investors were interested to invest in the areas near by the capital city. As a result, location advantages as Sululta town is found in the vicinity of Addis Abeba, is one of the important driving factor for the measured changes/urban expansion. As these economic development attract people who seeks job, a considerable people have moved to the town and reside in the vicinity of Sululta. Therefore, urban expansion is directly driven by a demand force, mainly land for settlement (built-up class).

The results of land use intensity analysis also revealed the same result which aligned with the land use land cover change results. It was conducted at three different levels: interval, category, and transition levels. At interval level, the annual land use change intensity during the first time interval (1990-2000) was less than from the uniform intensity and greater than for the remaining period. Hence, the total land-use changes were fast during two periods (2000-2010 and 2010-2020), while changes were slow in the time interval from 1990 to 2000. For the category level, the built up class experienced more gain than loss during all time

intervals and agricultural land experienced more loss than gain. The grass land is the next class experiencing more loss within these periods. For the last transition level analysis, the agricultural class was more contributed to the built-up area than grass land during all time intervals.

Besides, the increase in population size, rural-urban migration, location of the town and housing preference, resettlement because of political chaos, and informal access to land are the major driving forces for the Sululta town rapid expansion. The land brokers and private investors (speculators) are the key actors who contributed to the dramatic expansion on Sululta town. The imbalance between demand and supply of land for housing, construction of housing without plan and standards, proliferation of informal settlements, poor sanitation and housing conditions, and poor settlement pattern and land use intensity are the major impacts in Sululta town. In general, the present study concluded that, proximity to the capital city is the main driving force for many people to reside in and around Sululta area. Huge influx of people who have the same need/demand, job, residence, created pressure to get land. These in turn aggravate illegal settlement expansion. The changes measured by the present study reveal a trade-off as the changes have both positive and negative implications. Indeed, the introduction of numerous industry and manufacturing factories created job opportunity and have economic impact both at local and national level. Nonetheless, landscape changes, mainly urban expansion wouldn't have happened by converting the grain producing landscapes and ecologically important wetlands.

5.2 Recommendations

Based on the findings of the study, the following major recommendations were drawn;

- The landscape changes measured by the present study are good enough to show the need to develop an integrated land use plan. The town shall have a master plan to be revised in short term periods. If exist, it has to be implemented properly.
- This study showed that mapping and analyzing the changes of Land Use Land Cover (LULC) using freely available 30 m resolution Landsat satellite images. The study recommends to use very high resolution images as it will improve the result of the study for future research.
- The present study failed to provide quantitative analysis of the impact of the changes, for example environmental costs due to all these industry and settlement related built-up areas developed on highly productive agricultural lands and wetlands. Further study shall be conducted on these issues to assess the costs in detail.

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ANNEX

Annex I: Transition Matrix for the three time intervals

		LULC 2000				
		Agriculture	Built-up	Vegetation	Grass land	Grand Total
LULC 1990	Agriculture	72.90	0.67	0.30	0.13	74.00
	Built-up	0.01	0.40	0.06	0.04	0.51
	Vegetation	0.23	0.02	5.56	0.24	6.05
	Grass land	0.53	0.86	0.10	8.63	10.12
	Grand Total	**73.67**	**1.95**	**6.02**	**9.04**	**90.68**

		LULC 2010				
		Agriculture	Built-up	Vegetation	Grass land	Grand Total
LULC 2000	Agriculture	63.36	9.88	0.30	0.13	73.67
	Built-up	0.03	1.78	0.06	0.08	1.95
	Vegetation	1.82	0.40	3.56	0.24	6.02
	Grass land	1.90	1.09	0.28	5.77	9.04
	Grand Total	**67.11**	**13.15**	**4.20**	**6.22**	**90.68**

		LULC 2020				
		Agriculture	Built-up	Vegetation	Grass land	Grand Total
LULC 2010	Agriculture	58.56	7.83	0.29	0.43	67.11
	Built-up	0.55	11.41	0.95	0.24	13.15
	Vegetation	2.08	0.40	1.67	0.05	4.20
	Grass land	4.03	0.89	0.28	1.02	6.22
	Grand Total	**65.22**	**20.53**	**3.19**	**1.74**	**90.68**

Annex II: Key Informant Interview Questionnaire for Government officials, Kebele administrators and Experts

Addis Ababa University
College of Development Studies
Center for Environment and Sustainable Development
Questionnaires for Government officials, Kebele administrators and Experts

Survey date: _____

Dear Respondents

The main aim of this questionnaire is to collect data as input for the study titled "Drivers and implications of urban expansion, the case of Sululta town, Ethiopia". The purpose is to qualify the requirement for awarding the Master of Arts (MA) in Environment and Sustainable Development at Center for Environment and Sustainable Development, College of Development Studies, Addis Ababa University. Therefore, you are expected to provide genuine and accurate information with respect to the drivers and impacts of rapid urban expansion of Sululta town.

Thank you very much for your cooperation!

Part I: Background of Respondents

1. Address: ☐ Kebele 01 ☐ Nono Mene-Abichu ☐ Qaso-Weserbi ☐ Wele Lube
2. Gender: ☐ Male ☐ Female
3. Age: ☐ 18-30 ☐ 31-40 ☐ 41-50 ☐ Above 51
4. Place of Birth: ☐ Sululta ☐ Out of Sululta
5. Level of Education: ☐ Illiterate ☐ Read and write ☐ Elementary (1-8)
   ☐ Secondary ☐ Preparatory ☐ College ☐ University
6. Profession: ☐ Land Administration ☐ Urban Planner ☐ Surveying ☐ _____
7. Position: ☐ Head ☐ Deputy head ☐ Expert ☐ Kebele administrator
8. Year of experience: ☐ 1- 5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ Above 21

Part II: Drivers and actors of the Built-up Land Use and Land Cover Changes of Sululta Towns

9. What do you think on the following major drivers that contributed a lot for the rapid urban expansion of Sululta town over the last three decades?

Main Drivers	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Increase in population size					
Rural-urban migration					
Location of the town and housing preference					
Explosion of industrialization and manufacturing enterprises					
Development of social infrastructure and transportation					
Resettlement because of political chaos					

Informal access to land					

Other comments on the drivers

_____

_____

10. What do you think on the following key actors who contributed a lot for the rapid expansion of Sululta town in the last four decades?

Key Actors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Peri-urban farming communities					
Land brokers					
Government					
Government experts					
Private investors					
Community of the town					

Other comments on the key actors

_____

_____

Part III: Major Impacts on the settlements of Sululta Town

11. What are the major impacts of urban expansion on the settlements of Sululta town?

Major Impacts	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Imbalance between demand and supply of land for housing					
Construction of housing without plan and standards					
Proliferation of informal settlements					
Poor sanitation and housing conditions					
Poor settlement pattern and land use intensity					

Other comments on the key actors

_____

_____

Annex III: Informant Interview Questionnaire for Community

Addis Ababa University
College of Development Studies
Center for Environment and Sustainable Development
Questionnaires for Community

Survey date: _____

Dear Respondents

The main aim of this questionnaire is to collect data as input for the study titled "Drivers and implications of urban expansion, the case of Sululta town, Ethiopia". The purpose is to qualify the requirement for awarding the **Master of Arts in Development Studies (Environment and Sustainable Development)** at Center for Environment and Sustainable Development, College of Development Studies, Addis Ababa University. Therefore, you are expected to provide genuine and accurate information with respect to the drivers and impacts of rapid urban expansion of Sululta town.

Thank you very much for your cooperation!

Part I: Background of Respondents

1. Address: ☐ Kebele 01 ☐ Nono Mene-Abichu ☐ Qaso-Weserbi ☐ Wele Lube
2. Gender: ☐ Male ☐ Female
3. Age: ☐ 18-30 ☐ 31-40 ☐ 41-50 ☐ Above 51
4. Place of Birth: ☐ Sululta ☐ Out of Sululta
5. Level of Education: ☐ Illiterate ☐ Read and write ☐ Elementary (1-8) ☐ Secondary ☐ Preparatory ☐ College ☐ University

Part II: Drivers and actors of the Built Up Land Use and Land Cover Changes of Sululta Towns

6. What do you think on the following major drivers that contributed a lot for the rapid urban expansion of Sululta town over the last four decades?

Main Drivers	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Increase in population size					
Rural-urban migration					
Location of the town and housing preference					
Explosion of industrialization and manufacturing enterprises					
Development of social infrastructure and transportation					
Resettlement because of political chaos					
Informal access to land					

Other comments on the drivers

_____

_____

7. What do you think on the following key actors who contributed a lot for the rapid expansion of Sululta town in the last four decades?

Key Actors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Peri-urban farming communities					
Land brokers					
Government					
Government experts					
Private investors					
Community of the town					

Other comments on the key actors

_____

_____

Part III: Major Impacts on the settlements of Sululta Town

8. What are the major impacts of urban expansion on the settlements of Sululta town?

Key Actors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Imbalance between demand and supply of land for housing					
Construction of housing without plan and standards					
Proliferation of informal settlements					
Poor sanitation and housing conditions					
Poor settlement pattern and land use intensity					

Other comments on the key actors

_____

_____

Annex IV: Points for Focus Group Discussion

The following questions used as a discussion points for Focus Group Discussions (FGD):

1. What are the major drivers that contributed a lot for the rapid urban expansion of Sululta town over the last three decades?
2. What are the key actors who contributed a lot for the rapid expansion of Sululta town?
3. What are the major impacts of urban expansion on the settlements of Sululta town?

Annex V: Field Observation Checklists and Photos

In order to demonstrate the physical outward expansion of the town and its growth direction the researcher conducted field observation with key informants.

1. Trends of the physical growth of the town.
2. Identifying growth directions of the town and the highly affected urban fringe kebeles
3. Assessing the status of settlements and livelihood situation on the expansion areas.

Selected sample photos from field observations

(a)

(b)

(c)

(d)

(e)

(f)

Figure annex 1, Photographs captured on the field work. agricultural field and settlements changed from it **(a)**, Grass land **(b)**, Built-up area on the central part of the town **(c)**, Gravel road under construction through grass land **(d)**, Wetland and Grass land under preparation to settlements **(e)**, Illegal settlements on the higher side encroaching to Entoto forest **(f)**. (Photographs taken by Alima Abdela)